United States Department of Agriculture

Natural Resources Conservation Service

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Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin

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Cover:

***Upper left*.—An area of Land Resource Region Q (Pacific Basin Region).**

***Upper right*.—Recent volcanic deposits in an area of Land Resource Region W2 (Aleutian Alaska).**

***Lower left*.—Riparian buffer in an area of Land Resource Region M (Central Feed Grains and Livestock Region).**

***Lower right*.—Rangeland in an area of Land Resource Region B (Northwestern Wheat and Range Region).**

Contents

Preface

Natural vegetation is a result of the combination of geography, soils, and climate. People learned early in human history that soils that produced grass and trees could also produce grain, fruits, and vegetables. Early soil scientists recognized this relationship. Some of their earliest publications included a description of the climate and vegetation (or crop types) typical for particular soils. "Chestnut soils of the temperate to cool semiarid regions of grain and cattle grazing" is one example. Different social, economic, and political cultures can be considered outgrowths of the various types of soils, crops, and climate that occur in different regions. For example, cattle ranchers in western South Dakota are studies in contrast to potato farmers in northern Maine.

Early farmers and ranchers realized that the different soils and climates they encountered required them to grow certain types of crops in order to survive economically. Such terms as "Corn Belt" and "Cotton Belt" were coined because of the crops typically grown by the early settlers. These were very early versions of land resource areas. As soil mapping progressed across the country, soil scientists worked with other natural resource managers to subdivide land into resource units with similar soils, climate, and vegetation or crop types. This work allowed a few soil scientists and natural resource planners to provide soil interpretations and soil conservation recommendations that were useful to many landowners in a region instead of to a few limited individuals.

Those pioneer efforts resulted in the publication of the first edition of Agricultural Handbook 296 in 1965. The United States was subdivided into a number of land resource regions that were made up of many major land resource areas. The similar climate, soils, and land use activities in each land resource region helped natural resource planners to target efforts in education and financial and technical assistance.

Agricultural Handbook 296 was used when decisions about regional and national agricultural issues were made. It helped to identify the need for research and resource inventories, and it became the vehicle for extrapolating the results of research across political boundaries. It also became the basis for organizing and operating natural resource conservation programs. Today, soil survey offices are organized to serve groups of the major land resource areas defined in this handbook. The handbook was updated in 1978, and the second edition was printed in 1981. This 2006 version of the handbook is the third edition.

Land Resource Regions and Major Land Resource Areas

Introduction

This handbook is an assemblage of currently available information about land as a resource for farming, ranching, forestry, engineering, recreation, and other uses. It is a revision of United States Department of Agriculture (USDA) Handbook 296, *Land Resource Regions and Major Land Resource Areas of the United States*, published in 1981 (USDA, 1981). Revisions consist of:

1) refined delineations of land resource regions (LRRs) and major land resource areas (MLRAs),
2) addition of 3 new LRRs (including the Pacific Basin Region) and 70 new MLRAs,
3) a description of the extent of the major Hydrologic Unit Areas (identified by four-digit numbers) within each MLRA,
4) updated climate information (1961-1990),
5) descriptions of the sources and quantities of freshwater used in the year 1990,
6) classification of the identified soils of each region and area according to the taxonomic system described in *Soil Taxonomy* (Soil Survey Staff, 1999), and
7) land use statistics based on the National Resources Inventory (NRI) of 1997.

Soil scientists in appropriate States wrote the descriptions of new MLRAs and MLRAs with changed boundaries. The National Soil Survey Center staff wrote the descriptions of MLRAs with no boundary changes since 1981. The information in this handbook is current as of October 2005. The handbook includes large-scale maps of the LRRs and MLRAs. Image and geospatial data (digital) file versions of these maps are available at www.soils.usda.gov.

The information in this handbook provides a basis for making decisions about national and regional agricultural concerns, identifies needs for research and resource inventories, provides a broad base for extrapolating the results of research within national boundaries, and serves as a framework for organizing and operating soil surveys and resource conservation programs.

Land resource categories historically used at State and national levels are land resource units, land resource areas, and land resource regions. Land resource units (LRUs) are the basic units from which major land resource areas (MLRAs) are determined. They are also the basic units for State land resource maps. LRUs are typically coextensive with State general soil map units, but some general soil map units are subdivided into LRUs because of significant geographic differences in soils, climate, water resources, or land use. LRUs generally are several thousand acres in size. A unit can be one continuous area or several separate areas that are near each other. In 2005, these areas were designated as common resource areas (CRAs) within the Natural Resources Conservation Service (NRCS).

CRAs are created by subdividing MLRAs by topography, other landscape features, hydrologic units, resource concerns, resource uses, and human considerations affecting use and soil and water conservation treatment needs. Common resource areas, or land resource units, are not described in this handbook and are not shown on the national map.

Major land resource areas are geographically associated land resource units. Land resource regions are a group of geographically associated major land resource areas. Identification of these large areas is important in statewide agricultural planning and has value in interstate, regional, and national planning. In order to make this handbook more useful to other Federal agencies and private parties using ecological regions for planning or evaluation of natural resources programs and policies, Appendix I cross-references MLRAs with Environmental Protection Agency Level III Ecoregions (USEPA, 2003; Omernik, 1987) and U.S. Forest Service ecological sections (Cleland and others, 2005; McNab and others, 2005).

In this handbook, major land resource areas are generally designated by Arabic numbers and identified by a descriptive geographic name. Examples are MLRA 1 (Northern Pacific Coast Range, Foothills, and Valleys); MLRA 154 (South-Central Florida Ridge); and MLRA 230 (Yukon-Kuskokwim Highlands).

Some MLRAs are designated by an Arabic number and a letter because previously established MLRAs have been divided into smaller, more homogeneous areas, for example, MLRAs 102A, 102B, and 102C. The use of numbers and letters to identify the newly created MLRAs requires fewer changes in existing information in records and in databases. A few MLRAs consist of two or more parts separated for short distances by other land resource areas. In places one of these parts is widely separated from the main body of the MLRA and is in an adjoining LRR. The description of the respective MLRA also applies to these outlying parts.

Almost every MLRA has small areas, typically tens of square miles or less, that may not fit the overall description of that particular MLRA. Such areas may fit the description of an adjacent or nearby MLRA. These small areas are not described or shown on maps in this handbook.

Land resource regions generally are designated by capital letters and identified by descriptive names. An example is "A—Northwestern Forest, Forage, and Specialty Crop Region." Arabic numbers were added to the LRRs identified by the letters W and X after all of the letters in the alphabet were used.

The dominant physical characteristics of the 28 land resource regions are briefly described in separate sections. A location map for each LRR is provided with each LRR description. More detailed descriptions of the 278 major land resource areas follow the LRR descriptions.

A location map for each MLRA within its LRR is provided with each MLRA description. The introductory paragraph in this description lists the State or States in which an MLRA occurs and the areal extent of each MLRA. Appendix II shows the area and proportionate extent of all LRRs and MLRAs. The major cities or towns, highways, and Federal or State installations of significant national interest are indentified in each introductory paragraph. This paragraph is followed by headings for physiography, geology, climate, water, soils, biological resources, and land use for each MLRA.

Physiography.—The physiographic section, province, and division are listed for each MLRA. This information is based mainly on a classification system for the original 48 States within the United States (Fenneman and Johnson, 1946). Wahrhaftig's (1965) system was used to describe MLRAs in Alaska. There is no formal system of physical land divisions for Hawaii, the Pacific Basin, or Puerto Rico and the Virgin Islands. The topography and natural features of each area are described. The height above sea level and the relief, including significant exceptions, if applicable, are provided for the area as a whole. Units of elevation and relief are feet and meters. The units are typically rounded to the nearest 5 or 10 feet or meters. If the elevation is less than 50 feet or 15 meters, it generally is expressed in the nearest whole number. The conversion factor is 3.28 feet per meter.

The extent of the major Hydrologic Unit Areas (Seaber and others, 1984) within each MLRA is given in percent. These areas are identified by four-digit numbers. Digital coverage of eight-digit Hydrologic Unit Area boundaries was intersected with the digital MLRA map, and the eight-digit areas were aggregated to the four-digit level when these statistics were generated. The major rivers or streams draining each MLRA and any National Scenic or National Wild and Scenic River reaches within an MLRA are identified.

Geology.—The bedrock and surficial geology of each MLRA is described. This information was derived from a wide variety of State and Federal maps and reports that are not included in the list of references. The geologic time scale is shown in the Glossary.

Climate.— Spatial climate products (digital maps) were obtained from the NRCS National Water and Climate Center (NWCC). Parameter-elevation Regressions on Independent Slopes Model (PRISM) data developed by the Spatial Climate Analysis Service at Oregon State University, in cooperation with NWCC, were used to generate mean annual precipitation (MAP) and mean annual air temperature (MAAT) maps for the lower 48 States (figs. 1 and 2). PRISM data are based on National Weather Service climate records accumulated for the period 1961 through 1990. Only MAP data were available in digital form for Alaska, Hawaii, and Puerto Rico and the Virgin Islands (fig. 3) and for the Pacific Basin (fig. 4). Local NRCS staff provided the MAAT data for the climate narrative describing these areas. The data were primarily extrapolated from local weather station statistics within historic or ongoing soil survey areas.

The digital PRISM maps were intersected with the appropriate digital MLRA maps to determine the climate statistics for each MLRA. The climatic data include (1) a range of the average annual precipitation for the driest to wettest parts of the MLRA, (2) the seasonal distribution of precipitation, (3) a range of the average annual temperature, and (4) the shortest, longest, and average length of the freeze-free period.

The lowest and highest average annual rainfall and temperature values are reported as calculated from the PRISM-MLRA map intersection. Units of rainfall are inches and millimeters. The inches are not rounded, and the millimeters are rounded to the nearest 5 or 10 millimeters. The conversion factor is 25.4001 millimeters per inch. Units of temperature are in degrees Fahrenheit and centigrade. The degrees in Fahrenheit are not rounded, and the degrees in centigrade are rounded to the nearest whole number. Centigrade degrees are calculated by subtracting 32 degrees from the Fahrenheit degrees and multiplying by $^5/_9$ (0.5556).

If any inches of snow are listed, the centimeters also are provided. Snow amounts are not calculated values and are derived from a number of references and historical records that may be outside the period of record for the PRISM data (1961-1990). The inches of snow are listed as whole numbers and may or may not be rounded. The centimeters are rounded to the nearest 5 or 10 centimeters. The conversion factor is 2.54 centimeters per inch.

The average length and the actual length of the shortest and longest freeze-free periods within each MLRA are calculated by intersecting the digital PRISM and MLRA maps. The days listed in the narrative are rounded to the nearest 5 or 10 days.

Water.—The United States Geological Survey (USGS) publishes reports at approximately 5-year intervals on the estimated use of fresh and saline, surface and ground water in each State within the United States and in Puerto Rico and the Virgin Islands. An NRCS geologist used the report for water use in 1990 as the basis for estimating freshwater use in each MLRA (Solley and others, 1993). Water use varies annually in each State, depending on land use patterns, population, and wet and dry periods. For example, during a drought, farmers, ranchers, and other water suppliers will pump more ground water since surface water may be in short supply. Appendix III shows the total water use by States in 1980, 1990, and 2000 (Solley and others, 1983; Hutson and others, 2004). In 1980 and 2000, approximately half the States used less water than in 1990 and half used more water than in 1990. An exception was the amount of surface water used in 1980, which was much greater than the amount used in either 1990 or 2000. The year 1990 was selected for this handbook because data for that year were the most recent data available when work on this revision of the handbook was done. Also, 1990 was not an abnormally dry or wet year for most States.

Water use by State was apportioned to the different MLRAs within that State on the basis of the availability of surface and ground water resources, water quality, and the presence or absence of users in each MLRA. USGS reports on surface water sources, quality, and use by State (Moody and others, 1986) and ground water aquifers, quality, and use by State (Moody and others, 1988) were used to help apportion State water use to MLRAs. These reports also contained summaries on water use in the Pacific Basin and in Puerto Rico and the Virgin Islands. The section on water in the MLRA descriptions shows the total amount of surface and ground water used daily, on average, in each MLRA and the percent of the total used for public supply, livestock, irrigation, and other purposes. The “other” category includes municipal and industrial use, cooling of thermoelectric power plants, mining, domestic use, and any other miscellaneous water uses. Only the water actually withdrawn from a stream or other water body is reported in the MLRA narratives. No in-stream uses, such as generation of hydroelectric power, are included. MLRAs that depend on other areas for water supply and those that furnish water to other areas generally are identified.

Units for the volume of water used are millions of gallons per day (MGD). MGD is multiplied by 3.785 to obtain millions of liters per day. One MGD flowing for 1 year equals about 1,120 acre-feet, or 1.38 million cubic meters, of water.

Soils.— The soils described in this publication are classified and named in accordance with the USDA system of classifying soils described in *Soil Taxonomy* (Soil Survey Staff, 1999). Appendix IV gives a brief description of the soil classification system. The section on soils in the MLRA descriptions generally identifies the dominant soil orders in each MLRA, the major soil temperature and moisture regimes and particle-size and mineralogy classes of the dominant soils, and, for each soil order listed, one or more of the dominant great groups. Each of the great groups is identified with a common parent material and landscape position within the MLRA. Finally, one or more soil series considered representative of each great group is listed in parentheses.

This information was derived primarily from the intersection of Soil Survey Geographic Database (SSURGO) and MLRA maps. SSURGO coverage is available for most of the MLRAs. Historic information and State soil survey staffs were consulted for missing data.

Biological Resources.—The dominant plant species within each MLRA are identified by their common names. This information was derived from a wide variety of NRCS and other agency reports, and specific references are not listed. NRCS biologists and soil scientists utilized local knowledge to develop lists of common fish and wildlife species in each MLRA. Some scientific names had to be included for plants and animals in the Pacific Basin because of the variety of languages and dialects used on various islands and the fact that common names have not been developed. Also, scientific names had to be used to identify some of the plants in Hawaii.

Land Use.—The relative extent of various kinds of federally or privately owned land is indicated in the description of each MLRA. These data generally were derived from the 1997 National Resources Inventory (USDA, 1997). The land use in Alaska was determined by the State NRCS staff, which intersected the MLRA map with a locally generated land use map based on ecoregions (U.S. Department of the Interior, 1973). Land use statistics for Alaska reflect usage across all lands, both private and Federal. No NRI statistics are available for the Pacific Basin, so local NRCS soil scientists developed the land use statistics from local sources. Similarly, soil scientists in Hawaii utilized recent National Oceanic and Atmospheric Agency land cover information when developing land use statistics.

Categories of land use provided by NRI were combined into cropland, grassland, forest, urban development, water, and other. “Grassland” includes the NRI categories of pasture, range, brush, and tundra. Hayland was grouped with cropland. “Urban development” includes urban areas, built-up areas, and areas used for transportation. “Other” includes the NRI category of miscellaneous and barren. For example, rock outcrop and glaciers are considered to be “barren.” The percent of each relevant land use category in each MLRA is listed in the MLRA descriptions. The NRI statistics provide only a total figure for Federal land by MLRA. These values were returned to the appropriate States for State personnel to break down into the various land use categories.

Also included under the heading “Land Use” is a description of the dominant farming, ranching, or other land use activities in the MLRA. The principal crops are identified where cropland is significant, and tree species are listed where logging is the dominant land use activity.

NRCS natural resource specialists provided descriptions of some of the major resource management concerns in each MLRA. They also provided descriptions of some of the common soil and water conservation practices used to mitigate the impacts of the resource concerns in each MLRA.

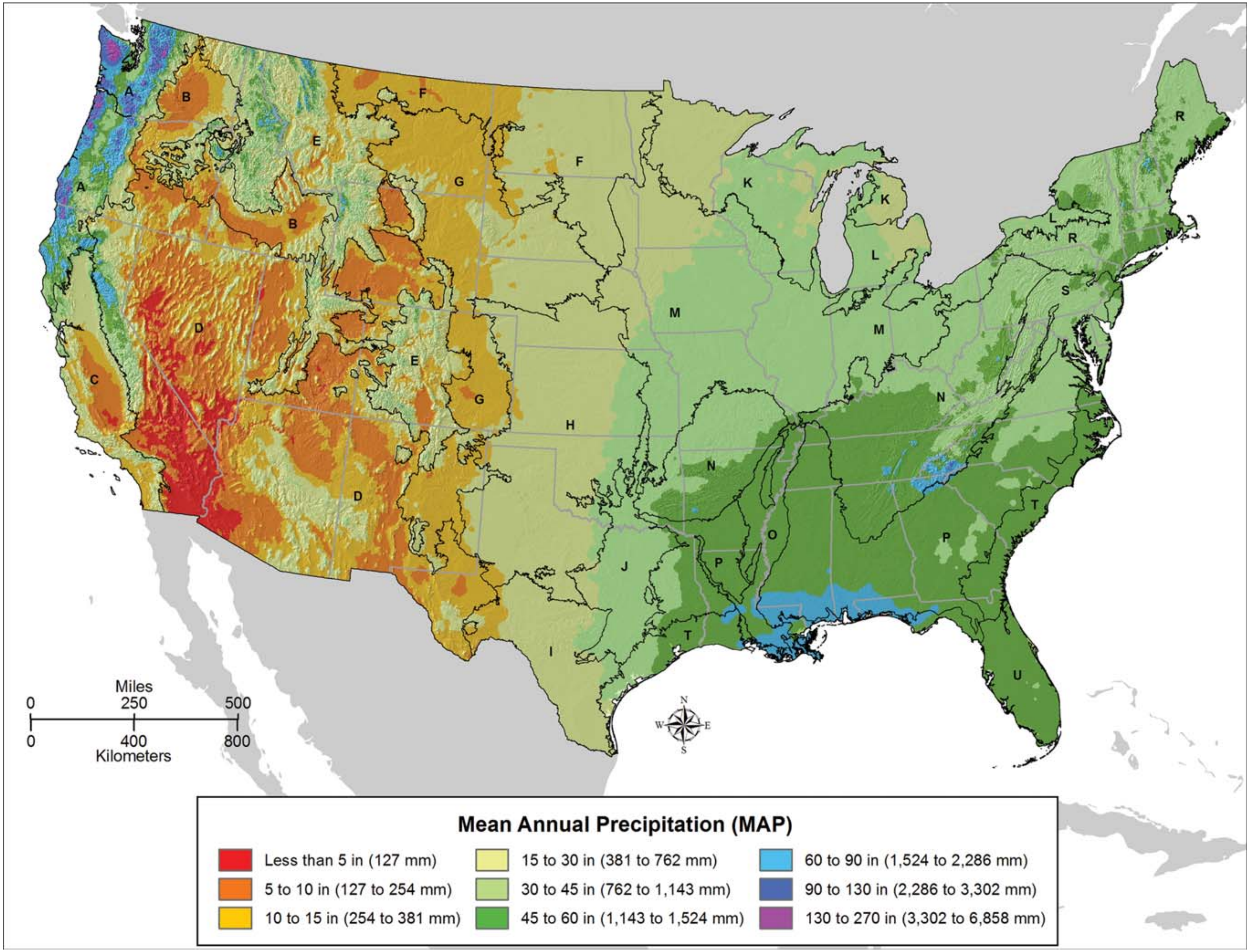

Figure 1: Mean annual precipitation (MAP) for the conterminous United States based on the period 1961-1990.

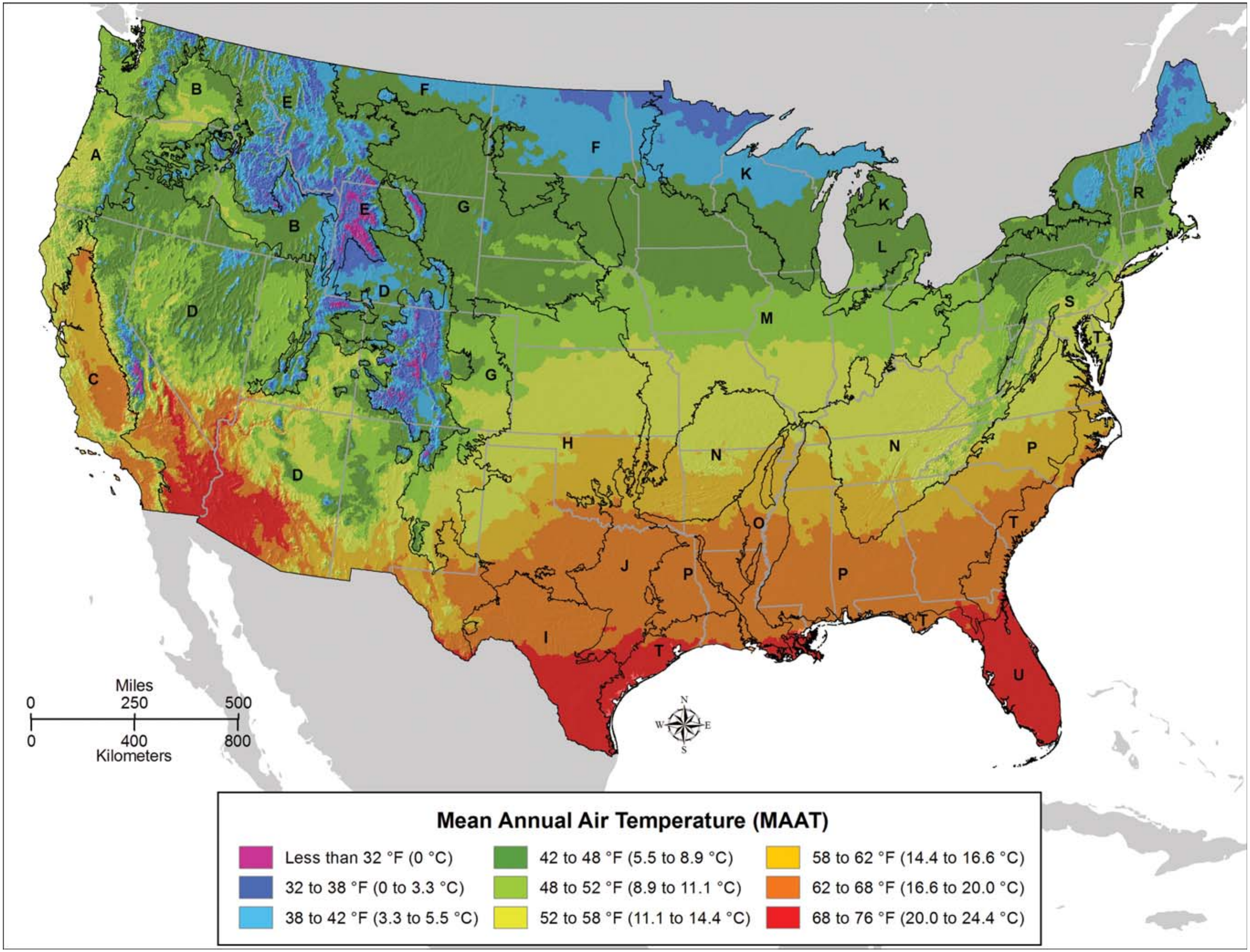

Figure 2: Mean annual air temperature (MAAT) for the conterminous United States based on the period 1961-1990.

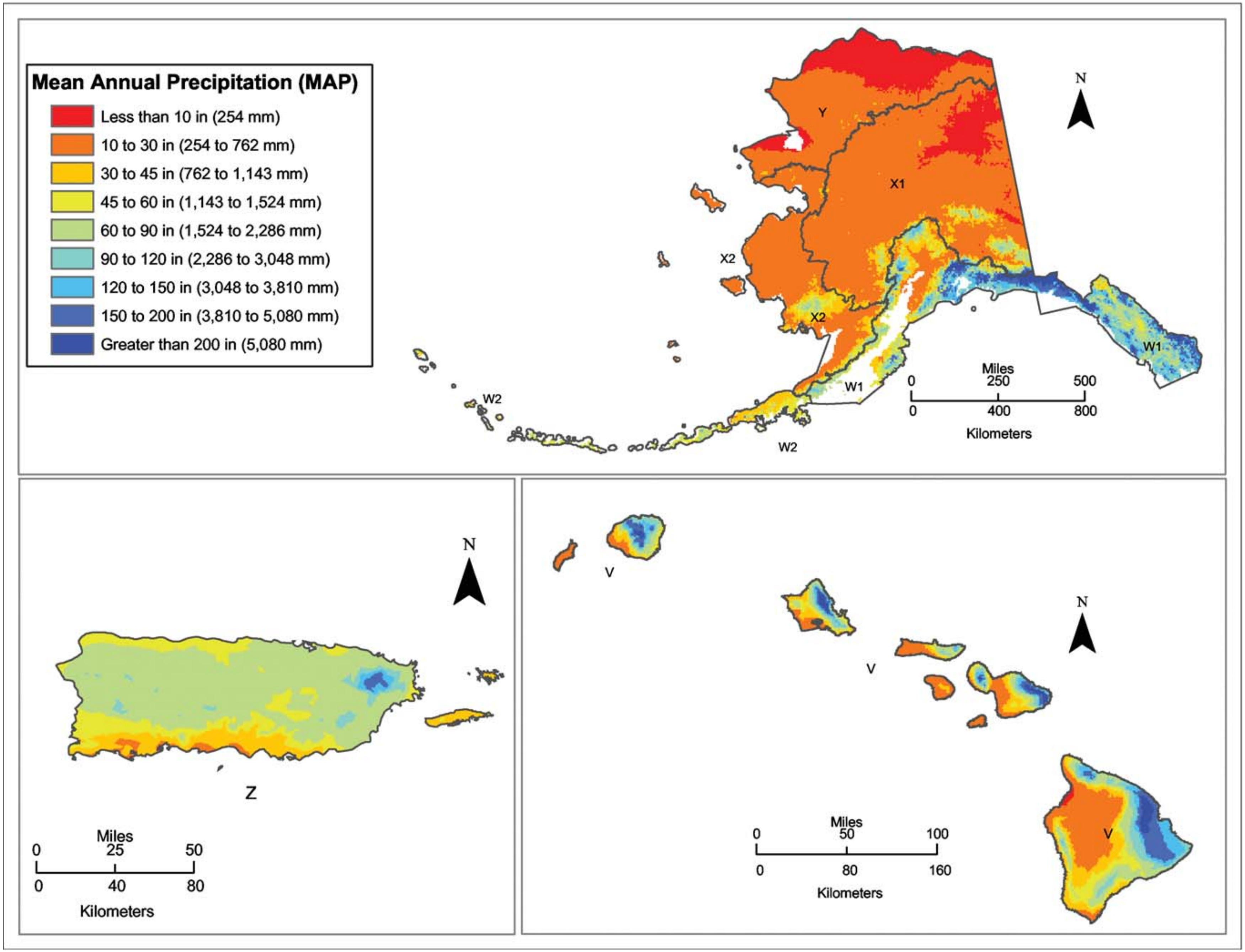

Figure 3: Mean annual precipitation (MAP) for Alaska, for Hawaii, and for Puerto Rico and the Virgin Islands. Only Alaska and Hawaii data are based on the period 1961-1990. The data for Puerto Rico and the Virgin Islands are from different local weather stations and from different time periods.

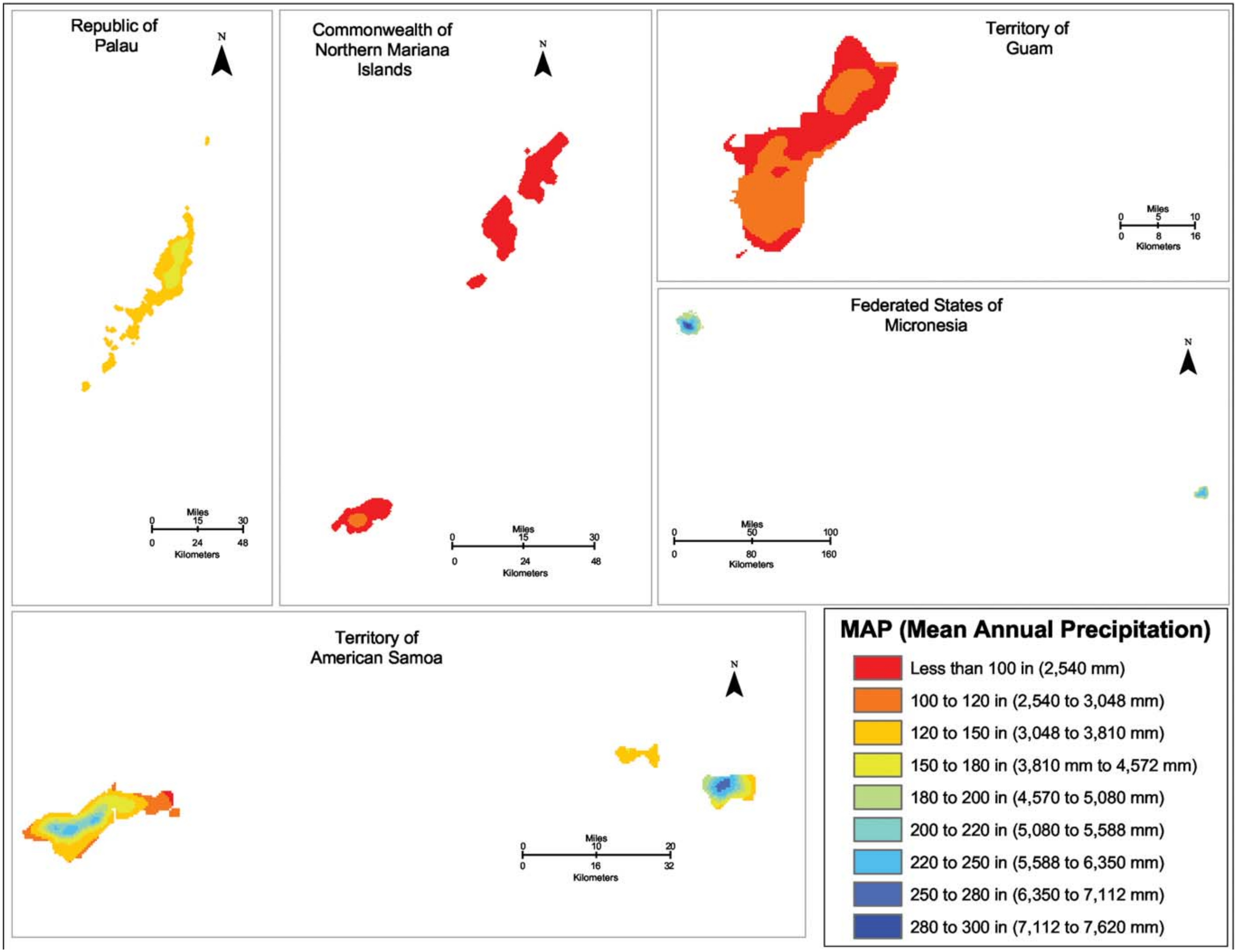

Figure 4: Mean annual precipitation (MAP) for the Pacific Basin based on local weather station data from different time periods.

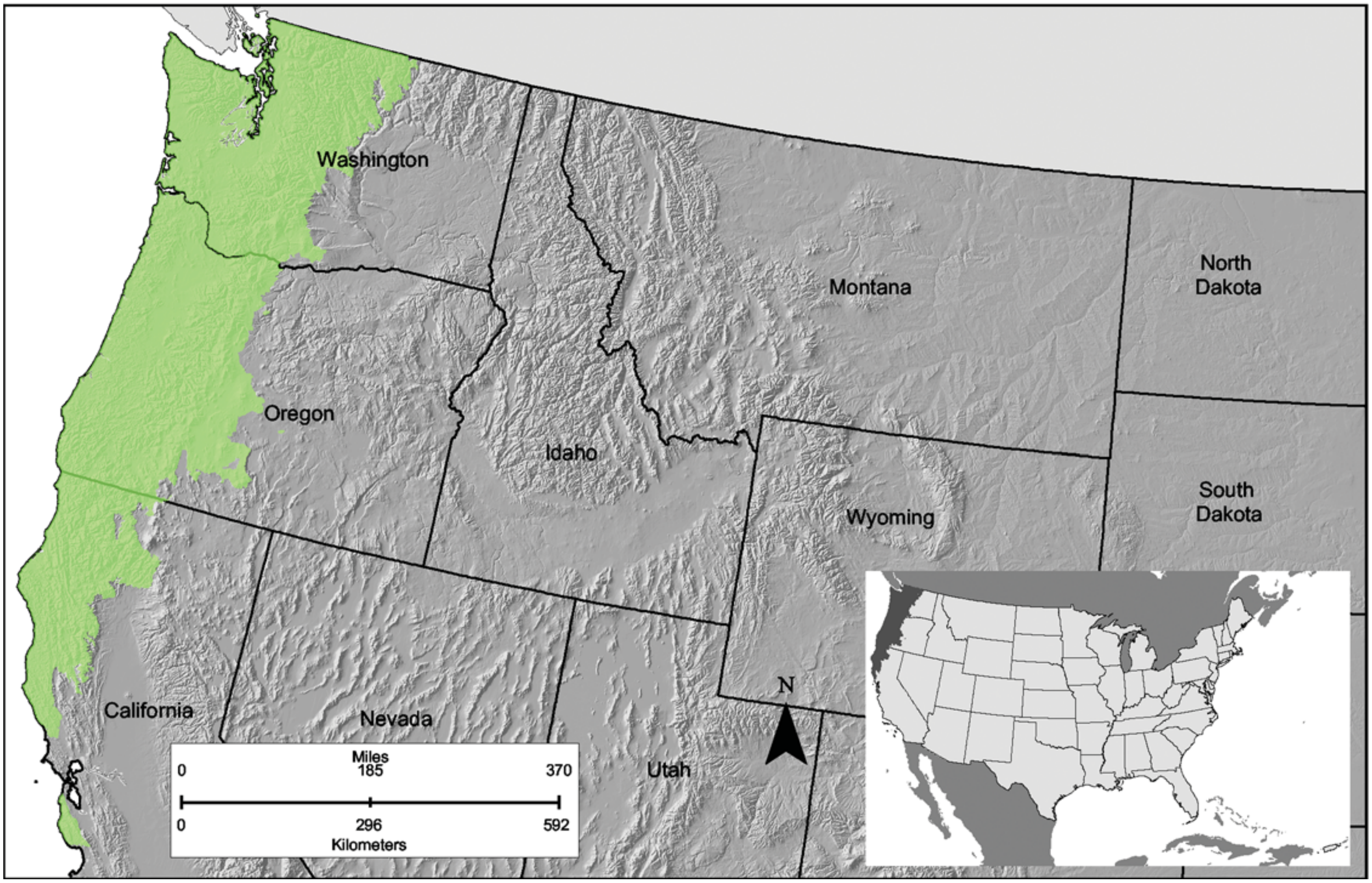

Figure A-1: Location of Land Resource Region A.

A—Northwestern Forest, Forage, and Specialty Crop Region

This region (shown in fig. A-1) is in Oregon (42 percent), Washington (39 percent), and California (19 percent). It makes up 90,165 square miles (233,635 square kilometers).

Steep mountains and narrow to broad, gently sloping valleys and plains characterize this region (fig. A-2). Two major mountain systems are in this region. One, the Coast Range, parallels the coast. It is anchored by the Olympic Mountains on the north and the Klamath Mountains on the south. It consists primarily of tilted, folded, and faulted sedimentary and metamorphic rocks. The Cascade Mountains, the other major mountain system in the region, consist primarily of volcanic crystalline rocks. The Willamette Valley separates the Coast Range from the higher Cascade Mountains inland. It is a rich agricultural area because of a mild coastal climate, high rainfall, and deep soils that formed in alluvium and glacial drift. A triple junction of two oceanic plates and one continental plate is directly offshore from Puget Sound. Movement between these plates has resulted in major earthquakes in this area in the past. Subduction of the oceanic plates under the westerly and northwesterly moving continental plate contributes to volcanic activity in the Cascades. The mountains in the Coast Range grade into gently sloping marine terraces along the Pacific Ocean coast. These terraces are cut by the many rivers draining this area.

The average annual precipitation ranges from 45 to 60 inches (1,145 to 1,525 millimeters) in much of the region, but it is 30 to 45 inches (760 to 1,145 millimeters) in the Puget Sound and Willamette Valley and 9 to 25 inches (230 to 635 millimeters) on the east side of the Cascade Mountains. The annual precipitation in the mountains is typically more than 100 inches (2,540 millimeters), but it can exceed 250 inches (6,350 millimeters) on the highest peaks. This region is dry in summer. The average annual temperature is 45 to 55 degrees F (7 to 13 degrees C) in most of the region, but it is 37 to 42 degrees F (3 to 5.5 degrees C) in the Cascades and it can be as low as 32 degrees F (0 degrees C) on the highest peaks. The freeze-free period is more than 200 days in most of the valleys, as long as 365 days along the coast in the southern part of the region, and only 40 to 70 days on mountain slopes.

Surface water and ground water resources are abundant in

Figure A-2: A typical mountain area of Land Resource Region A.

this region. About 78 percent of the total water used in the region is from surface water sources. About 49 percent of the water is used for irrigation. Because of the heavily populated coastal area of the Pacific Northwest, 22 percent of the water is public supply water and 28 percent is used by industry.

The dominant soil orders in this region are Alfisols, Andisols, Entisols, Inceptisols, Spodosols, and Ultisols. Soils on the hilly and steep uplands are mostly Andisols and Inceptisols. These soils are shallow to very deep and are well drained. Soils on the marine and glacial outwash terraces are dominantly Andisols and Spodosols. These soils are shallow or moderately deep to cemented materials or are deep or very deep. They are poorly drained to well drained. Entisols and Inceptisols are on flood plains and estuaries. These soils are very deep and typically are very poorly drained or poorly drained. Alfisols and Ultisols are on the mountains slopes. They are moderately deep or deep and are well drained. Mollisols are in the Willamette Valley. These soils are moderately deep to very deep and typically are moderately well drained. Most of the soils in the region have a mesic soil temperature regime, but those on mountain slopes typically have a frigid temperature regime and those at the highest elevations have a cryic temperature regime. The dominant soil moisture regime in the region is udic, but xeric and ustic moisture regimes also occur. Most of the soils formed in colluvium or residuum weathered from siltstone and sandstone, but some formed in colluvium weathered from basalt or other volcanic rocks. The soils have a mixed mineralogy.

About 44 percent of this region is Federal land, mostly in national forests. The mountains are heavily forested, and timber production is the major industry. Dairy farming is an important enterprise in the valleys that receive abundant rainfall. Grain crops, grass and legume seeds, fruits, and horticultural specialty crops are grown extensively in the drier valleys. Water erosion on the steeper slopes and in unprotected orchards, vineyards, and other areas of specialty crops is a common management concern. Sediment from logging roads and landings on steep forested slopes also is a concern. Landslides can occur during wet periods in the mountains. ■

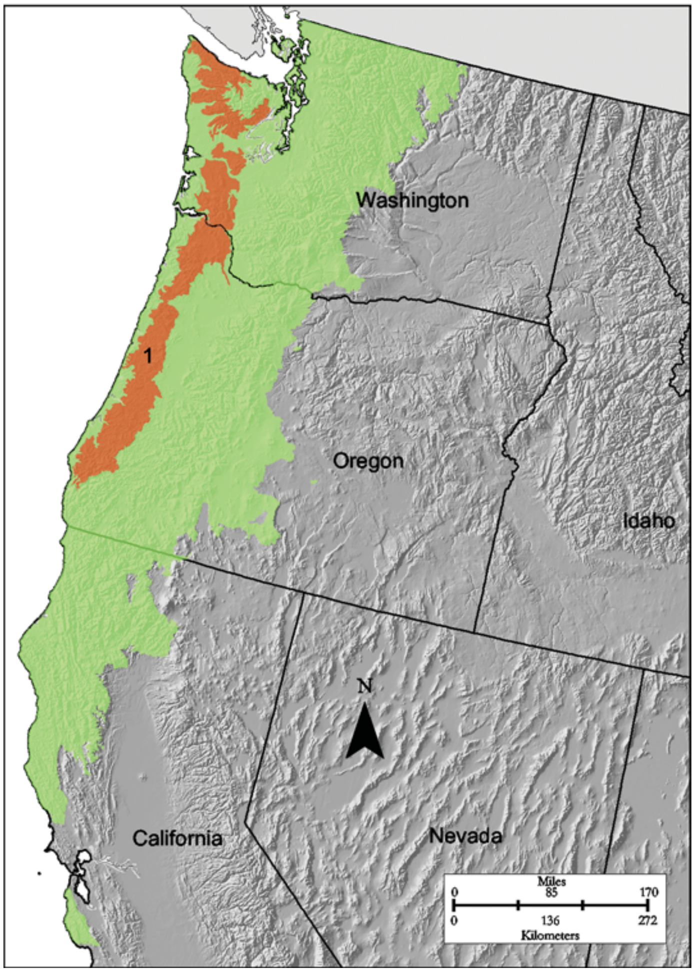

Figure 1-1: Location of MLRA 1 in Land Resource Region A.

1—Northern Pacific Coast Range, Foothills, and Valleys

This area (shown in fig. 1-1) is in Oregon (65 percent) and Washington (35 percent). This long, narrow MLRA makes up about 10,295 square miles (26,675 square kilometers). It has no major towns. U.S. Highways 101, 12, 30, 26, and 20 cross this area. The area has a small number of Washington and Oregon State parks. The Siuslaw National Forest is in the part of this area in Oregon, and a portion of the Olympic National Forest is in the northern part of the area, in Washington. The Grand Ronde and Siletz Indian Reservations are in the part of this area in Oregon.

Physiography

All of this area is within the Pacific Border Province of the Pacific Mountain System. The Olympic Mountains Section is in the northern third of the area, in Washington, and the rest of the area is in the Oregon Coast Range Section. The area is bounded by the Olympic Mountains on the north and the Klamath Mountains on the south. Most of the area consists of hills and low mountains with gentle to steep slopes. The valleys are mostly narrow and of small extent.

In Washington, elevation ranges from 100 to 2,500 feet (30 to 760 meters); it is mostly 200 feet (60 meters). Elevations are typically higher in Oregon. Some peaks in the southern end of the area range to 4,000 feet (1,220 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Oregon-Washington Coastal (1710), 75 percent; Lower Columbia (1708), 9 percent; Willamette (1709), 8 percent; and Puget Sound (1711), 8 percent. The Columbia River bisects this MLRA, and the headwaters for a number of rivers are in this area.

Geology

The portion of this MLRA in Washington consists primarily of young Tertiary sedimentary rocks (siltstone and sandstone) mixed with volcanic rocks of the same age. Also, glacial till and outwash deposits are in the northern half of the portion of the area in Washington. The portion of this MLRA in Oregon consists primarily of sedimentary rocks with some minor volcanic rocks. In the far southern portion of the area, near the Klamath Mountains, the sedimentary rocks are older and some have been metamorphosed.

Climate

The average annual precipitation in this area is 60 to 200 inches (1,525 to 5,080 millimeters), increasing with elevation. Most of the rainfall occurs as low-intensity, Pacific frontal storms. Precipitation is evenly distributed throughout fall, winter, and spring, but summers are cool and dry. Snowfall occurs in all of the area. The average annual temperature is 40 to 55 degrees F (4 to 13 degrees C), decreasing with elevation. The freeze-free period averages 200 days and ranges from 150 to 280 days, decreasing with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 12.4%; ground water, 3.7%
Livestock—surface water, 0.2%; ground water, 0.7%
Irrigation—surface water, 32.5%; ground water, 9.0%
Other—surface water, 21.1%; ground water, 20.4%

The total withdrawals average 320 million gallons per day (1,210 million liters per day). About 34 percent is from ground water sources, and 66 percent is from surface water sources. Precipitation and perennial streams fed by springs provide abundant surface water for all present needs. This area supplies water to the adjoining MLRAs at lower elevations that receive less precipitation.

Surface water quality is generally good for all uses. The ground water is mainly of good quality. It generally meets the water-quality standards for most designated uses.

Soils

The dominant soil orders in this MLRA are Andisols, Inceptisols, and Ultisols. The soils in the area dominantly have a mesic or frigid soil temperature regime and a udic soil moisture regime. They are generally shallow to very deep, well drained, medial, and loamy or clayey and occur on foothills and mountain slopes and ridges. Hapludands (Slickrock series) formed in colluvium over residuum. Fulvudands (Boistfort and Bunker series) formed in colluvium derived from basalt. Dystrudepts (Bohannon, Preacher, Rinearson, and Blachly series) formed in colluvium derived from sedimentary rocks, Eutrudepts (Digger and Umpcoos series) formed in colluvium and residuum derived from sedimentary rocks, and Palehumults (Buckpeak and Honeygrove series) formed in colluvium derived from sedimentary rocks.

Biological Resources

This area supports dense forest stands. Douglas-fir, western hemlock, and red alder are the most common species. There are lesser amounts of western red cedar and grand fir. At the higher elevations, noble fir is an important part of the plant community. Huckleberry, salal, blackberry, twinflower, vine maple, bigleaf maple, Pacific yew, thimbleberry, rhododendron, Oregon-grape, salmonberry, violet, trillium, swordfern, insideout flower, oxalis, beargrass, and false azalea dominate in the understory.

Some of the major wildlife species in this area are black bear, cougar, Roosevelt elk, black-tailed deer, coyote, bobcat, river otter, beaver, raccoon, skunk, muskrat, rabbit, squirrel, weasel, chipmunk, bald eagle, spotted owl, marbled murelet, and Steller's jay. The species of fish in the area include salmon, steelhead, and cutthroat trout.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 1%
Grassland—private, 3%
Forest—private, 62%; Federal, 30%
Urban development—private, 2%
Water—private, 1%
Other—private, 1%

Most of the area is densely forested, and timber production is the major industry. Recreation and wildlife habitat also are important land uses.

The major soil resource concerns are water erosion, surface compaction, and sedimentation of streams. The quality of surface water resources also is a major concern.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control surface compaction, the erosion caused by concentrated flow, and sediment delivery to streams. ■

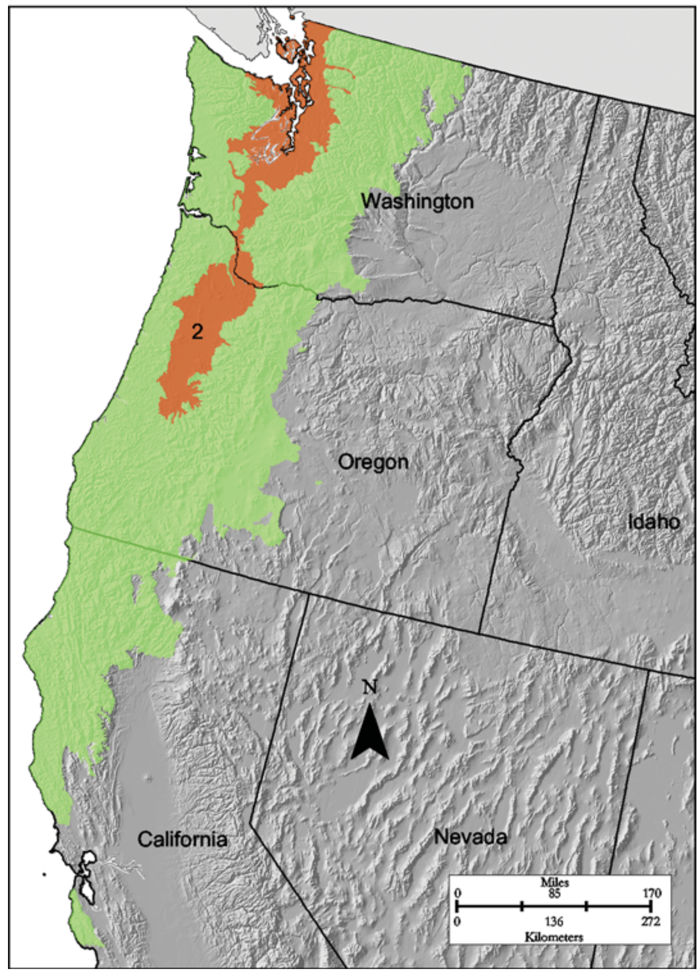

Figure 2-1: Location of MLRA 2 in Land Resource Region A.

2—Willamette and Puget Sound Valleys

This area (shown in fig. 2-1) is in Washington (57 percent) and Oregon (43 percent). It makes up about 12,210 square miles (31,640 square kilometers). The major cities of Seattle, Tacoma, Olympia, and Vancouver, Washington, and Portland, Corvallis, and Eugene, Oregon, are in this MLRA. Interstate 5 extends the entire length of the area from north to south. Interstate 90 joins Interstate 5 in Seattle, and Interstate 84 joins it in Portland. Numerous State parks are throughout the part of this area in

Washington, especially south of Puget Sound. A number of national wildlife refuges are in the Willamette Valley, in Oregon. The Lummi, Tulalip, and Nisqually Indian Reservations, McChord Air Force Base, and Fort Lewis are in the part of this MLRA in Washington.

Physiography

Almost all of this area lies within the Puget Trough Section of the Pacific Border Province of the Pacific Mountain System. The lowlands of the Puget Sound are partly submerged, and major terrace systems flank the Willamette Valley. The western edge of this area is the Oregon Coast Range of the Pacific Border Province of the Pacific Mountain System. The Cascade Mountains border this MLRA on the east, and the Coast Range and Olympic Mountains border it on the west.

Elevation ranges from sea level to 1,640 feet (500 meters). The Willamette Valley consists of nearly level to gently sloping flood plains bordered by higher terraces that are cut by tributaries of the Willamette River. The Puget Sound Valley consists of nearly level lacustrine deposits and dissected glacial till and glacial outwash.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Puget Sound (1711), 45 percent; Willamette (1709), 41 percent; Lower Columbia (1708), 8 percent; and Oregon-Washington Coastal (1710), 6 percent. The Columbia River, flowing east to west, bisects the area. The Willamette River runs down the middle of the southern half of the area. The Willamette and Columbia Rivers join in Portland, Oregon.

Geology

Glacial till, glacial outwash, and lacustrine deposits cover the floor of the Puget Sound Valley. The Willamette Valley is underlain primarily by alluvium.

Climate

The average annual precipitation is 30 to 60 inches (760 to 1,525 millimeters) in much of the area. Lower annual rainfall, down to 17 inches (430 millimeters), occurs on the lee side of the Coast Range Mountains along the western border of this area. The highest average annual rainfall, 60 to 109 inches (1,525 to 2,770 millimeters), is in the higher areas along the eastern border of the MLRA. Most of the rainfall occurs as low-intensity, Pacific frontal storms. Rain turns to snow at the higher elevations. Precipitation is evenly distributed throughout fall, winter, and spring, but summers are dry. The average annual temperature is 42 to 54 degrees F (6 to 12 degrees C). The lower temperatures occur at the higher elevations on the eastern edge of this area. The average annual temperature is 50 degrees F (8 degrees C) or more in much of the area. The freeze-free period averages 190 days and ranges from 165 to 220 days in most of this area. It can be as short as 70 days at the highest elevations and as long as 305 days near the Puget Sound.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 12.6%; ground water, 11.4%
Livestock—surface water, 0.2%; ground water, 0.3%
Irrigation—surface water, 49.9%; ground water, 4.7%
Other—surface water, 17.7%; ground water, 3.3%

The total withdrawals average 2,560 million gallons per day (9,690 million liters per day). About 20 percent is from ground water sources, and 80 percent is from surface water sources. Seattle and Portland consume most of the public water supply in Washington and Oregon, respectively. High-value crops are grown under irrigation in parts of the Willamette Valley, but rainfall is the source of water for most crops.

Moderate precipitation and abundant streamflow provide enough water for present needs. Surface water supplies, however, are often short in the summer, and farms located far from streams may require supplemental ground water for irrigation. Some additional surface water is available from the adjoining mountain ranges if reservoirs are constructed. Surface water quality is good for all uses. Irrigation return flows may be high in salts from fertilizers.

Ground water quality in this area generally meets drinking water standards. Ground water is plentiful in glacial and alluvial deposits around Seattle, Washington. It is soft water of good quality. High concentrations of naturally occurring iron and manganese, however, may exceed the drinking water standards for some ground water in the Puget Sound area. The city of Portland, Oregon, obtains some of its drinking water from wells in the basalt along the Columbia River. The water from the basalt aquifer is moderately hard and of good quality.

Soils

The dominant soil orders in this MLRA are Alfisols, Inceptisols, Mollisols, and Ultisols. The soils in the area dominantly have a mesic soil temperature regime, a xeric soil moisture regime, and mixed mineralogy. They generally are moderately deep to very deep, poorly drained to well drained, and loamy or clayey. Nearly level, somewhat poorly drained Argialbolls (Amity series), poorly drained Albaqualfs (Dayton series), and moderately well drained Argixerolls (Woodburn series) formed in lacustrine sediments on terraces. Somewhat excessively drained Dystroxerepts (Everett series) formed in outwash sediments and alluvium on terraces and moraines. Moderately well drained Dystroxerepts (Alderwood and Kapowsin series) formed in till on till plains and moraines. Gently sloping to steep, well drained Haplohumults (Bellpine and Nekia series) and Palehumults (Jory series) formed in colluvium and residuum on foothills. Moderately well drained Vitrixerands (Tokul series) formed in a mixture of till, loess, and volcanic ash on hills.

Biological Resources

This area supports forest vegetation in many places, prairie vegetation in some places, and savanna vegetation in others. Douglas-fir is the dominant tree species. Bigleaf maple, western red cedar, and grand fir also are common. Red alder is aggressive on disturbed sites in Washington. Stands of cottonwoods and willows grow on overflow channels, streambanks, and islands. Oregon white oak is common in savannas, especially in Oregon. Red and western fescues, bromes, and sedges are common in the prairies and savannas. Forest and savanna understory species include tall Oregon-grape, Indian plum, snowberry, hazel, oceanspray, serviceberry, rose, poison oak, swordfern, dwarf Oregon-grape, and thimbleberry.

Some of the major wildlife species in this area are black-tailed deer, coyote, bobcat, beaver, rabbit, pheasant, ruffed grouse, California quail, owls, and woodpeckers.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private,15%
Grassland—private, 10%
Forest—private, 37%; Federal, 3%
Urban development—private, 19%
Water—private, 10%
Other—private, 5%

In the Puget Sound Valley, nearly one-third of the land is forested and timber production is the major industry. In the Willamette Valley, less than one-tenth of the land is forested and timber production is of lesser importance. Urbanization is increasing in much of the area. Agriculture is highly diversified. Deciduous fruits, berries, vegetables, seed crops, and grains grown under intensive management are the major crops. The acreage used for wine grapes is increasing rapidly, especially in the Willamette Valley. A large acreage is used for hay or grain for dairy and poultry feed. High-value crops are grown under irrigation in some areas, but rainfall is the source of water for most crops.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and tilth of the soils, soil productivity, and sedimentation of streams and road ditches. The quality of surface and ground water resources also is a major concern.

Conservation practices on cropland generally include crop residue management, conservation crop rotations, waste utilization, nutrient management, pest management, filter strips, grassed waterways, and irrigation water management.

Conservation practices on pasture and hayland generally include prescribed grazing, forage harvest management, nutrient management, waste utilization, and filter strips. These practices help to protect water quality and aquatic habitat for fish and wildlife by reducing the movement of nutrients and pesticides to surface water and ground water.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control surface compaction, the erosion caused by concentrated flow, and sediment delivery to streams. ■

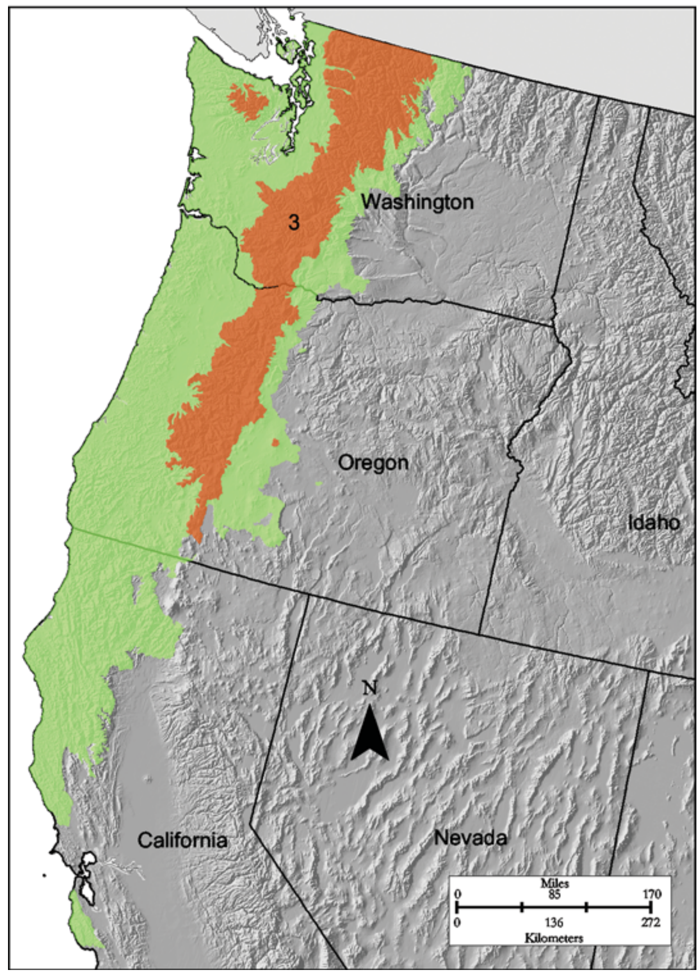

Figure 3-1: Location of MLRA 3 in Land Resource Region A.

3—Olympic and Cascade Mountains

This area (shown in fig. 3-1) is in Oregon (61 percent) and Washington (39 percent). It makes up about 24,375 square miles (63,170 square kilometers). It has no major cities. Interstate 90 crosses the Cascade Mountains in the center of the part of this area in Washington, and Interstate 84 crosses the area on the border between Washington and Oregon. A major portion of this MLRA consists of national forests (including the Olympic, Mt. Baker-Snoqualmie, Gifford Pinchot, Mt. Hood, Willamette, and Umpqua National Forests) and national parks (including Olympic, North Cascades, Mt. Rainier, and Crater Lake). A number of wilderness areas are set aside in the national forests.

Physiography

The northern one-fourth of this area is in the Northern Cascade Mountains Section of the Cascade-Sierra Mountains Province of the Pacific Mountain System. Almost all of the other areas in this MLRA are in the Middle Cascade Mountains Section of the Cascade-Sierra Mountains Province of the Pacific Mountain System. The Olympic Mountains are included within this MLRA, in the Olympic Mountains Section of the Pacific Border Province of the Pacific Mountain System.

Elevation generally ranges from 660 to 5,600 feet (200 to 1,710 meters), but it is as high as 14,400 feet (4,390 meters) on mountain peaks. The Cascade Mountains typically have sharp alpine summits of accordant height and some isolated volcanic cones. These volcanic peaks rise thousands of feet above the surrounding mountains. Examples are Mt. Baker, Mt. Rainier, Mt. Hood, and Mt. Jefferson. The Olympic Mountains are very similar to the Cascades but do not have the volcanic cones. Steep mountains, narrow valleys, some U-shaped glaciated valleys, and narrow divides are dominant in the Olympic Mountains. Plateaus and narrow bands of flood plains and terraces border some of the streams.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Puget Sound (1711), 30 percent; Willamette (1709), 23 percent; Lower Columbia (1708), 16 percent; Upper Columbia (1702), 11 percent; Oregon-Washington Coastal (1710), 8 percent; Middle Columbia (1707), 8 percent; Yakima (1703), 3 percent; and Klamath-Northern California Coastal (1801), 2 percent. The Columbia River bisects this MLRA. This mountainous area contains the headwaters of numerous rivers in Washington and Oregon, including the Willamette River.

Geology

The Northern Cascades are made up of a mixture of a variety of sedimentary rocks on the western slopes and metamorphic rocks cut by igneous intrusives on the eastern slopes. South of this northern quarter, the rest of the Cascade range consists primarily of andesite and basalt flows and some tuffs. The Olympic Mountains consist of uplifted sedimentary rocks. Thin deposits of alluvium are at the lower elevations along the major streams draining the Cascades. All of the Cascades have been glaciated, and isolated remnants of till and outwash deposits are at the lower elevations on the flanks of the mountains.

Climate

The average annual precipitation is 60 to 140 inches (1,525 to 3,555 millimeters) in most of this area and is as much as 280 inches (7,110 millimeters) on Mt. Olympus. Some small areas in the northeast corner and the southernmost tip of the area receive only13 to 45 inches (330 to 1,145 millimeters). Most of the rainfall occurs as low-intensity, Pacific frontal storms during fall, winter, and spring. Rain turns to snow at the higher elevations, and all of the area receives snow in winter. The average annual temperature is 27 to 53 degrees F (-3 to 12 degrees C), decreasing with elevation. The freeze-free period averages 189 days and ranges from 72 to 307 days. The longest growing season occurs only in the southernmost part of this area, and there may be no growing season at all at the highest elevations. Frost may occur during every month of the year at the higher elevations.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 12.9%; ground water, 3.9%
Livestock—surface water, 0.1%; ground water, 0.2%
Irrigation—surface water, 3.2%; ground water, 0.7%
Other—surface water, 69.0%; ground water, 10.0%

The total withdrawals average 155 million gallons per day (585 million liters per day). About 15 percent is from ground water sources, and 85 percent is from surface water sources. Precipitation and perennial streams fed by glaciers and springs provide abundant surface water for all of the present needs in the area. This area supplies water to the lower lying adjoining MLRAs that receive less precipitation.

This MLRA has very few aquifers. Columbia River basalt and basin fill and alluvial aquifers along the Columbia River in Oregon are the only two extensive aquifers. Ground water is mainly of good quality. It generally meets the water-quality standards for most designated uses.

Soils

The dominant soil orders in this MLRA are Andisols, Inceptisols, Spodosols, and Ultisols. The soils in the area dominantly have a mesic, frigid, or cryic soil temperature regime and a udic soil moisture regime. They generally are moderately deep to very deep, well drained, ashy, medial, and loamy or clayey and occur on mountain slopes and ridges. Vitricryands (Castlecrest series) formed in volcanic ash, pumice, and cinders. Some Dystrudepts (Aschoff and Zygore series), Haploxerands (Cinebar series), and Cryohumods (Playco series) formed in colluvium mixed with volcanic ash. Other Dystrudepts formed in colluvium over residuum (Kinney and Klickitat series) or in colluvium (Blachly series). Shallow Fulvudands (Dimal series) formed in residuum weathered from sandstone. Moderately deep Durudands (Elwell series) formed in till mixed with volcanic ash and loess. Palehumults (Honeygrove and Olympic series) and moderately deep Fulvudands (Solleks series) formed in colluvium over residuum weathered dominantly from sandstone. Haplohumults (Peavine series) formed in colluvium over residuum weathered from siltstone and shale. Haplocryods (Nimue series) and Haplorthods (Pitcher series) formed in colluvium mixed with volcanic ash over residuum.

Biological Resources

This area supports dense forest stands. Douglas-fir, Pacific silver fir, and western hemlock are the most common species. The area has lesser amounts of western red cedar, noble fir, grand fir, and white fir. At the higher elevations, mountain hemlock is an important part of the plant community and subalpine fir and whitebark pine grow near timberlines. Huckleberry, salal, blackberry, twinflower, vine maple, bigleaf maple, Pacific yew, thimbleberry, rhododendron, Oregon-grape, salmonberry, violet, trillium, swordfern, insideout flower, oxalis, beargrass, and false azalea may occur in the understory.

Some of the major wildlife species in this area are black bear, cougar, Roosevelt elk, black-tailed deer, coyote, bobcat, river otter, mountain beaver, raccoon, skunk, opossum, muskrat, rabbit, squirrel, weasel, chipmunk, bald eagle, osprey, turkey vulture, pheasant, ruffed and blue grouse, California quail, Steller's jay, and meadowlark. The species of fish in the area include salmon, steelhead, smelt, shad, sturgeon, whitefish, bass, trout, sunfish, perch, and crappie.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—private, 1%
Forest—private, 27%; Federal, 63%
Urban development—private, 1%
Water—private, 1%; Federal, 6%
Other—private, 1%

Most of the area is densely forested, and timber production is the major industry. At high elevations, alpine meadows provide summer range. Mining is important in some areas. Recreation and wildlife habitat also are important land uses.

The major soil resource concerns are water erosion, surface compaction, and sedimentation of streams. The quality of surface water resources also is a major concern.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control surface compaction, the erosion caused by concentrated flow, and sediment delivery to streams. ■

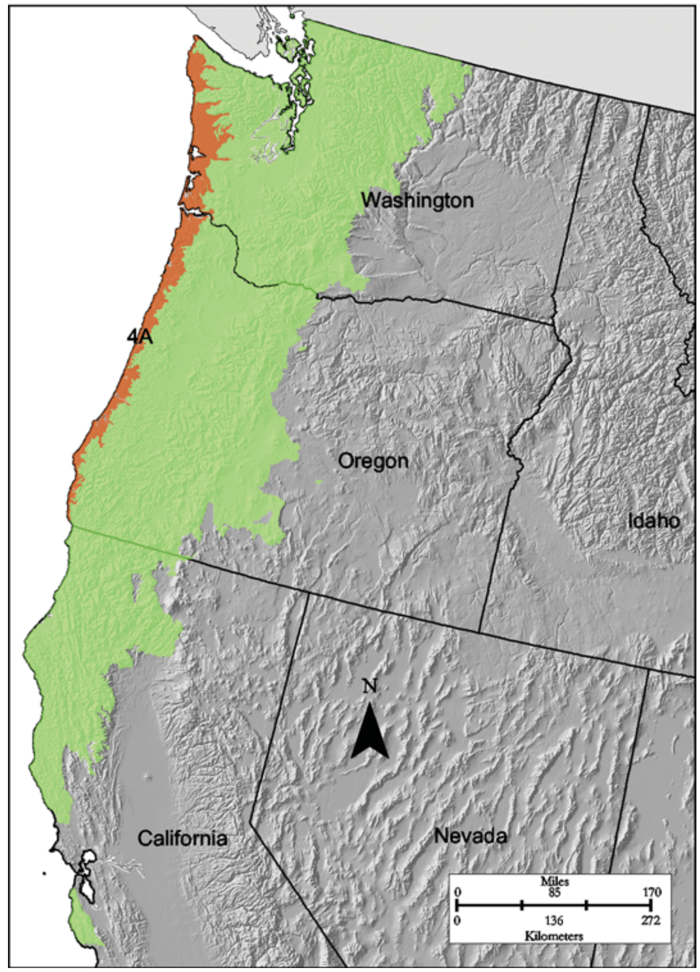

Figure 4A-1: Location of MLRA 4A in Land Resource Region A.

4A—Sitka Spruce Belt

This area (shown in fig. 4A-1) is in Washington (55 percent) and Oregon (45 percent). It is along the Pacific Ocean coast. This long, narrow MLRA makes up about 5,305 square miles (13,740 square kilometers). The major towns in Washington are Aberdeen, Hoquiam, and Forks. The towns of Astoria, Tillamook, and Coos Bay, Oregon, are in the southern part of the MLRA. U.S. Highway 101 follows the coastline in the southern half of the area. Part of the Olympic National Park is in the northwest corner of the area, and many Washington and Oregon State parks are along the coast. The MLRA includes parts of the Siuslaw and Siskiyou National Forests in Oregon. Part of the Olympic National Forest is in the far northeast end of the area. The Quinault, Quileute, Ozette, Hoh, and Makah Indian Reservations are in the northern part of the area.

Physiography

All of this area is within the Pacific Border Province of the Pacific Mountain System. Three different physiographic sections occurring in this area are, from north to south, the Olympic Mountains Section, the Oregon Coast Range Section, and the Klamath Mountains Section. Even though all of these sections are named after mountain ranges, there are actually no mountains within this coastal area.

In Washington, elevation ranges from sea level to a maximum of 1,800 feet (550 meters) inland. A cliff 50 to 200 feet (15 to 60 meters) high forms most of the western edge of the part of this MLRA in Washington. Most of this part of the MLRA has an elevation of 50 to 300 feet (15 to 90 meters). From the edge of the cliff, the land slopes up onto glacial drift deposits, marine terraces, or young, continental sedimentary rocks in the northern portion. In the southwest corner of Washington, the land slopes from the edge of the cliff up onto alluvial or marine terraces or flood plains and beach dunes. The MLRA is very hilly away from the coast.

The Oregon portion of this MLRA is similar to the portion in Washington. A rugged cliff 50 to 250 feet (15 to 75 meters) high forms most of the western edge of the part of this MLRA in Oregon, and elevations reach 1,800 feet (550 meters) inland on the area's eastern boundary. The coastal area around the mouth of the Columbia River and the flood plains along the major rivers near the coast are flat, but inland areas are very hilly. Marine terraces are common along the coast, and the coast consists of numerous bays, coves, headlands, and estuaries. The coast is eroding. Isolated rocks and small islands are directly offshore.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Oregon-Washington Coastal (1710), 89 percent; Lower Columbia (1708), 7 percent; and Puget Sound (1711), 4 percent. The area is highly dissected by numerous perennial rivers and creeks. The Columbia River discharges into the Pacific Ocean in the middle of this MLRA.

Geology

The portion of this MLRA in Washington consists primarily of glacial and alluvial sediments and some scattered areas of young Tertiary sedimentary rocks (siltstone). Glacial deposits are dominant in the northern half of the area, and alluvium and beach dune deposits are more prominent in the southern half of the part of the MLRA in Washington. A significant portion of the part of the MLRA in Oregon consists of marine and estuarine sediments and some minor sedimentary and volcanic rocks. At the far southern part of this area, near the Klamath Mountains, the sedimentary rocks are older and some have been metamorphosed.

Climate

The average annual precipitation is 52 to 60 inches (1,320 to 1,525 millimeters) near the beach and up to 191 inches (4,850 millimeters) at the higher elevations on the inland edge of the MLRA. Most of the rainfall occurs as low-intensity, Pacific frontal storms. Precipitation is evenly distributed throughout fall, winter, and spring, but summers are cool and dry. Snowfall accumulation is rare on the ocean side of this area, but some snowfall occurs on the eastern boundary. This area lies within the coastal fog belt zone, and heavy fogs are common in summer. Supplemental moisture is provided by fog condensation. The average annual temperature is 45 to 55 degrees F (7 to 13 degrees C). The freeze-free period averages 290 days and ranges from 220 to 365 days in most of this area. The ocean influence on the western edge of this area increases the length of the freeze-free period, and the period is much shorter at the higher elevations on the eastern edge of the area.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 44.3%; ground water, 21.2%
Livestock—surface water, 0.3%; ground water, 0.1%
Irrigation—surface water, 2.7%; ground water, 0.0%
Other—surface water, 30.3%; ground water, 1.1%

The total withdrawals average 56 million gallons per day (210 million liters per day). About 22 percent is from ground water sources, and 78 percent is from surface water sources. Abundant precipitation and many perennial streams provide enough water for most needs. Rainfall is the source of water for most crops, but some high-value crops are grown under irrigation on the coastal flats and on the flood plains a short distance inland from the mouths of the major rivers. The drier valleys depend on streamflow from the mountains. The surface water supply is often short in summer, and farms located far from streams may require supplemental ground water for irrigation. Surface water quality is generally good for all uses.

Ground water is plentiful in alluvial, glacial outwash, terrace, and beach dune deposits. It is soft water, and it generally meets drinking water standards, except for naturally occurring levels of iron and manganese in the northern part of the area.

Soils

The dominant soil orders in the MLRA are Andisols, Inceptisols, Spodosols, and Entisols. The soils have either an isomesic or isofrigid soil temperature regime. They have a udic or perudic soil moisture regime. They are acid throughout; most are very strongly acid or strongly acid. The hilly to extremely steep uplands are dominated by Andisols and Inceptisols. These soils are shallow to very deep and are well drained. They have ferrihydritic or isotic mineralogy. Fulvudands (Solleks, Necanicum, Lytell, and Tolovana series) and Dystrudepts (Templeton series) dominate the uplands. The undulating to hilly marine and glacial outwash terraces are dominated by Andisols and Spodosols. These soils are shallow or moderately deep to cemented materials or are deep or very deep. They are poorly drained to well drained. They have ferrihydritic or isotic mineralogy. Fulvudands (Lint and Mopang series), Durudands (Hoko series), Placaquands (Halbert series), Haplorthods (Netarts and Yaquina series), and Duraquods (Depoe series) dominate the terraces. The soils on the nearly level flood plains and in the estuaries are primarily Entisols and Inceptisols with minor areas of Histosols. These soils are very deep and typically are very poorly drained or poorly drained. They have mixed mineralogy. Fluvaquents (Coquille and Ocosta series), Humaquepts (Brenner and Clatsop series), Udifluvents (Grehalem series), Dystrudepts (Nehalem series), and Haplohemists (Brallier series) dominate the flood plains and estuaries.

Biological Resources

This area is highly diverse in flora and fauna. Its eastward extent is coincident with the extent of plant communities dominated by Sitka spruce. The uplands are dominated by a dense overstory of Sitka spruce, western hemlock, western red cedar, red alder, and Douglas-fir. Their understory is dominated by salal, western swordfern, huckleberry, and oxalis. The terraces have shore pine as a dominant overstory species in addition to the species on uplands. The flood plains and estuaries are dominated by saltgrass, skunk cabbage, tussock and other sedges, and reeds. During periods of low tide, large nonvegetated mudflats are exposed in the coastal bays.

Some of the major wildlife species in this area are black bear, Roosevelt elk, black-tailed deer, coyote, fox, bobcat, beaver, otter, raccoon, skunk, muskrat, opossum, rabbit, squirrel, mink, wood rat, bald eagle, osprey, crow, ruffed grouse, blue grouse, raven, merganser, kingfisher, band-tailed pigeon, and the endangered spotted owl and marbled murelet. Salamanders, newts, and slugs are common in the decomposing forest litter. The tidal estuaries are habitat for clams, crabs, and salmonids. The species of fish in the area include salmon, steelhead trout, white sturgeon, Columbia River smelt, and cutthroat trout. The rivers and bays in this area are important spawning grounds and habitat for steelhead, salmon, and cutthroat trout.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—private, 4%
Forest—private, 68%; Federal, 11%
Urban development—private, 5%
Water—private, 8%
Other—private, 4%

Most of this area consists of privately owned farms, ranches, or forests. Lumbering is the major industry. A small acreage in the area is grassland used for grazing. Less than 1 percent of the area is cultivated land, which is used mainly for forage and grain for dairy cattle. Although the freeze-free period is long, the area lacks the heat units necessary for the maturation of most crops. Vegetables and fruits (apples) are grown in areas where the soils and climate are favorable. Specialty crops, such as cranberries and lily bulbs, also are grown in the area.

The major soil resource concerns are water erosion and its subsequent deposition of sediment into the rivers and creeks. Soils in basins and on flood plains are susceptible to flooding, deposition of sediments, and local streambank cutting. The hazard of erosion is moderate on terraces and coastal benches. Erosion can be severe if the vegetative cover on the upland soils is removed by logging, fire, overgrazing, or cultivation. Landslides in the uplands are a source of sediment.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control surface compaction, the erosion caused by concentrated flow, and sediment delivery to streams. Maintaining a vegetative cover or forest litter over the mineral soil surface helps to control runoff and erosion.

Conservation practices on cropland are nutrient management and measures that reduce the hazard of erosion. ■

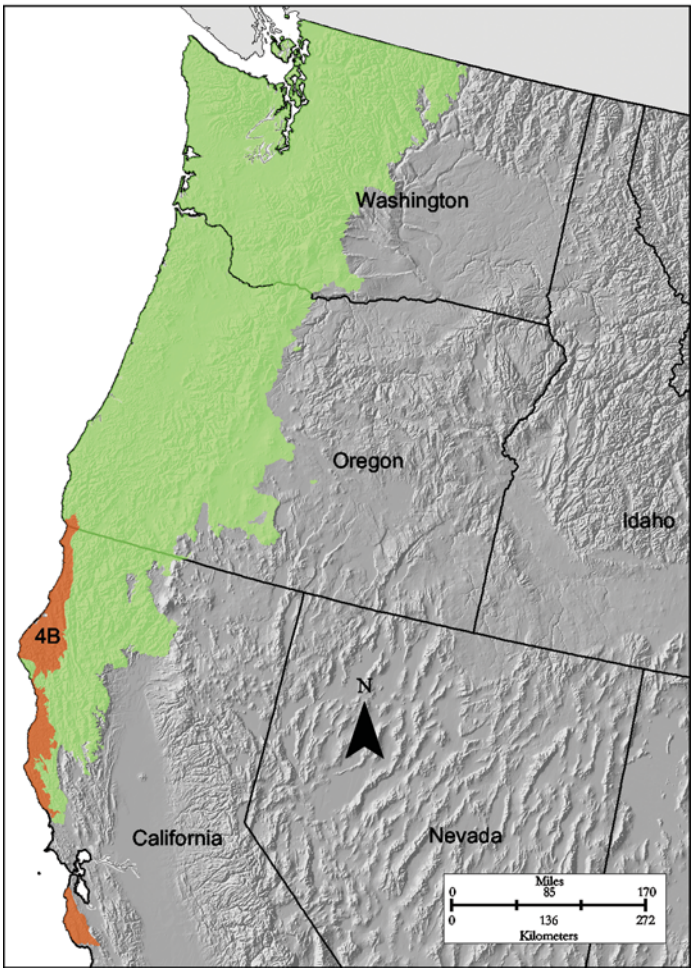

Figure 4B-1: Location of MLRA 4B in Land Resource Region A.

4B—Coastal Redwood Belt

This area (shown in fig. 4B-1) is primarily in California (98 percent). A small part of the area is in Oregon (2 percent). This MLRA makes up about 4,670 square miles (12,095 square kilometers). The towns of Crescent City, Arcata, Eureka, and Fort Bragg, California, and Brookings, Oregon, are in this MLRA. U. S. Highway 101 parallels the coastline in the northern half of the area. Redwood National Park, King Range National Conservation Area (BLM), and numerous California State parks are in this MLRA.

Physiography

The northern one-third of this area lies within the Klamath Mountains Section of the Pacific Border Province of the Pacific Mountain System. The rest of the area is in the California Coast Ranges Section of the Pacific Border Province of the Pacific Mountain System. The Klamath Mountains are an uplifted peneplain consisting of resistant rocks that have been eroded by numerous streams. Numerous peaks of erosion-resistant rock are in these low mountains. The California Coast Ranges consist of parallel ranges and valleys underlain by folded and faulted metamorphic rocks. Their peaks are rounded, and landslides are a dominant geomorphic process.

Elevation generally ranges from sea level to 2,600 feet (795 meters), but on some Coast Range peaks it is 3,940 feet (1,200 meters). The Pacific Ocean bounds this area on the west, and the Coast Range forms the eastern edge. The MLRA is an area of steep mountainous terrain. Low but steeply sloping mountains are dominant. Gently sloping marine terraces border the coast, and a few broad valleys extend inland through the mountains. This area is very hilly inland. Most of the coast is a rugged, steep mountain face 200 to 900 feet (60 to 275 meters) high. Beaches occur at the mouth of rivers. The coast is eroding, and some isolated rocks and small islands are directly offshore.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Klamath-Northern California Coastal (1801), 83 percent; Central California Coastal (1806), 8 percent; San Francisco Bay (1805), 7 percent; and Oregon-Washington Coastal (1710), 2 percent. The Smith, Klamath, Mad, Eel, Mattole, Noyo, Navarro, Chetco, Winchuck, and Garcia Rivers and Redwood Creek discharge into the Pacific Ocean from this area.

Geology

The mountains in this MLRA consist primarily of contorted metamorphic rocks. Some igneous intrusives are in the Klamath Mountains. Serpentine is evident in many of the metamorphic units, and failure planes in landslides are common within the serpentine layers. Changes in sea level created marine terraces along the coast. The terraces consist of sand and gravel originally deposited as beach or alluvial fan deposits at the mouth of the major rivers.

Climate

The average annual precipitation in this area is 23 to 98 inches (585 to 2,490 millimeters), increasing with elevation inland. Most of the rainfall occurs as low-intensity, Pacific frontal storms. Precipitation is evenly distributed throughout fall, winter, and spring, but summers are dry. Snowfall is rare along the coast, but snow accumulates at the higher elevations directly inland. Heavy fogs are common along the coast in summer. The average annual temperature is 49 to 59 degrees F (10 to 15 degrees C). The freeze-free period averages 300 days and ranges from 230 to 365 days, decreasing inland as elevation increases.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 1.6%; ground water, 0.5%
Livestock—surface water, 0.1%; ground water, 0.0%
Irrigation—surface water, 77.5%; ground water, 15.5%
Other—surface water, 4.4%; ground water, 0.4%

The total withdrawals average 32 million gallons per day (120 million liters per day). About 16 percent is from ground water sources, and 84 percent is from surface water sources. Abundant precipitation and many perennial streams provide enough water for most needs. Rainfall is the source of water for most crops, but some high-value crops, such as lily bulbs, are grown under irrigation on the coastal terraces and on the flood plains a short distance inland from the mouth of the major rivers. The drier valleys depend on streamflow from the mountains. The surface water supply is often short in summer, and farms located far from streams may require supplemental ground water for irrigation. Surface water quality is generally good for all uses.

Ground water is plentiful in alluvial deposits along the major rivers and in coastal valleys. It is moderately hard or hard water of generally good quality and is suitable for most uses.

Soils

The dominant soil orders in the MLRA are Alfisols, Entisols, Inceptisols, and Ultisols. The soils dominantly have an isomesic or mesic soil temperature regime; a udic, xeric, or ustic soil moisture regime; and mixed mineralogy. They generally are deep or very deep, well drained, and loamy or clayey and occur on mountain slopes and hills in addition to coastal terraces. The dominant parent material is residuum weathered from sandstone. The soils of dominant extent include Hapludalfs (Dehaven and Irmulco series), Dystroxerepts (Hugo series), Haplohumults (Vandamme, Winchuck, and Loeb series), Dystrudepts (Dulandy series), Haploxerults (Josephine series), and Haplustalfs (Kibesillah, Ornbaun, Yellowhound, and Zeni series). The soils on flood plains are Udifluvents (Bigriver and Cottoneva series).

Biological Resources

This area supports forest and grass vegetation. Redwood, Douglas-fir, grand fir, bishop pine, western red cedar, Port-Orford cedar, red alder, California bay laurel, golden chinkapin, Pacific madrone, tanoak, Sitka spruce, and California black oak are the dominant tree species. California oatgrass, tufted hairgrass, western and Idaho fescues, Pacific reedgrass, and native and introduced bentgrasses are common perennial grasses. Soft chess, wild oats, bromes, filaree, and burclover are important naturalized annuals. Gorse-broom and Scotch-broom are dominant in some parts of the coastal zone.

Some of the major wildlife species in this area are black-tailed deer, coyote, gray fox, raccoon, muskrat, river otter, rabbit, squirrel, mink, turkey, blue grouse, California valley quail, band-tailed pigeon, and mourning dove. The species of fish in the area include bluegill, redear, black bass, crappie, catfish, steelhead, salmon, striped bass, rainbow trout, surf perch, tom cod, and sculpin.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 4%
Grassland—private, 14%
Forest—private, 60%; Federal, 12%
Urban development—private, 7%
Water—private, 2%
Other—private, 1%

Most of this area consists of privately owned farms, ranches, or forests. Lumbering is the major industry. About 14 percent of the area is grassland used for grazing. Cultivated land is in the valleys and along the coast. It is used mainly for forage and grain for dairy cattle. Vegetables, fruits (apples), and lily bulbs are grown in areas where the soils and climate are favorable.

Because of steep slopes, erodible soils, and high rainfall, the major soil resource concern on uplands is erosion. The erosion hazard is severe if the plant cover is removed. Mass movement in the form of landslides and slips is a serious problem and a major source of sediment in the rivers. Older or improperly designed roads also contribute sediment. Other management concerns include compaction resulting from farming activities, impacts on the health of forestland, such as catastrophic wildfire, and maintenance of the content of organic matter in the soils.

Conservation practices on forestland generally include tree and shrub establishment, forest stand improvement, forest harvest trails and landings, critical area planting, and control of understory fuels. These practices improve forest health and reduce the impacts on wildlife. They also control erosion on access roads and protect riparian areas and fish habitat.

Conservation practices on rangeland and other grazing land generally include prescribed grazing, fencing, and water management.

Conservation practices on cropland generally include those activities that keep erosion within acceptable limits in the fields while protecting riparian areas and reducing the hazard of streambank erosion. Conservation practices on dairy farms generally include the proper containment and disposal of animal waste. ■

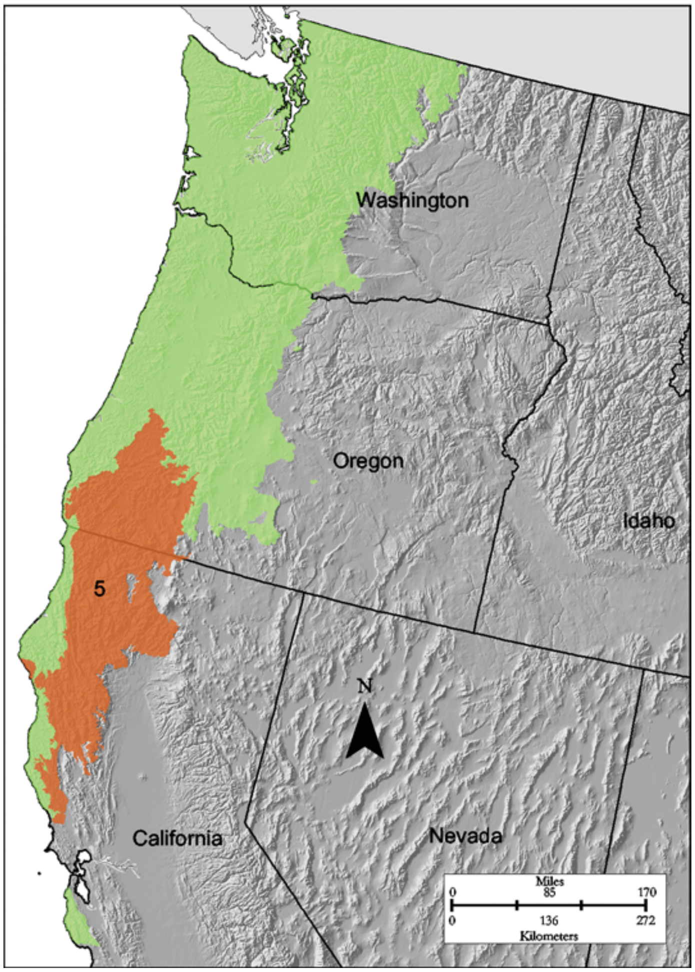

Figure 5-1: Location of MLRA 5 in Land Resource Region A.

5—Siskiyou-Trinity Area

This area (shown in fig. 5-1) is in California (62 percent) and Oregon (38 percent). It makes up about 20,150 square miles (52,215 square kilometers). The towns of Grants Pass, Medford, and Roseburg, Oregon, and Weaverville, California, are in this area. Interstate 5 crosses the northeast corner of the area, in Oregon. Many national forests, including the Umpqua, Rogue River, Siskiyou, Six Rivers, Klamath, Trinity, Shasta, and Mendocino National Forests, are in this area. National wilderness areas occur within almost all the national forests. The Hoopa Valley and Round Valley Indian Reservations are in this MLRA.

Physiography

The eastern half of the northern third of this area is in the Middle Cascade Mountains Section of the Cascade-Sierra Mountains Province of the Pacific Mountain System. This section is an area of steep mountainous terrain with generally accordant summits interspersed with higher volcanic cones. The Klamath Mountains Section of the Pacific Border Province of the Pacific Mountain System forms the western half of the northern third of this MLRA and also makes up most of the remaining area to the south. This section consists of an uplifted and eroded peneplain on very hard rocks. Numerous higher peaks are in scattered areas throughout this mountainous region. The "Trinity Alps" and "Marble Mountains" are in this province. The southeast portion of this MLRA is in the California Coast Ranges Section of the Pacific Border Province of the Pacific Mountain System. This section consists of parallel ranges and valleys underlain by folded and faulted metamorphic rocks. In this section, peaks are rounded and landslides are a dominant geomorphic process.

Elevation generally ranges from 330 to 6,000 feet (100 to 1,830 meters), but on some mountain peaks it is 8,850 feet (2,700 meters). Rounded but steeply sloping mountains are dominant. These mountains are underlain mainly by sandstone and shale. In some areas, however, the mountains are underlain by granodiorite, gabbro, and other intrusive rocks. The narrow valleys have gently sloping flood plains and alluvial fans and are bordered by strongly sloping foothills.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Klamath-Northern California Coastal (1801), 55 percent; Oregon-Washington Coastal (1710), 37 percent; and Sacramento (1802), 8 percent. The Rogue River in Oregon and the Eel, Trinity, and Klamath Rivers in California are the largest rivers in this MLRA. Reaches of the Rogue, Illinois, Smith, Klamath, Salmon, and Eel Rivers are designated as Wild and Scenic Rivers in this area.

Geology

Most of this area consists of Mesozoic, marine sandstones and shales. In some areas granodiorite, gabbro, and other intrusive rocks of the same age are dominant. Mesozoic ultramafic rocks also are included in this area. All of these rocks have been metamorphosed to some extent. An extensive area of older Paleozoic marine sediments occurs in the south half of this area. These marine sediments are cut by the Mesozoic volcanics common in the north. The rocks in the south have also been strongly metamorphosed.

Climate

The average annual precipitation is 14 to 20 inches (355 to 510 millimeters) at the lower elevations and as much as 200 inches (5,080 millimeters) in the mountains. Most of the rainfall occurs as low-intensity, Pacific frontal storms. Rain turns to snow at the higher elevations. Very little precipitation occurs in summer. Most of the precipitation occurs between November and April. The average annual temperature is 40 to

62 degrees F (5 to 17 degrees C), decreasing with elevation. The freeze-free period averages 240 days and ranges from 110 to 365 days. The shorter freeze-free periods occur at the higher elevations.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 8.6%; ground water, 8.8%
Livestock—surface water, 0.6%; ground water, 0.5%
Irrigation—surface water, 27.2%; ground water, 13.1%
Other—surface water, 38.4%; ground water, 2.7%

The total withdrawals average 150 million gallons per day (565 million liters per day). About 25 percent is from ground water sources, and 75 percent is from surface water sources. The moderate to high precipitation provides enough water in the mountains and higher valleys for most needs. The mountains also supply irrigation water for the lower, drier valleys. The surface water is suitable for almost all uses.

There are no major aquifers in the Klamath Mountains or the Coast Range. Ground water is abundant, however, in alluvial deposits in most valleys. The surface and ground water generally meets the recommended standards for all uses.

Soils

The dominant soil orders in this MLRA are Alfisols, Inceptisols, and Ultisols. Xerolls are of minor extent on the grasslands. The soils in the area dominantly have a mesic soil temperature regime, a xeric soil moisture regime, and mixed mineralogy. They generally are moderately deep or deep, well drained, and loamy and occur on mountain slopes and hills. Dystroxerepts (Beekman, Neuns, and Sheetiron series) formed in colluvium or in colluvium over residuum. Shallow Dystroxerepts (Maymen and Vermisa series) formed in residuum. Haploxeralfs (Casabonne, Hopland, Sanhedrin, Speaker, and Vannoy series) and Haploxerults (Josephine series) formed in colluvium over residuum. Argixerolls and Haploxerolls (McNull, McMullin, Medco, and Yorktree series) formed in colluvium and residuum on low hills.

Biological Resources

This area supports forest, open forest, and grassland vegetation. Douglas-fir, ponderosa pine, sugar pine, incense-cedar, white fir, red fir, tanoak, Oregon white oak, California black oak, canyon live oak, and Pacific madrone are the dominant tree species. Poison-oak, snowberry, ceanothus, manzanita, and rose characterize the forest understory. Blue wildrye, fescues, bluegrass, mountain brome, and some browse species are in the understory in open stands of timber. Soft chess, wild oats, burclover, fescues, and bromes are the major grassland species.

Some of the major wildlife species in this area include amphibians and reptiles along with black bear, mountain lion, mule deer, black-tailed deer, coyote, fox, raccoon, ring-tailed cat, porcupine, skunk, mink, squirrel, grouse, northern spotted owl, band-tailed pigeon, mountain quail, and California valley quail. The species of fish in the area include coho and king salmon, steelhead, and trout.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private,1%
Grassland—private, 6%; Federal, 4%
Forest—private, 34%; Federal, 50%
Urban development—private, 2%
Water—private, 1%; Federal, 1%
Other—private, 1%

Most of this area is in coniferous forests that are important for wood products, wildlife habitat, and recreation. About one-tenth of the area is grazed, and a smaller acreage is cropped. The raising of livestock is the principal farm enterprise. Irrigated pasture, hay crops, and some truck crops are grown in the valleys where water is available. On the more sloping parts of the valleys, hay and pasture are grown as feed for livestock.

Because of steep slopes, erodible soils, and high rainfall, the major soil resource concern on uplands is erosion. The erosion hazard is severe if the plant cover is removed. Mass movement in the form of landslides and slips is a serious problem and a major source of sediment in the rivers. Older or improperly designed roads also contribute sediment. Other concerns include compaction from farming activities, impacts on the health of forestland, such as catastrophic wildfire, and maintenance of the content of organic matter in the soils.

Conservation practices on forestland generally include tree and shrub establishment, forest stand improvement, forest harvest trails and landings, critical area planting, and control of understory fuels. These practices improve forest health and reduce the impacts on wildlife. They also control erosion on access roads, protect riparian areas, and improve the habitat for fish.

Conservation practices on rangeland and other grazing land generally include prescribed grazing, fencing, and water management. Conservation practices on cropland generally include irrigation water management and nutrient management. The cropland and grazing land practices help to keep erosion within acceptable limits in the fields, protect riparian areas, and reduce the hazard of streambank erosion. ■

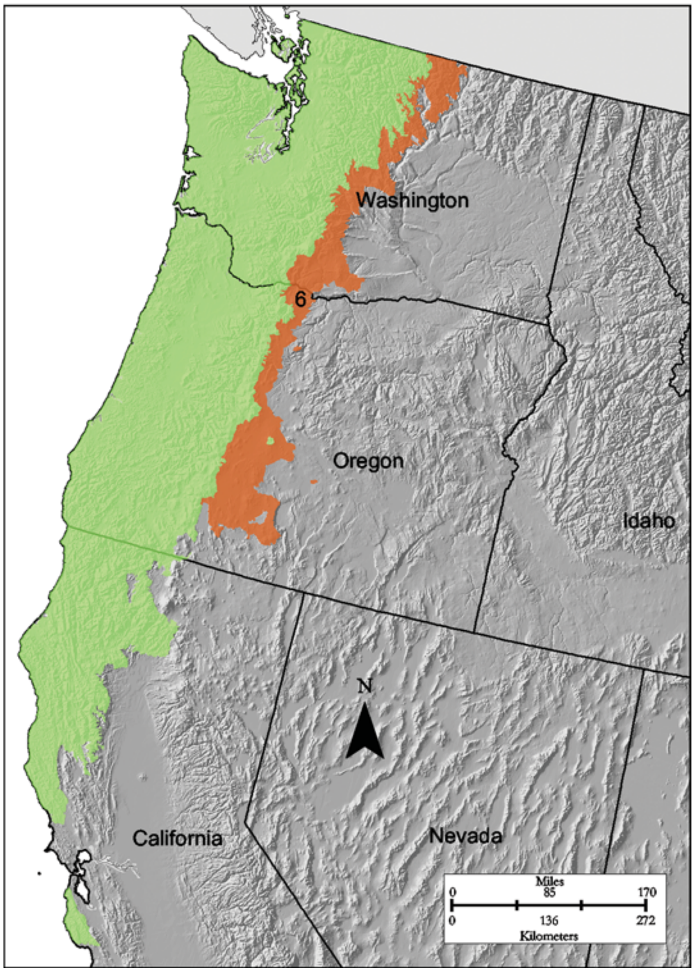

Figure 6-1: Location of MLRA 6 in Land Resource Region A.

6—Cascade Mountains, Eastern Slope

This area (shown in fig. 6-1) is in Oregon (52 percent) and Washington (48 percent). It makes up about 13,160 square miles (34,100 square kilometers). The only major town occurring in the part of this MLRA in Washington is Leavenworth. Bend, Oregon, is on the exteme eastern edge of the southern part of the area. The town of The Dalles, Oregon, is directly east of where the area crosses the Columbia River. Interstate 84, along the south bank of the Columbia River, crosses the center of the MLRA, and Interstate 90 crosses the northern half. Parts of many national forests occur in this area, including the Okanogan, Wenatchee, Snoqualmie, Gifford Pinchot, Mount Hood, Deschutes, Winema, and Fremont National Forests. The Yakama Indian Reservation and the Warm Springs Indian Reservation are in the area.

Physiography

About half of this MLRA, mostly south of the Columbia River in Oregon, is in the Walla Walla Plateau Section of the Columbia Plateaus Province of the Intermontane Plateaus. The southernmost tip of the MLRA is in the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. The Harney Section of the Columbia Plateaus Province lies between the Walla Walla Plateau and Great Basin Sections in the southern end of this area. In Washington, almost all of this MLRA is in the Northern Cascade Mountains and Middle Cascade Mountains Sections of the Cascade-Sierra Mountains of the Pacific Mountain System. This mountainous area consists of sharp alpine summits of accordant height with some higher volcanic cones. The Cascade Mountains, Eastern Slope, is a transitional area between the Cascade Mountains to the west and the lower lying Columbia Basalt Plateau to the east. It has some of the landforms typical of both the mountains and the plateau.

Elevations in this MLRA generally range from 900 to 8,000 feet (275 to 2,440 meters). Some mountain peaks approach 10,000 feet (3,050 meters) in elevation. Strongly sloping mountains and U-shaped glaciated valleys are dominant in the north, and eroded basalt plateaus are more typical in the south. A few isolated volcanic peaks occur in the Harney and Great Basin Sections in the south. Many streams dissect the gently sloping crests and benches in the plateau sections.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Middle Columbia (1707), 39 percent; Upper Columbia (1702), 22 percent; Klamath-Northern California (1801), 17 percent; Yakima (1703), 14 percent; and Oregon Closed Basins (1712), 8 percent. The Columbia River separates the north and south parts of this MLRA, and the headwaters of a few central Washington and Oregon streams occur in the area.

Geology

The northern half of this MLRA consists of Pre-Cretaceous metamorphic rocks cut by younger igneous intrusives. Tilted blocks of marine shale, carbonate, and other sediments occur in the far north, and some younger continental, river-laid sediments occur around Leavenworth, Washington. Columbia River basalt is dominant in the rest of the MLRA in both Washington and Oregon. The southern part of the area, south of Bend, Oregon, is blanketed by a very thick deposit of ash and pumice from the eruption of Mount Mazama, commonly known as Crater Lake. Isolated remnants of continental sediments occur within the expanse of basalt and andesite flows that make up the southern extent of the Cascade Range. Alpine glaciation has left remnants of glacial till, debris, and outwash in the northern part of this MLRA.

Climate

The average annual precipitation in most of this area is 12 to 87 inches (305 to 2,210 millimeters), generally increasing with elevation to the west. The lowest rainfall occurs along the eastern edge of the area, away from the mountains, where 12 to 15 inches per year (305 to 380 millimeters) is typical. The central parts receive 15 to 45 inches per year (380 to 1,145 millimeters). Some mountain crests receive 100 inches (2,540 millimeters) or more of precipitation in an average year. Most of the rainfall occurs as low-intensity, Pacific frontal storms during winter, spring, and fall. Rain turns to snow at the higher elevations. All areas receive snow in winter. Summers are relatively dry. The average annual temperature is 32 to 53 degrees F (0 to 12 degrees C), decreasing with elevation. The freeze-free period averages 145 days and ranges from 0 to 250 days. The shortest freeze-free periods occur along the western edge and the northern and southern ends of this MLRA, which are mountainous. The longest freeze-free periods occur in the central part of the area, along the Columbia River gorge. Away from these areas of extremes, the freeze-free period averages 70 days and ranges from 40 to 140 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 7.4%; ground water, 7.1%
Livestock—surface water, 0.5%; ground water, 0.7%
Irrigation—surface water, 26.6%; ground water, 9.7%
Other—surface water, 36.6%; ground water, 11.3%

The total withdrawals average 205 million gallons per day (775 million liters per day). About 29 percent is from ground water sources, and 71 percent is from surface water sources. Precipitation and perennial streams provide ample surface water. Perennial streams and reservoirs supply water to the drier and lower lying MLRAs to the east. Surface water runoff is dominated by snowmelt, and water quality is good to excellent.

Almost all of the northern half and the west half of the southern half of this MLRA consist of rock units that are not aquifers. Most of the supplies of ground water are untapped. Irrigation water for cropland on valley floors can be pumped from river alluvium in Washington and from alluvium and basin fill deposits in Oregon. The Grand Ronde and Wanapum aquifers are in the Columbia River basalt aquifer in Washington, directly north of the Columbia River. The basalt aquifer consists of five different units in Oregon, directly south of the Columbia River. Most of the southern half of this MLRA is underlain by the volcanic and sedimentary aquifer group in Oregon. Ground water is of good quality and has low levels of dissolved solids. The basalt aquifers provide hard or moderately hard water.

Soils

The dominant soil orders in this MLRA are Alfisols, Andisols, Inceptisols, and Mollisols. The Andisols and Inceptisols in this area are similar to the soils to the west, and the Mollisols in the area are more typical of the soils to the east. The soils in the MLRA dominantly have a mesic, frigid, or cryic soil temperature regime, a xeric soil moisture regime, and mixed or glassy mineralogy. They generally are moderately deep to very deep, well drained, and loamy or ashy. Haploxerolls formed in till (Newbon series) or in till with a loess or ash mantle (Conconully series). They are on ground moraines and foothills. Haploxerepts formed in residuum and colluvium on mountain slopes and ridges (Jumpe series) and in a mixture of ash and loess over alluvium or colluvium on uplands (Wamic series). Vitricryands formed in ash and pumice (Lapine series), ash (Steiger series), and ash over loamy material (Shanahan series) on plateaus. Vitricryands (Naxing series) and Vitrixerands (Smiling series) formed in colluvium mixed with loess and ash. They are on mountain slopes. Moderately deep Vitrixerands (Maset series) formed in ash over residuum on benches and hills. Haploxeralfs (Nard and Underwood series) formed in residuum and colluvium with an ash mantle. They are on terraces and uplands.

Biological Resources

This area supports conifer forest and grass vegetation. The kind of vegetation gradually changes with increases in elevation and in precipitation. Important species on grasslands at the lowest elevations are bluebunch wheatgrass, Sandberg bluegrass, big sagebrush, antelope bitterbrush, Idaho fescue, and Cusick bluegrass. The dominant tree species in the forested areas are ponderosa pine, Douglas-fir, grand fir, white fir, western larch, and lodgepole pine. Pacific silver fir, subalpine fir, and whitebark pine are at the highest elevations. Understory species include vine maple, hazel, snowberry, oceanspray, antelope bitterbrush, and green manzanita.

Some of the major wildlife species in this area are bear, elk, deer, coyote, bobcat, rabbit, turkey, pheasant, Hungarian and chukar partridge, blue grouse, California quail, dove, and songbirds. The fish in the area include several species of trout and salmon.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 2%
Grassland—private, 8%; Federal, 2%
Forest—private, 40%; Federal, 45%
Urban development—private, 1%
Water—private, 1%
Other—private, 1%

About one-half of this area is in privately owned farms, ranches, or woodland. Most of the area is coniferous forest. Timber production is an important industry. About one-tenth of the area supports grasses and is used for grazing. Some of the woodland is grazed by cattle. Recreation and wildlife habitat also are important land uses. A very small area in the valleys is cropland, most of which is irrigated. Crops include tree fruits, small grains, and forage crops.

The major soil resource concerns are wind erosion and water erosion, surface compaction, sedimentation of streams and road ditches, and maintenance of the content of organic matter and tilth in the soils. The quality of surface water also is a concern.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control surface compaction, the erosion caused by concentrated flow, and sediment delivery to streams.

Conservation practices on cropland are those that help to control erosion and protect water quality. They generally include cover crops, conservation crop rotations, crop residue management, waste utilization, nutrient management, pest management, filter strips, grassed waterways, and irrigation water management.

Conservation practices on pasture and hayland generally include prescribed grazing, forage harvest management, nutrient management, waste utilization, and filter strips. These practices protect water quality and aquatic habitat for fish and wildlife by reducing the movement of nutrients and pesticides to surface water and ground water. ■

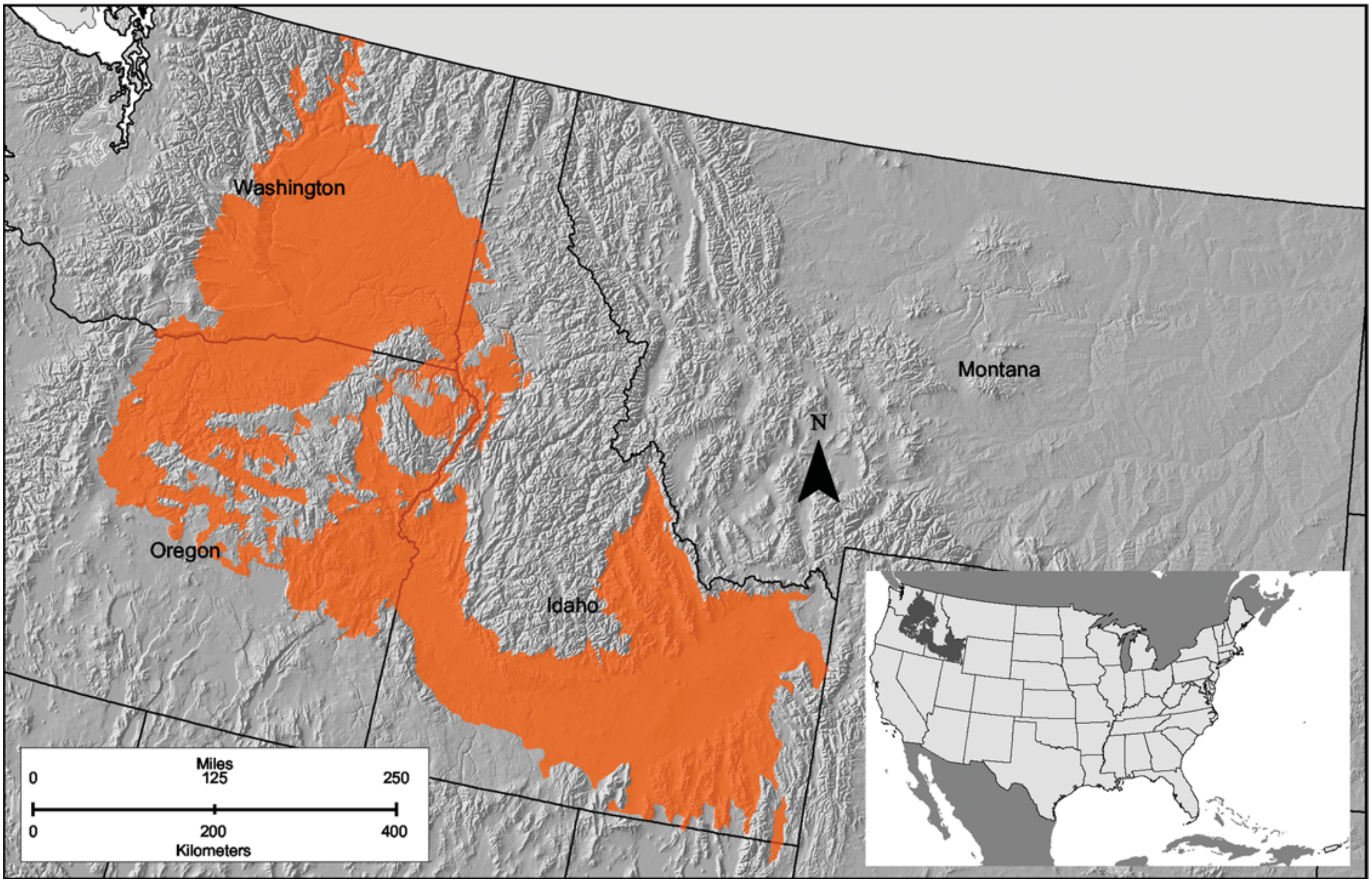

Figure B-1: Location of Land Resource Region B.

B—Northwestern Wheat and Range Region

This region (shown in fig. B-1) is in Idaho (44 percent), Washington (29 percent), and Oregon (27 percent). A very small part is in Utah. The region makes up 81,255 square miles (210,555 square kilometers).

This region is on the lee side of the Cascade Mountains in Washington and Oregon and extends east into Idaho along the Snake River Plains. It is an area of smooth to deeply dissected plains and plateaus. Well developed terraces are along the Snake River. Most of this region is underlain by Miocene-age basalt flows from the Columbia and Idaho Batholiths. The basalt is covered with a veneer of loess and volcanic ash in most areas. The region has a few isolated mountain ranges.

The average annual precipitation is 6 to 20 inches (150 to 510 millimeters) in most of the region. It is lowest in the Columbia Basin area in central Washington and in valleys in Oregon, in southeastern Idaho, and south of the Snake River in Idaho. The average annual precipitation can be as much as 45 to 85 inches (1,145 to 2,160 millimeters) in the mountains. Summers are dry. The average temperature is 40 to 49 degrees F (5 to 10 degrees C) in most of the region, but it ranges from 30 to 55 degrees F (-1 to 13 degrees C). In most areas the freeze-free period averages 160 days and ranges from 125 to 220 days. It is typically 40 to 70 days in the mountains.

The total withdrawals of freshwater in this region average 53,715 million gallons per day (203,310 million liters per day). This region uses the largest amount of water among all of the land resource regions. Surface water is abundant throughout most of the region. About 72 percent of the total water used in the region is from surface water sources. The Snake and Columbia River systems provide almost all of the surface water. Irrigation is the largest use of water in the region (91 percent). Ground water is obtained from basalt aquifers and from alluvium in river valleys.

The dominant soil orders in the region are Mollisols and Aridisols. Other soil orders that occur in the region are Alfisols, Andisols, Entisols, and Inceptisols. Mollisols and Aridisols formed in a deep mixture of loess and ash deposits overlying the basalt flows in this region. The other soil orders formed in alluvium on terraces and flood plains or in residuum and colluvium on foothills and mountain slopes. Most of the soils

Figure B-2: A field of peas on the rolling hills of the Palouse Area in the northern part of Land Resource Region B.

are deep or very deep, well drained, and loamy. They generally have a mesic or frigid soil temperature regime but have a cryic temperature regime in the mountains. Almost all of the soils have a xeric or aridic soil moisture regime.

This region is primarily a mixture of grazing land and cropland. A few very small areas are forested. About 29 percent of the land is federally owned grazing land. Wheat grown by dry farming methods is the major crop in the region, but oats, barley, lentils, and peas (fig. B-2) also are important. Fruits, mainly apples, are a major crop in the western part of the region. Potatoes, sugar beets, beans, and forage crops are grown under irrigation in the central Columbia basin in Washington and along the Snake River in Idaho. A variety of specialty crops are grown in local areas, including vegetables, vegetable seeds, mint, and hops. Grazing is the major land use in the drier parts of the region. Water erosion, wind erosion, surface compaction, maintenance of the content of organic matter and tilth in the soils, and conservation of soil moisture are major resource management concerns on cropland. Overgrazing and invasion of undesirable plant species are resource management concerns on grazing lands. ■

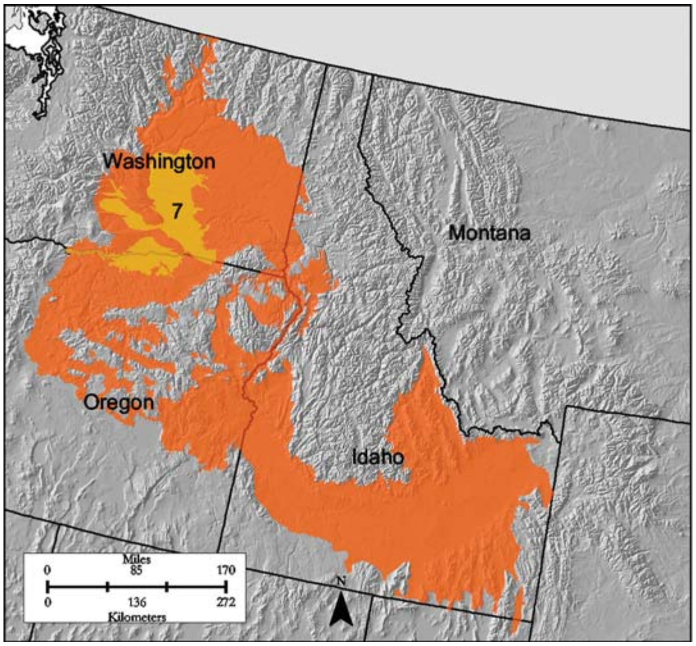

Figure 7-1: Location of MLRA 7 in Land Resource Region B.

7—Columbia Basin

This area (shown in fig.7-1) is in Washington (78 percent) and Oregon (22 percent). It makes up about 6,610 square miles (17,130 square kilometers). The towns of Yakima, Pasco, Kennewick, Richland, and Ephrata, Washington, and Hermiston, Oregon, are in this MLRA. Interstate 90 bisects the northern half of the MLRA, and Interstate 84 follows the south side of the Columbia River until it turns east to Pendleton. Interstate 82 connects Interstates 90 and 84, following the Yakima River for most of its length. Many State and national wildlife refuges occur in this MLRA. The Larson Air Force Base, the Hanford Atomic Energy Reservation, the Umatilla Army Depot, and the Boardman Bombing Range also are in the MLRA.

Physiography

This MLRA is in the Walla Walla Plateau Section of the Columbia Plateaus Province of the Intermontane Plateaus. Elevation ranges from 300 to 2,000 feet (90 to 610 meters), but most of the area is 300 to 1,200 feet (90 to 365 meters) above sea level. In general, the area is a smooth, gently sloping plain broken by some steep basalt ridges. The smooth plain also is dissected into large areas by rivers and streams.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Columbia (1702), 40 percent; Middle Columbia (1707), 38 percent; Yakima (1703), 17 percent; and the Lower Snake (1706), 5 percent. The Columbia River flows through this MLRA, and the Snake and Yakima Rivers join the Columbia River within the MLRA. The Deschutes, John Day, and Umatilla Rivers enter the Columbia River on the Oregon side in this area.

Geology

This MLRA is almost entirely underlain by Miocene basalt flows. Columbia River basalt is covered in most areas with as much as 200 feet of eolian, lacustrine, and alluvial deposits. This basin generally corresponds to the vast temporary lakes created by floodwaters from glacial Lakes Missoula and Columbia. Most of the fluvial and lacustrine sediments were deposited about 16,000 years ago, when an ice dam on the ancient Columbia River burst and when glacial Lake Missoula periodically emptied, creating catastrophic floods.

Climate

The average annual precipitation is 6 to 10 inches (150 to 255 millimeters) in most of this area, but it can be as high as 20 inches (150 to 255 millimeters) in the southwest and northwest corners. This MLRA is the warmest and driest MLRA within the Columbia Plateau geographic area. Two-thirds of the precipitation occurs in winter from low-intensity, Pacific frontal storms. The winter precipitation typically occurs as a mixture of rain and snow. Summers are dry. The average annual temperature is 49 to 53 degrees F (9 to 12 degrees C). In most of this area, the freeze-free period averages 160 days and ranges from 130 to 200 days. Including the extremes at the edges of the area, the freeze-free period averages 220 days and ranges from 170 to 265 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 2.1%; ground water, 1.7%
Livestock—surface water, 0.1%; ground water, 0.1%
Irrigation—surface water, 80.0%; ground water, 10.8%
Other—surface water, 4.2%; ground water, 1.0%

The total withdrawals average 2,860 million gallons per day (10,825 million liters per day). About 14 percent is from ground water sources, and 86 percent is from surface water sources. This area is in the rain shadow of the Cascade Mountain Range. Irrigation is necessary for the production of agricultural crops. The Columbia, Yakima, and Snake Rivers supply large quantities of surface water for irrigation. Surface water runoff is dominated by snowmelt, and water quality is good to excellent. Most of the irrigation water is diverted from the natural river channels or is pumped to a higher elevation and delivered to individual farms by gravity flow. Some high salt loads occur in irrigation return flows. Surface water is scarce in all nonirrigated areas.

Although ground water supplies have increased since irrigation became established in the area, they are largely untapped. The principal aquifer within this MLRA is Columbia River basalt, which consists of three units in Washington called the Grand Ronde, Wanapum, and Saddle Mountain. The Grand Ronde aquifer occurs primarily in the west, along the Yakima River, and in the southeast, along the Snake River. The Wanapum and Saddle Mountain aquifers occur in most of the rest of the MLRA. The basalt aquifer in Oregon consists of five different groups. The basalt aquifers provide almost all of the domestic water supply on the Columbia Plateau. The Columbia Plateau unconsolidated aquifer occurs under a large area around Moses Lake. This aquifer consists of glacial drift and terrace and valley fill sediments. The aquifers in Oregon occur in areas of river valley alluvium and basin fill. Ground water is of good quality and has low levels of dissolved solids. It is hard or moderately hard. Applications of fertilizer in agricultural areas are creating high nitrate levels in some wells. Ground water beneath the Hanford Atomic Energy Reservation has been degraded by industrial spills and seepage.

Soils

The dominant soil orders in this MLRA are Aridisols and Entisols. The soils in the area dominantly have a mesic soil temperature regime, an aridic soil moisture regime, and mixed mineralogy. They generally are moderately deep to very deep, well drained to excessively drained, and loamy. Haplocalcids formed in eolian deposits on hills (Adkins series) and in loess over lacustrine deposits on stream terraces (Sagehill series). Haplocambids formed in outwash on outwash terraces (Malaga series) and in mixtures of loess, glaciofluvial deposits, lacustrine deposits, alluvium, and colluvium on hills, plateaus, benches, and terraces (Prosser, Shano, Starbuck, and Warden series). Haplodurids formed in loess and glaciolacustrine sediments (Burke series) and alluvium (Taunton series) on terraces, plains, and mesas. Torriorthents formed in glaciofluvial deposits or alluvium (Burbank and Hezel series) or in lacustrine deposits (Kennewick series) on terraces. Torripsamments formed in sandy eolian material on dunes (Quincy series).

Biological Resources

This area supports shrub-grass associations. Basin big sagebrush, Wyoming big sagebrush, and bluebunch wheatgrass are the dominant species on the medium textured soils. Bitterbrush and needleandthread are abundant on the sandy soils. Very shallow soils support stiff sagebrush and Sandberg bluegrass. Inland saltgrass, basin wildrye, and greasewood grow on saline-alkali soils.

Some of the major wildlife species in this area are coyote, hawks, eagles, prairie falcon, pheasant, sharp-tailed grouse, sage grouse, gray partridge, chukar, California quail, and burrowing owl.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 41%
Grassland—private, 28%; Federal, 14%
Urban development—private, 7%
Water—private, 5%
Other—private, 5%

About two-fifths of this area supports native grasses and shrubs grazed by cattle. Another two-fifths is irrigated cropland used for fruits, vegetables, sugar beets, hops, grain, hay, and pasture. The use of sprinkler irrigation has rapidly increased in the area. Less than one-tenth of the area is urban.

The major soil resource concerns on cropland are wind erosion, water erosion, and maintenance of the content of organic matter and tilth in the soils. The major concerns on rangeland are overgrazing and invasion of undesirable plant species.

Conservation practices on cropland generally include conservation crop rotations, crop residue management, waste utilization, nutrient management, pest management, filter strips, and irrigation water management. These practices help to control erosion and protect water quality.

Conservation practices on rangeland generally include brush management, prescribed grazing, prescribed burning, exclusion from use as needed, and range planting. Rangeland conservation systems help to control erosion, improve forage production, and protect water quality.

Conservation practices on pasture and hayland generally include prescribed grazing, forage harvest management, nutrient management, waste utilization, and filter strips. These practices protect water quality and aquatic habitat for fish and wildlife by reducing the movement of nutrients and pesticides to surface water and ground water. ■

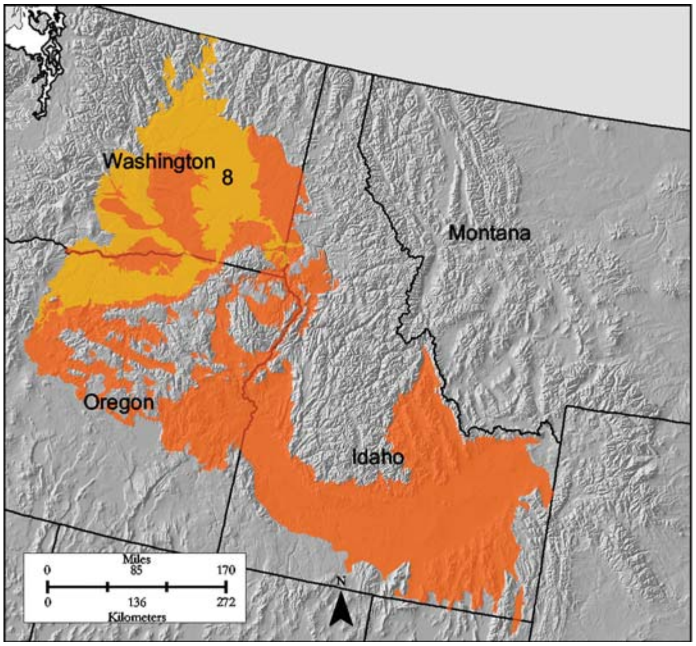

Figure 8-1: Location of MLRA 8 in Land Resource Region B.

8—Columbia Plateau

This area (shown in fig. 8-1) is primarily in Washington (75 percent) and Oregon (25 percent), but it includes a small area in Idaho. It makes up about 18,505 square miles (47,955 square kilometers). The towns of Pendleton, Oregon, and Walla Walla and Ellensburg, Washington, are in this MLRA. Interstate 90 bisects the northern half of the MLRA, and Interstate 84 follows the south side of the Columbia River until it turns east to Pendleton. Interstate 82 connects Interstates 90 and 84, following the Yakima River for most of its length. Grand Coulee Dam on the Columbia River and many State wildlife refuges occur in the area. Parts of the Yakama and Colville Indian Reservations also occur in the area.

Physiography

Almost all of this area lies within the Walla Walla Plateau Section of the Columbia Plateaus Province of the Intermontane Plateaus. The plateau is nearly level to steeply sloping, and its surface is a series of rolling hills with young, incised valleys. Some areas of the western and far northwestern parts of this MLRA lie within the Northern and Middle Cascade Mountains of the Cascade-Sierra Mountains Province of the Pacific Mountain System. Some areas of the far northern and northeastern parts of the MLRA are within the Northern Rocky Mountains Province of the Rocky Mountain System. The valley of the south-flowing Okanogan River separates the Pacific Mountain and Rocky Mountain Systems near the Canadian border.

Elevation in this area is 1,300 to 3,600 feet (395 to 1,100 meters). The area is characterized by a nearly level basalt plateau. The higher elevations occur along the western and northernmost edges of the area. Steep slopes are common along the walls of the major valleys and in scablands.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Columbia (1702), 45 percent; Middle Columbia (1707), 32 percent; Yakima (1703), 12 percent; and Lower Snake (1706), 11 percent. The south- and west-flowing Columbia River bisects this area. Two major tributaries of the Columbia, the Yakima and Snake Rivers, cross the middle portions of this MLRA. The Deschutes and John Day Rivers enter the Columbia River from the Oregon side.

Geology

This MLRA is almost entirely underlain by Miocene basalt flows. Columbia River basalt is covered in many areas with as much as 200 feet of loess and volcanic ash. Small areas of sandstones, siltstones, and conglomerates of the Upper Tertiary Ellensburg Formation are along the western edge of this area. Some Quaternary glacial drift covers the northern edge of the basalt flows, and some Miocene-Pliocene continental sedimentary deposits occur south of the Columbia River, in Oregon. The sediments in Oregon were deposited during episodes of natural damming of the Columbia River. These river-laid deposits have layers of ash-flow tuffs and some interbedded rhyolite flows. A wide expanse of scablands in the eastern portion of this MLRA, in Washington, was deeply dissected about 16,000 years ago, when an ice dam that formed ancient glacial Lake Missoula was breached several times, creating catastrophic floods.

The geology of the northernmost part of this MLRA is distinctly different from that of the rest of the area. Alluvium, glacial outwash, and glacial drift fill the valley floor of the Okanogan River and the side valleys of tributary streams. The fault parallel with the valley separates pre-Tertiary metamorphic rocks on the west, in the Cascades, from older, pre-Cretaceous metamorphic rocks on the east, in the Northern Rocky Mountains. Mesozoic and Paleozoic sedimentary rocks cover the metamorphic rocks for most of the length of the valley on the west.

Climate

The average annual precipitation is 10 to 16 inches (255 to 405 millimeters) in most of this area. It can be as low as 6 inches (150 millimeters) along the boundary with the drier Columbia Basin and as high as 36 inches (915 millimeters) in the foothills in the valley of the Okanogan River. More than 80 percent of the precipitation occurs in fall, winter, and spring from low-intensity, Pacific frontal storms. The precipitation typically occurs as rain in fall and spring but may occur as either rain or snow in winter. The average annual temperature is 48 to 54 degrees F (8 to 12 degrees C) in most of the area. It can be as low as 41 degrees F (5 degrees C) in the valley of the Okanogan River. In most areas the freeze-free period averages 190 days and ranges from 130 to 245 days. The longest freeze-free periods are along the border between this area and the Columbia Basin and in the river gorges. The freeze-free period can be as short as 100 days in the higher parts of the valley of the Okanogan River.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 3.5%; ground water, 1.9%
Livestock—surface water, 0.1%; ground water, 0.1%
Irrigation—surface water, 77.3%; ground water, 8.8%
Other—surface water, 7.1%; ground water, 1.1%

The total withdrawals average 4,925 million gallons per day (18,640 million liters per day). About 12 percent is from ground water sources, and 88 percent is from surface water sources. This area is in the rain shadow of the Cascade Mountain Range. The low or moderate precipitation limits the choice of agricultural enterprises. The major rivers provide water for irrigation along their courses, but small streams provide little water. Surface water runoff is dominated by snowmelt, and water quality is good to excellent. Some high salt loads occur in irrigation return flows.

The principal aquifer in the northernmost part of this MLRA is the Northeast glacial drift aquifer underlying the valley of the Okanogan River. Some ground water is derived from small areas of glacial drift and terrace-and-valley or basin fill aquifers along the western edges of the MLRA and south of the Columbia River, in Oregon. In the rest of the MLRA, the supplies of ground water in the underlying basalt are small and mostly untapped. The Columbia River basalt aquifer consists of three units in Washington called the Grand Ronde, Wanapum, and Saddle Mountain. The Grand Ronde occurs in the west, the Wanapum dominates the east, and the Saddle Mountain lies between the other two. The basalt is not differentiated in Oregon. Ground water is of good quality and has low levels of dissolved solids. The basalt aquifers provide almost all of the domestic water supply on the Columbia Plateau. The water is hard or moderately hard. Applications of fertilizer in agricultural areas are creating high nitrate levels in some wells.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a mesic soil temperature regime, a xeric soil moisture regime, and mixed mineralogy. They generally are moderately deep to very deep, well drained, and loamy. Haploxerolls formed in loess (Anders, Condon, Mikkalo, Ritzville, and Walla Walla series), loess mixed with glaciofluvial sediments (Roloff series), ash over loess (Valby series), loess over outwash (Benge series), mixed materials (very shallow Bakeoven and shallow Kuhl series), and colluvium (shallow Lickskillet series) on uplands. Argixerolls (Bagdad, Morrow, and Renslow series) formed in loess on plateaus and hills. Durixerolls (Willis series) formed in ash over loess on terraces and uplands. Haploxerolls (Esquatzel, Hermiston, and Onyx series) formed in alluvium on flood plains.

Biological Resources

This area supports shrub-grass associations. Basin big sagebrush, Wyoming big sagebrush, and bluebunch wheatgrass are dominant on the moderately deep to very deep, gently sloping and moderately sloping soils and on soils that have steep and very steep south exposures. Basin big sagebrush and Idaho fescue are dominant on most moist sites and on moderately steep to very steep north exposures. Stiff sagebrush, low sagebrush, and Sandberg bluegrass are dominant on shallow and very shallow, stony soils. Small stands of ponderosa pine, along with oak on the warmer sites along the Columbia River, are on north-facing slopes, in canyons and draws, and along stream channels. Dwarf hardwoods of hackberry and maple also grow in canyons and draws. Snowberry is the most common shrub in the pine stands. Poison-oak is the most common shrub in the oak stands.

Some of the major wildlife species in this area are mule deer, coyote, bobcat, goshawk, Cooper's hawk, sharp-tailed grouse, pheasant, Canada goose, cackling goose, English sparrow, and dusky horned lark. The species of fish in the area include steelhead trout, rainbow trout, brown trout, Chinook salmon, bullhead, channel catfish, and sturgeon.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 43%
Grassland—private, 42%; Federal, 6%
Forest—private, 3%
Urban development—private, 2%
Water—private, 1%
Other—private, 3%

More than two-fifths of this area is cropland, which is mostly dry-farmed. Where the annual precipitation exceeds 14 inches (355 millimeters), the main crops are wheat, barley, peas, and lentils, but a small acreage is used for alfalfa, grass, or improved pasture. Where the annual precipitation is less than about 14 inches (355 millimeters), a cropping system of alternate grain and summer fallow is used. Small areas along the major streams are used for irrigated vegetables, apples, or hay. Less than one-half of the area is used as rangeland. A few small areas are used as woodland.

The major soil resource concerns on cropland are wind erosion, water erosion, sedimentation of streams and road ditches, and maintenance of the content of organic matter and tilth in the soils. The major concerns on rangeland are overgrazing and invasion of undesirable plant species.

Conservation practices on cropland generally include conservation crop rotations, crop residue management, terraces, waste utilization, nutrient management, pest management, filter strips, grassed waterways, and irrigation water management. These practices help to control erosion and protect water quality. Conservation practices on rangeland generally include brush management, prescribed grazing, prescribed burning, exclusion from use as needed, and range planting.

Conservation practices on pasture and hayland generally include prescribed grazing, forage harvest management, nutrient management, waste utilization, and filter strips. These practices protect water quality and aquatic habitat for fish and wildlife by reducing the movement of nutrients and pesticides to surface water and ground water.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control surface compaction, the erosion caused by concentrated flow, and sediment delivery to streams. ■

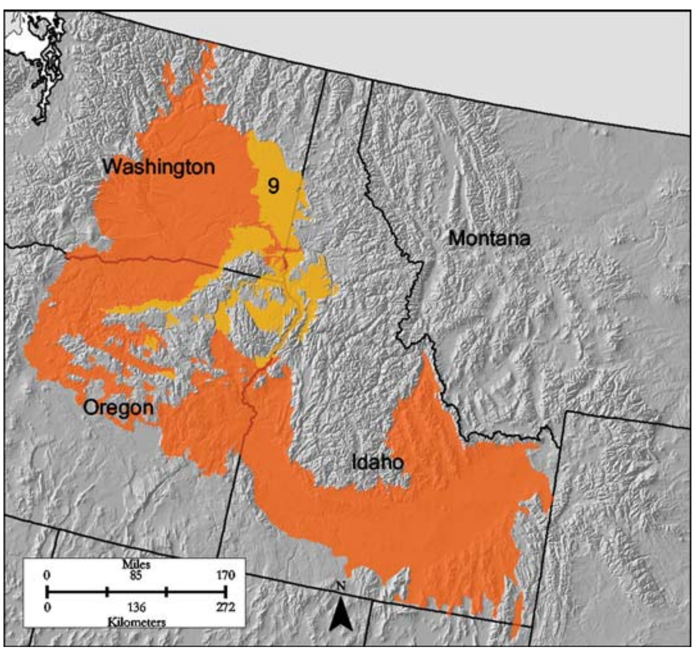

Figure 9-1: Location of MLRA 9 in Land Resource Region B.

9—Palouse and Nez Perce Prairies

This area (shown in fig. 9-1) is in Washington (52 percent), Oregon (28 percent), and Idaho (20 percent). It makes up about 8,810 square miles (22,825 square kilometers). The towns of Moscow, Idaho, and Pullman, Washington, are in this MLRA. Spokane, Washington, is just outside the northern border of the MLRA. Interstate 90 crosses the northern half of the MLRA, and Interstate 84 crosses the southernmost parts. Very small portions of the Wallowa-Whitman and Umatilla National Forests occur in this MLRA. The Turnbull and Chief Joseph State Wildlife Refuges and the Umatilla, Coeur d'Alene, and Nez Perce Indian Reservations also are in this MLRA.

Physiography

Almost all of this MLRA lies within the Walla Walla Plateau Section of the Columbia Plateaus Province of the Intermontane Plateaus. The area is characterized by an undulating basalt plaeau that has been highly dissected. The major streams have cut deep, steep-walled canyons. The plateau is nearly level to steeply sloping, and its surface is moderately dissected or strongly dissected. Slopes are mostly hilly and steep. Some areas in the southeastern portion of this MLRA are in the Blue Mountain Section of the Columbia Plateaus Province. Small areas on the eastern edge of the area are in the Northern Rocky Mountains Province of the Rocky Mountain System. Elevation along the major streams is about 650 feet (200 meters). On most of the plain, however, it ranges from 2,000 to 4,000 feet (610 to 1,220 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Snake (1706), 72 percent; Middle Columbia (1707), 12 percent; Kootenai-Pend Oreille-Spokane (1701), 11 percent; Upper Columbia (1702), 2 percent; and Middle Snake (1705), 1 percent. The Snake River flows in the center of this MLRA, where it forms the border between Washington and Idaho and between Oregon and Idaho. The Spokane River forms part of the northern boundary of the MLRA.

Geology

This MLRA is almost entirely underlain by Miocene basalt flows. Columbia River basalt is covered in many areas by thick layers of loess and volcanic ash. Some Mesozoic sedimentary rocks occur along the eastern edge of the southeast limb of this MLRA, and some Precambrian sediments are exposed in a portion of the MLRA in the southeast corner of Washington.

Climate

The average annual precipitation is 13 to 28 inches (330 to 710 millimeters) in most of this area. It can be as low as 9 inches (230 millimeters) along parts of the western border and as high as 43 inches (1,090 millimeters) on the southern border, where the area butts against MLRAs that are much higher in elevation. Winter precipitation, primarily snow, occurs during low-intensity, Pacific frontal storms. During winter, these storms produce occasional rains that fall on frozen or thawing ground surfaces. High-intensity, convective thunderstorms produce some rain during the growing season. Precipitation is evenly distributed throughout fall, winter, and spring. Summers are relatively dry. The average annual temperature is 47 to 54 degrees F (8 to 12 degrees C) in most of this area, but it can be as low as 40 degrees F (5 degrees C) at the higher elevations in the south. Including the extremes at the edges of this MLRA, the freeze-free period averages 165 days and ranges from 100 to 230 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 10.7%; ground water, 7.4%
Livestock—surface water, 0.3%; ground water, 2.4%
Irrigation—surface water, 47.2%; ground water, 6.4%
Other—surface water, 20.6%; ground water, 4.9%

The total withdrawals average 625 million gallons per day (2,365 million liters per day). About 21 percent is from ground water sources, and 79 percent is from surface water sources. Precipitation is adequate for dryland farming. The Snake River and many of the smaller rivers and streams provide water for irrigation and hydroelectric power generation. Surface water runoff is dominated by snowmelt, and water quality is good to excellent. Some high sediment and salt loads occur during high runoff periods and in irrigation return flows. Runoff from mine tailings and from municipal and industrial waste causes problems with surface water quality in some areas.

The principal aquifer in this MLRA is Columbia River basalt. The basalt has layers of tuffaceous sediments that also yield ground water. Some ground water is derived from small areas of glacial drift and terrace-and-valley or basin fill deposits. The Columbia River basalt aquifer consists of three units in Washington called the Grand Ronde, Wanapum, and Saddle Mountain, all of which occur in this MLRA. The basalt is not differentiated in Idaho or Oregon. The ground water is of good quality and has low levels of dissolved solids. It is hard or moderately hard.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a mesic or frigid soil temperature regime, a xeric soil moisture regime, and mixed mineralogy. They are generally deep or very deep, well drained or moderately well drained, and loamy. Haploxerolls formed in loess (Palouse and Athena series) on hills and in glaciofluvial deposits with an ash and loess mantle (Cheney series) and colluvium mixed with loess and ash (shallow Rockly series) on uplands. Argixerolls formed in loess (Larkin, Naff, Southwick, and Thatuna series) on hills and plateaus, in ash-mantled loess (Taney series) on plains and plateaus, in loess-mantled outwash (Hesseltine series), and in loess-mantled colluvium and residuum (Gwin and Waha series).

Biological Resources

This area supports grass, shrubs, and trees. The rangeland areas support a shrub-grassland plant community in which the dominant shrub is snowberry in the eastern part of the MLRA and big sagebrush in the western part. Bluebunch wheatgrass and Idaho fescue are the dominant grasses. Rose, common cowparsnip, black hawthorn, and arrowleaf balsamroot also are important. On forestland, ponderosa pine and Douglas-fir are the major tree species and the understory is mainly snowberry, ninebark, Idaho fescue, bluebunch wheatgrass, and pinegrass.

Some of the major wildlife species in this area are deer, pheasant, chukar, Hungarian partridge, California quail, mourning dove, thrushes, vireos, and woodpeckers.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 58%
Grassland—private, 29%; Federal, 1%
Forest—private, 7%
Urban development—private, 3%
Water—private, 1%
Other—private, 1%

Some small areas of forestland are on north-facing slopes. The rangeland in the area is on breaks, scablands, and buttes. Dry-farmed wheat is the major crop in the areas of cropland. Both annual cropping and fallow systems are common. Other important crops are barley, peas, lentils, alfalfa, and grasses. A small part of the cropland is irrigated and used for vegetables and other specialty crops. A few small areas are developed for urban uses.

The major soil resource concerns are water erosion and maintenance of the content of organic matter and tilth in the soils. Water erosion caused by snowmelt or rainfall when the soils are frozen or thawing is of particular concern. The major concerns on rangeland are overgrazing and invasion of undesirable plant species.

Conservation practices on cropland generally include conservation crop rotations; crop residue management systems, such as mulch-till and no-till; terraces; contour stripcropping; cross-slope farming; divided slopes; buffer strips; water- and sediment-control basins; grassed waterways; nutrient management; pest management; and irrigation water management. These practices help to control erosion and protect water quality. Conservation practices on rangeland generally include brush management, prescribed grazing, prescribed burning, exclusion from use as needed, and range planting.

Conservation practices on pasture and hayland generally include prescribed grazing, forage harvest management, nutrient management, waste utilization, and filter strips. These practices protect water quality and aquatic habitat for fish and wildlife by reducing the movement of nutrients and pesticides to surface water and ground water.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control surface compaction, the erosion caused by concentrated flow, and sediment delivery to streams. ■

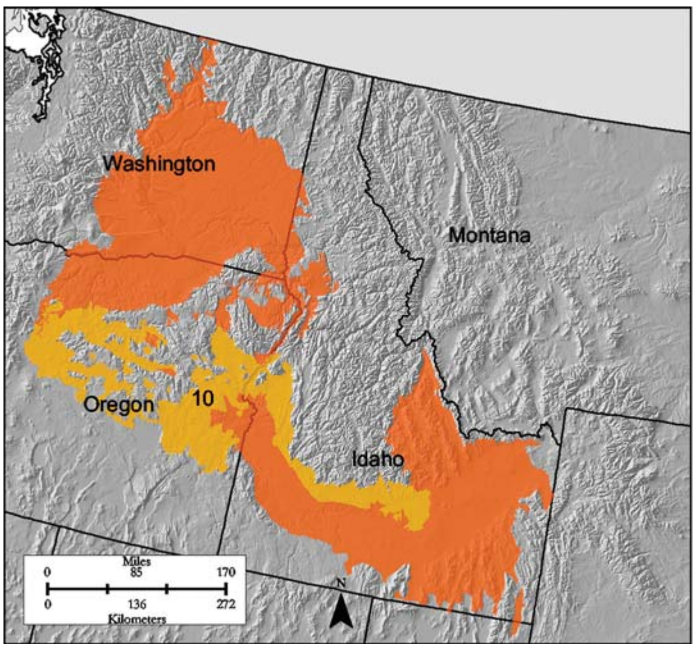

Figure 10-1: Location of MLRA 10 in Land Resource Region B.

10—Central Rocky and Blue Mountain Foothills

This area (shown in fig. 10-1) is in Oregon (71 percent) and Idaho (29 percent). It makes up about 17,515 square miles (45,385 square kilometers). Bend, Oregon, is near the western edge of the MLRA, and Boise, Idaho, is near the southern edge. Also included are John Day and Baker City, Oregon. Interstate 84 crosses the part of the area in western Oregon. Small parts of many national forests are on the edges of the area. Craters of the Moon National Monument is in the far eastern end of the area, and the John Day Fossil Beds National Monument is in the western part.

Physiography

Almost all of this MLRA is in the Columbia Plateaus Province of the Intermontane Plateaus. The western half of this area is in the Walla Walla Plateau Section, which is an area of rolling plateaus with young, incised valleys. A portion on the west edge of Idaho is in the Payette Section, which also is a young area of dissected plateaus. The eastern one-quarter of the MLRA is in two different physiographic provinces. The north half is in the Northern Rocky Mountains Province of the Rocky Mountain System, and the south half is in the Snake River Plain Section of the Intermontane Plateaus. A small area connecting the Oregon and Idaho parts of the MLRA is in the Harney Section of the Intermontane Plateaus. It is a young lava plateau with some evidence of recent volcanism. Small areas of the central portion of the MLRA are in the Blue Mountain Section, which is a dissected volcanic plateau in a complex of mountains. This MLRA is typified by gently rolling to steep hills, plateaus, and low mountains. Elevation ranges from 1,300 to 6,600 feet (395 to 2,010 meters), increasing from west to east.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Middle Snake (1705), 47 percent; Middle Columbia (1707), 36 percent; Upper Snake (1704), 14 percent; and Oregon Closed Basins (1712), 3 percent. The Deschutes and John Day Rivers, below the Blue Mountains in Oregon, are in this MLRA. The Snake River cuts across the area at the border between Oregon and Idaho.

Geology

The geology of this MLRA varies widely in age and lithology. It ranges from raw young lava flows at Craters of the Moon National Monument, Idaho, to very old Cretaceous rocks at John Day Fossil Beds National Monument, Oregon. The part of the area in southwest and south-central Idaho consists of basalt flows from the Columbia and Idaho Batholiths. The flows in the east half are cut by Yellowstone Volcanics. Some Paleozoic sediments occur in the east. Deep alluvial deposits are in valleys along the major streams and on fans adjacent to the mountains. Lithologies include basalt, rhyolite, schist, granite, graywacke, limestone, sandstone, and tuff.

Climate

The average annual precipitation is 8 to 16 inches (205 to 405 millimeters) in most of this area. It increases from west to east and with elevation. It is as much as 41 inches (1,040 millimeters) at the higher elevations along the northern border of the area. Precipitation is evenly distributed throughout fall, winter, and spring but is low in summer. Some high-intensity, convective thunderstorms occur during the growing season. Winter precipitation is primarily snow. The average annual temperature is 36 to 53 degrees F (2 to 12 degrees C). The freeze-free period averages 140 days and ranges from 60 to 220 days, decreasing from west to east and with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 1.7%; ground water, 0.9%
Livestock—surface water, 0.1%; ground water, 1.9%
Irrigation—surface water, 67.3%; ground water, 21.7%
Other—surface water, 5.1%; ground water, 1.4%

The total withdrawals average 4,100 million gallons per day (15,520 million liters per day). About 26 percent is from ground water sources, and 74 percent is from surface water sources. Streams provide enough irrigation water to meet the present needs along the major valleys. Runoff from snowmelt is the principal source of surface water, and water quality is good to excellent. The surface water is typically soft.

The principal aquifers in this MLRA are Columbia River basalt and basin fill and alluvial aquifers in Oregon and the basalt aquifer and sedimentary and volcanic aquifer in Idaho. The chemical quality of the ground water is good to excellent, meeting national drinking water standards. The water is hard or moderately hard. In Idaho, the ground water can be thermal, 170 to 200 degrees F (76 to 95 degrees C), or nonthermal, 78 degrees F (25.5 degrees C). Thermal water sources generally are more than 400 feet from the land surface. Nonthermal water wells typically are less than 400 feet deep.

Soils

The dominant soil order in this MLRA is Mollisols. Aridisols are of minor extent. The soils in the area have a mesic or frigid soil temperature regime, a xeric or aridic soil moisture regime, and mixed or smectitic mineralogy. They are very shallow to very deep, well drained, and clayey or loamy. Haploxerolls formed in residuum (Bakeoven series) and colluvium (Lickskillet, Rockly, and Westbutte series) on hills, plateaus, and mountains. Palexerolls (Simas series) formed in mixed loess and colluvium on hills. Argixerolls formed in ash (Tub series), in eolian sediments (Madras series), in residuum (Deshler, Gem, Merlin, Reywat, and Waterbury series), and in residuum mixed with alluvium, colluvium, or loess (Ateron, McCarey, Riggins, Ruckles, and Vitale series) on hills, plateaus, and mountains. Argixerolls also formed in mixed alluvium and colluvium on fan terraces, hills, and mountains (Simonton series).

Biological Resources

This area supports a shrub-grass association. Big sagebrush, bluebunch wheatgrass, and Idaho fescue are the dominant species. Stiff sagebrush, low sagebrush, and Sandberg bluegrass are dominant on the drier sites. Antelope bitterbrush grows on moist sites. Western juniper is associated with rock outcrop and rubbly areas. With the suppression of wildfires, western juniper has greatly expanded its extent in Oregon.

Some of the major wildlife species in this area are antelope, mule deer, coyote, porcupine, beaver, golden eagle, Cooper's hawk, and chukar. The species of fish in the area include trout in the perennial streams and rivers; steelhead trout and salmon in the Deschutes and John Day Rivers in Oregon; and warm-water fish, such as bluegill, crappie, perch, catfish, and bass, in ponds and reservoirs.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 8%
Grassland—private, 43%; Federal, 42%
Forest—private, 1%; Federal, 3%
Urban development—private, 1%
Water—private, 1%
Other—private, 1%

Nearly half of the MLRA is federally owned and managed by the Bureau of Land Management. The rest is mainly in farms or ranches. Most of the area is used for livestock grazing. Irrigated agriculture occurs along the major rivers and in the Deschutes Basin in Oregon. Both irrigated and nonirrigated agriculture occur on the Camas Prairie in Idaho. Alfalfa and small grains are the dominant crops. Specialty crops, such as mint, carrots, onions, and fruits, can be grown in local areas.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, loss of nutrients, streambank erosion, mass movement of soil caused by overuse of irrigation water, conservation of soil moisture, and preservation of water quality.

Conservation practices on cropland generally include irrigation water management, water-control structures, irrigation system improvements, nutrient management, critical area plantings, and streambank stabilization.

Conservation practices on rangeland and pasture generally include prescribed grazing, spring development, watering facilities, wells, pipelines, fencing, and brush management. Cool-season grasses, both introduced and native, are often planted to improve production and forage quality. Renovation of old pastures may include chiseling, disking, and applying fertilizer. ■

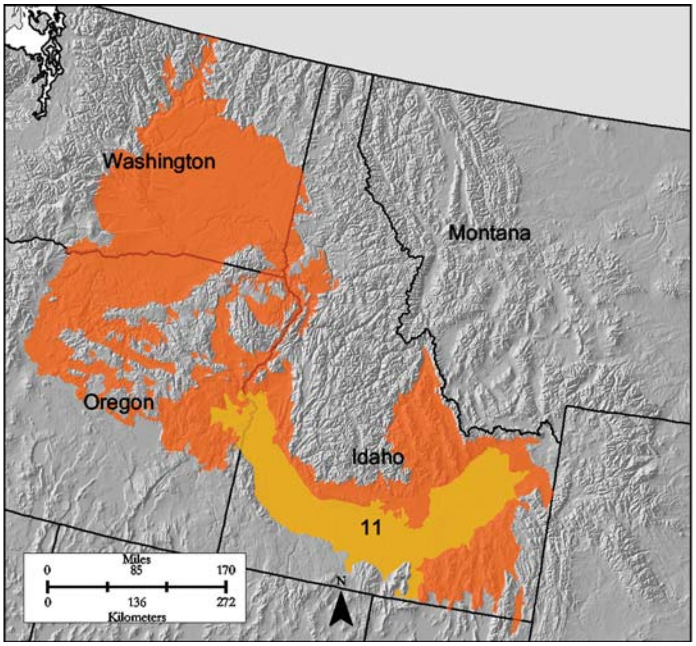

Figure 11-1: Location of MLRA 11 in Land Resource Region B.

11—Snake River Plains

This area (shown in fig. 11-1) is in Idaho (94 percent) and Oregon (6 percent). It makes up about 16,475 square miles (42,685 square kilometers). Most of the area is on the Snake River Plain in Idaho. A small area is west of the Snake River in Oregon. Boise, Twin Falls, and Idaho Falls, Idaho, and Ontario, Oregon, are in this MLRA. Interstate 84 follows the Snake River through the west half of the area, Interstate 15 cuts across the easternmost part, and Interstate 86 connects Interstates 84 and 15 in Pocatello, Idaho, on the southern boundary of the MLRA. Part of the Fort Hall Indian Reservation, the Deer Flat National Wildlife Refuge, the Snake River Birds of Prey Wilderness Study Area, and the Idaho National Engineering and Environmental Laboratory are in this MLRA.

Physiography

All of this MLRA is in the Columbia Plateaus Province of the Intermontane Plateaus. The west half is in the Payette Section, and the east half is in the Snake River Plain Section. These two sections are essentially young, nearly level to gently sloping lava plateaus. Elevation ranges from 2,100 to 5,000 feet (640 to 1,525 meters). Some of the major streams have cut deep, steep-walled canyons in the basalt flows and terraces. Alluvial fans, terraces, and bottom lands are gently sloping or moderately sloping.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Snake (1704), 63 percent, and Middle Snake (1705), 37 percent. The Snake River, which has broad alluvial terraces paralleling it, runs through the center of the MLRA.

Geology

This area consists of lava plains formed from the Idaho Batholith and from Columbia River basalt flows. Floods from a breach of glacial Lake Bonneville formed the valley of the Snake River Plain. The present-day Snake River cut through the glacial outwash, lacustrine deposits, and river alluvium and into the lava plain on the valley floor, leaving broad terraces along the river. Loess covers most of this MLRA. Alluvial fans encroach on the edges of the plains, where they are bordered by mountains.

Climate

The average annual precipitation is 7 to 12 inches (180 to 305 millimeters) in most of this area. It can be as high as 20 inches (510 millimeters) at the higher elevations in the northeast corner. Spring rains are important to agriculture on the Snake River Plain. Most of the precipitation falls as rain in fall, winter, and spring. Snowfall is common during winter. Little or no precipitation occurs in summer. The average annual temperature is 41 to 55 degrees F (5 to 13 degrees C). The freeze-free period averages 165 days and ranges from 110 to 220 days. It is shortest in the northeastern part of the area.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.2%; ground water, 1.0%
Livestock—surface water, 0.0%; ground water, 2.8%
Irrigation—surface water, 61.6%; ground water, 32.8%
Other—surface water, 0.4%; ground water, 1.0%

The total withdrawals average 13,240 million gallons per day (50,115 million liters per day). This is the second highest amount of water used among all of the MLRAs. About 38 percent is from ground water sources, and 62 percent is from surface water sources. Large quantities of surface water are available for irrigation along the Snake River and its tributaries. The surface water is derived primarily from snowmelt runoff. It is soft water of good to excellent quality.

Ground water is plentiful in some of the deep alluvial deposits throughout the area, in the lava north of the Snake River in eastern and south-central Idaho, and in the Columbia River basalt in Oregon. The ground water comes from the sedimentary and volcanic aquifers under the Snake River Plain in the western half of the area. The water is hard or moderately hard and is of good to excellent quality. It is used extensively for irrigation. In Idaho, the ground water can be thermal, 170 to 200 degrees F (76 to 95 degrees C), or nonthermal, 78 degrees

F (25.5 degrees C). Thermal water sources generally are more than 400 feet from the land surface. Nonthermal water wells typically are less than 400 feet deep.

Soils

The dominant soil order in this MLRA is Aridisols. The soils in the area dominantly have a mesic or frigid soil temperature regime, an aridic soil moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep and generally are well drained. They are silty, loamy, or clayey and commonly are skeletal. Haplocalcids formed in loess (Pancheri series), in mixed alluvium and lacustrine deposits (Declo series), and in mixed loess and alluvium (Portneuf and Bahem series) on fan terraces, hills, and plains. Calciargids (Power and Paulville series) formed in mixed loess and ash over alluvium on plains and in valleys. Argidurids formed in mixed loess and ash over alluvium (Chilcott, Elijah, and Purdam series) and in mixed alluvium and ash (Colthorp series) on plains and terraces and in valleys. Haplocambids formed in loess and alluvium over basalt (Trevino series) on plains.

Biological Resources

This area supports an overstory of sagebrush and an understory of grasses. Big sagebrush, winterfat, shadscale, Indian ricegrass, needleandthread, Thurber needlegrass, and Sandberg bluegrass grow on the lower Snake River Plains. Big and threetip sagebrush, bluebunch wheatgrass, Thurber needlegrass, and arrowleaf balsamroot grow on the middle Snake River Plains. Bluebunch wheatgrass and big sagebrush grow on the upper Snake River Plains. Black sagebrush and Gardner's saltbush are dominant on some soils. Phlox, tapertip hawksbeard, biscuitroot, and penstemon also are important.

Some of the major wildlife species in this area are mule deer, antelope, bald eagle, golden eagle, and pheasant. The species of fish in the area include rainbow trout, walleye, brown trout, kokanee, smallmouth bass, perch, black crappie, and sturgeon.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 28%
Grassland—private, 18%; Federal, 47%
Urban development—private, 4%
Water—private, 1%
Other—private, 2%

Rangeland and irrigated cropland are the major uses in this area. Forage production is low, and annual grasses have invaded much of the rangeland in the western part of the area as a result of repeated wildfires. About one-fourth of the area (the plains bordering the Snake River and its tributaries) is irrigated. Potatoes, grain, sugar beets, beans, and alfalfa hay are the principal crops. The area has a wide variety of specialty crops, such as hops, vegetables, vegetable seeds, mint, and onions, especially in the Treasure Valley west of Boise. Some areas are used as irrigated pasture.

The major soil resource concerns on cropland are wind erosion, water erosion, and maintenance of the content of organic matter and tilth in the soils. The major concerns on rangeland are overgrazing and invasion of undesirable plants.

Conservation practices on cropland generally include conservation crop rotations, crop residue management, waste utilization, nutrient management, pest management, filter strips, and irrigation water management. These practices help to control erosion and protect water quality. Conservation practices on rangeland generally include brush management, prescribed grazing, prescribed burning, exclusion from use as needed, and range planting.

Conservation practices on pasture and hayland generally include prescribed grazing, forage harvest management, nutrient management, waste utilization, and filter strips. These practices protect water quality and aquatic habitat for fish and wildlife by reducing the movement of nutrients and pesticides to surface water and ground water. ■

12—Lost River Valleys and Mountains

This area is entirely in Idaho (fig. 12-1). It makes up about 6,070 square miles (15, 735 square kilometers). It has no major cities. The major centers of commerce are Challis and Salmon. Interstate 15 crosses the far eastern end of the area. Several national forests are in this MLRA, including the Salmon, Targhee, and Challis National Forests.

Physiography

This area is almost entirely within the Northern Rocky Mountains Province of the Rocky Mountain System. It consists of deeply dissected mountain uplands and intermontane basins aligned along a northwest to southeast axis. The mountains are not anticlinal ranges. Elevation ranges from 4,000 feet (1,220 meters) in the valleys to more than 12,000 feet (3,660 meters) at the highest mountain crests. Steep or very steep mountains make up about 50 percent of the area. The expansive valleys are level to moderately steep. Broad coalesced alluvial fans extend from the foot of the mountains to the stream terraces in the center of the valleys. The southern end of the area extends out onto a high part of the Snake River Plain Section of the Columbia Plateaus Province of the Intermontane Plateaus. This young lava plateau is level to steep. Alpine glaciation was quite extensive in the mountains of this MLRA.

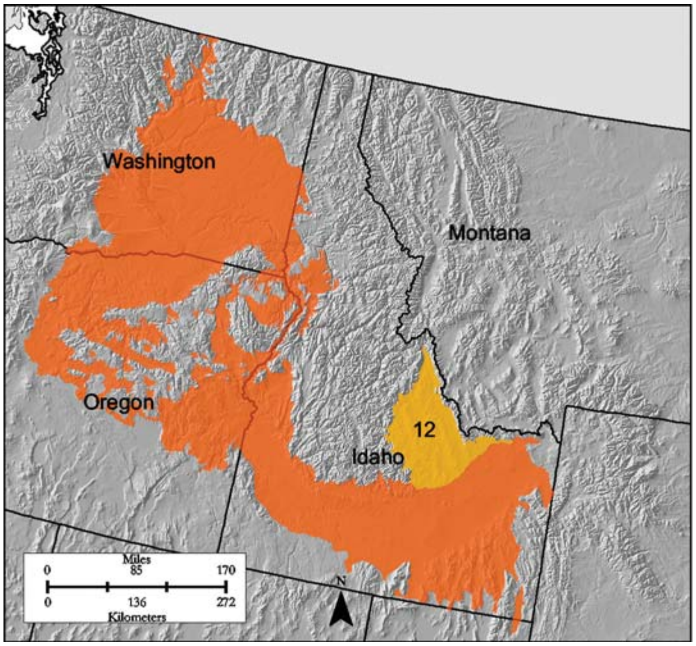

Figure 12-1: Location of MLRA 12 in Land Resource Region B.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Snake (1704), 55 percent, and Lower Snake (1706), 45 percent. The Lemhi and Pahsimeroi Rivers are major tributaries to the Salmon River. The Big Lost and Little Lost Rivers flow into alluvial sinks in the southeast portion of the MLRA. The East Fork of the Salmon River is in this area. The Salmon River is a major tributary of the Snake River, joining the Snake near the Idaho, Oregon, and Washington borders.

Geology

Mixed sedimentary and metasedimentary rocks and volcanic rocks underlie the mountains. The Idaho Batholith and Challis Volcanics dominate the north half of the area, and Paleozoic sediments are more common in the south half. The valleys and the portion of this area on the Snake River Plain are deeply mantled by recent alluvium and some lacustrine deposits. The rivers are incised with terraces in the valleys, and high alluvial fans occur on the valley floors and Snake River Plain next to the mountains.

Climate

The average annual precipitation is 7 to 25 inches (180 to 635 millimeters) in the valleys and 45 inches (1,145 millimeters) or more on mountain crests. Most of the precipitation occurs as rain and snow in fall, winter, and spring. It is dominantly snow in winter. A few high-intensity, convective thunderstorms occur during summer. The average annual temperature is 35 to 45 degrees F (2 to 7 degrees C) in the valleys but is much lower in the mountains. The freeze-free period averages 110 days and ranges from 65 to 150 days in most of this area. At the higher elevations, however, freezing may occur during every month of the year.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.1%; ground water, 0.3%
Livestock—surface water, 0.0%; ground water, 1.0%
Irrigation—surface water, 62.5%; ground water, 35.8%
Other—surface water, 0.0%; ground water, 0.4%

The total withdrawals average 1,050 million gallons per day (3,975 million liters per day). About 37 percent is from ground water sources, and 63 percent is from surface water sources. Both the surface water and the ground water are available in limited supply. The Big Lost and Little Lost Rivers are two of many streams north of the Snake River Plain that do not reach the Snake River. Streamflow infiltrates to the basalt aquifer under the Snake River Plain. The only other sources of ground water in this area are valley fill aquifers.

The moderate precipitation provides enough moisture for grass and shrubs to grow on mountain slopes. The valleys depend on the streamflow of the Salmon, Lemhi, Pahsimeroi, Big Lost, and Little Lost Rivers for livestock and irrigation water. The surface water is derived from snowmelt runoff and is of exceptionally good quality. Springs and deep wells in the valleys supply ground water for domestic uses and for irrigation. The ground water is of good to excellent quality and is typically nonthermal, less than 78 degrees F (25.5 degrees C).

Soils

The dominant soil orders in this MLRA are Mollisols and Aridisols. Histosols occur in old oxbows on flood plains. The soils in the area dominantly have a frigid or cryic soil temperature regime, a xeric or aridic soil moisture regime, and mixed, carbonatic, or siliceous mineralogy. They generally are very deep, well drained, and loamy, loamy-skeletal, or sandy-skeletal. Argixerolls (Cronks and Dacont series), Argicryolls (Zeebar series), and Calciargids (Dawtonia series) formed in colluvium on foothills and mountains. Haplocalcids (Simeroi and Whiteknob series) and Haplocambids (Pahsimeroi series) formed in alluvium on outwash fans and alluvial fans. Haplocalcids (Zer series) also formed in loess and colluvium on mountains and foothills. Natrargids (Millhi series) formed in lacustrine sediments on foothills and lake terraces. Cryosaprists (Grandjean series) formed in organic material in old oxbows on flood plains at high elevations.

Biological Resources

This area supports desert shrub, shrub-grass, and forest vegetation. Indian ricegrass, needleandthread, shadscale, Gardner's saltbush, and scarlet globemallow are the major species in the valleys. Wyoming big sagebrush, black sagebrush, low sagebrush, winterfat, bluebunch wheatgrass, Sandberg bluegrass, and a variety of forbs grow on mountain footslopes. Bluebunch wheatgrass, prairie junegrass, oniongrass, Indian paintbrush, lupine, sedge, big and low sagebrush, and rabbitbrush grow on low mountain slopes. Curl-leaf mountain mahogany, Douglas-fir, aspen, and Rocky Mountain juniper grow on mountain slopes. Subalpine fir, whitebark pine, and limber pine grow at the higher elevations.

Some of the major wildlife species in this area are antelope, mule deer, elk, mountain goat, bighorn sheep, coyote, jackrabbit, shore birds, songbirds, and birds of prey. The major game fish are various species of trout.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 5%
Grassland—private, 11%; Federal, 83%
Other—private, 1%

Nearly all of this area is federally owned grassland. The grasses and shrubs on the lower slopes and in valleys are grazed. Irrigated land in the valleys is used mostly for hay and pasture, but potatoes and small grains also are grown. The high mountain slopes are forested, and some lumber is produced.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, loss of nutrients, streambank erosion, mass movement of soil caused by overuse of irrigation water, conservation of soil moisture, and preservation of water quality.

Conservation practices on cropland generally include irrigation water management, water-control structures, irrigation system improvements, nutrient management, riparian forest buffers, critical area plantings, and streambank stabilization. Conservation practices on rangeland and pasture generally include prescribed grazing, development of springs, watering facilities, wells, pipelines, fencing, and brush management. Cool-season grasses, both introduced and native, are often planted to improve production and forage quality. Renovation of old pastures may include chiseling, disking, and applying fertilizer.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control surface compaction, the erosion caused by concentrated flow, and sediment delivery to streams. ■

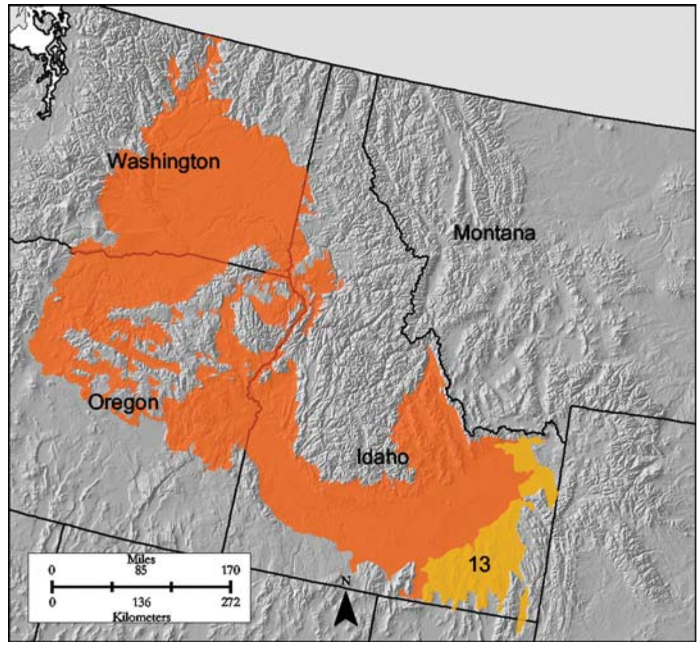

Figure 13-1: Location of MLRA 13 in Land Resource Region B.

13—Eastern Idaho Plateaus

This area (shown in fig. 13-1) is primarily in Idaho (99 percent), but it includes a small part of Utah (1 percent). It makes up about 7,270 square miles (18,840 square kilometers). It has no major cities. Rexburg, Idaho Falls, and Pocatello, Idaho, are directly west of the MLRA boundary. Interstate 15 cuts this area in half north to south and intersects with Interstate 86 in Pocatello just outside of the MLRA. The Fort Hall Indian Reservation and several national forests are in this MLRA, including the Caribou, Cache, and Targhee National Forests. Yellowstone and Grand Teton National Parks occur just outside the northeast boundary.

Physiography

Most of this area is in the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. This is an area of isolated, fault-block mountain ranges that are dissected. The mountain ranges are aligned almost north to south and are separated by aggraded desert plains. This MLRA is very narrow where the Snake River crosses it. The portion north of the Snake River, about 20 percent of the area, is in the Snake River Plain Section of the Columbia Plateaus Province of the Intermontane Plateaus. The plain is a young lava plateau. The southeast corner and the easternmost valleys of the Snake and Teton Rivers in the area are in the Middle Rocky Mountains Province of the Rocky Mountain System. Elevation ranges from 4,500 to 6,600 feet (1,370 to 2,010 meters) on the plateaus and foothills and is as much as 9,500 feet (2,895 meters) on mountain crests.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Snake (1704), 74 percent; Bear (1601), 19 percent; and Great Salt Lake (1602), 7 percent. The Bear, Portneuf, Blackfoot, Snake, and Teton Rivers all occur in this area.

Geology

The foothills and dissected plateaus and plains are mantled by loess ranging from a few inches to tens of feet in thickness. The underlying bedrock is mainly sedimentary and metasedimentary rock and some volcanic rock. Lacustrine deposits and deep alluvium fill some level valleys and basins. The plains and plateaus are separated by many rugged but discontinuous mountain ranges of folded sedimentary and metasedimentary rocks. Alluvial fans occur on the plains and valley floors at the foot of the mountains. Terraces occur along most of the larger rivers and creeks. The area has not been glaciated.

Climate

The average annual precipitation is mainly 12 to 25 inches (305 to 635 millimeters) but can be as high as 48 inches (1,220 millimeters) at the highest elevations. Most of the precipitation occurs as rain and snow in fall, winter, and spring. It is dominantly snow in winter. A few high-intensity, convective thunderstorms occur in summer. The minimum precipitation occurs from midsummer through autumn. The average annual temperature generally is 36 to 48 degrees F (2 to 9 degrees C), but it is lower in the mountains. The freeze-free period averages 130 days and ranges from 90 to 175 days. On the high mountains, however, freezing may occur every month of the year.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.1%; ground water, 0.4%
Livestock—surface water, 0.0%; ground water, 1.3%
Irrigation—surface water, 65.6%; ground water, 32.0%
Other—surface water, 0.0%; ground water, 0.5%

The total withdrawals average 1,875 million gallons per day (7,095 liters per day). About 34 percent is from ground water sources, and 66 percent is from surface water sources. Precipitation provides water for dryland farming and grazing, but careful management is needed to make the best use of the limited amount. Several large streams that flow through the area supply water for irrigation, mainly outside the MLRA. Small but important tracts are irrigated along the Bear, Portneuf, Blackfoot, Snake, and Teton Rivers. The surface water is primarily from snowmelt runoff and is soft and of very good quality. The ground water is scarce, except near the large streams with valley fill aquifers. The basalt aquifer beneath the Snake River Plain also is a source of ground water. Many wells and springs produce thermal water at temperatures that exceed 170 to 200 degrees F (76 to 95 degrees C). The ground water is hard or moderately hard but is of good quality.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a frigid or cryic soil temperature regime, a xeric soil moisture regime, and mixed mineralogy. They generally are deep or very deep, well drained, and loamy. Haploxerolls formed in loess and alluvium (Lanoak, Newdale, Rexburg, and Ririe series) and colluvium (Hondoho series) on foothills, terraces, and mountains. Argicryolls (Dranyon series) formed in alluvium, colluvium, and residuum on mountains and uplands. Haplocryolls (Driggs series) formed in alluvium on alluvial fans and terraces. Haplocryolls (Pavohroo series) formed in alluvium and colluvium on mountains. Palecryolls (Robin series) and Haplocryolls (Tetonia and Rin series) formed in loess on foothills and terraces.

Biological Resources

The rangeland in this MLRA supports grass-shrub vegetation. Bluebunch wheatgrass is dominant. There are minor amounts of Idaho fescue and Wyoming big sagebrush. Arrowleaf balsamroot, prairie junegrass, Sandberg bluegrass, Nevada bluegrass, oniongrass, slender wheatgrass, milkvetch, lambstongue, fawnlily, phlox, penstemon, antelope bitterbrush, rabbitbrush, snowberry, and low Oregon-grape are other important plants. Scattered stands of Douglas-fir with some aspen and bigtooth maple grow on north-facing slopes and on the more moist soils. Lodgepole pine and subalpine fir grow at the higher elevations.

Some of the major wildlife species in this area are mule deer, moose, elk, beaver, muskrat, mink, rabbit, pheasant, sage grouse, Hungarian partridge, sharp-tailed grouse, ruffed grouse, blue grouse, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 30%
Grassland—private, 34%; Federal, 24%
Forest—private, 5%; Federal, 3%
Urban development—private, 2%
Water—private, 1%
Other—private, 1%

Nearly three-fourths of this area is in farms and ranches. The rest, including the Fort Hall Indian Reservation, is federally owned. About one-third of the area is dry-farmed, and wheat and barley are the major crops. Some land along the large streams is irrigated. It is used mainly for alfalfa hay, meadows, and pasture, but some small grains and potatoes also are grown. More than one-half of the area is rangeland. Less than one-tenth of the area, consisting of high mountain slopes, is in forests that produce some timber.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and productivity of the soils, and conservation of soil moisture.

Conservation practices on irrigated cropland generally include conservation crop rotations, crop residue management (such as no-till and mulch till), surface roughening, nutrient management, irrigation water management, and water- and sediment-control basins. Conservation practices on nonirrigated cropland generally include no-till systems that reduce the need for summer fallow, crop residue management, mulch till, deep tillage, cross-slope farming, nutrient management, water- and sediment-control basins, and terraces.

Conservation practices on rangeland and pasture generally include prescribed grazing, spring development, watering facilities, wells, pipelines, fencing, streambank restoration, and brush management. Cool-season grasses, both introduced and native, are often planted to improve production. Renovation of old pastures may include chiseling, disking, and applying fertilizer.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control surface compaction, the erosion caused by concentrated flow, and sediment delivery to streams. ■

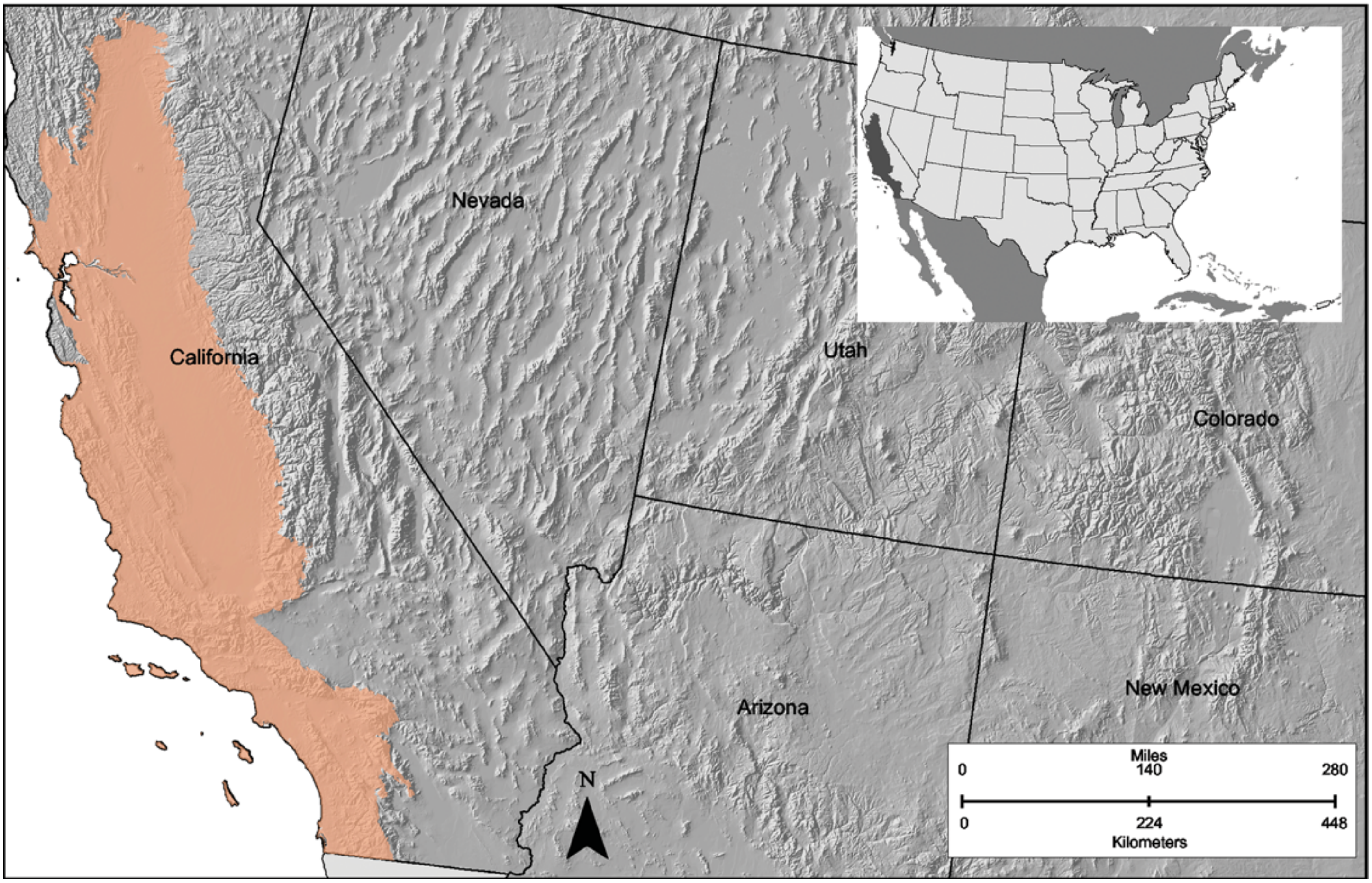

Figure C-1: Location of Land Resource Region C.

C—California Subtropical Fruit, Truck, and Specialty Crop Region

This region is entirely in California (fig. C-1). It makes up 62,350 square miles (161,570 square kilometers). Most of the people in California live in this region.

This region of low mountains and broad valleys has a long, warm growing season and low precipitation. The average annual precipitation ranges from less than 6 inches to 12 inches (150 to 305 millimeters) in the San Joaquin Valley, 12 to 30 inches (305 to 760 millimeters) in areas along the coast south of San Francisco and in the Sacramento River Valley, and 15 to 40 inches (380 to 1,015 millimeters) in areas along the coast north of San Francisco. Very little precipitation falls from late in April through October. The average annual temperature is 41 to 67 degrees F (5 to 20 degrees C). The lower temperatures occur at the higher elevations. The freeze-free period averages 245 to 345 days in most of this region. It ranges from 125 days in the higher mountains to 365 days in the valleys in the southern part of the region.

The total withdrawals of freshwater in this region average about 30,260 million gallons per day (114,535 million liters per day). About 54 percent is from surface water sources, and 46 percent is from ground water sources. This land resource region is one of six that use more than 30,000 million gallons per day (113,550 million liters per day). Surface water is abundant in the mountains of northern California. Federal and State water projects have built reservoirs that store snowmelt runoff for later use in the more heavily populated southern California. Reservoir water is sent to the Sacramento-San Joaquin Delta via the Sacramento River and is pumped out of the delta and into a Federal (Delta-Mendota) and California canal system that moves the water down to the southern terminus of the San Joaquin Valley. The canal water is used for public supplies in cities along the way, but most is used for irrigation. Ground water is used for public supply and irrigation in the San Joaquin Valley. About 79 percent of all water used in the State is used for irrigation, and 17 percent is public supply. A little over half of the public supply comes from ground water. Los Angeles and San Diego obtain most of their water from the Colorado River via canals.

Figure C-2: Lettuce and almond trees in an area of Land Resource Region C.

The soils in this region are dominantly Alfisols, Entisols, Mollisols, and Vertisols. The dominant suborders are Xeralfs, Xererts, and Xerolls, which are extensive on uplands and the older terraces throughout the region. Fluvents, Orthents, and Ochrepts on flood plains and alluvial fans are the most important soils used for agricultural purposes in this region. The soils in the region dominantly have a thermic soil temperature regime, a xeric soil moisture regime, and mixed or smectitic mineralogy.

Federal land makes up about 16 percent of this region. It makes up about 48 percent of the part of the region in the Southern California Mountains. This region has a wide variety of crops and agricultural enterprises (fig. C-2). Citrus fruits, other subtropical and tropical fruits, and nuts are the major crops in the southern half of the region. Many kinds of vegetables, grown mainly under irrigation, are produced throughout the region. Rice, sugar beets, cotton, grain crops, and hay also are important crops. Dairying is a major enterprise near the large cities. Beef cattle production on feedlots and rangeland also is important.

Many of the soils on flood plains and low terraces in the valley of the San Joaquin River are affected by salts and must be skillfully managed for good crop production. The agricultural drainage water in this valley commonly has a high salt load, and the salinity in receiving streams typically increases in a downstream direction. Control of the water erosion caused by rainfall and irrigation and maintenance of the content of organic matter in the soils are soil resource concerns throughout this agriculturally rich region. Wind erosion is a hazard in the valley of the San Joaquin River and in some of the coastal valleys. Irrigation water management is a priority in this populous region, where agriculture and urban areas compete for good-quality water. Salinity and the intrusion of saltwater into aquifers are management concerns in the coastal valleys. ■

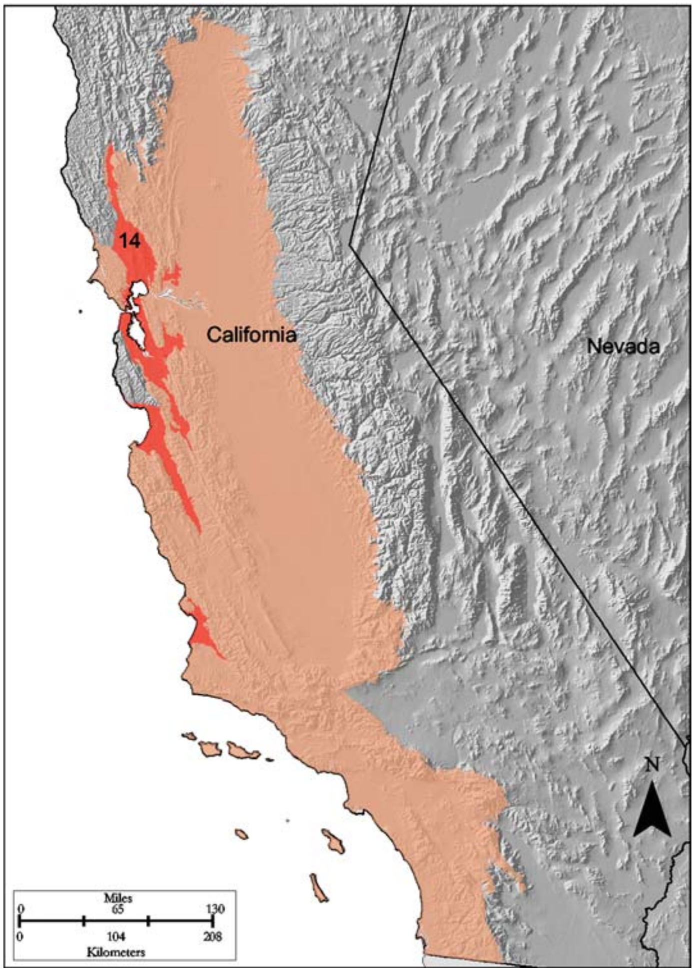

Figure 14-1: Location of MLRA 14 in Land Resource Region C.

14—Central California Coastal Valleys

This area is entirely in California (fig. 14-1). It makes up about 3,170 square miles (8,215 square kilometers). There are three parts in the area. The northern part includes the cities of Ukiah, Santa Rosa, and Napa. The central part includes all the metropolitan areas surrounding San Francisco and San Pablo Bay. The major cities in this part are San Francisco, Berkeley, Vallejo, Oakland, and San Jose. The southern part includes the towns of Santa Cruz, Monterey, and Carmel on the shores of Monterey Bay. Hollister, the city of Salinas, and the agriculturally important Salinas Valley are in inland areas in the southern part. Interstate 80 ends on the San Francisco side of the Bay Bridge. United States Highway 101 and California State Highway 1 are scenic drives as well as major thoroughfares in this area.

A number of tourist destinations are in this area, including the cities of San Francisco, Napa, Oakland, and Monterey. Alcatraz, the Golden Gate Bridge, the wineries in Napa Valley, the Monterey Bay Aquarium, and the beaches on the Pacific Ocean coastline are all tourist attractions. Moffett Field, the United States Naval Fuel Depot and Naval Supply Station, and the Oakland Army Base are in the San Francisco area. The Presidio of Monterey and the Naval Postgraduate School are in the Monterey Bay area. There are a number of national wildlife management areas and State parks along the coastline and bays in this area.

Physiography

This area is in the California Coast Ranges Section of the Pacific Border Province of the Pacific Mountain System. It is a network of gently sloping valley floors bordered by higher and more sloping terraces and alluvial fans and by steep uplands. Elevation ranges from sea level to 1,970 feet (600 meters), but it is less than 985 feet (300 meters) in most of the area.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: San Francisco Bay (1805), 46 percent; Central California Coastal (1806), 38 percent; and Klamath-Northern California Coastal (1801), 16 percent. The Russian River flows through the northern part of the area, and the Napa and Petaluma Rivers empty into San Pablo Bay. The Salinas River is in the southern part of the area. The Hetch Hetchy Aqueduct brings Sierra Nevada Mountain water from the Yosemite area to the bay area for municipal, public supply, and industrial uses. The aqueduct empties into the Upper Crystal Springs Reservoir, in the San Andreas Fault zone directly south of San Francisco.

Geology

With the possible exception of the Santa Maria Valley to the south, the coastal valleys in this area are structural basins. The elongated shape and northwest-southeast orientation of the valleys are strongly controlled by right-lateral strike-slip movement along a regional set of faults that includes the San Andreas, Rogers Creek, Hayward, and Calaveras Fault Zones and other potentially active and inactive faults. The San Andreas Fault Zone is a transform boundary where the North American plate is moving northwest relative to the Pacific tectonic plate to the west. The probability of a large magnitude earthquake is considered to be particularly high along the Rogers Creek-Hayward Fault Zones, which together extend from approximately Healdsburg, southeastward beneath San Pablo Bay, towards Milpitas.

These coastal valleys are partly filled with unconsolidated and semiconsolidated marine sedimentary rocks that were deposited during periodic encroachment of the sea and with unconsolidated nonmarine alluvial, flood-plain, alluvial-fan, and hillslope deposits derived from bedrock weathered from the adjacent uplands. Older, more consolidated eolian, lacustrine, and terrace deposits also occur. The coarser, more permeable nonmarine sand and gravel store relatively large volumes of fresh ground water; these coastal basin aquifers are variably confined, semiconfined, and unconfined and are in areas at risk of saltwater intrusion and overdraft.

Mesozoic and Tertiary bedrock exposed in the hills, foothills, and uplands in this MLRA include the Sonoma Volcanics exposed in and around Napa and Sonoma Valleys; graywackes, chert, ophiolites, and other units of the Franciscan Formation; metamorphics and granitics of the Salinian block flanking the Salinas Valley; and sedimentary formations exposed near the Salinas and Santa Maria Valleys. Landslides are common in steep areas underlain by rocks weakened by faulting and deformation (e.g., Central Belt Franciscan) and/or lack of cementation (e.g., Tertiary sedimentary shale formations).

Climate

The average annual precipitation in this area is 11 to 66 inches (280 to 1,675 millimeters). The higher amounts of precipitation occur at the higher elevations in the area north of San Francisco. Most of the rainfall occurs as low- or moderate-intensity, Pacific frontal storms during winter. This area is very dry from mid spring to mid autumn. Snowfall is rare. The average annual temperature is 56 to 61 degrees F (13 to 16 degrees C). The freeze-free period averages 315 days and ranges from 265 to 365 days. It is longest near the coast, and it becomes shorter with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 22.8%; ground water, 17.1%
Livestock—surface water, 0.1%; ground water, 0.5%
Irrigation—surface water, 15.3%; ground water, 37.9%
Other—surface water, 5.2%; ground water, 1.0%

The total withdrawals average 3,100 million gallons per day (11,735 million liters per day). About 56 percent is from ground water sources, and 44 percent is from surface water sources. The low or moderate rainfall and local streamflow are inadequate for present water needs. Water from adjoining MLRAs is brought in for agriculture and for the domestic and industrial requirements of the many large cities. For example, most of the public water in the bay area is provided by an aqueduct from the Hetch Hetchy Reservoir in the Sierra Nevada Mountains. The quality of the water in this reservoir is excellent. The quality of the water in the rivers in the valleys is not as good. Agricultural runoff, municipal and industrial wastes, and irrigation return flows are all sources of contamination of local surface water.

The major ground water sources in this area are the alluvium and older sediments in the coastal valleys. Surface water infiltrating from irrigated areas mixes with the shallow ground water in this aquifer, so some of the water that is pumped is a combination of surface and ground water. This water is very hard and requires softening for public, municipal, or domestic uses. It typically contains more than 1,000 parts per million (milligrams per liter) total dissolved solids, which exceeds the national drinking water standard. The yield of ground water in the deeper alluvial deposits, especially in the Santa Clara Valley, is declining, and the intrusion of seawater is becoming a problem. Nitrate and pesticide contamination in the shallow aquifer in the Salinas Valley also is becoming a concern.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Mollisols, and Vertisols. The soils in the area dominantly have a thermic soil temperature regime, a xeric soil moisture regime, and mixed or smectitic mineralogy. They generally are very deep, somewhat excessively drained to somewhat poorly drained, and loamy or clayey. Haploxeralfs (Arbuckle and Pleasanton series) and Xerofluvents (Metz and Yolo series) formed in alluvium on alluvial fans and stream terraces. Fluvaquents (Reyes series) formed in alluvium in marshes. Xeropsamments (Oceano series) formed in eolian deposits on dunes. Argixerolls (Chualar and Lockwood series) and Haploxerolls (Elder, Mocho, Salinas, and Sorrento series) formed in alluvium on alluvial fans and stream terraces. Endoaquerts (Clear Lake series) formed in alluvium in basins and swales. Haploxererts (Cropley series) formed in alluvium on alluvial fans and flood plains.

Biological Resources

This area supports grasses, brush, and trees. Naturalized annual grasses and forbs are dominant in many areas. Soft chess, wild oats, bromes, fescues, filaree, burclover, and some remnant perennials are the major species. Scattered valley oak grows on the well drained soils. Saltgrass, iodinebush, and other salt-tolerant plants grow in tidal areas. Some areas have a few remnant stands of redwood trees.

Some of the major wildlife species in this area are turkey, California quail, mourning dove, meadowlark, blackbird, white-crowned sparrow, white-tailed kite, robin, mockingbird, thrush, brown towhee, and cedar waxwing.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 19%
Grassland—private, 23%; Federal, 3%
Forest—private, 10%; Federal, 1%
Urban development—private, 28%
Water—private, 9%
Other—private, 7%

Most of the MLRA is in farms and ranches. The acreage used for urban development is increasing rapidly. The gently sloping soils in the valleys are intensively used for many kinds of crops. Truck crops, wine grapes, strawberries and other fruits, cut flowers, small grains, hay, and pasture are the principal crops grown on irrigated land. Small grains are the principal crops in dry-farmed areas. Dairy farming is an important enterprise near the large cities. The more sloping fans and foothills, making up one-fourth or more of the area, are in native range used for livestock grazing. Sites along streams are susceptible to flooding and bank cutting.

The major soil resource concerns are erosion, maintenance of the content of organic matter in the soils, and water quality. The erosion hazard is slight on the soils in valleys and on terraces and benches of the valleys, except where improper irrigation practices are more damaging than rainfall. If the surface is unprotected in winter, the hazard of sheet and gully erosion is severe on the sloping soils on coastal terraces and benches and on upland soils. Salinity and encroachment of seawater into ground-water basins are problems in areas of valleys near sea level.

The conservation practices that are important on cropland are those that control erosion. These practices include mulching, cover crops, irrigation water management, and tailwater return systems on the steeper irrigated slopes. The conservation practices that are important on dairy farms are manure-handling systems, including nutrient management. Prescribed grazing, fencing, and water management are the most important practices on rangeland and other grazing land. ■

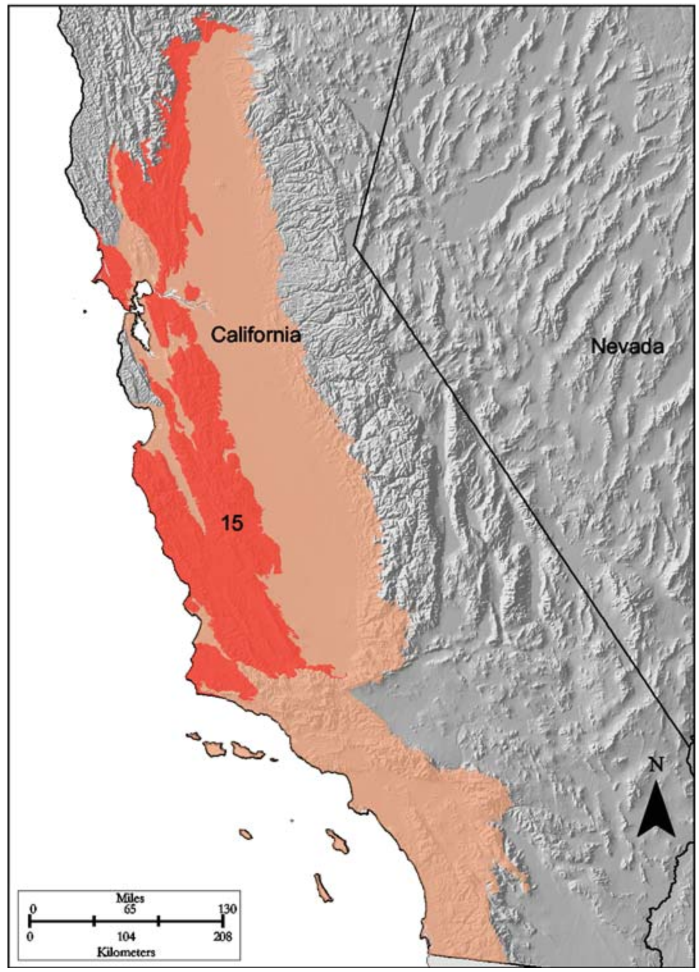

Figure 15-1: Location of MLRA 15 in Land Resource Region C.

15—Central California Coast Range

This area is entirely in California (fig. 15-1). It makes up about 17,840 square miles (46,235 square kilometers). The town of Clearlake is almost in the center of the northern part of this MLRA, and the towns of Suisun City and Benicia are at the south end of the northern half. The towns of Martinez, Concord, Pleasant Hill, and Alamo are in the north end of the southern half of the area. The towns of Atascadero and Paso Robles are in the south end of the southern half. The Hunter Liggett and Camp Roberts Military Reservations, Vandenburg Air Force Base, and Santa Ynez Indian Reservation are in the southern half. Parts of the Mendocino and Trinity National Forests occur along the west edge of the northern half of the area. The Los Padres National Forest is in the south end of the southern half. Interstate 80 crosses the junction of the northern and southern halves of the area, directly north of the Carquinez Straits, which connect the Sacramento-San Joaquin Delta with San Pablo Bay.

Physiography

All of this area is in the Pacific Border Province of the Pacific Mountain System. Most of this MLRA is in the California Coast Ranges Section of the province. The extreme northern end is in the Klamath Mountains Section, and the southwest corner is in the Los Angeles Ranges Section. The MLRA is an area of gently sloping to steep, low mountains. The coastal plains are narrow and discontinuous, and stream valleys are narrow and widely separated. Elevation ranges from sea level to 2,650 feet (810 meters) in most of the area, but it is 4,950 feet (1,510 meters) in some of the mountains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Central California Coastal (1806), 48 percent; Sacramento (1802), 20 percent; San Francisco Bay (1805), 12 percent; Tulare-Buena Vista Lakes (1803), 9 percent; San Joaquin

(1804), 8 percent; and Klamath-Northern California Coastal (1801), 3 percent. Clear Lake and Lake Berryessa are in the northern half of the area. This half is drained by Sacramento River tributaries, such as Cache Creek and Putah Creek. Few perennial streams are in the southern half of the area. The streams in this half typically drain to the Pacific Ocean.

Geology

The landscape and geology of the Coast Range are strongly controlled by right-lateral strike-slip movement along the San Andreas and other active and inactive faults that dissect the range. The northwest-southeast orientation of the river courses and intervening ridges reflects the area's youthful geologic history along a transform boundary, where the Pacific tectonic plate is moving northwest relative to the North American plate to the east. Recent and historic earthquakes centered in the Coast Range attest to the active plate motion and associated seismicity that continue to shape the landscape. These quakes include the 1906 San Francisco earthquake, the Loma Prieta earthquake of 1989, and numerous large earthquakes centered near Parkfield (most recently in September 2004).

Most of the Northern Coast Range is underlain by deformed and metamorphosed sandstones and shales of the Franciscan Formation, which were deposited offshore during the Mesozoic, conveyed eastward towards the Franciscan trench, and then subducted as a series of terranes beneath the old ocean floor at the continental margin. Narrow bands of serpentine-bearing ophiolites, representing remnants of an old ocean floor, separate these Franciscan terranes from the relatively undisturbed marine sedimentary rocks of the Great Valley sequence, which is exposed along the eastern margin of the Northern Coast Range. The Central Belt of the Franciscan Formation consists of a highly disturbed mélange, which was intensely sheared and deformed when strike-slip movement along the San Andreas Fault replaced subduction through the Franciscan trench beginning very roughly 30 million years ago. Mélange consists of relatively resistant metamorphic rocks and boulders "floating" in intensely sheared and weak matrix material. Steep areas underlain by Franciscan mélange tend to be highly prone to landslides.

The geology of the Southern Coast Range is highly varied. It includes bands of the Franciscan Formation along the northeast edge of the San Andreas Fault and along the southeast edge of the Nacimiento Fault in the Santa Lucia Range; Mesozoic granitics of the Salinian block, which were "rafted" hundreds of miles to their present locations in Pinnacles National Monument and elsewhere in the Coast Range by movement along the transform boundary; and Tertiary and Pleistocene marine and nonmarine sedimentary formations, including the diatomaceous Monterey Shale, which is a significant source rock for oil reserves.

Climate

In the part of this MLRA south of San Francisco, the average annual precipitation is 6 to 20 inches (150 to 510 millimeters) and snowfall is rare. The northern half of the MLRA can be divided into two rainfall and snowfall zones. In the southern half of the part of the MLRA north of San Francisco, the average annual precipitation is 18 to 40 inches (455 to 1,015 millimeters) and snowfall is rare. In the northern half of the part north of San Francisco, the average annual precipitation is 40 to 79 inches per year (1,015 to 2,005 millimeters) and snowfall is common. Precipitation is evenly distributed throughout fall, winter, and spring but is very low in summer. Coastal areas receive some moisture from fog in summer. Most of the rainfall occurs as low- or moderate-intensity, Pacific frontal storms during the period October to May. The average annual temperature is 51 to 66 degrees F (10 to 19 degrees C), decreasing from south to north. The freeze-free period averages 275 days and ranges from 180 to 365 days, decreasing in length with elevation and from south to north.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 51.6%; ground water, 13.3%
Livestock—surface water, 1.7%; ground water, 0.5%
Irrigation—surface water, 19.9%; ground water, 7.4%
Other—surface water, 4.5%; ground water, 1.1%

The total withdrawals average 680 million gallons per day (2,575 million liters per day). About 22 percent is from ground water sources, and 78 percent is from surface water sources. The low or moderate rainfall and moderate streamflow limit agriculture to dryfarming in most of the area. Reservoirs are used to store surface runoff for use during most of the year when streams are low. Surface water generally is of good quality and is suitable for almost all uses.

Ground water is limited in this area. There are some wells in alluvium and older sediments in the major river valleys and in low areas. This water is very hard and typically requires softening prior to its use. Levels of total dissolved solids exceed the national drinking water standard of 500 parts per million (milligrams per liter). Igneous rocks in this area have some ground water. Well yields are low since the water is in joints and fractures in the bedrock. Few test results are available, so little is known about the quality of this water.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Mollisols, and Vertisols. The soils in the area dominantly have a thermic soil temperature regime, a xeric soil moisture regime, and mixed or smectitic mineralogy. They generally are very shallow to deep, somewhat excessively drained or well drained, and loamy or clayey. Haploxeralfs (Vallecitos series), Xerorthents (Cieneba, Gaviota, and Shedd series), Argixerolls (Henneke, Los Gatos, and Los Osos series), Haploxerepts (Millsholm series), Dystroxerepts (Maymen series), Haploxerolls (Nacimiento, San Benito, Santa Lucia, and Sheridan series), and Haploxererts (Altamont, Diablo, and Sehorn series) formed in residuum on hills and mountains.

Biological Resources

This area supports grasses, grass-oak, and shrub vegetation. Naturalized annuals, including soft chess, bromes, fescues, wild oats, filaree, and burclover, characterize the open and oak woodlands. Blue oak, valley oak, and canyon live oak are the dominant trees. California sagebrush, coyotebrush, chamise, manzanita, ceanothus, and scrub oak are the major brush species. Forests of Douglas-fir, madrone, grand fir, tanoak, and bigleaf maple and a few remnant stands of redwood trees are along the west side of the Coast Range. Stands of ponderosa pine with madrone, black oak, live oak, California buckeye, manzanita, and ceanothus are on the drier sites.

Some of the major wildlife species in this area are black-tailed deer, feral pig, turkey, blue grouse, valley quail, and band-tailed pigeon. The species of fish in the area include trout, largemouth bass, bluegill, minnow, stickleback, channel catfish, bullhead, carp, sculpin, steelhead, salmon, and crappie.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 7%
Grassland—private, 48%; Federal, 13%
Forest—private, 21%; Federal, 4%
Urban development—private, 4%
Water—private, 2%
Other—private, 1%

More than four-fifths of this area consists of private land, mainly in farms and ranches. The rest generally is federally owned. About one-tenth of the area is used for dry-farmed grain, and slightly more than three-fifths is in range of native grasses and brush. Open woodland, also used for grazing, makes up about one-fourth of the area. A small acreage is used for urban development.

The major soil resource concerns are erosion, maintenance of the content of organic matter in the soils, water quality, and low infiltration rates resulting from hydrophobic soils. If the surface is unprotected in winter, the hazard of sheet and gully erosion is severe on the sloping soils on terraces and benches and on upland soils.

The conservation practices that are important on cropland include leaving crop residue on the surface. Prescribed grazing, fencing, and water management are the most important practices on rangeland and other grazing land. ■

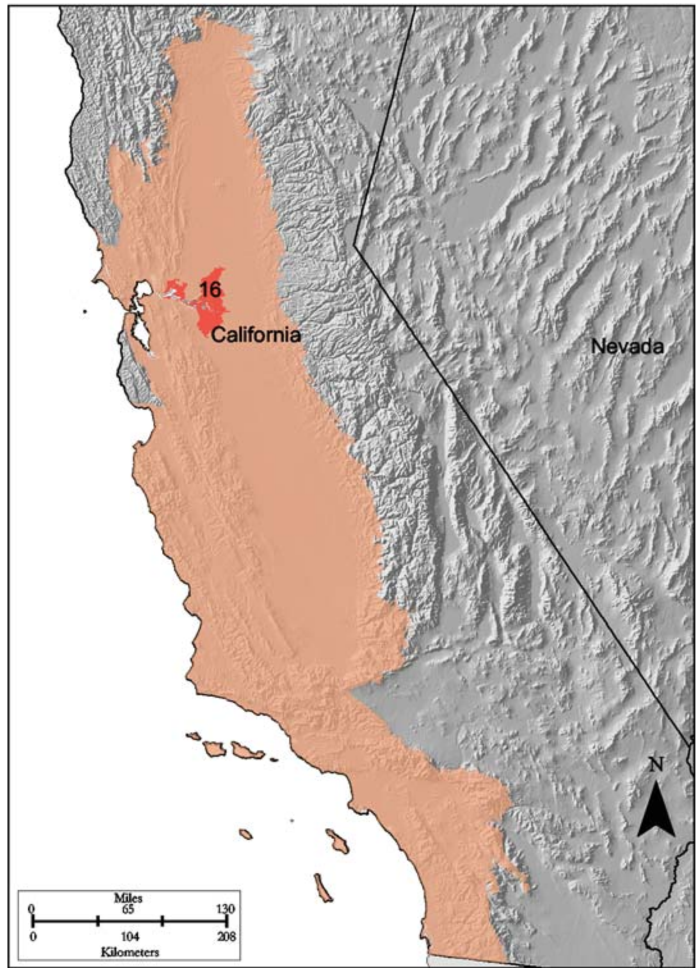

Figure 16-1: Location of MLRA 16 in Land Resource Region C.

16—California Delta

This area is entirely in California (fig. 16-1). It makes up about 805 square miles (2,080 square kilometers). It has no cities or large towns. Suisun, Honker, and Grizzly Bays and Franks Tract State Recreation Area are in the area. The delta is above the San Pablo and San Francisco Bays. It formed at the junction of the two major rivers draining the Central Valley of California—the Sacramento River to the north and the San Joaquin River to the south. A major pumping plant at Tracy lifts water from the delta into the California and Delta-Mendota Canals, which take the water south to farms in the Central

Valley and Tulare Lake Basin and to southern California cities. During periods of low flow, the plant causes a flow reversal and brackish water from San Pablo Bay can move up into the delta. A system of levees keeps the farmland from flooding.

Physiography

Most of this area is in the California Trough Section of the Pacific Border Province of the Pacific Mountain System. A small part at the west edge of the area is in the California Coast Ranges Section of the same province and division. This MLRA was originally the conjoined flood plain along the Sacramento and San Joaquin Rivers. As sediment from these rivers built up in San Pablo Bay, a delta formed, creating many streams that divide this nearly level area into "islands." Strong levees and drainage systems are needed to protect the islands from flooding. Elevation of the islands ranges from below sea level to slightly above sea level.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: San Joaquin (1804), 47 percent; Sacramento (1802), 35 percent; and San Francisco Bay (1805), 18 percent.

Geology

This area is underlain by interbedded marine, estuarine, and fine grained nonmarine sediments transported to the delta by the Sacramento and San Joaquin Rivers as they flowed into San Pablo Bay. As the sediments built up, a delta formed and freshwater mixed with brackish water in marshes and on flood plains. As the marsh vegetation became covered with new sediments, the organic matter content in the soils built up to very high levels. When drained and exposed to the air, these peaty soils oxidize and shrink and then subside.

Climate

The average annual precipitation in this area is 12 to 21 inches (305 to 535 millimeters). Summers are dry. Most of the rainfall occurs as low- or moderate-intensity, Pacific frontal storms during the period October to May. Snowfall is rare in this area. The average annual temperature is 59 to 61 degrees F (15 to 16 degrees C). The freeze-free period averages 345 days and ranges from 330 to 360 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 0.2%; ground water, 0.1%
Irrigation—surface water, 79.6%; ground water, 19.4%
Other—surface water, 0.6%; ground water, 0.2%

The total withdrawals average 720 million gallons per day (2,725 million liters per day). About 20 percent is from ground water sources, and 80 percent is from surface water sources. Almost all of the water is used for agriculture. Most of it comes from the many sloughs and waterways that cross the area. Controlling salinity and the intrusion of saltwater is a major concern.

The small amount of ground water used for irrigation on the east side of this area is pumped from the alluvium and older sediments in the Central Valley. This water is hard or very hard and generally contains about 300 parts per million (milligrams per liter) total dissolved solids. Nitrates from agricultural runoff can contaminate this shallow ground water.

Soils

The dominant soil orders in the MLRA are Entisols, Histosols, and Mollisols. The soils in the area dominantly have a thermic soil temperature regime, an aquic soil moisture regime, and mixed mineralogy. They generally are very deep, poorly drained or very poorly drained, and clayey. Fluvaquents formed in alluvium on flood plains and deltas (Valdez series) and in marshes (Reyes series). Endoaquepts (Tamba series) formed in alluvium in salt marshes. Haplosaprists formed in organic material in salt marshes (Joice series) and freshwater marshes (Kingile and Rindge series). Endoaquolls (Egbert, Gazwell, Peltier, and Ryde series) formed in alluvium in basins, marshes, and sloughs and on deltas.

Biological Resources

This area supports marsh vegetation. Fat-hen saltweed, brass buttons, alkali bulrush, cattails, tules, saltgrass, and pickleweed characterize the area.

Some of the major wildlife species in this area are small mammals, river otter, beaver, and various songbirds. The species of fish in the area include striped bass, black bass, crappie, sunfish, catfish, salmon, steelhead, varieties of minnows, and sturgeon. The area is extremely important for wintering waterfowl, neotropical migrants, and year-round shore birds.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 55%
Grassland—private, 7%; Federal, 1%
Urban development—private, 3%
Water—private, 17%
Other—private, 17%

More than one-half of this area is farmed. The most important crops are asparagus, sugar beets, potatoes, corn, grain, and hay grown under intensive management. Fruit trees, mainly pear trees, and some grapes are grown on slopes of the protecting levee system. Erosion of the levees by wave action is a continuous problem. Subsidence of the peaty and mucky soils also is a problem.

The major soil resource concern is the subsidence caused mainly by oxidation, wind erosion, and shrinkage of organic soils. The most important conservation practice on cropland is controlling the water table by applying irrigation and drainage water management and by flooding the fields during idle periods. Other important practices are conservation cropping systems, selection of water-tolerant crops for planting, and nutrient and pest management. ■

17—Sacramento and San Joaquin Valleys

This area is entirely in California (fig. 17-1). It makes up about 18,650 square miles (48,330 square kilometers). From north to south, the major towns or cities in this area are Redding, Red Bluff, Chico, Yuba City, Marysville, Woodland, Davis, Vacaville, Fairfield, Sacramento, Stockton, Modesto, Merced, Madera, Firebaugh, Fresno, Hanford, Visalia, and Bakersfield. Interstate 5 and California State Highway 99 both traverse the entire length of the area. Interstate 80 crosses the midpoint of the area in Sacramento. The MLRA includes Beale, McClellan, Mather, Travis, and Castle Air Force Bases; the Sacramento Army Depot, Lemoore Naval Air Station, and Naval Petroleum Reserves #1 and #2; and numerous national wildlife refuges. The area is locally known as the Central Valley and is part of the Pacific migratory waterfowl flyway.

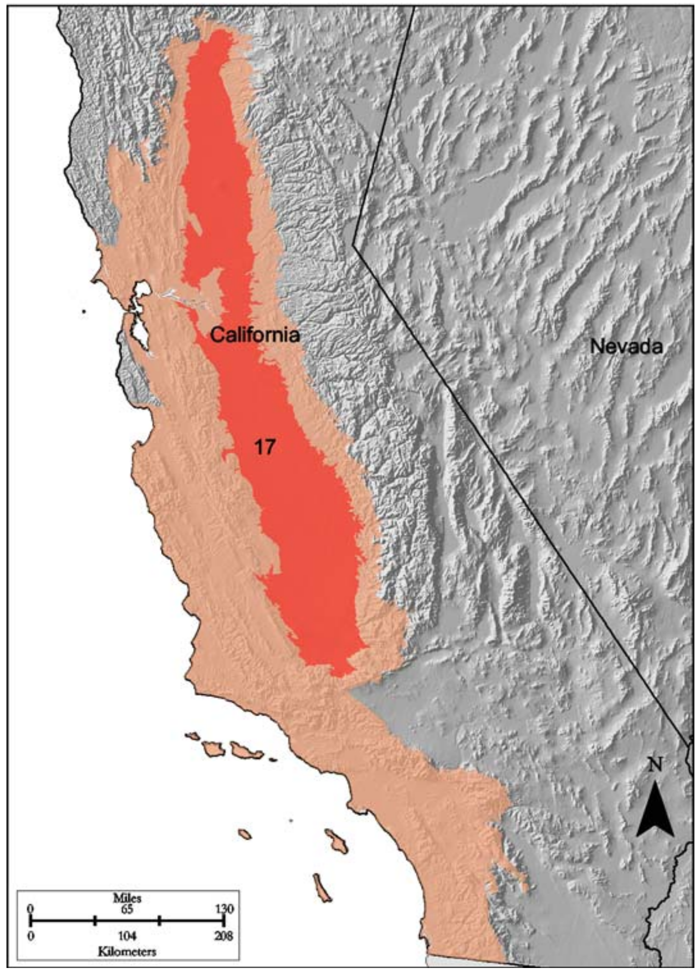

Figure 17-1: Location of MLRA 17 in Land Resource Region C.

Physiography

All of this area is in the Pacific Border Province of the Pacific Mountain System. Almost all of the area is in the California Trough Section. Small areas along the western border are in the California Coast Ranges Section. This area includes the valley basins adjacent to the Sacramento and San Joaquin Rivers, fans and flood plains of tributary streams, and terraces and foothills around the edge of the valleys. Elevation ranges from sea level to 660 feet (200 meters) in the foothills surrounding the Central Valley. The valley floor is almost flat, and relief is small even along the borders of the area.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Tulare-Buena Vista Lakes (1803), 42 percent; Sacramento (1802), 31 percent; and San Joaquin (1804), 27 percent. The Sacramento and San Joaquin Rivers are in this MLRA. The major water-supply reservoirs on the Sacramento River and its tributaries are just outside the north and east boundaries of the area. A stretch of the American River below Folsom Lake has been designated as a National Wild and Scenic River. Two major canals are in this area. The State-owned California Aqueduct and the Federal Delta-Mendota Canal move water from northern California, from the California Delta, to Buena Vista Lake directly southwest of Bakersfield.

Geology

California's Great Valley is underlain by as much as 8 or 9 miles of sediments derived from the adjacent uplands and deposited in a variety of marine and nonmarine environments. The Great Valley began to separate from the open ocean roughly 150 million years ago, when subduction of Franciscan marine sediments and volcanics beneath the edge of the old ocean floor jacked it up and created a barrier to movement of sediments. The oldest sediments were derived in large part from the early Sierra Nevada volcanoes and deposited in a deeper marine environment. The composition of the sediments shifted as the volcanic cover was stripped off, exposing the granites of the Sierra Nevada Batholith to erosion. At the same time, the valley started to fill and deposition was occurring in an increasingly shallow marine environment, particularly in the Sacramento Valley, where shallow marine environments started giving way to nonmarine depositional processes roughly 50 million years ago. The interbedded layers of clays, sands, silts, and gravel strongly influence subsurface hydrology and are a source of gas reserves in the Sacramento Valley and oil and gas reserves in the deeper San Joaquin Valley.

The uppermost sediments reflect a recent history of sedimentation in a variety of nonmarine depositional environments. The finer grained deposits are typically associated with flood plains, basins, and lakes. The coarser grained sands and gravel are deposited in stream channels and across alluvial fans. Erosional remnants of gravelly stream terraces and older sedimentary formations also occur, especially along the edges of the valley. Almost all of the surface of this area is covered by recent alluvial deposits. There are some sandy areas, but most of the deposits are flood-plain sediments with a texture of silt to clay. Some gravel occurs in terraces and abandoned channels along modern streams and rivers draining from the surrounding mountains down into this area. Some marine sediments are buried beneath these thick alluvial deposits. Sutter Butte, in the northern part of the Sacramento River Valley, consists of the eroded remnants of a volcano.

Climate

The average annual precipitation is 5 to 12 inches (125 to 305 millimeters) in the San Joaquin Valley. The Tulare Basin, at the southern end of this MLRA, typically receives less than 6 inches (150 millimeters) of rainfall per year. The average annual precipitation is 12 to 30 inches (305 to 760 millimeters) in most of the Sacramento Valley. It is 40 inches (1,015 millimeters) at the higher elevations on the edges of the valley at the north end. Summers are long, hot, and dry, and winters are cool and rainy. Most of the rainfall occurs as low- or moderate-intensity, Pacific frontal storms from October to May. Snow is very rare in this MLRA but has occurred in the Sacramento Valley from Sacramento to points farther north. The average annual temperature is 59 to 67 degrees F (15 to 20 degrees C), decreasing from south to north. The freeze-free period averages 325 days and ranges from 280 to 365 days, decreasing in length with elevation and from south to north.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.5%; ground water, 6.5%
Livestock—surface water, 0.4%; ground water, 0.7%
Irrigation—surface water, 51.5%; ground water, 38.1%
Other—surface water, 0.7%; ground water, 1.5%

The total withdrawals average 22,755 million gallons per day (86,240 million liters per day). This is the largest amount of water used in any MLRA. About 47 percent is from ground water sources, and 53 percent is from surface water sources. Because of the low rainfall and relatively small flow from streams, water is scarce in many parts of this area. Water for irrigated crops comes from stream diversions, wells, and canals of organized irrigation districts that obtain most of their water from State and Federal water systems. The Sacramento River supplies the most water for use in this area. The river water is hard but is of good quality and is suitable for drinking after minimal treatment. The tributaries of the San Joaquin River draining the Sierra Nevada Mountains to the east have water of excellent quality. Water in the lowland streams is often degraded by sediment and salts from agricultural irrigation and drainage and municipal and industrial waste discharges, especially during the summer low-flow season.

The deep alluvium and older sediments filling the Sacramento and San Joaquin Valleys are the sources of ground water in this area. Water beneath the Sacramento basin is hard and has a median concentration of about 300 parts per million (milligrams per liter) total dissolved solids. Boron concentrations exceed the national standard for drinking water in the southwest corner of the Sacramento basin. The boron comes from thermal springs in the Coast Range and upward seepage of ground water from marine sediments.

Water quality varies in the San Joaquin basin. The water is much fresher on the east side of the valley as it comes off the granite rocks in the Sierra Nevada Mountains. Total dissolved solids of 200 parts per million (milligrams per liter) are not uncommon on the east side of the valley, while levels 10 times higher typically occur on the west side, where recharge is from marine sediments in the Coast Range. A confining layer called the Corcoran Clay separates the water described above from deeper, confined ground water. The water below the Corcoran Clay has a more uniform level of total dissolved solids of about 1,000 parts per million (milligrams per liter). The ground water beneath the San Joaquin basin is hard, and boron concentrations may exceed the national standard for drinking water. The boron comes from thermal springs in the Coast Range and upward seepage of ground water from marine sediments. Ground subsidence has been significant (more than 20 feet in some areas) on the San Joaquin Valley floor because of historic excessive pumping of ground water aquifers, which has resulted in consolidation of the aquifers.

Soils

The dominant soil orders in the MLRA are Alfisols, Aridisols, Entisols, Mollisols, and Vertisols. The soils in the area dominantly have a thermic soil temperature regime, an aridic or xeric soil moisture regime, and mixed or smectitic mineralogy. They generally are very deep, well drained or moderately well drained, and loamy or clayey. Some soils are shallow to a duripan. Durixeralfs (Redding and San Joaquin series) and Palexeralfs (Newville series) formed in alluvium on terraces. Haplocambids (Cerini and Panoche series) formed in alluvium on alluvial fans. Haplargids (Milham series) formed in alluvium on alluvial fans and terraces. Xeropsamments (Delhi series), Xerorthents (Hanford series), and Torriorthents (Hesperia and Kimberlina series) formed in alluvium on flood plains, fans, and terraces. Haploxerolls (Grangeville and Nord series) formed in alluvium on alluvial fans and flood plains. Haploxererts (Capay series) formed in alluvium on alluvial fans and flats. Very poorly drained Endoaquerts (Willows series) formed in alluvium in basins.

Biological Resources

This area supports naturalized annuals and scattered trees. Wild barley, wild oats, soft chess, ripgut brome, red brome, foxtail fescue, burclover, and filaree are the dominant species. Scattered oaks on terraces and oak, willow, and cottonwood grow along the rivers and streams and in overflow areas. Saltgrass, along with such shrubs as iodinebush and Australian saltbush, grow on saline-sodic soils on terraces and in basins.

The major wildlife species include jackrabbit, coyote, fox, ground squirrel, pocket gopher, and various songbirds. The species of fish include salmon, striped bass, steelhead, shad, sturgeon, largemouth bass, smallmouth bass, bluegill, and catfish. Portions of the area are extremely important for wintering waterfowl and seasonally neotropical migrants.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 58%
Grassland—private, 25%; Federal, 2%
Forest—private, 2%
Urban development—private, 8%
Water—private, 1%
Other—private, 4%

More than four-fifths of the area is in farms and ranches. The acreage used for urban development is increasing rapidly. Three-fourths or more of the cropland is irrigated. The cropland in this MLRA represents about one-third of the cropland in California, and the irrigated cropland represents more than four-fifths of the irrigated land in the State. Cotton, nuts, grapes, hay, grain, pasture, rice, alfalfa, citrus, and truck crops, including tomatoes, are the principal crops in irrigated areas. The more sloping nonirrigated cropland is used for dry-farmed grain. About a third of the MLRA is in areas of native grasses, brush, and open woodland used mostly for grazing.

The major resource concerns are maintenance of the content of organic matter in the soils, water quality, irrigation-induced erosion, wind erosion, and irrigation water management. If the plant cover is removed, water erosion is a hazard on the more sloping soils on terraces and the hazard of wind erosion is severe on the sandy, wind-modified soils in the San Joaquin Valley. In areas of low precipitation, maintaining a favorable salinity status in the root zone is a resource concern.

The conservation practices that are important on cropland are crop rotations, minimum tillage, and the utilization of crop residue to maintain good soil tilth and favorable soil structure. Wind abrasion is a critical problem during crop establishment on coarse textured soils. It can be controlled by crop residue management and windbreaks. In areas where the amount of rainfall is too low to leach salts from the soils, all leaching must be accomplished with the use of irrigation water.

The important conservation practices on dairy farms include manure-handling systems, including nutrient management. The important conservation practices on grazing land include prescribed grazing, fencing, and water management. ■

18—Sierra Nevada Foothills

This area is entirely in California (fig. 18-1). It makes up about 8,160 square miles (21,145 square kilometers). The towns of Auburn, Folsom, Cameron Park, Oroville, and Ione are in the

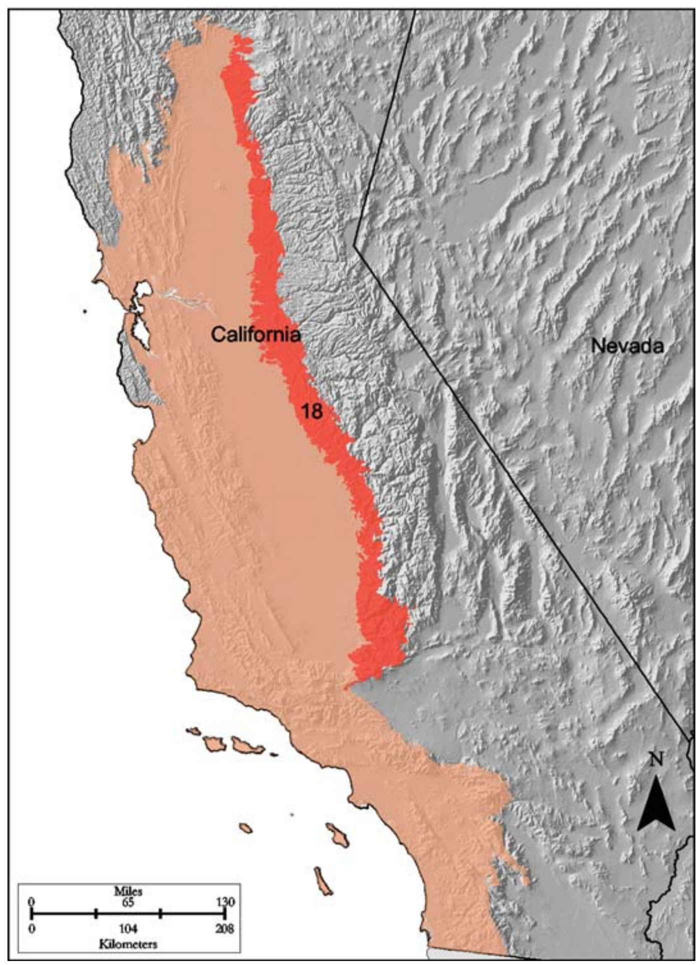

Figure 18-1: Location of MLRA 18 in Land Resource Region C.

north half of this area. The western edges of the Lassen, Plumas, Sierra, and Sequoia National Forests are in this MLRA. The Tule Indian Reservation is in the southern part of the area. California State Highway 49 traverses the middle third of this MLRA, and Interstate 80 crosses the midpoint.

Physiography

This area straddles the boundary between two physiographic provinces in the Pacific Mountain System. Most of the western half is in the California Trough Section of the Pacific Border Province. Most of the eastern half is in the Sierra Nevada Section of the Cascade-Sierra Mountains Province. The Sierra Nevada Mountains are a fault-block mountain range. The fault on the east side of the mountains created a steep face of alpine summits, but the west side has a more gentle slope from east to west. This MLRA is at the toe of that gentle east-west slope. It is an area of rolling to steep dissected hills and low mountains. The stream valleys are narrow and fairly steep. Elevation generally ranges from 660 to 1,650 feet (200 to 505 meters), but it is 3,950 feet (1,205 meters) on some isolated mountain peaks.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: San Joaquin (1804), 36 percent; Tulare-Buena Vista Lakes (1803), 35 percent; Sacramento (1802), 26 percent; and Northern Mojave-Mono Lake (1809), 3 percent. Many of the streams crossing this area were hydraulically mined for placer gold from 1849 to 1900. Some of the major streams draining the Sierra Nevada Mountains from north to south in the area include the Butte, Feather, Yuba, American, Cosumnes, Mokelumne, Tuolumne, San Joaquin, Kings, and Kern Rivers. Numerous Federal and State water project reservoirs are in this MLRA, including Lakes Oroville, Collins, Englebright, Camp Far West, Folsom, Comanche, Pardee, New Hogan, New Melones, Don Pedro, McClure, Millerton, Pine Flat, Kaweah, Success, and Isabella.

Geology

The northernmost end of this area is underlain dominantly by volcanic mudflow and pyroclastic rocks of the Tuscan Formation, which was derived from the eruption of Cascade volcanoes during the Pliocene, roughly 3 to 4 million years ago. South of about Oroville, the foothills are underlain by Mesozoic-age, metamorphosed marine sedimentary and volcanic rocks emplaced as terranes when the subduction trench was located in the vicinity of the present-day Sierra Nevada Mountains. Discrete granitic plutons are intruded through the older Mesozoic metamorphics in the northern part of the area, and a thin band of Tertiary sedimentary formations is exposed along the eastern edge from the Cosumnes River south. From around Merced southward, the foothills are underlain dominantly by Mesozoic granites of the Sierra Nevada Batholith, with local exposures of gabbro, metavolcanics, and other metamorphics. Tertiary sedimentary formations and Quaternary alluvial terrace deposits extend westward from the granitics in the vicinity of Bakersfield.

Climate

The average annual precipitation is 18 to 45 inches (455 to 1,145 millimeters) in most of this area. It increases from south to north and with elevation. It is as little as 8 inches (205 millimeters) in the extreme southern end of the area and as much as 68 inches (1,725 millimeters) in the extreme northern end. Summers are hot and dry, and winters are cool and moist. Most of the rainfall occurs as Pacific frontal storms during the period October to May. The average annual temperature is 47 to 67 degrees F (8 to 20 degrees C). The freeze-free period averages 275 days and ranges from 180 to 365 days, decreasing in length from south to north and with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 48.0%; ground water, 8.4%
Livestock—surface water, 2.2%; ground water, 0.7%
Irrigation—surface water, 32.8%; ground water, 1.6%
Other—surface water, 5.2%; ground water, 1.1%

The total withdrawals average 120 million gallons per day (455 million liters per day). About 12 percent is from ground water sources, and 88 percent is from surface water sources. The moderate rainfall and intermittent streamflow are the major water sources. Numerous stock ponds are throughout the area, but little has been done to construct small reservoirs for irrigation. The major reservoirs in this area store water for use outside the area. The surface water generally is of very good quality and is suitable for almost all uses with little to no treatment.

Ground water supplies are small and mostly untapped. Some water can be obtained from joints and fractures in the volcanic rocks in the northeast corner of the area. No data are available on the quality of this ground water. Shallow wells can be developed in the alluvial deposits along the major streams crossing the area. This ground water is similar to the surface water and is suitable for almost all uses with minimal treatment. Some ground water can be obtained from wells in the alluvium and older sediments along the western edge of this area on the fringes of the Central Valley. This water is hard but is of good quality. It generally has a median level of total dissolved solids of about 200 parts per million (milligrams per liter).

Soils

The dominant soil orders in the MLRA are Alfisols, Entisols, Inceptisols, and Mollisols. The soils in the area dominantly have a thermic soil temperature regime, a xeric soil moisture regime, and mixed mineralogy. They generally are very shallow to deep, well drained or somewhat excessively drained, and loamy. Haploxeralfs (Ahwahnee, Auberry, Blasingame, Coarsegold, and Sobrante series), Xerorthents (Cieneba series), Haploxerepts (Auburn, Toomes, and Vista series), Argixerolls (Arujo and Supan series), and Haploxerolls (Pentz and Walong series) formed in residuum on mountains, foothills, and footslopes.

Biological Resources

This area supports naturalized annual grasses, shrubs, and trees. Soft chess, wild oats, filaree, burclover, ripgut brome, and foxtail fescue are the dominant species on grassland. Some areas have an overstory of blue oak and foothill pine occurring as scattered individual trees to very dense stands. Scrub live oak is an important component in the overstory. Chamise, manzanita, wedgeleaf ceanothus, yerba santa, and poison oak are dominant on brushland. Scattered stands of ponderosa pine, mixed with manzanita and black oak, are at the higher elevations.

Some of the major wildlife species in this area are black-tailed deer, mountain lion, coyote, gray fox, raccoon, porcupine, skunk, jackrabbit, ground squirrel, pocket gopher, brown rat, field mouse, valley quail, band-tailed pigeon, red-headed woodpecker, mourning dove, mallard, cinnamon teal, wood duck, and rattlesnake. The species of fish in the area include black bass, bluegill, crappie, trout, salmon, steelhead, and catfish.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—private, 51%; Federal, 10%
Forest—private, 28%; Federal, 4%
Urban development—private, 4%
Water—private, 2%
Other—private, 1%

Production of livestock on rangeland is the main enterprise in this area. A significant acreage is brushland or openland hardwood forest. A small acreage is cropland. In the past most of the cropland in the area was used for dry-farmed grain, but more and more small tracts are now used for nuts, grapes, and other kinds of fruit grown under sprinkler, micro, and drip irrigation systems.

The major soil resource concerns are erosion, maintenance of the content of organic matter in the soils, water quality, and low infiltration rates resulting from hydrophobic soils. The hazard of erosion is moderate or severe if the plant cover is removed by overgrazing, cultivation, or fire. If the surface is unprotected in winter, the hazard of sheet and gully erosion is severe on the sloping soils on terraces and benches and on upland soils.

The conservation practices that are important on cropland include crop residue management, cover crops, and irrigation water management. Prescribed grazing, fencing, and stock water development are the most important practices on rangeland and other grazing land.

The conservation practices that are important in developing urban land include controlling erosion on and around sites for houses and roads. The important erosion-control practices are methods of phasing construction that maintain as much of the native vegetation as possible, mulch and geotextile erosion blankets, a temporary cover of vegetation, and sediment-control systems, including sediment-debris basins and traps, silt fences, fiber rolls, and straw wattles. ■

19—Southern California Coastal Plain

This area is entirely in California (fig. 19-1). It makes up about 4,120 square miles (10,675 square kilometers). It is considered the Citrus Belt of California. Ventura, Los Angeles, and San Diego are in this MLRA. Interstate 5 parallels the coast

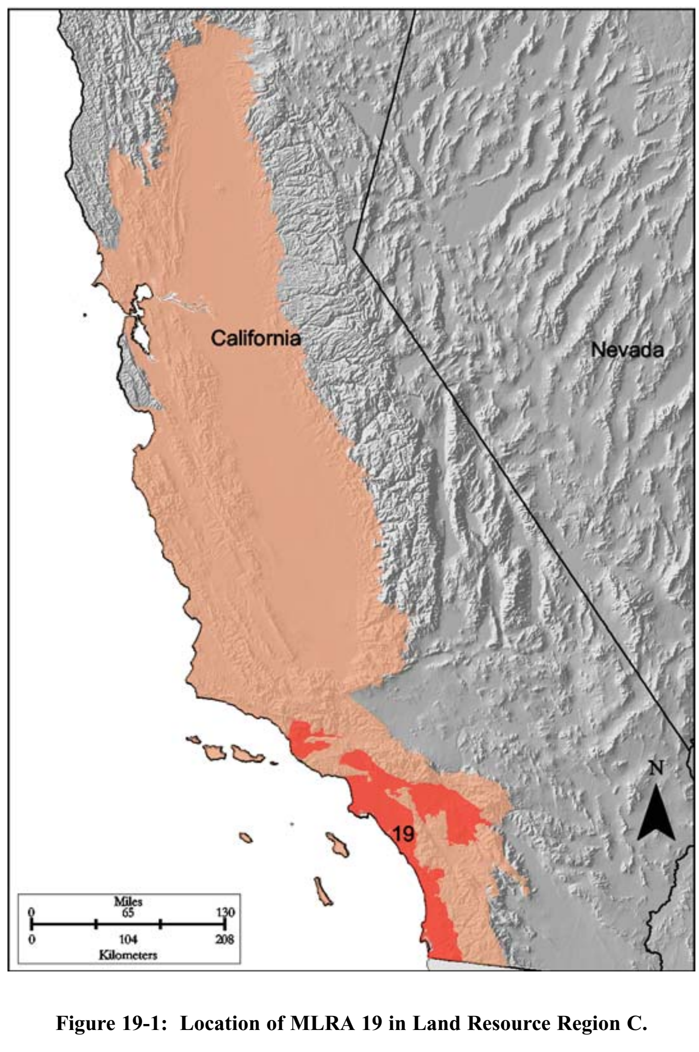

Figure 19-1: Location of MLRA 19 in Land Resource Region C.

through this area, and Interstate 15 parallels Interstate 5 inland in the foothills. Interstate 10 crosses the northern end of the area, and Interstate 8 crosses the southern end. Numerous other interstate segments are around the two major cities in this populous MLRA. The area includes the San Clemente, Camp Pendleton, and Miramar Naval Air Station Military Reservations; the Santa Monica Mountains National Recreation Area; and the Angeles National Forest.

Physiography

The Ventura and Los Angeles parts of this area are in the Los Angeles Ranges Section of the Pacific Border Province of the Pacific Mountain System. These parts of the MLRA consist mainly of gently sloping to strongly sloping, dissected coastal and alluvial plains that are bordered by steep hills. Changes in sea level over time have changed the coastal plains into terraces. Stream incision has created abandoned flood plains, or terraces, adjacent to most rivers. The inland boundary of these parts of the MLRA occurs where the sloping plains coalesce with steeper alluvial fans and colluvial slopes coming off inland mountain ranges. The eastern end of the Sierra Madre Range forms the inland border in the Ventura area, and the San Gabriel Mountains form the inland border in the Los Angeles area. Elevation ranges from sea level to 1,970 feet (600 meters).

The southern part of this MLRA, around San Diego, is in the Lower Californian Province of the Pacific Mountain System. In this part of the MLRA, the coastal plain between the Pacific Ocean and the Vallecito Mountains is narrow and colluvial slopes from the mountains form the eastern boundary.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Southern California Coastal (1807), 99 percent, and Southern Mojave-Salton Sea (1810), 1 percent. The Los Angeles River is confined to a concrete-lined flood-control channel through the city of Los Angeles. A series of debris dams near the inland border of this MLRA traps the sand, gravel, cobbles, and boulders that are carried by the mountain streams down to the coastal plain. The dams not only reduce the need for dredging in the Los Angeles River but also create a new source of sand and gravel for construction. The Santa Clara River enters the ocean near Ventura. This city is protected from flooding by levees. The Santa Clara River is the primary source of sand for the beaches of Los Angeles and other communities to the south. Extensive gravel mining from this river has decreased the amount of coarse material reaching the sea and has led to severe beach erosion, which has prompted local officials to build numerous groins and jetties intended to trap sand moving south in littoral currents and to reduce the hazard of beach erosion.

Geology

The coastal plains in this MLRA consist of thick layers of river-laid sediments that tend to become finer textured nearer the ocean. Very coarse sediment is on the colluvial slopes and alluvial fans on the inland border of the MLRA. Lower sea levels have transformed the plains into the marine terraces of today. Southern California is the western boundary of the North American continental plate. The Pacific Ocean plate is being subducted beneath the continental plate in this area. The continental plate is moving up and northwest as the ocean plate slides beneath it. Numerous faults occur in this MLRA, and earthquakes are common as the plates slide past each other.

Climate

The average annual precipitation in this area is 10 to 29 inches (255 to 735 millimeters). Most of the rainfall occurs as low- or moderate-intensity, Pacific frontal storms during winter. At the higher elevations, rain occasionally turns to snow during winter. Summers are dry, but fog provides some moisture along the coast. The average annual temperature is 55 to 66 degrees F (13 to 19 degrees C). The freeze-free period averages 310 days and ranges from 255 to 365 days along the coast. The length of the period decreases towards the hills.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 36.7%; ground water, 26.9%
Livestock—surface water, 0.1%; ground water, 0.0%
Irrigation—surface water, 27.1%; ground water, 7.6%
Other—surface water, 1.3%; ground water, 0.3%

The total withdrawals average 2,490 million gallons per day (9,425 million liters per day). About 35 percent is from ground water sources, and 65 percent is from surface water sources. The low rainfall and intermittent streamflow provide small quantities of surface water for local use. Much of the water for irrigation and nearly all of the water for large urban areas is diverted from the Colorado and Owens Rivers, in eastern California, and from northern California rivers via aqueducts. This imported water is typically of good quality and is suitable for drinking after minimal treatment. The competition for water between the populated areas and the agricultural areas has increased the cost of water in southern California. Desalinization is becoming economically viable as the cost of imported surface water rises.

The limited ground water in the alluvial deposits and older sediments under the coastal plains has been heavily exploited. The quality of this ground water in inland areas is generally good. It is suitable for all uses. Declining water tables and the intrusion of saltwater are reducing both the quantity and quality of this water. The level of total dissolved solids typically exceeds 1,000 parts per million (milligrams per liter) near the coast, and the level of chloride reduces the usefulness of the water for irrigating salt-sensitive crops.

Soils

The dominant soil orders in the MLRA are Alfisols, Entisols, and Mollisols. The soils in the area dominantly have a thermic soil temperature regime, a xeric soil moisture regime, and mixed mineralogy. They generally are deep or very deep, well drained or somewhat excessively drained, and loamy or sandy. The dominant soils in the MLRA formed in alluvial sediments. Haploxeralfs (Greenfield and Ramona series) and Haploxerolls (Mocho series) are on alluvial fans and terraces. Haploxerolls (Chino series), Xerofluvents (Camarillo, Hueneme, Metz, and San Emigdio series), Xeropsamments (Corralitos and Tujunga series), and Xerorthents (Hanford series) are on alluvial fans and flood plains. Durixeralfs (Redding series) are on dissected terraces. Haploxeralfs (Cajalco and Fallbrook series), Xerorthents (Cieneba and Exchequer series), and Haploxerolls (Friant and Hambright series) are on hills.

Biological Resources

The vegetation in this area consists primarily of annual and perennial grasses and scattered coast live oak. Rangeland supports wild oats, soft chess, red brome, filaree, burclover, needlegrass, tarweed, mustard, and annual lupine interspersed with coast live oak occurring as scattered individual trees to dense stands. Stands of brush include buckwheat, ceanothus, California sagebrush, chamise, and scrub oak. A unique stand of rare Torrey pine grows in this area between Del Mar and Solana Beach.

The major wildlife species include deer, feral hog, mountain lion, coyote, bobcat, raccoon, skunk, jackrabbit, gray squirrel, ground squirrel, rattlesnake, turkey vulture, roadrunner, crow, quail, pigeon, blackbird, dove, heron, and coot.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 6%
Grassland—private, 20%; Federal, 3%
Forest—private, 4%
Urban development—private, 53%; Federal, 9%
Water—private, 1%
Other—private, 3%; Federal, 1%

Nearly two-thirds of this area consists of urban or built-up areas, and other land in the area is rapidly being converted to urban uses. About a third of the area is brushland used for watershed protection. The irrigated crops are subtropical fruits, deciduous fruits, grain, truck crops, grapes, hay, and pasture. Dairy farming and flower seed production are other important enterprises. Some livestock is produced on the rangeland.

The major soil resource concerns are erosion, maintenance of the content of organic matter in the soils, water quality, and low infiltration rates resulting from hydrophobic soil properties created via plant chemical exudates and/or after wildfires. The erosion hazard is slight on the soils in valleys and on terraces and benches in the valleys, except where improper irrigation practices are more damaging than rainfall. If the surface is unprotected in winter, the hazard of sheet and gully erosion is severe on the sloping soils on coastal terraces and benches and on upland soils. Salinity and encroachment of seawater into ground-water basins is a problem in the valleys at sea level.

The important conservation practices on cropland and dairy farms are irrigation water management and nutrient management. Prescribed grazing, fencing, and water management are important practices on rangeland and other grazing land. ■

20—Southern California Mountains

This area is entirely in California (fig. 20-1). It makes up about 9,605 square miles (24,890 square kilometers). The towns of Santa Barbara, Fillmore, Ramona, and Banning, California,

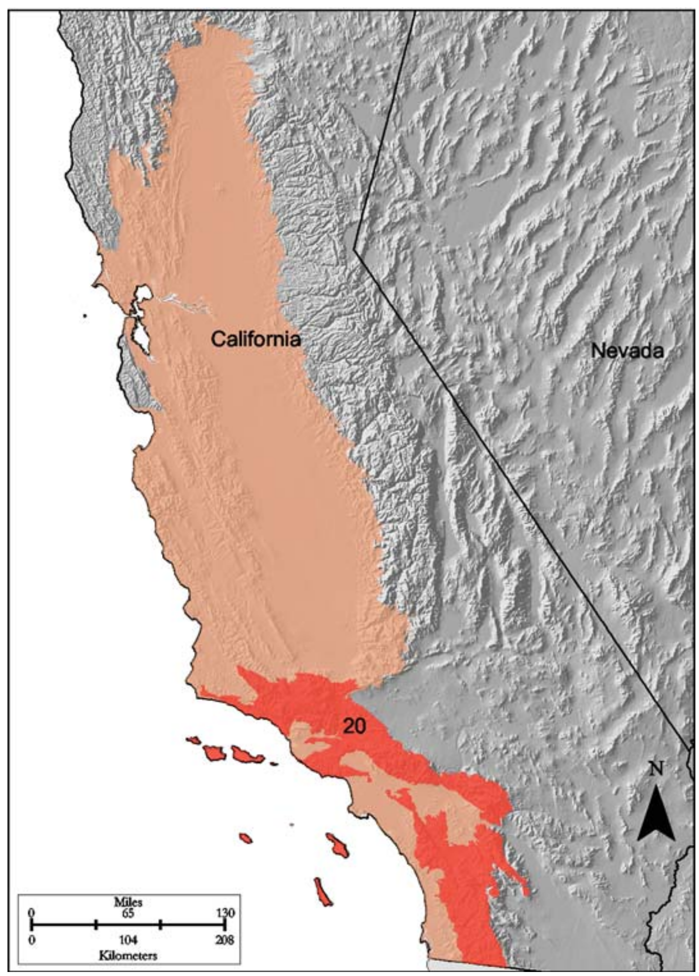

Figure 20-1: Location of MLRA 20 in Land Resource Region C.

are in this MLRA. A major portion of the MLRA is made up of national forests, including Los Padres, San Rafael, Angeles, Cleveland, and San Bernardino National Forests. The area has numerous Indian reservations. Interstate 5 crosses the center of the northern half of the area, and Interstate 15 crosses the eastern end of the northern half.

Physiography

The northern half of this area is in the Los Angeles Ranges Section of the Pacific Border Province of the Pacific Mountain System. The northwestern end of the MLRA is in the California Coast Ranges Section of the same province and system. The mountains in this area are called the Transverse Ranges since their trend is almost east and west, almost perpendicular to all other mountain ranges in California. In the northwestern end of the area, the Transverse Ranges merge with the Coast Range. The southern half of this MLRA is called the Peninsular Range and is in the Lower Californian Province of the Pacific Mountain System. The Sierra Madre, San Gabriel, San Bernardino, Santa Rosa, and Vallecitos Mountains occur in this area, from north to south. The eight Channel Islands also occur in this area.

This MLRA is an area of narrow mountain ranges and broad fault blocks. Elevation ranges from 1,000 to 7,900 feet (305 to 2,400 meters) in most of the area. The highest peaks can exceed 12,000 feet (3,660 meters). A narrow strip along the northern edge of the area is almost at sea level. The strongly sloping to precipitous mountains have unstable slopes and sharp crests. Valleys are typically narrow and are filled with alluvium. Almost all of the valleys have streams with actively eroding banks. The valley floors for Calleguas Creek and the Santa Clara River are wide, and colluvial slopes and alluvial fans have formed at the edges of these valleys.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Southern California Coastal (1807), 71 percent; Central California Coastal (1806), 14 percent; Southern Mojave-Salton Sea (1810), 8 percent; Northern Mojave-Mono Lake (1809), 5 percent; and Tulare-Buena Vista Lakes (1803), 2 percent. The Santa Clara River, the chief source of sand for the beaches to the south, originates in this area. The headwaters of the Los Angeles River also are in this area.

Geology

The mountains in the Transverse Ranges primarily consist of uplifted and tilted Cenozoic marine sediments. The far eastern end of this range consists of Precambrian rocks and Mesozoic volcanics. The Peninsular Range is primarily granite. Mesozoic sediments that have been metamorphosed occur at the margins of the granitic intrusives. The valleys are filled with relatively coarse alluvium since most of the sediments have not moved far from their source.

The Transverse Ranges are very young from a geological perspective and are bounded by the San Andreas Fault. This fault occurs where the North American continental plate is sliding over the Pacific Ocean plate. Earthquakes are common as the two plates slip past each other. Landslides also are a major land-forming process in this MLRA. These frequently occur during rainstorms in winter, when the soils become saturated, and following brush fires after the root systems of the brush decay.

Climate

The average annual precipitation in this area is 8 to 51 inches (205 to 1,295 millimeters), increasing with elevation. Most of the rainfall occurs as low- or moderate-intensity, Pacific frontal storms during winter. Rain can turn to snow at the higher elevations. A little snow may fall in winter, but it does not last. Summers are dry. The average annual temperature is 41 to 66 degrees F (5 to 19 degrees C), decreasing with elevation. The freeze-free period averages 245 days and ranges from 125 to 365 days in most of the area. It decreases in length with elevation. The longest freeze-free period occurs at the lower elevations along the western edge of the area.

The climate on the eight Channel Islands can differ somewhat from the climate on the mainland portions of this MLRA. The southern Channel Islands tend to be warmer and drier than their northern counterparts because the California Current (ocean current) is warmer when it reaches the southern islands. Santa Catalina Island has an average annual precipitation of 12 inches (305 millimeters measured for over 30 years at Avalon) and an average annual summer temperature of 59 to 74 degrees F (15 to 23 degrees C). The average annual winter temperature, recorded at Avalon, ranges from 49 to 63 degrees F (9 to 17 degrees C). The northern islands have a climate that tends to be moderated by fog. They have slightly higher humidity and lower cloud cover than the adjacent coastal mainlands. These northern islands, especially Santa Cruz and Santa Rosa, receive consistent and regular winds prevailing from the northwest. These winds may have higher velocity than the mainland winds.

Water

Following are the estimated withdrawals of freshwater by use on the mainland portions of this MLRA:

Public supply—surface water, 25.4%; ground water, 45.8%
Livestock—surface water, 0.4%; ground water, 0.2%
Irrigation—surface water, 11.4%; ground water, 12.7%
Other—surface water, 2.1%; ground water, 2.0%

The total withdrawals average 395 million gallons per day (1,495 million liters per day). About 61 percent is from ground water sources, and 39 percent is from surface water sources. The moderate rainfall provides water for brushland and range and also meets part of the water needs of the adjacent lower areas. Runoff is rapid. All but the larger streams and those that drain from the higher watersheds are dry through the summer and in periods of low precipitation. There are very few manmade or natural lakes in the area. Most of the public water supplies are obtained from surface water diverted from northern California rivers. This water is of good quality and is suitable for drinking after minimal treatment.

Deep sand and gravel deposits in the valleys yield water for livestock and domestic use and for some irrigation. The median level of total dissolved solids in this ground water is near the national drinking water standard of 500 parts per million (milligrams per liter).

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Inceptisols, and Mollisols. The soils in the area dominantly have a mesic or thermic soil temperature regime, a xeric soil moisture regime, and mixed mineralogy. They generally are very shallow to deep, well drained or somewhat excessively drained, and loamy or sandy. The dominant soils formed in residuum. Very shallow and shallow Xerorthents (Cieneba and Exchequer series) are on uplands, and deep Xerorthents (Saugus series) are on terraces and foothills. Shallow Haploxerolls (Friant, Sheephead, and Tollhouse series), deep (Crouch series) and moderately deep (La Posta series) Haploxerolls, and moderately deep Rhodoxeralfs (Las Posas series) are on mountain slopes. Deep Haploxeralfs (Fallbrook series) are on hills. Moderately deep Haploxerepts (Vista series) are on hills and mountain slopes.

Biological Resources

This area supports forest, brush, and shrub-grass mixtures. Open stands of Jeffrey pine, Coulter pine, sugar pine, Douglas-fir, incense-cedar, and oak are at elevations above 4,000 feet (1,220 meters). At elevations above 8,000 feet (2,440 meters), subalpine conifer forests occur. They consist of lodgepole pine, limber pine, white fir, and western juniper. The greater part of the area is covered with sparse to dense stands of brush. Scrub oak, juniper, chamise, ceanothus, manzanita, and red shank are typical species. The rangeland soils support naturalized annual and native perennial grasses and brush. California juniper, big sagebrush, flattop buckwheat, needlegrass, wild oats, soft chess, cheatgrass, and filaree characterize the plant cover on the coarse textured soils. Oaks, Jeffrey pine, and an understory of soft chess, wild oats, needlegrass, blue wildrye, ceanothus, flattop buckwheat, and other brush species grow on the medium textured soils. Creeping wildrye, pine bluegrass, sedges, and native clovers are the major species in the wet meadows.

The vegetative communities on the Channel Islands include native island endemics, such as island hazardia, island malacothrix, cliff malacothrix, live-forever, island manzanita, island scrub oak, island oak, Channel Island tree poppy, island poppy, island buckwheat, island ceanothus, island redberry, island ironwood, and island monkeyflower. Nonendemics play a significant role in the diverse plant life of the islands. These are California sagebrush, lemonade berry, toyon, coyotebrush, needlegrasses, canyon live oak, and Bishop pine.

Some of the major wildlife species in this MLRA include deer, feral hog, mountain lion, bighorn sheep, coyote, bobcat, raccoon, skunk, jackrabbit, gray squirrel, ground squirrel, rattlesnake, California condor, turkey vulture, roadrunner, crow, quail, pigeon, blackbird, dove, heron, and coot. Species of concern include cactus wren, California gnatcatcher, Bell’s vireo, mountain yellow and red-legged frogs, arroyo toad, and southwestern willow flycatcher.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 3%
Grassland—private, 29%; Federal, 36%
Forest—private, 5%; Federal, 10%
Urban development—private, 6%
Water—private, 1%
Other—private, 9%; Federal, 1%

Less than one-tenth of this area is used for urban development, and the rest is in farms, ranches, or other private holdings. Less than one-fifth of the area is open woodland and brushland used for grazing. More than half of the area has a brush cover that is not grazed. Most of the larger valleys are used for dry-farmed grain and hay, but in some areas fruits are grown under irrigation.

The major soil resource concern is a severe erosion hazard in areas where the plant cover is depleted or destroyed by overgrazing or fire. Preventing or controlling brush fires is a major concern.

The important conservation practices are prescribed grazing, fencing, and water management on rangeland and other grazing land; erosion control, irrigation water management, and nutrient management on urban land; erosion control, irrigation water management, and nutrient management on cropland, including orchards; and thinning and control of competing vegetation on forestland. ■

Figure D-1: Location of Land Resource Region D.

D—Western Range and Irrigated Region

This region (shown in fig. D-1) is in Arizona (21 percent), Nevada (20 percent), California (14 percent), New Mexico (13 percent), Utah (11 percent), Wyoming (7 percent), Texas (5 percent), Oregon (4 percent), Colorado (3 percent), Idaho (2 percent), and Montana (less than 1 percent). It makes up 549,725 square miles (1,424,480 square kilometers). This is the largest of all the land resource regions in land area.

This is a semidesert or desert region of plateaus, plains, basins, and many isolated mountain ranges (fig. D-2). The average annual precipitation ranges from 6 inches (150 millimeters) on some of the plains and in some basins to 42 inches (1,065 millimeters) on some of the higher mountains. In the southeast part of the region, most of the precipitation falls as rain during the warm season. Elsewhere in the region, however, most of the precipitation falls during the cool season. In most of this region, the average annual temperature is 40 to 60 degrees F (4 to 16 degrees C). The freeze-free period ranges from 105 days in the north and in some of the higher mountains to 260 days in the south.

The total withdrawals of freshwater in this region average about 30,025 million gallons per day (113,645 million liters per day). About 76 percent is from surface water sources, and 24 percent is from ground water sources. About 86 percent of the water is used for irrigation. Because of its large area, this is one of six land resource regions that use more than 30,000 million gallons (113,550 million liters) of water daily.

The soils in this region are dominantly Aridisols, Entisols, and Mollisols. The dominant suborders are Argids and Calcids on plains and in basins; Orthents on plains, on plateaus, and in valleys throughout the region; and Xerolls and Ustolls on mountain slopes. The soils in the region dominantly have a mesic soil temperature regime, an aridic soil moisture regime, and mixed mineralogy.

About 60 percent of the land in this region is federally owned. The native vegetation consists mainly of shrubs with interspersed grasses and scattered trees. Much of the land in the

Figure D-2: An area of Land Resource Region D.

region is used for grazing. Irrigated crops are grown in areas where water is available and the soils are suitable. Feed crops for livestock are grown on much of the irrigated land. Peas, beans, and sugar beets are grown in many areas. Cotton and citrus fruits are important crops in southwestern Arizona. The major resource management concerns on cropland include soil productivity and the content of salts and sodium in the soils. Overgrazing is a concern on rangeland. ■

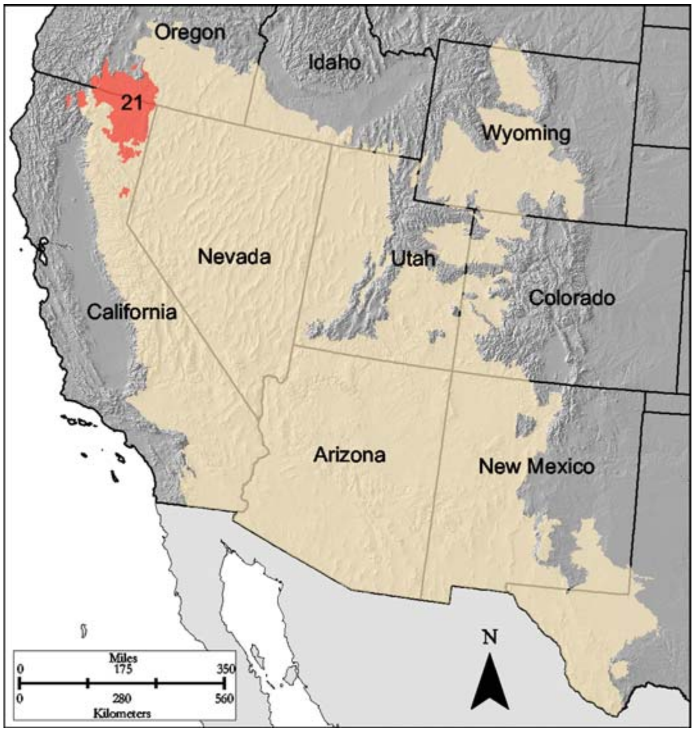

Figure 21-1: Location of MLRA 21 in Land Resource Region D.

21—Klamath and Shasta Valleys and Basins

This area (shown in fig. 21-1) is in California (65 percent) and Oregon (35 percent). It makes up about 11,495 square miles (29,790 square kilometers). The towns of Alturas, Adin, Canby, Yreka, and Fall River Mills, California, and Klamath Falls, Lakeview, Malin, and Merrill, Oregon, are in this MLRA. U.S. Highways 97 and 385 cross the west and east parts of this area, respectively. Numerous national forests are in the MLRA, including the Klamath, Modoc, Fremont, Lassen, Plumas, and Shasta National Forests.

Physiography

This area is in a transition zone between the Basin and Range Province to the southeast, the Cascade and Klamath Mountains to the west and northwest, and the Sierra Nevada Mountains to the south. Most of this MLRA is in the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. Small areas in the west and northwest parts of the MLRA are in the Middle Cascade Mountains Section of the Cascade-Sierra Province of the Pacific Mountain System. The Shasta River Valley portion of this MLRA, near Yreka, is along the western edge of the Cascade Range, near the Klamath Mountains, while the Scott River Valley portion is farther west within the Klamath Mountains. The Modoc portion of the MLRA is characterized by a vast volcanic upland interspersed with numerous reservoirs, lakes, and narrow stream valleys that comprise the Pit and Klamath River drainages; hydrologically separate, internally drained basins with lakes or periodically dry lakebeds; and isolated volcanic peaks.

Elevation typically ranges from 2,600 to 4,600 feet (795 to 1,400 meters), but many mountain peaks exceed 7,000 feet (2,135 meters) and a few peaks in Oregon exceed 8,000 feet (2,440 meters). Lava plateaus and many valleys and basins make up most of the area. Steep mountain spurs and rimrock escarpments surround the plateaus.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Klamath-Northern California Coastal (1801), 47 percent; Sacramento (1802), 36 percent; North Lahontan (1808), 11 percent; and Oregon Closed Basins (1712), 6 percent. The Klamath River originates in this area.

Geology

The Modoc portion of this MLRA is underlain by Cenozoic volcanic rocks. Surface exposures are dominated by Miocene to Pleistocene “flood basalts” and rhyolite ash. Andesites, volcanic mudflow deposits, and rhyolitic intrusives also occur. Volcanism and the extrusion of flood basalts occurred as a result of crustal thinning and extension associated with development of the Basin and Range. Valleys are typically underlain by recent alluvial, lacustrine, and dry lakebed (playa) deposits. Pliocene to Pleistocene nonmarine sedimentary deposits (including fan and stream terrace deposits and old lake deposits) underlie portions of many of the basins.

The geology of the Shasta River Valley portion of this MLRA is complex, reflecting its location between the Klamath Mountains and the High Cascades. Uplands in the northern and western parts of the area are underlain by pre-Cenozoic metamorphics and sedimentary formations, while the eastern portion is dominated by Tertiary and Quaternary volcanics.

The Scott River Valley portion of this MLRA is underlain by alluvium and alluvial terrace deposits derived from the nearby Klamath Mountains, which are locally composed of pre-Cenozoic metamorphic, granitic, and ultramafic rocks.

Climate

The average annual precipitation is 12 to 30 inches (305 to 760 millimeters) in most of this area. The drier areas can receive as little as 9 inches (230 millimeters). In small areas at high elevations on the western and southwestern edges of this MLRA, the average annual precipitation is much higher, 30 to 58 inches (760 to 1,475 millimeters). Higher precipitation zones also occur in the scattered mountain ranges throughout the rest of this area. Most of the rainfall occurs as low- or moderate-intensity, Pacific frontal storms during the winter. At the higher elevations, rain generally turns to snow. Snow may fall at the lower elevations in winter but does not last. Summers are dry. The average annual temperature is 39 to 52 degrees F (4 to 11 degrees C). The freeze-free period averages 130 days and ranges from 70 to 185 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 0.7%; ground water, 0.9%
Irrigation—surface water, 70.1%; ground water, 24.2%
Other—surface water, 2.3%; ground water, 1.9%

The total withdrawals average 1,470 million gallons per day (5,565 million liters per day). About 27 percent is from ground water sources, and 73 percent is from surface water sources. The somewhat limited precipitation and the lack of sufficient water storage limits the supply of water for agriculture. In the narrower valleys, the irrigated land is in areas on alluvial fans where surface runoff from the mountains can be diverted to fields. Some terraces along the major drainages also are irrigated. The surface water is of excellent quality and is suitable for drinking.

Ground water is scarce in the dense lava rocks underlying much of the area. On sites underlain by the more porous rocks, the supplies of ground water are large but are mostly untapped. Some irrigation water is obtained from fracture and rubble zones and layers of sand and gravel within the lava. Also, some is obtained from the basin fill aquifers between the mountain ranges. Little information about the quality of the ground water is available, except that the water is suitable for irrigation.

Soils

The dominant soil order in this MLRA is Mollisols. Small areas of Inceptisols and Histosols are in the basins. The soils in this area dominantly have a mesic or frigid soil temperature regime, a xeric soil moisture regime, and mixed or smectitic mineralogy. They generally are well drained, but they may be poorly drained or very poorly drained in the basins. They generally are loamy, clayey, or sandy and are shallow to very deep. Argixerolls formed in residuum (Lorella and Orhood series) and in residuum mixed with loess and/or volcanic ash (Devada, Royst, and Woodcock series) on plateaus, hills, and mountains. Haploxerolls (Fordney series) formed in sandy alluvium on terraces. Haploxerolls (Petescreek series) formed in residuum on hills and mountains. Palexerolls (Booth series) formed in colluvium on plateaus, hills, and mountains. Durixerolls (Salisbury series) formed in old alluvium on terraces. Humaquepts (Tulana series) formed in lacustrine sediments on lacustrine bottoms. Haplohemists (Lather series) formed in organic material in marshes.

Biological Resources

This area has a cover of shrubs interspersed with annual and perennial grasses. Nevada bluegrass, Sandberg bluegrass, Idaho fescue, and bluebunch wheatgrass are the major species. The basins and meadows support sedges, wiregrass, slender wheatgrass, creeping wildrye, and bluegrass. Sagebrush, rabbitbrush, bitterbrush, and mountain mahogany are the main shrubs. Western juniper is common, and scattered ponderosa pine trees are on the lower foothills. The higher elevations support ponderosa pine, Douglas-fir, white fir, and California red fir with an understory of bitterbrush and ceanothus.

Some of the major wildlife species in this area are elk, mule deer, antelope, golden eagle, red-tailed hawk, prairie falcon, great horned owl, barn owl, sage grouse, and chukar.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 5%
Grassland—private, 21%; Federal, 20%
Forest—private, 17%; Federal, 24%
Urban development—private, 1%
Water—private, 5%; Federal, 6%
Other—private, 1%

Most of the privately and publicly owned land in this area is grazed. A small acreage is used for irrigated potatoes, grain, seed crops, hay, or pasture or for dry-farmed grain. Trees are harvested for lumber in some forested areas.

The major soil resource concerns on cropland are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, conservation of soil moisture, and the quality of irrigation water. The hazard of water erosion is slight in most of the basin areas but can be high in the steeper areas if the surface is bare. In some areas the hazard of wind erosion is high, especially when the surface is disturbed during the period of highest wind velocities. Maintaining good drainage is the principal management concern in the valley basins. Some sites should be protected from overflow, and others are affected by alkali. Overgrazing and the invasion of undesirable species are management concerns on rangeland. Surface compaction and sedimentation of streams are the major management concerns on forestland.

Conservation practices on cropland generally include irrigation water management, water-control structures, irrigation system improvements, and nutrient management. Conservation practices on rangeland and pasture generally include prescribed grazing, water developments, and brush management.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control compaction, the erosion caused by concentrated flow, and sediment delivery to streams. ■

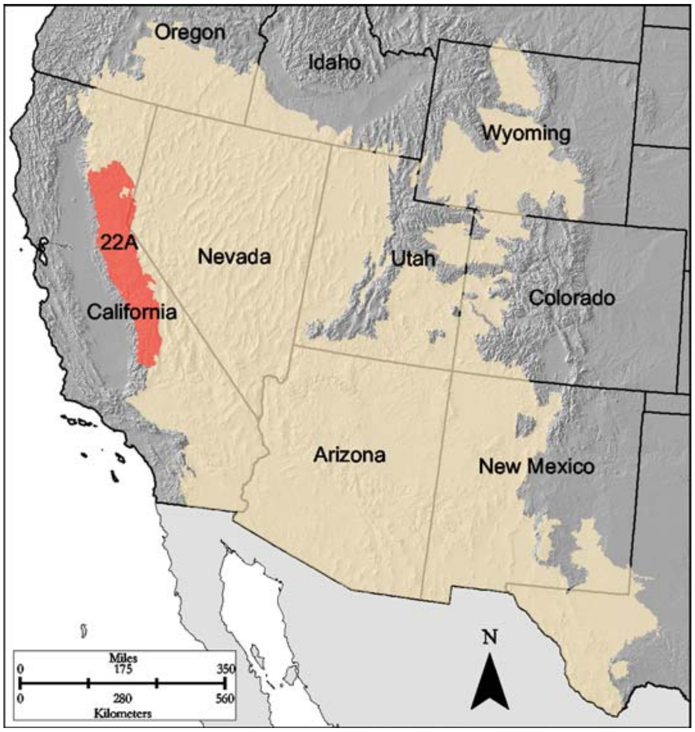

Figure 22A-1: Location of MLRA 22A in Land Resource Region D.

22A—Sierra Nevada Mountains

This area (shown in fig. 22A-1) is in California (98 percent) and Nevada (2 percent). It makes up about 18,810 square miles (48,745 square kilometers). It has a few large communities. Quincy, South Lake Tahoe, and Truckee, California, are in this MLRA. The smaller communities include Markleeville, Colfax, and Kernville. Interstate 80 crosses the center of this area. Yosemite and Sequoia-Kings Canyon National Parks occur in the area. A major portion of this MLRA is in national forests, including the Eldorado, Inyo, Plumas, Sierra, Sequoia, Stanislaus, and Tahoe National Forests. Numerous Indian reservations are in the MLRA, including the Berry Creek Rancheria, Enterprise Rancheria, Greenville Rancheria, Jackson Rancheria, Sheep Ranch Rancheria, and Tuolumne Rancheria Reservations.

Physiography

This MLRA lies entirely within the Sierra Nevada Section of the Cascade-Sierra Mountain Province of the Pacific Mountain System. This area consists of the higher elevations of the Sierra Nevada Mountains. It is a strongly asymmetric mountain range with a long, gentle western slope and a steep eastern escarpment. It is characterized by hilly to steep mountain relief and occasional mountain valleys. It is 50 to 80 miles (80 to 130 kilometers) wide and runs in an approximately north-south direction through eastern and central California for more than 400 miles (645 kilometers).

Elevation ranges from 1,500 to 9,000 feet (455 to 2,745 meters) in most of the area. The highest peaks can exceed 12,000 feet (3,660 meters). Mount Whitney, at an elevation of 14,494 feet (4,419 meters), is the highest point in the lower 48 States. The strongly sloping to precipitous mountains have unstable slopes and sharp crests. Valleys are typically narrow and are filled with alluvium. Almost all of the valleys have streams with actively eroding banks.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Sacramento (1802), 31 percent; San Joaquin (1804), 31 percent; Tulare-Buena Vista Lakes (1803), 20 percent; Central Lahontan (1605), 10 percent; Northern Mojave-Mono Lake (1809), 7 percent; and North Lahontan (1808), 1 percent. The American, Carson, Kern, San Joaquin, Truckee, Walker, and Yuba Rivers originate in this area.

Geology

Most of this area is dominated by plutonic (dominantly quartz monzonite and granodiorite) rocks of Mesozoic age, otherwise known as the Sierra Nevada Batholith. The north half of the range is flanked on the west by the western metamorphic belt, an area of strongly deformed and metamorphosed sedimentary and volcanic rocks of Paleozoic and Mesozoic age. Farther south, some of these metamorphic rocks are within the batholith on the western edge or along the crest of the range. Volcanic activity of minor extent has produced Miocene-age lava flows. The valleys are filled with relatively coarse alluvium since most of the sediments have not moved far from their source.

Gold occurs as lode deposits in Mesozoic metamorphic rocks of the western foothills, where heat generated from the intrusion of the Sierra Nevada Batholith mobilized and concentrated the gold in quartz veins. The most productive districts are in the “Mother Lode” belt in the northern and central parts of the Sierra Nevada Mountains. Placer deposits of gold, which accounted for more than 40 percent of California’s total gold output, are in Tertiary stream gravel in the northwestern part of the Sierra Nevada Mountains and in recent stream channels where gold-bearing rocks eroded from areas near the Sierran crest are transported towards the valleys of the Sacramento and San Joaquin Rivers.

Pleistocene to Recent glaciers have shaped the Sierra Nevada Mountains by scouring out cirques, U-shaped valleys, and other glacial erosional features, depositing poorly sorted till in glacial moraines and influencing streamflow patterns by contributing variable amounts of runoff and periodically forming ice dams and lakes. The intermontane valleys are filled with coarse glacial deposits and with coarse alluvium since most of the deposits have not moved far from their source.

Climate

The average annual precipitation is 40 to 80 inches (1,015 to 2,030 millimeters) in much of this area, but it as low as 6 inches (150 millimeters) in the lower valleys and foothills and as much as 100 inches (2,540 millimeters) on the mountain peaks. The amount of precipitation increases with elevation and from south to north. Summers are dry, but there are occasional thunderstorms. Much of the winter precipitation occurs as snow. The average annual temperature is 25 to 63 degrees F (-4 to 17 degrees C), decreasing with elevation. The freeze-free period averages 205 days and ranges from 65 to 345 days, decreasing in length with elevation. It is longest at the lower elevations along the western edge of the area.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 41.8%; ground water, 0.0%
Livestock—surface water, 25.5%; ground water, 0.9%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 24.9%; ground water, 6.9%

The total withdrawals average 2 million gallons per day (8 million liters per day). About 8 percent is from ground water sources, and 92 percent is from surface water sources. The abundant rainfall and snowfields on the higher mountain slopes provide water for forestland and rangeland. Also, they meet part of the water needs of the lower adjacent areas by supplying water to many perennial rivers. Much of the water is stored in large reservoirs and is used in the valleys of the Sacramento and San Joaquin Rivers and in heavily populated southern California. Most of the public water supplies are obtained from surface water. This water is of good quality and is suitable for drinking after minimal treatment. The mountains provide opportunities for recreation to many people in California and to visitors from other States. There have been problems with fecal coliform and Giardia contamination in the surface water at high elevations.

There are no principal aquifers in the Sierra Nevada Mountains. Some ground water is obtained from alluvium on valley floors. The fractures and joints in bedrock are the only other sources of ground water. The ground water is suitable for almost all uses, but it is little used in this area.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Inceptisols, Mollisols, and Ultisols. The soils in the area dominantly have a mesic, frigid, or cryic soil temperature regime, depending largely on elevation; a xeric soil moisture regime; and mixed mineralogy. They generally are very shallow to deep, well drained or somewhat excessively drained, and loamy or sandy. The dominant soils in the MLRA formed in residuum and colluvium on hills and mountains.

The soils at elevations below 3,900 to 4,900 feet (1,190 to 1,495 meters) include deep or very deep Haplohumults (Sites and Aiken series), Haploxeralfs (Secca, Holland, and Cohasset series), Haploxerults (Josephine series), and moderately deep Haploxerults (Mariposa series), all of which formed in material weathered from metavolcanic and metasedimentary rocks. Deep and very deep Dystroxerepts (Chaix and Shaver series) formed in material weathered from granodiorite.

At the higher elevations, deep and very deep Haploxeralfs (Holland and Musick series), Xeropsamments (Cagwin, Corbett, and Toiyabe series), and Dystroxerepts (Meeks series) formed in material weathered from granodiorite and Dystroxerepts (Umpa series), Haploxerands (Meiss series), and Vitrixerands (Waca and Windy series) formed in material weathered from andesite. Large areas of rock outcrop are throughout the MLRA. They are on broad expanses on ridge crests and peaks above timberline, at an elevation of 7,875 to 8,850 feet (2,400 to 2,700 meters).

The soils in mountain valleys formed in mixed alluvium. They include Dystroxerepts (Gefo and Jabu series), Argicryolls (Macareeno series), and Haploxeralfs (Inville series).

Biological Resources

This area supports montane coniferous forest vegetation. The main species are ponderosa pine, Douglas-fir, incense cedar, sugar pine, white fir, California red fir, Jeffrey pine, lodgepole pine, and mountain hemlock. Bristlecone pine grows in protected draws at elevations above 8,850 feet (2,700 meters). Bluegrass, hairgrass, sedges, wiregrass, clovers, and wild iris grow in montane meadows. Manzanita, sagebrush, blue wildrye, fescues, bluegrasses, and mountain brome are common understory species in open stands of timber.

Some of the major wildlife species in this area are black-tailed deer, mountain lion, bighorn sheep, coyote, bobcat, gray fox, raccoon, skunk, jackrabbit, gray squirrel, rattlesnake, California condor, turkey vulture, roadrunner, crow, quail, band-tailed pigeon, and blackbird. The species of fish in the area include rainbow, brown, brook, cutthroat, and golden trout, anadromous salmonids, and northern pike minnow.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—private, 2%; Federal, 5%
Forest—private, 18%; Federal, 65%
Urban development—private, 2%
Water—private, 2%; Federal, 5%
Other—private, 1%

About three-fourths of this area is federally owned land, which is primarily in national forests and parks. The rest of the area is privately owned forestland, farms, and ranches. About 83 percent of the area is forestland used for timber, recreation, wildlife habitat, and watershed. Approximately 7 percent is pasture or range. The area has very little cropland. The cropland is used mainly for deciduous fruits, grain, or hay. Livestock grazing is confined to mountain meadows, which are grazed during summer, and to areas with open stands of timber.

The major resource management concerns on upland soils at intermediate elevations are low pH (moderate or strong acidity) and fertility. The uplands are hilly to mountainous and are subject to erosion in areas where the soils are disturbed by logging, fires, overgrazing, or cultivation. The hazard of erosion is highest on the moderately coarse textured, granitic soils. In areas of shallow soils, soil depth and a low available water capacity are limitations.

The upland soils at high elevations have severe climatic limitations. They also have low pH (moderate or strong acidity) and fertility. Erosion is a hazard in areas on these high-elevation, mountainous slopes where the soils are disturbed by fires and logging operations. Most of the soils are stony and have a low available water capacity.

In the mountain valleys, water management is needed to prevent stream downcutting and gullying and to maintain a satisfactory moisture condition for the growth of desirable plant species. Drainage can be a problem in many of the soils. Preventing or controlling wild-land fires is a major management concern. Older or improperly designed roads contribute sediment to streams. Other management concerns include compaction resulting from farming activities, the impacts of catastrophic wildfire on forestland, and maintenance of the content of organic matter in the soils.

Conservation practices on all kinds of land in this MLRA include measures that control erosion on access roads and measures that protect riparian areas. The most important conservation practices on forestland are those that improve forest health, reduce the chance of catastrophic wildfire, and protect wildlife habitat. These practices include tree and shrub establishment, forest stand improvement, forest harvest trails and landings, critical area planting, and reduction of the extent of understory fuels.

Conservation practices on cropland and pasture generally include irrigation water management, water-control structures, protection of riparian areas, control of streambank erosion, and nutrient and pesticide management. Prescribed grazing, fences, and water management are the most important practices on rangeland and other grazing land.

Conservation practices in rapidly expanding areas used for urban development generally include properly designing roads, improving forest health, and reducing the chance of catastrophic wildfire and thus protecting wildlife habitat. ■

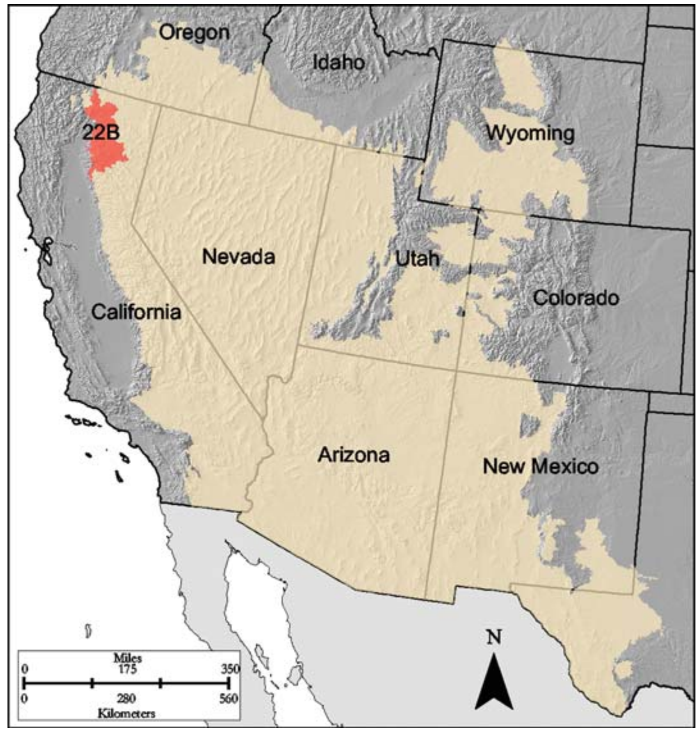

Figure 22B-1: Location of MLRA 22B in Land Resource Region D.

22B—Southern Cascade Mountains

This area (shown in fig. 22B-1) is entirely in California. It makes up about 5,855 square miles (15,175 square kilometers). The most prominent town in this MLRA is Burney. U.S. Highway 97 crosses the western part of the area. Lassen Volcanic National Park occurs in the area. A major portion of this MLRA is in national forests, including the Lassen and Klamath National Forests and portions of the Shasta-Trinity National Forest. The area has several Indian reservations, including the Big Bend Rancheria, Montgomery Creek Rancheria, and Roaring Creek Rancheria Reservations.

Physiography

The area lies within the southern end of the Middle Cascade Mountains Section of the Cascade-Sierra Mountains Province of the Pacific Mountain System. A small area in the southeast part of the MLRA is in the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. This MLRA is the southernmost extent of the Cascade Mountain Range trending north-south. It lies east of the Trinity Mountains and the Northern Sacramento Valley and west of the Modoc Plateau and the Great Basin and is bordered on the north by Butte Valley and the Central Cascade Mountains. It extends to the Sierra Nevada Mountains to the south.

Elevation generally ranges from a low in the foothills of about 1,500 feet (455 meters) to 8,200 feet (2,500 meters). It is as high as 14,162 feet (4,318 meters) on Mount Shasta. This MLRA consists mostly of rolling volcanic mountains and intermontane basins.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this area is as follows: Sacramento (1802), 78 percent; Klamath-Northern California Coastal (1801), 13 percent; and North Lahontan (1808), 9 percent. The McCloud and Sacramento Rivers originate in this area, and the Pit River flows through the area from east to west.

Geology

The Southern Cascade Mountains are made up primarily of Tertiary and Quaternary volcanics (basalt, andesite, dacite, and rhyolite) exposed as prominent peaks and volcanic uplands, surrounded by lower, moderately steep and steep shield and composite volcanoes and cinder cones. Prominent peaks and recently active volcanic areas in this portion of the Southern Cascades include the Medicine Lake Highlands and Medicine Lake Volcano (located on the border with the Modoc Plateau and characterized by silicic to basaltic eruptions as recently as 200 to 300 years ago); Mount Lassen (composed of andesite and dacite with some glacial deposits), which most recently erupted from 1914 to 1921; and Mount Shasta. Mount Shasta is an active stratovolcano with two eruptive centers that have produced pyroclastic flows, andesitic lava flows, and debris flows. Active glaciers and associated deposits extend downslope from the summit of Mount Shasta.

Paleozoic to Mesozoic metamorphics, sedimentary formations, and volcanics, flanked on the east by a thin band and stringers of Eocene sandstones, shales, and conglomerates, are exposed in the west-central portion of the MLRA, in a band that extends southward from the Siskiyou County line to the uplands east of Shasta Lake. Quaternary alluvial, fluvial, and lacustrine deposits have accumulated in small depressions on lava flows, in larger depressions between lava flows, and in stream valleys and basins.

Climate

The average annual precipitation in this MLRA typically is 15 to 80 inches (380 to 2,030 millimeters). It is as high as 125 inches (3,175 millimeters). The precipitation falls mainly from fall to spring, mostly as snow. Winter precipitation is from Pacific storms that are frontal in nature. The amount of precipitation decreases from west to east. Summers are typically warm and dry, but there are occasional thunderstorms. The average annual temperature is 33 to 62 degrees F (1 to 17 degrees C). The freeze-free period averages 215 days and ranges from 85 to 350 days. The lowest annual temperatures and the shortest freeze-free periods occur in the mountains.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 1.7%; ground water, 0.8%
Irrigation—surface water, 90.3%; ground water, 2.3%
Other—surface water, 4.5%; ground water, 0.5%

The total withdrawals average 220 million gallons per day (835 million liters per day). About 4 percent is from ground water sources, and 96 percent is from surface water sources. The abundant rainfall and snowfields on the higher mountain slopes provide water for forestland and rangeland. Also, they meet part of the water needs of the lower adjacent areas by supplying water to perennial streams. The major amounts of snow during wet, cold storms in winter provide considerable runoff for the summer water supply. The surface water is of high quality and has few impurities.

Ground water is in fractures, in rubble zones, and in sand and gravel layers interbedded in the lava flows. Some also is in the alluvial fill in the valleys. The use of ground water is minimal in this MLRA. Recharge to the aquifers exceeds withdrawals.

Soils

The dominant soils in this area are Alfisols, Andisols, Entisols, Inceptisols, and Mollisols. The soil temperature regimes are mostly mesic in the foothills and frigid in the mountains. They are cryic at the highest elevations. The soils on uplands are mostly well drained and have a xeric soil moisture regime, and the soils in basins are somewhat poorly drained or poorly drained and have a xeric to aquic soil moisture regime. The soils on volcanic flows and mountains are mostly Haploxeralfs (Cohasset, Eaglelake, and Lyonsville series), Palexeralfs (Jimmerson series), Vitrixerands (Jiggs, Neer, Ponto, Scarface, and Windy series), Haploxerands (McCarthy series), Xerorthents (Avis series), Dystroxerepts (Iller, Inskip, and Nanny series), and Argixerolls (Chirpchatter and Pinehurst series). The soils in intermountain valleys and basins include very deep Endoaqualfs (Gardens series), Xerorthents (Orset series), Humaquepts (Chummy series), Endoaquolls (Esro series), Epiaquolls (Swanberger series), and Haploxerolls (Jacksback series).

Biological Resources

This MLRA has three main vegetation types—low-elevation mixed conifer (ponderosa pine) forest, mixed conifer forest, and upper montane red fir forest. The oak grasslands of the foothills on the western slopes grade into a mixed conifer forest in which ponderosa pine is the dominant species and incense cedar and

California black oak are important associated species. Important understory plants include sticky whiteleaf manzanita, whiteleaf manzanita, and poison oak. At the higher elevations on the western slopes, the mixed conifer forest consists of white fir, sugar pine, ponderosa pine, incense cedar, Douglas-fir, California black oak, and Oregon white oak. The understory species include snowbrush ceanothus, bitter cherry, sharpleaf snowberry, and Sierra gooseberry. The upper montane forest communities at the higher elevations consist dominantly of red fir and lodgepole pine. The communities on the eastern slopes are dominated by Jeffrey pine and ponderosa pine with an understory of antelope bitterbrush, big sagebrush, and greenleaf manzanita. Three types of meadows are throughout areas of these forest types. Wet meadows consist mainly of perennial sedges, rushes, and grasses. Woodland meadows consist mainly of scattered grasses and forbs interspersed with lodgepole pine, willows, quaking aspen, and black cottonwood. The shorthair sedge type occurs on the drier meadow sites. It consists mainly of shorthair sedge, Brewer's lupine, western needlegrass, and spike trisetum.

Some of the major wildlife species in this area include black-tailed deer, mule deer, mountain lion, coyote, bobcat, yellow-bellied marmot, marten, fisher, Sierra Nevada red fox, wolverine, and porcupine. Birds include eagles, hawks, owls, woodpeckers, falcons, osprey, quail, northern goshawk, and blue grouse. Species of concern include the California and northern spotted owl. The species of fish in the area include rainbow, brown, brook, and redband trout, anadromous salmonids, and northern pike minnow.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 2%
Grassland—private, 8%; Federal, 9%
Forest—private, 33%; Federal, 39%
Urban development—private, 2%
Water—private, 1%; Federal, 3%
Other—private, 1%; Federal, 2%

More than half of the area is federally owned land, primarily in national forests. The rest is privately owned forestland, farms, and ranches. About 72 percent of the land consists of forests used for timber, recreation, wildlife habitat, and watershed. Approximately 17 percent is pasture and range, and less than 2 percent is cropland.

The major soil resource concerns include the hazard of water erosion, which can be severe if the soils are disturbed by logging, fires, overgrazing, or cultivation. Other management concerns include compaction resulting from farming activities, the impacts of catastrophic wildfire on forestland, and maintenance of the content of organic matter in the soils. The soils in the mountain valleys and meadows are susceptible to gullying and streambank erosion. The older or improperly designed roads contribute sediment to streams.

Conservation practices on all kinds of land in this MLRA include measures that control erosion on access roads and protect riparian areas. Conservation practices on forestland generally include forest stand improvement, forest site preparation, reforestation, control of erosion on roads and log landings, control of competing understory vegetation, streambank and shoreline protection, riparian area management, stream corridor habitat protection and improvement, wetland wildlife management, and prescribed grazing.

Conservation practices on cropland and pasture generally include irrigation water management, water-control structures, protection of riparian areas, control of streambank erosion, and nutrient and pesticide management. Prescribed grazing, fences, and water management are the most important conservation practices on rangeland and other grazing land. ■

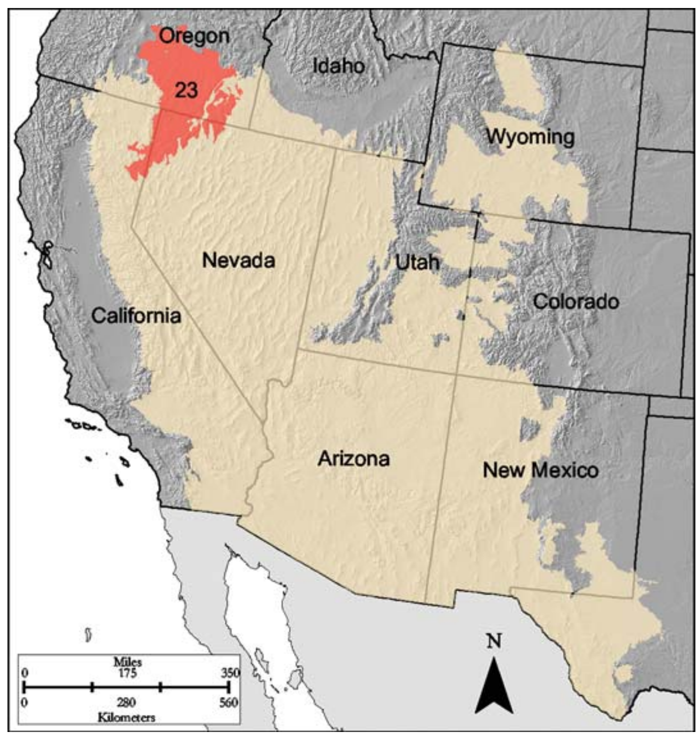

Figure 23-1: Location of MLRA 23 in Land Resource Region D.

23—Malheur High Plateau

This area (shown in fig. 23-1) is in Oregon (67 percent), Nevada (25 percent), and California (8 percent). It makes up about 22,895 square miles (59,320 square kilometers). It has no major cities. The only major highway in this area, U.S. Highway 395, crosses the southern tip of the part of the area in

California. The Sierra Army Depot Military Reservation occurs in this MLRA. Malheur Lake and numerous wilderness study areas and national wildlife refuges also occur in this MLRA.

Physiography

All of this MLRA is on the Intermontane Plateaus. The southern two-thirds of the area is in the Great Basin Section of the Basin and Range Province. Almost all of the northern third of the area is in the Harney Section of the Columbia Plateaus Province, and a small part of the northern third is in the Payette Section of the Columbia Plateau Province. Elevation ranges from 3,900 to 6,900 feet (1,190 to 2,105 meters) in most of the area, but it exceeds 9,000 feet (2,745 meters) on some mountains. This area consists primarily of nearly level to moderately steep plateaus, basins, and valleys bordered by long, gently sloping alluvial fans. Occasional north-south trending fault-block mountain ranges separate the basins. Volcanic plateaus rise sharply above the valleys. Drainage patterns have not yet been established on the youngest lava plateaus.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Oregon Closed Basins (1712), 58 percent; Black Rock Desert-Humboldt (1604), 23 percent; North Lahontan (1808), 9 percent; Middle Columbia (1707), 6 percent; and Middle Snake (1705), 4 percent. The area has no major rivers. It consists mostly of closed basins.

Geology

Most of this area consists of young andesite and basalt layers (6 to 17 million years old). Older volcanic rocks and marine and continental sediments are exposed in the mountain ranges. These north-south trending ranges are uplifted fault blocks. The basins between the mountains and lava plateaus are filled with a mixture of Quaternary alluvium, continental sediments, and volcanic ash. The long alluvial fans consist of coarser alluvium near the mountains and fine grained sediments at their distal ends. Playas or shallow lakes are common in the lowest areas within the closed basins.

Climate

In most of this area, the average annual precipitation is 6 to 12 inches (150 to 305 millimeters). It is as much as 57 inches (1,450 millimeters), however, in the mountain ranges. The precipitation is fairly evenly distributed throughout fall, winter, and spring but is low in summer. Snow can occur throughout the area in winter. The average annual temperature is 39 to 52 degrees F (4 to 11 degrees C), decreasing with elevation. The freeze-free period averages 105 days and ranges from 35 to 175 days, decreasing in length with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 0.2%; ground water, 0.2%
Irrigation—surface water, 88.5%; ground water, 10.2%
Other—surface water, 0.4%; ground water, 0.4%

The total withdrawals average 1,080 million gallons per day (4,090 million liters per day). About 11 percent is from ground water sources, and 89 percent is from surface water sources. Surface water is scarce, except in areas at the higher elevations where precipitation is greater. Streamflow is erratic and depends mostly on runoff from melting snow. Most of the water is used for irrigating grain and hay for cattle feed. Irrigated areas are on alluvial fans and pluvial lake terraces. Surface water from mountain runoff is generally of excellent quality. As the water seeps through the alluvial fan deposits, salts left in the soil as a result of evapotranspiration are dissolved. In the wetter years, when springs discharge this seepage water at the toe of the fan, the water quality is degraded. As the surface water evaporates on its path to a playa, the salt concentrations increase, making the water unsuitable for all uses.

The large supply of ground water in the gravel- and sand-filled valleys and basins is mostly untapped. Little is known about the quality of this ground water in California and Nevada. The basin fill deposits in Oregon have soft to moderately hard water with a median concentration of about 170 parts per million (milligrams per liter) total dissolved solids. The ground water near the alluvial fans typically has lower levels of total dissolved solids than the ground water near playas. Wells closer to the playas typically contain 1,000 or more parts per million (milligrams per liter) total dissolved solids. The volcanic rocks are considered to be aquifers, but they are little used and not much is known about the range of water quality. Water can be found in layers of rubble, cracks, and tubes within the lava. Layers of alluvium and continental sediments occurring between the andesite and basalt flows also may contain ground water.

Soils

The dominant soil orders in this MLRA are Aridisols and Mollisols. The soils in the area dominantly have a mesic or frigid soil temperature regime, an aridic or xeric soil moisture regime, and mixed or smectitic mineralogy. The soils on uplands generally are well drained, loamy or clayey, and shallow or moderately deep. The soils in basins generally are poorly drained to well drained, loamy or clayey, and very deep. Locally, large areas have an ashy particle-size class and glassy mineralogy.

Shallow Argidurids (Actem series) formed in residuum and colluvium on hills and tablelands. Moderately deep Argidurids (Brace series) formed in residuum and alluvium on structural benches and foothills. Shallow Haplargids (Anawalt and Coztur series) formed in residuum on hills, mountains, and plateaus. Moderately deep Haplocambids (Felcher series) and shallow Haplodurids (Raz series) formed in residuum and colluvium on mountains and plateaus. Moderately deep Haplocryolls (Baconcamp series) formed in colluvium on hills and mountain slopes. Argixerolls (shallow Devada, Ninemile, and Wylo series and moderately deep Bucklake series) formed in residuum on hills, plateaus, and mountain slopes. Moderately deep Palexerolls (Carryback series) formed in colluvium and residuum on plateaus. Very deep Endoaquolls (Fury and Ozamis series), Natrargids (Ausmus series), and Halaquepts (Lolak and Reese series) formed in lacustrine sediments on lake plains. Very deep Haplocambids (Catlow and Enko series), Natrargids (Poujade series), and Paleargids (Spangenburg series) formed in alluvium on lake terraces.

Biological Resources

This area supports a shrub-grass association. Big sagebrush, low sagebrush, rabbitbrush, needlegrasses, and squirreltail are common on the plateaus and mountains. Big sagebrush and basin wildrye are on bottom lands. Spiny hopsage and bud sagebrush are on the drier sites. Greasewood, saltbush, and saltgrass grow on salty and sodic soils in basins. Silver sagebrush grows on moist sites that have intermittent water, such as areas along the margin of playas. Western juniper is on rocky sites. Aspen groves occur on moist sites at high elevations, and isolated stands of Douglas-fir and whitebark pine also occur in the mountains.

Some of the major wildlife species in this area are elk, mule deer, bighorn sheep, antelope, migratory birds and waterfowl, golden eagle, red-tailed hawk, prairie falcon, great horned owl, long-eared owl, common barn owl, sage grouse, chukar, meadowlark, and vesper sparrow.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 3%
Grassland—private, 19%; Federal, 65%
Forest—Federal, 3%
Water—private, 2%; Federal, 4%
Other—private, 1%; Federal, 3%

About 75 percent of this area is federally owned. Native range vegetation covers much of the area. Livestock production on rangeland is the principal agricultural enterprise. A small percentage of the area is used for irrigated alfalfa hay, grain, hay for winter feed, or pasture. Pasture and hay provide seasonal feed for livestock. Small areas on the upper mountain slopes are forested.

The major soil resource concerns are control of wind erosion and reduction of the content of salts and sodium in the areas of soils used for the production of crops or hay. Conservation practices on cropland generally include irrigation water management, crop residue management, and toxic salt reduction. Prescribed grazing, brush management, and development of watering facilities are important conservation practices on rangeland. ■

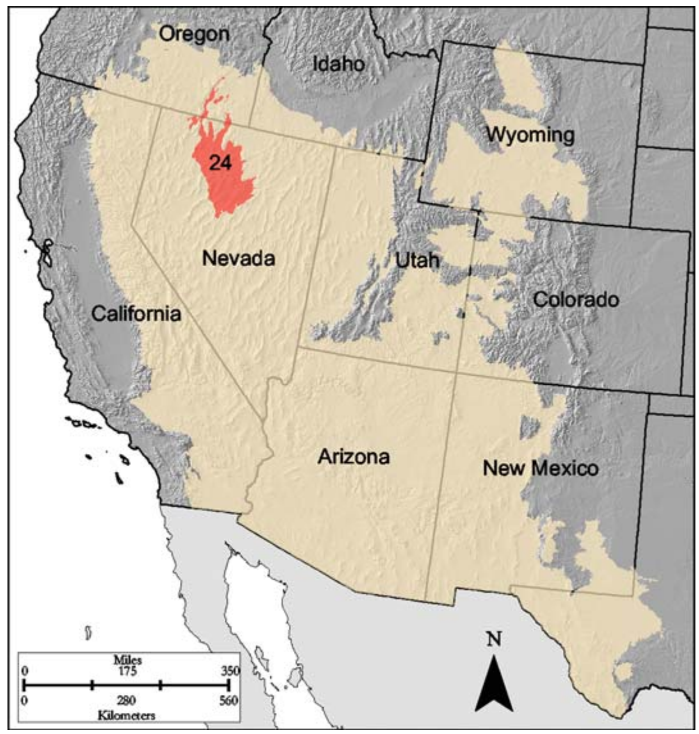

Figure 24-1: Location of MLRA 24 in Land Resource Region D.

24—Humboldt Area

This area (shown in fig. 24-1) is in Nevada (94 percent) and Oregon (6 percent). It makes up about 12,680 square miles (32,855 square kilometers). The towns of Winnemucca and Battle Mountain, Nevada, are along Interstate 80, which crosses this MLRA. A small portion of the Humboldt-Toiyabe National Forest and numerous wilderness study areas occur in this area. The Fort McDermitt Indian Reservation and the very small Battle Mountain and Winnemucca Indian Reservations also are in this area.

Physiography

This MLRA is in the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. A series of widely spaced north-south trending mountain ranges are separated by wide valleys filled with alluvium and lacustrine materials. The isolated ranges are dissected, uplifted fault-block mountains. Elevation ranges from 3,950 to 5,900 feet (1,205 to 1,800 meters) in most of the area, but it is more than 8,850 feet (2,700 meters) on some mountain peaks.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Black Rock Desert-Humboldt (1604), 84 percent; Central Nevada Desert Basins (1606), 10 percent; and Oregon Closed Basins (1712), 6 percent. The Humboldt River flows through this area on its way to the Humboldt Sink.

Geology

Most of this area consists of wide valleys filled with deposits of alluvium washed in from the adjacent mountain ranges. Playas occur in the lowest areas in valleys with closed drainage systems. Most of the valleys, however, are drained by tributaries to the Humboldt River. Mesozoic and Paleozoic volcanic rocks and marine and continental sediments are exposed in the mountain ranges. Some young andesite and basalt layers (6 to 17 million years old) occur at the margins of the mountains. These north-south trending ranges are uplifted fault blocks. Alluvial fans consist of coarser alluvium near the mountains and fine grained sediments at their distal ends.

Climate

In most of this area, the average annual precipitation is 6 to 12 inches (150 to 305 millimeters). It is as much as 40 inches (1,015 millimeters), however, in the mountain ranges. Most of the rainfall occurs as high-intensity, convective thunderstorms in spring and autumn. Precipitation occurs mainly as snow in winter. Summers are dry. The average annual temperature is 38 to 53 degrees F (3 to 12 degrees C). The freeze-free period averages 135 days and ranges from 100 to 175 days, decreasing in length with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 0.0%; ground water, 0.1%
Irrigation—surface water, 68.6%; ground water, 29.0%
Other—surface water, 1.2%; ground water, 1.0%

The total withdrawals average 985 million gallons per day (3,730 million liters per day). About 30 percent is from ground water sources, and 70 percent is from surface water sources. The low precipitation provides a small amount of water. Surface water is available from perennial and intermittent streams that carry snowmelt from the mountains. Late-season surface water supplies are deficient. Most of the water is used for irrigating grain and hay grown for cattle feed.

Irrigated areas are on alluvial fans and along streams in the valleys. Diversions from the Humboldt River are common. Because of additions of poor-quality drainage water from the irrigated areas, the quality of water in the Humboldt River deteriorates as the river flows west. Rye Patch Reservoir, on the lower reaches of the Humboldt River, in the southwest corner of this area, is the only large irrigation storage reservoir in this MLRA. Surface water from mountain runoff is generally of excellent quality. As the water seeps through the alluvial fan deposits, salts left in the soil as a result of evapotranspiration are dissolved. In the wetter years, when springs discharge this seepage water at the toe of the fan, local surface water quality can be degraded.

Limited quantities of ground water in valley fill are being rapidly developed for irrigation of crops. This water is typically of good quality and generally meets the national standards for drinking water. In some areas of geothermal activity or in shallow alluvial-lacustrine and volcanic deposits, high levels of arsenic (more than 50 parts per billion) exceed the national standards for drinking water. Ground water from the basin fill aquifers is slightly hard and has 200 to 400 parts per million (milligrams per liter) total dissolved solids.

Soils

The dominant soil order in the MLRA is Aridisols. Entisols, Inceptisols, and Mollisols also are important. The soils in the area dominantly have a mesic soil temperature regime, an aridic soil moisture regime, and mixed mineralogy. They generally are well drained, loamy, and very deep. Torriorthents (Boton series) formed in loess and alluvium over lacustrine sediments on lake plains and basin floors. Somewhat poorly drained Halaquepts (Wendane series) formed in alluvium on flood plains and terraces. Natrargids (Beoska and Oxcorel series) formed in loess over alluvium on fan piedmonts and plateaus. Haplocambids formed in loess over alluvium on alluvial fans and alluvial flats (Broyles, Orovada, and Weso series) and in alluvium on alluvial fans and lake terraces (Davey, Enko, and McConnel series). Shallow Argidurids formed in alluvium on fans and terraces (Tumtum series) and in loess and alluvium on fan remnants and plateaus (Dewar series). Moderately deep Haplargids (Roca series) formed in colluvium and residuum on hills and mountain slopes. Moderately deep Argixerolls (Reluctan series) formed in colluvium and residuum on hills, mountains, and plateaus.

Biological Resources

This area supports shrub-grass vegetation. In areas where the average annual precipitation is about 8 inches (200 millimeters) or more, big sagebrush is the characteristic plant. Low sagebrush is characteristic on some soils with a clayey subsoil. Thurber needlegrass, bluebunch wheatgrass (scarce on the drier sites), basin wildrye, squirreltail, Sandberg bluegrass, forbs, spiny hopsage, and Douglas rabbitbrush are common associated plants. Locally important are Idaho fescue and snowberry on sites where moisture is favorable, Utah juniper in a few high rocky areas, and Indian ricegrass and needleandthread on sandy soils. Shadscale and bud sagebrush associated with Indian ricegrass and bottlebrush squirreltail are dominant on the drier sites. Black greasewood, basin wildrye, and Nuttall saltbush are locally important on some low terraces and flood plains. Winterfat is prevalent in some areas.

Some of the major wildlife species in this area are mule deer, coyote, bobcat, beaver, muskrat, jackrabbit, cottontail, pheasant, chukar, Hungarian partridge, sage grouse, quail, ducks, and geese. The Humboldt River supports some warm-water fish. Trout are in some of the mountain streams.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 3%
Grassland—private, 20%; Federal, 75%
Forest—Federal, 1%
Other—private, 1%

About three-fourths of this area is federally owned. The rest is used for farms, ranches, industrial enterprises (mining), and some urban and transportation purposes. Livestock grazing on native range is the principal agricultural enterprise. About 3 percent of the area, generally consisting of narrow strips along the major streams and margins of valleys, is used for irrigated hay, grain, pasture, alfalfa seed, or potatoes. The hay produced in the area is used principally for winter feeding of resident livestock.

The major soil resource concerns are control of wind erosion and reduction of the content of salts and sodium in the soils in areas used for crops or pasture. The main management considerations include proper grazing practices and the efficient use of the available supplies of surface water and ground water. Conservation practices on cropland generally include irrigation water management, crop residue management, and toxic salt reduction. Important practices on rangeland include prescribed grazing, brush management, and development of watering facilities. ■

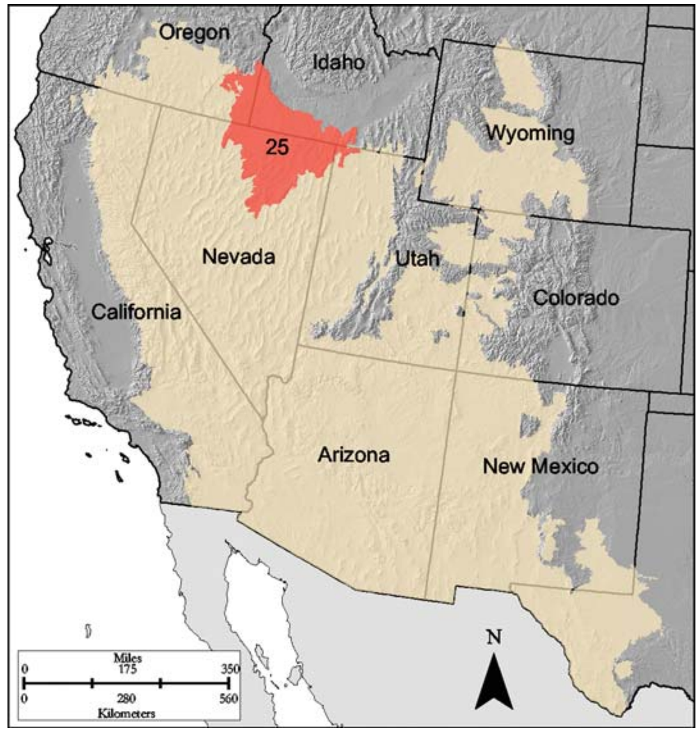

Figure 25-1: Location of MLRA 25 in Land Resource Region D.

25—Owyhee High Plateau

This area (shown in fig. 25-1) is in Nevada (52 percent), Idaho (29 percent), Oregon (16 percent), and Utah (3 percent). It makes up about 28,930 square miles (74,960 square kilometers). The city of Elko, Nevada, which is along Interstate 80, is in this MLRA. The Humboldt-Toiyabe and Sawtooth National Forests and numerous wilderness study areas also occur in this MLRA. Most of the wilderness study areas are in the high desert canyon lands of southern Idaho. The Duck Valley, South Fork, Ruby Valley, and Te-Moak Indian Reservations are in this area.

Physiography

All of this area lies within the Intermontane Plateaus. The southern half is in the Great Basin Section of the Basin and Range Province. This part of the MLRA is characterized by isolated, uplifted fault-block mountain ranges separated by narrow, aggraded desert plains. This geologically older terrain has been dissected by numerous streams draining to the Humboldt River. The northern half of the area lies within the Columbia Plateaus Province. This part of the MLRA forms the southern boundary of the extensive Columbia Plateau basalt flows. Most of the northern half is in the Payette Section, but the northeast corner is in the Snake River Plain Section. Deep, narrow canyons draining into the Snake River have been incised into this broad basalt plain. Elevation ranges from 3,000 to 7,550 feet (915 to 2,300 meters) on rolling plateaus and in gently sloping basins. It is more than 9,840 feet (3,000 meters) on some steep mountains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Middle Snake (1705), 49 percent; Black Rock Desert-Humboldt (1604), 28 percent; Upper Snake (1704), 15 percent; Great Salt Lake (1602), 5 percent; and Central Nevada Desert Basins (1606), 3 percent. The Humboldt River, route of a major western pioneer trail, crosses the southern half of this area. Reaches of the Owyhee River in this area have been designated as National Wild and Scenic Rivers.

Geology

The dominant rock types in the area are volcanic. They include andesite, basalt, and rhyolite. In the north and west parts of the area, Miocene volcanic rocks dominate and Cretaceous granitic rocks occur in the mountains. A Mesozoic igneous and metamorphic rock complex dominates the south and east parts of the area. Upper and Lower Paleozoic sediments, including extensive limestone deposits, occur in the mountains. Only a few narrow valleys occur in this area (2 to 3 percent of the land area). Alluvial fan and basin fill sediments occur in the valleys.

Climate

The average annual precipitation in most of this area is 7 to 16 inches (180 to 405 millimeters), but it can exceed 50 inches per year (1,270 millimeters) in the mountains. The amount of precipitation is lowest in the eastern part of the area and increases with elevation. Rainfall occurs in spring and sporadically in summer. Precipitation occurs mainly as snow in winter. The precipitation is distributed fairly evenly throughout fall, winter, and spring. The amount of precipitation is lowest from midsummer to early autumn. The average annual temperature is 35 to 53 degrees F (2 to 12 degrees C). The freeze-free period averages 130 days and ranges from 65 to 190 days, decreasing in length with elevation. It is typically less than 70 days in the mountains.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.1%; ground water, 0.1%
Livestock—surface water, 0.2%; ground water, 4.8%
Irrigation—surface water, 49.8%; ground water, 35.5%
Other—surface water, 3.3%; ground water, 6.3%

The total withdrawals average 570 million gallons per day (2,155 million liters per day). About 47 percent is from ground water sources, and 53 percent is from surface water sources. The supply of water from precipitation and streamflow is small and unreliable, except along the Owyhee, Bruneau, and Humboldt Rivers. Streamflow depends largely on accumulated snow in the mountains. Surface water from mountain runoff is generally of excellent quality and is suitable for all uses. Precipitation is adequate for dryfarming in a few areas of deep soils in Idaho.

The basin fill sediments in the narrow alluvial valleys between the mountain ranges provide some ground water for irrigation. The alluvial deposits along the large streams have the most ground water. Based on measurements of water quality in similar deposits in adjacent areas, the basin fill deposits probably contain moderately hard water with a concentration of less than 400 parts per million (milligrams per liter) total dissolved solids. The carbonate rocks in this area are considered to be aquifers, but they are little used. The water in this aquifer is suitable for almost all uses. The concentrations of total dissolved solids are less than the Nevada drinking water standard of 1,000 parts per million (milligrams per liter). Springs are common along the edges of the limestone outcrops.

Soils

The dominant soil orders in this MLRA are Aridisols and Mollisols. The soils in the area dominantly have a mesic or frigid soil temperature regime, an aridic or xeric soil moisture regime, and mixed or smectitic mineralogy. They generally are well drained, clayey or loamy, and shallow or moderately deep. Haplodurids (Bioya and Coonskin series) formed in loess over alluvium on fan piedmonts and plateaus. Argidurids (Dacker, Bruncan, and Hunnton series) and some Durixerolls (Donna and Heckison series) formed in mixed loess and volcanic ash over alluvium on fan piedmonts and plateaus. Other Durixerolls (Stampede series) formed in alluvium on alluvial fans and fan piedmonts. Argidurids (Arbidge and Diawell series) formed in alluvium on fan piedmonts and stream terraces. Haplargids formed in residuum and colluvium on hills, mountain slopes, and plateaus (Vanwyper and Dougal series) and in alluvium on alluvial fans, ballenas, and plateaus (very deep Wieland and Owsel series). Some Argixerolls (shallow Cleavage, Gaib, and Ninemile series and moderately deep Quarz, Mulshoe, and Sumine series) formed in residuum and colluvium on hills, plateaus, and mountain slopes. Other Argixerolls (McIvey series) formed in alluvium or colluvium on fans, hills, and mountain slopes.

Biological Resources

This area supports shrub-grass vegetation characterized by big sagebrush or low sagebrush and by bluebunch wheatgrass, western wheatgrass, or Idaho fescue. Other important plants are Sandberg bluegrass, foxtail wheatgrass, penstemon, phlox, milkvetch, lupine, aster, and rabbitbrush. The high plateaus support juniper and curl-leaf mountain mahogany and an understory of dominantly snowberry and ceanothus. Conifers, aspen, and very large curl-leaf mountain mahogany are in the Owyhee, Ruby, and Jarbridge Mountains. The conifers include whitebark pine, Douglas-fir, limber pine, Engelmann spruce, subalpine fir, and bristlecone pine.

Some of the major wildlife species in this area are mule deer, bighorn sheep, pronghorn, mountain lion, coyote, bobcat, badger, river otter, mink, weasel, golden eagle, red-tailed hawk, ferruginous hawk, Swainson's hawk, northern harrier, prairie falcon, kestrel, great horned owl, short-eared owl, long-eared owl, burrowing owl, pheasant, sage grouse, chukar, gray partridge, and California quail. Reptiles and amphibians include western racer, gopher snake, western rattlesnake, side-blotched lizard, western toad, and spotted frog. The species of fish in the area include bull trout, red band trout, and rainbow trout.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 1%
Grassland—private, 22%; Federal, 73%
Forest—Federal, 2%
Water—private, 1%
Other—private, 1%

About three-fourths of this area is federally owned. The rest is mainly in farms and ranches. Livestock production on rangeland is the main agricultural enterprise. A few areas in valleys are used for irrigated grain and forage for livestock. Small areas in Idaho are used for dry-farmed wheat. Open forests on mountain slopes at high elevations are grazed by livestock and wildlife.

The major soil resource concerns include accelerated erosion, runoff, and sedimentation. Forest health and rangeland quality are additional concerns.

Conservation practices on cropland generally include irrigation water management, pasture and hayland seeding, and weed control. The efficiency of irrigation water use can be improved by sprinkler systems and installation of gated pipe, field runoff management, and water source development. The plant species selected for seeding on pasture and hayland should be those that are suited to the various soil and environmental conditions. Weed control may include the removal of noxious and invasive plants followed by seeding with adapted forage species. Forest health can be enhanced by practices that include thinning, site preparation, forest stand improvement, and properly located and constructed forest roads and landings. Rangeland quality can be maintained or improved by developing livestock watering facilities, reseeding, prescribed burning, proper fencing, and weed control. ■

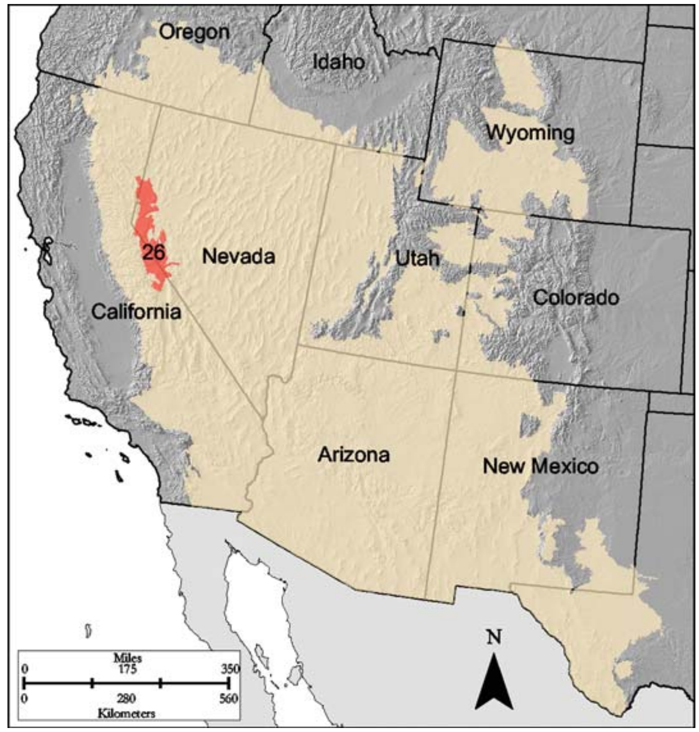

Figure 26-1: Location of MLRA 26 in Land Resource Region D.

26—Carson Basin and Mountains

This area (shown in fig. 26-1) is in Nevada (75 percent) and California (25 percent). It makes up about 6,520 square miles (16,890 square kilometers). The cities of Carson City, Reno, and Sparks, Nevada, are in this MLRA. Interstate 80 crosses the central part of this area. The Plumas, Humboldt-Toiyabe, and Inyo National Forests occur in the area. The Washoe and Reno-Sparks Indian Reservations and the western part of the Walker River Indian Reservation also are in the area.

Physiography

Almost all of this area is in the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. Isolated north-south trending mountain ranges are separated by aggraded desert plains. The mountains are uplifted fault blocks with steep side slopes. Most of the valleys are drained by three major rivers flowing east across this MLRA. A narrow strip along the western border of the area is in the Sierra Nevada Section of the Cascade-Sierra Mountains Province of the Pacific Mountain System. The Sierra Nevada Mountains are primarily a large fault block that has been uplifted with a dominant tilt to the west. This structure leaves an impressive wall of mountains directly west of this area. Parts of this eastern face, but mostly just the foothills, mark the western boundary of this area.

Elevation ranges from 3,900 to 6,550 feet (1,190 to 1,995 meters) in valleys and is as high as 13,100 feet (3,995 meters) on mountain crests.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Central Lahontan (1605), 72 percent; Northern Mojave-Mono Lake (1809), 16 percent; North Lahontan (1808), 7 percent; and Central Nevada Desert Basins (1606), 5 percent. The Truckee River originates at Lake Tahoe and runs through Reno, Nevada, on its way east to its terminus just outside this area in Pyramid Lake. The headwaters of the Carson River run through Carson City, Nevada. This river flows to its terminus just outside this area in the Carson Sink, below the Lahontan Reservoir. The East and West Walker Rivers join to form the Walker River in the southern tip of this area. The Walker River flows into Weber Reservoir and then on to its terminus, Walker Lake, just outside this area.

Geology

Mesozoic and Tertiary intrusives are common in this area. These rocks are granitic near the Sierra Nevada Mountains on the west side but are typically andesite and basalt in the rest of the area. There are some young tuffaceous sediments in this MLRA, and a complex of Mesozoic sediments and volcanic rocks occurs on the edges of uplifted fault blocks. Alluvium fills the valleys between the mountains. The major rivers in the area have reworked the alluvium, forming prominent terraces and flood plains. There is a level line evident on the higher slopes marking the former extent of glacial Lake Lahontan.

Climate

The average annual precipitation in this area is 5 to 36 inches (125 to 915 millimeters), increasing with elevation. Most of the rainfall occurs as high-intensity, convective storms in spring and autumn. Precipitation is mostly snow in winter. Summers are dry. The average annual temperature is 37 to 54 degrees F (3 to 12 degrees C). The freeze-free period averages 115 days and ranges from 40 to 195 days, decreasing in length with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 7.6%; ground water, 7.9%
Livestock—surface water, 0.2%; ground water, 0.2%
Irrigation—surface water, 56.2%; ground water, 25.7%
Other—surface water, 1.1%; ground water, 1.0%

The total withdrawals average 935 million gallons per day (3,530 million liters per day). About 35 percent is from ground water sources, and 65 percent is from surface water sources. The low precipitation in the valleys provides little water, but a few large rivers that have their source in high mountains outside the area supply water for irrigation and other uses along the course of the rivers. The reservoirs used principally for storing irrigation water include Washoe Lake in the headwaters of the Carson River and Weber Reservoir on the Walker River in Nevada and Bridgeport Reservoir and Topaz Lake on the Walker River in California. Surface water from mountain runoff is generally of excellent quality and is suitable for all uses.

Limited quantities of ground water in valley fill are being rapidly developed for urban, industrial, and agricultural uses. The alluvial deposits along the larger streams contain the most ground water. This water is of good quality, although the total dissolved solids can exceed the Nevada drinking water standard of 1,000 parts per million (milligrams per liter) in some areas. The basin fill aquifer typically has moderately hard to very hard water with a concentration of 150 to 1,000 parts per million (milligrams per liter) total dissolved solids.

Soils

The dominant soil orders in this MLRA are Aridisols and Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an aridic or xeric soil moisture regime, and mixed or smectitic mineralogy. They generally are well drained, are clayey or loamy and commonly skeletal, and are very shallow to moderately deep. Argixerolls (Duco and Ister series) formed in residuum and colluvium on hills and mountain slopes. Argidurids (Fulstone, Reno, and Smedley series) and very deep Haplocambids (Haybourne series) formed in alluvium on alluvial fans, terraces, and piedmonts. Haplargids (Old Camp and Xman series) and Argidurids (Lapon series) formed in residuum and colluvium on hills, plateaus, and mountain slopes.

Biological Resources

This area supports shrub-grass vegetation characterized by big sagebrush. Low sagebrush and Lahontan sagebrush occur on some soils. Antelope bitterbrush, squirreltail, desert needlegrass, Thurber needlegrass, and Indian ricegrass are important associated plants. Green ephedra, Sandberg bluegrass, Anderson peachbrush, and several forb species also are common. Juniper-pinyon woodland is typical on mountain slopes. Jeffrey pine, lodgepole pine, white fir, and manzanita grow on the highest mountain slopes. Shadscale is the typical plant in the drier parts of the area. Sedges, rushes, and moisture-loving grasses grow on the wettest parts of the wet flood plains and terraces. Basin wildrye, alkali sacaton, saltgrass, buffaloberry, black greasewood, and rubber rabbitbrush grow on the drier sites that have a high concentration of salts.

Some of the major wildlife species in this area are mule deer, coyote, beaver, muskrat, jackrabbit, cottontail, raptors, pheasant, chukar, blue grouse, mountain quail, and mourning dove. The species of fish in the area include trout and catfish. The Lahontan cutthroat trout in the Truckee River is a threatened and endangered species.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 2%
Grassland—private, 23%; Federal, 58%
Forest—private, 2%; Federal, 9%
Urban development—private, 2%
Water—private, 2%
Other—private, 2%

About two-thirds of this area is federally owned. The rest is used mainly for farming, ranching, urban development, industrial enterprises, and transportation. Grazing of livestock on native grasses and shrubs is the principal agricultural enterprise. About 2 percent of the total area, principally in valleys along the major streams, is used for irrigated hay, grain, tame pasture, onions, potatoes, or garlic. About one-tenth of the area is forestland on mountain slopes. Some areas formerly used for farming are being converted to urban uses.

The major soil resource concerns are maintenance of the content of organic matter and productivity of the soils and the accelerated erosion resulting from recreational activities and construction. In some areas the content of salts and sodium in the soils is a concern. Forest and rangeland health is an additional management concern.

Conservation practices on cropland generally include irrigation water management and crop residue management. Prescribed grazing, brush management, and watering facilities are important on rangeland. Pasture and hay provide seasonal feed for livestock. In areas of forestland, forest stand improvement, forest site preparation, properly located forest trails and landings, and firebreaks can help to reduce the effects of catastrophic wildfires and the damage caused by insects and disease. ■

27—Fallon-Lovelock Area

This area is almost entirely in Nevada (fig. 27-1). It makes up about 12,565 square miles (32,560 square kilometers). The towns of Lovelock, Fallon, Yerington, and Hawthorne are in this MLRA. Interstate 80 crosses the north part of this area. The Fallon Naval Air Station is in the area. The Stillwater and Fallon National Wildlife Refuges and the Pyramid Lake, Walker River, and Lovelock Indian Reservations also are in the area.

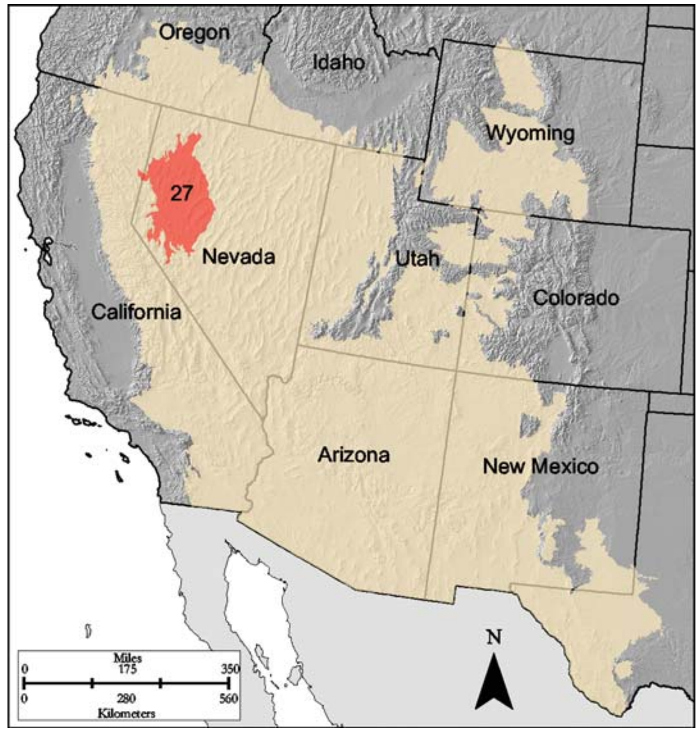

Figure 27-1: Location of MLRA 27 in Land Resource Region D.

Physiography

This area is in the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. Isolated mountain ranges trending north to south are separated by broad, aggraded desert plains and valleys. The mountains are uplifted fault blocks with steep side slopes. The mountains and valleys are dissected by the Humboldt, Truckee, Carson, and Walker Rivers and their tributaries. Elevation generally ranges from 3,300 to 5,900 feet (1,005 to 1,800 meters) in valleys, but on some mountain peaks it is more than 7,870 feet (2,400 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Central Lahontan (1605), 45 percent; Central Nevada Desert Basins (1606), 32 percent; and Black Rock Desert-Humboldt (1604), 23 percent. The major rivers in the area are, from north to south, the Humboldt River, the Truckee River, the Carson River, and the Walker River. The Humboldt River terminates in the Humboldt Sink, the Truckee River terminates in Pyramid Lake, the Carson River terminates in the Carson Sink (after flowing through the Lahontan Reservoir), and the Walker River terminates in Walker Lake (after flowing through the Weber Reservoir).

Geology

Almost half of this area has surface deposits of alluvial valley fill. The rest has andesite and basalt rocks of different ages. Mesozoic and Tertiary intrusives are concentrated along the western border of the area, and Lower Volcanic Rocks (17 to 43 million years old) are common on the eastern side of the area. Also, some scattered outcrops of Mesozoic sedimentary and volcanic rocks and tuffaceous sedimentary rocks are in the mountains within the interior of this MLRA.

Climate

The average annual precipitation is 5 to 10 inches (125 to 255 millimeters) in most of the area but is as much as 19 inches (485 millimeters) on high mountain slopes. Most of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. The amount of precipitation is very low from summer to midautumn. The precipitation in winter occurs mainly as snow. The average annual temperature is 43 to 54 degrees F (6 to 12 degrees C). The freeze-free period averages 155 days and ranges from 110 to 195 days, decreasing in length with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.1%; ground water, 0.1%
Livestock—surface water, 0.3%; ground water, 0.3%
Irrigation—surface water, 76.5%; ground water, 17.7%
Other—surface water, 3.1%; ground water, 2.0%

The total withdrawals average 425 million gallons per day (1,610 million liters per day). About 20 percent is from ground water sources, and 80 percent is from surface water sources. The amount of precipitation is very low, and water for irrigation is obtained principally from diversions on the four large rivers in the area and from water stored in the Lahontan, Rye Patch, and Weber Reservoirs. The irrigated areas are mainly near Fallon, Lovelock, and Yerington. The surface water is generally suitable for most uses, but local water-quality problems result from high concentrations of total dissolved solids and sediment loads in irrigation return flows. Pyramid Lake and Walker Lake are terminal lakes used principally for recreation. Much of the Truckee River is diverted for irrigation, so the Pyramid Lake level is falling, causing problems for native fish species that use the Truckee River and the lake.

Ground water is scarce and of poor quality in the major valleys. Limited supplies of ground water of good or fair quality in some of the outlying valleys are being rapidly developed for irrigation. The basin fill aquifers contain very soft to very hard water that typically has total dissolved solids of less than 500 parts per million (milligrams per liter). Ground water pumped from the lower elevations in the valleys, nearer the playa lakes and sinks, typically has more than 1,000 parts per million (milligrams per liter) total dissolved solids.

A volcanic rock aquifer in western Churchill County, in the Carson Sink desert, has ground water suitable for most uses. Arsenic levels, however, exceed the 50 parts per billion (micrograms per liter) standard for drinking water.

Soils

The dominant soil orders in this MLRA are Aridisols and Entisols. The soils in the area dominantly have a mesic soil temperature regime, an aridic soil moisture regime, and mixed mineralogy. They generally are well drained, are loamy or sandy and commonly skeletal, and are shallow to very deep. Shallow Argidurids (Cleaver series) formed in alluvium on fan piedmonts. Very deep Natrargids formed in loess- and ash-mantled alluvium on fan piedmonts (Dorper series) and in alluvium on fan remnants and lake terraces (Jerval series). Shallow Haplargids (Old Camp and Theon series) formed in residuum and colluvium on hills, plateaus, and mountain slopes. Very deep Torripsamments formed in alluvium on sand sheets (Hawsley series) and in sandy eolian material on dunes (Isolde series). Very shallow Torriorthents (Singatse series) formed in residuum and colluvium on hills and mountain slopes. Very deep Torriorthents formed in alluvium on alluvial fans and terraces (Bluewing and Trocken series) and in mixed alluvium and lacustrine sediments on basin floors, alluvial flats, and terraces (Mazuma series).

Biological Resources

This area supports desert shrub vegetation. Shadscale is widespread. It is mixed with Bailey greasewood on uplands and with black greasewood and seepweed on the lower sites. Grasses are generally sparse, although Indian ricegrass is prominent on the sandy soils. Fourwing saltbush, winterfat, spiny hopsage, wolfberry, ephedra, dalea, and bud sagebrush are common shrubs. Basin wildrye, creeping wildrye, alkali sacaton, saltgrass, black greasewood, rubber rabbitbrush, and big saltbush are important plants on saline bottom lands and terraces. A few tule marshes support cattail, bulrushes, sedges, and rushes. Big sagebrush, along with scattered Utah juniper and singleleaf pinyon, is associated with Thurber needlegrass, basin wildrye, Sandberg bluegrass, and squirreltail on some shallow soils on the higher alluvial fans and mountain slopes.

Some of the major wildlife species in this area are feral horse, mule deer, antelope, kit fox, bobcat, black-tailed jackrabbit, antelope ground squirrel, kangaroo rat, bushy-tailed woodrat, desert mouse, Pacific rattlesnake, gopher snake, whip-tailed lizard, sagebrush lizard, sage grouse, chukar, loggerhead shrike, Brewer’s sparrow, sage thrasher, blue-grey gnat-catcher, and American kestrel. The Lahontan cutthroat trout and cui-ui are two threatened and endangered fish species in the lower reaches of the Truckee River.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 2%
Grassland—private, 24%; Federal, 64%
Forest—Federal, 4%
Water—private, 2%; Federal, 2%
Other—private, 2%

More than two-thirds of this area is federally owned land, large tracts of which are used for training and testing purposes by the Armed Forces. The rest is in farms and ranches. Livestock production on rangeland is the principal agricultural enterprise. A small percentage of the area is used for irrigated alfalfa (including alfalfa seed), grain, garlic, or onions.

The major soil resource concerns are wind erosion and the content of salts and sodium in the soils. Conservation practices on cropland generally include irrigation water management, toxic salt reduction, and crop residue management. These practices help to reduce the hazard of wind erosion and increase the available water capacity of the soils. Conservation practices on rangeland generally include development of watering facilities and prescribed grazing. ■

28A—Great Salt Lake Area

This area (shown in fig. 28A-1) is in Utah (82 percent), Nevada (16 percent), and Idaho (2 percent). It makes up about 36,775 square miles (95,300 square kilometers). Salt Lake City, Logan, Ogden, Provo, Richfield, and Cedar City, Utah, and Malad City and Preston, Idaho, are in this MLRA. Interstate 80 crosses the northern end of the MLRA, and Interstate 15 parallels the eastern border. Interstate 84 crosses the northern tip, and Interstate 70 ends at Interstate 15 in the south end of the MLRA. Several national forests occur in this MLRA, including the Caribou, Dixie, Wasatch-Cache, Humboldt-Toiyabe, and Fish Lake National Forests. The Deseret Test Center and the Desert Range Experiment Station, including the Biosphere Reserve, are in this area. The Hill and Wendover Air Force Ranges, the Tooele Military Depot, and the Dugway Proving Grounds also are in this area. The Skull Valley Indian Reservation is in the area. The Bonneville Salt Flats Speedway, used by experimental cars for setting land speed records, also is in the area. The Golden Spike National Historic Site (joining point for the first transcontinental railroad) is in this MLRA.

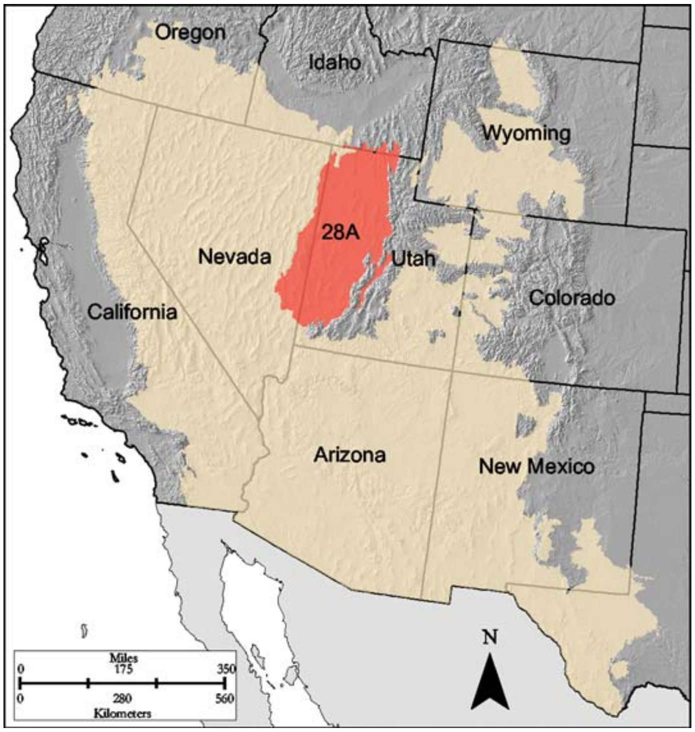

Figure 28A-1: Location of MLRA 28A in Land Resource Region D.

Physiography

This area is the farthest eastern extent of the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. It is an area of nearly level basins between widely separated mountain ranges trending north to south. The basins are bordered by long, gently sloping alluvial fans. The mountains are uplifted fault blocks with steep side slopes. They are not well dissected because of low rainfall in the MLRA. A large salt desert playa is south and west of Great Salt Lake. Most of the valleys in this MLRA are closed basins containing sinks or playa lakes. Elevation ranges from 3,950 to 6,560 feet (1,205 to 2,000 meters) in the basins and from 6,560 to 11,150 feet (2,000 to 3,400 meters) in the mountains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Great Salt Lake (1602), 58 percent; Escalante Desert-Sevier Lake (1603), 28 percent; Central Nevada Desert Basins (1606), 6 percent; Bear (1601), 5 percent; and Lower Colorado-Lake Mead (1501), 3 percent. The Jordan, Bear, and Weber Rivers, the main rivers in this area, all terminate in Great Salt Lake. The Sevier River is in the south half of the area. Numerous creeks drain the Wasatch Mountain front directly east of Salt Lake City, and many terminate in Great Salt Lake directly west of Salt Lake City.

Geology

Most of this area has alluvial valley fill and playa lakebed deposits at the surface. Great Salt Lake is all that remains of glacial Lake Bonneville, which covered this area during the most recent ice age. A level line on some mountain slopes indicates the former extent of this glacial lake. The uplifted mountains have exposed some Precambrian rocks at their margins. Most of the mountains in the interior of this area consist of tilted blocks of marine sediments from Cambrian to Mississippian age. There are no rocks representing the Mesozoic era in this area. Scattered outcrops of Tertiary continental sediments and volcanic rocks are throughout the area. These units are concentrated on the east and west edges of the area. The Tertiary intrusives are the dominant rock types at the southern end of the MLRA.

Climate

The average annual precipitation is 5 to 12 inches (125 to 305 millimeters) in the valleys and is as much as 49 inches (1,245 millimeters) in the mountains. Most of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. The driest period is from midsummer to early autumn. Precipitation in winter typically occurs as snow. The average annual temperature is 39 to 53 degrees F (4 to 12 degrees C). The freeze-free period averages 165 days and ranges from 110 to 215 days, decreasing in length with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 5.5%; ground water, 8.5%
Livestock—surface water, 1.2%; ground water, 0.8%
Irrigation—surface water, 65.3%; ground water, 14.5%
Other—surface water, 1.0%; ground water, 3.2%

The total withdrawals average 3,575 million gallons per day (13,530 million liters per day). About 27 percent is from ground water sources, and 73 percent is from surface water sources. Water is scarce. For the most part, streams are small and intermittent and depend on sources in the higher mountains. Reservoirs are used to store water in the mountains east of this area for irrigation in the flatter areas of this MLRA. As an example, the Sevier River, in the southern part of this area, is the most heavily used river in the United States. Almost 99 percent of its total flow is used before it reaches its terminus in the mostly dry Sevier Lake. The surface water from the mountains is of good quality, and its use generally is not limited. Irrigation return flows raise the levels of dissolved salts and suspended sediments, causing some contamination.

Both surface water and ground water are used for irrigation. Use of deep wells is limited by a high cost. Shallow wells in the basin and valley fill aquifers provide almost all of the ground water used in this area. This shallow ground water generally contains less than 1,000 parts per million (milligrams per liter) total dissolved solids. Along the northeastern border of this area, near the Wasatch Front where the alluvial aquifers are recharged, ground water is much lower in dissolved salts (typically less than 250 parts per million) and is a primary source of drinking water for the populated areas all along the Wasatch Front. The ground water becomes almost saline near the playa lakes west of the recharge zone. A basin fill deposit near Sevier Lake and the ground water in the Rush Valley area of Tooele County contain high levels of arsenic.

Soils

The dominant soil orders in this MLRA are Aridisols, Entisols, and Mollisols. The soils in the area dominantly have a mesic or frigid soil temperature regime, an aridic or xeric soil moisture regime, and mixed mineralogy. They generally are well drained or somewhat excessively drained, loamy or loamy-skeletal, and very deep.

Calcixerolls formed in alluvium on alluvial fan remnants and lake terraces (Abela series) and in alluvium and lacustrine sediments on lake terraces (Collinston series). Moderately deep Haploxerolls (Middle series) formed in residuum on mountain slopes. Deep and very deep Haploxerolls (Ririe and Rexburg series) formed in loess and silty alluvium on fans, terraces, foothills, and basalt plains. Shallow Haploxerolls (Hymas series) to very deep Haploxerolls (Hondoho series) formed in colluvium and residuum derived from limestone on mountains and foothills. Torriorthents formed in alluvium on alluvial fans and beach plains (Cliffdown series) and in alluvium mixed with lacustrine sediments on alluvial flats and fans, lake terraces, and lake plains (Timpie and Tooele series). Poorly drained Aquisalids (Saltair series) formed in alluvium and lacustrine sediments on lake plains and basin floors. Torripsamments (Yenrab series) formed in sandy eolian material on dunes. Haplocalcids formed in residuum on hills and mountains (shallow Amtoft series); in alluvium and colluvium on alluvial fans, terraces, and hills (Hiko Peak series); in mixed alluvium and lacustrine sediments on alluvial fans, terraces, and lake plains (Taylorsflat series); and in lacustrine sediments on lake terraces (Thiokol series). Natrargids (Skumpah series) formed in alluvium on alluvial fans and flats.

Biological Resources

This area supports desert shrub, shrub-grass, and woodland vegetation. In areas where the average annual precipitation is less than about 200 millimeters, the soils support shadscale, winterfat, black sagebrush, and associated grasses, such as Indian ricegrass and squirreltail. Greasewood and Nuttall saltbush grow on soils having a high content of salts or sodium. In areas where the average annual precipitation is 200 to 300 millimeters, the soils support big sagebrush, shadscale, winterfat, and associated grasses, such as bluebunch wheatgrass, Indian ricegrass, and bluegrasses. In areas where the average annual precipitation is more than 300 millimeters, the soils support Utah juniper, singleleaf pinyon, big sagebrush, bluebunch wheatgrass, bluegrasses, and needleandthread. A large, nearly barren area west of Great Salt Lake has a very sparse cover of pickleweed, seepweed, and greasewood.

Some of the major wildlife species in this area are mule deer, jackrabbit, cottontail, Cooper's hawk, American kestrel, red-tailed hawk, prairie falcon, rough-legged hawk, Swainson's hawk, and chukar. Brine shrimp occur in Great Salt Lake, and warm-water species of fish occur in other freshwater lakes in the valleys. Mountain streams in the Wasatch Mountains are inhabited by trout.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 6%
Grassland—private, 21%; Federal, 44%
Forest—private, 2%; Federal, 12%
Urban development—private, 2%
Water—private, 7%; Federal, 2%
Other—private, 4%

About three-fifths of this area is federally owned land, large tracts of which are used for training and testing purposes by the Armed Forces and the Nuclear Regulatory Commission. A large area west and southwest of Great Salt Lake is a salty playa. The rest of the area is in farms and ranches. Livestock production on rangeland is a principal agricultural enterprise in the west. The production of desert shrubs and grasses is very low. In most of the area, the extent of the livestock industry is determined largely by the amount of hay, pasture, and grain that can be produced under irrigation from limited water supplies. About 5 percent of the area is irrigated cropland or hayland used for alfalfa, small grain (wheat, barley, oats, and triticale), Austrian winter peas, corn for grain or silage, potatoes, vegetables (onions, pumpkins, sweet corn, peas, and squash), and fruits (apples, peaches, pears, apricots, and cherries). A small portion of the irrigated land is used for pasture. About 5 percent is used for production of dryland winter wheat and safflower.

The management concerns on rangeland include forage production and the efficient use of range vegetation. The rangeland in the area is increasingly impacted by invasive nonnative plants.

The management concerns on dry-farmed cropland include productivity, wind erosion, water erosion, moisture management, and weed control. The management concerns on irrigated cropland and hayland include productivity, the efficient use of limited water supplies, control of irrigation-induced erosion, and nutrient and pest management. Soil tilth, compaction, and maintenance of the content of organic matter in the soils are additional concerns on irrigated and dry-farmed cropland.

The management concerns on irrigated pasture include productivity, proper grazing use, efficient use of limited water supplies, nutrient management, and weed control.

Conservation practices on rangeland generally include brush management, rangeland seeding, prescribed grazing, fencing, development of watering facilities, and erosion control. Conservation practices on dry-farmed cropland generally include terraces, sediment-control basins, summer fallow tillage, crop residue management, pest management, and nutrient management. Conservation practices on irrigated cropland and hayland include irrigation system improvement, irrigation water management, no-till hayland planting, forage harvest management, nutrient management, windbreaks, and pest management. Conservation practices on irrigated pasture generally include irrigation system improvement, irrigation water management, pasture planting, development of watering facilities, fencing, prescribed grazing, nutrient management, and pest management. ■

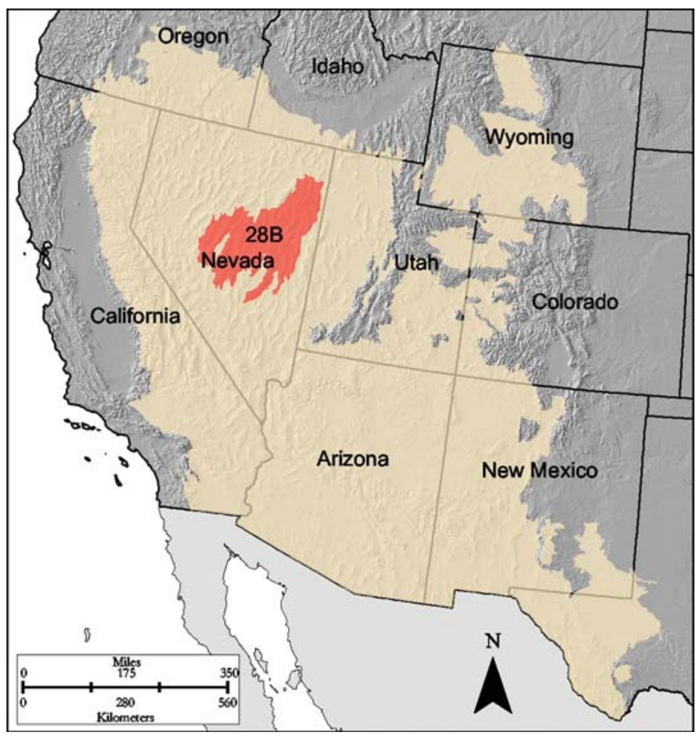

Figure 28B-1: Location of MLRA 28B in Land Resource Region D.

28B—Central Nevada Basin and Range

This area is entirely in Nevada (fig. 28B-1). It makes up about 23,555 square miles (61,035 square kilometers). The town of Ely, Nevada, is in this MLRA. Interstate 80 crosses the northeastern tip of the area. One of the world's largest open-pit mines, the Ruth Copper Pit, is directly west of Ely. Portions of the Humboldt and Toiyabe National Forests occur in this area. The Odgers Ranch, Goshute, and Duckwater Indian Reservations and the Great Basin National Park also are in this area.

Physiography

This area is in the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. It is an area of nearly level, aggraded desert basins and valleys between a series of mountain ranges trending north to south. The basins are bordered by long, gently sloping to strongly sloping alluvial fans. The mountains are uplifted fault blocks with steep side slopes. They are not well dissected because of a low amount of rainfall in the area. Many of the valleys in this MLRA are closed basins containing sinks or playas. Elevation ranges from 4,900 to 6,550 feet (1,495 to 1,995 meters) in the valleys and basins and from 6,550 to 11,900 feet (1,995 to 3,630 meters) in the mountains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Central Nevada Desert Basins (1606), 82 percent; Black Rock Desert-Humboldt (1604), 7 percent; Lower Colorado-Lake Mead (1501), 6 percent; and Great Salt Lake (1602), 5 percent. The MLRA has no major rivers. The Duck River is north and east of Ely.

Geology

The mountains in the southern half of this area are dominated by andesite and basalt rocks that were formed in the Miocene and Oligocene. Paleozoic and older carbonate rocks are prominent in the mountains to the north. Scattered outcrops of older Tertiary intrusives and very young tuffaceous sediments are throughout this area. The valleys consist mostly of alluvial fill, but lake deposits are at the lowest elevations in the closed basins. The alluvial valley fill consists of cobbles, gravel, and coarse sand near the mountains in the apex of the alluvial fans. Sands, silts, and clays are on the distal ends of the fans.

Climate

The average annual precipitation is 4 to 12 inches (100 to 305 millimeters) in most areas on the valley floors. It is about 8 to 36 inches (205 to 915 millimeters) in the mountains. Most of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. The driest period is from midsummer to midautumn. The average annual temperature is 34 to 52 degrees F (1 to 11 degrees C). The freeze-free period averages 125 days and ranges from 80 to 170 days, decreasing in length with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 0.0%; ground water, 0.4%
Irrigation—surface water, 86.8%; ground water, 9.6%
Other—surface water, 0.1%; ground water, 3.0%

The total withdrawals average 520 million gallons per day (1,970 million liters per day). About 13 percent is from ground water sources, and 87 percent is from surface water sources. Water is scarce. Most streams are small and intermittent and depend on sources in the higher mountains. A few small reservoirs have been constructed throughout the area for storage of water for irrigation and recreation purposes. The surface water from the mountains is generally of good quality, and its use is not limited. Irrigation return flows raise the levels of dissolved salts and suspended sediments in some streams, causing some contamination.

Both surface water and ground water are used for irrigation. Shallow wells in the basin and valley fill aquifers provide almost all of the ground water used in this area. This shallow ground water generally contains less than 1,000 parts per million (milligrams per liter) total dissolved solids. On the alluvial fan deposits near the mountains, where the valley fill aquifers are recharged, ground water is much lower in dissolved salts (typically less than 500 parts per million). The ground water becomes almost saline near the playas far away from the recharge zone.

The carbonate rock in this area is considered to be an aquifer. Use of this aquifer is limited because of the expense of drilling deep wells. Water from the carbonate rock is suitable for most uses and is considered to be hard or very hard. The concentrations of total dissolved solids are generally less than the Nevada drinking water standard of 1,000 parts per million (milligrams per liter).

Soils

The dominant soil orders in this MLRA are Aridisols, Entisols, and Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an aridic or xeric soil moisture regime, and mixed or carbonatic mineralogy. They generally are well drained, loamy or loamy-skeletal, and shallow to very deep. Moderately deep Calcixerolls (Cavehill series), shallow Haplocalcids (Pookaloo and Tecomar series), and shallow Torriorthents (Zimbob series) formed in residuum and colluvium on mountain slopes and hills. Very deep Haplocalcids (Kunzler and Wintermute series) formed in alluvium on alluvial fans, fan terraces, and stream terraces. Torriorthents (Katelana and Sheffit series) formed in alluvium on alluvial flats and lake plains. Shallow Haplodurids (Palinor and Shabliss series) and shallow Durixerolls (Urmafot series) formed in alluvium on alluvial fan piedmonts, terraces, and ballenas.

Biological Resources

This area supports saltbush-greasewood, big sagebrush, and pinyon-juniper woodland vegetation in the progression from the lowest to the highest elevation and precipitation. Shadscale, in association with bud sagebrush, spiny hopsage, ephedra, winterfat, fourwing saltbush, Indian ricegrass, squirreltail, and galleta, characterizes the saltbush-greasewood type. With an increase in moisture, plants associated with shadscale are replaced by needlegrasses, bluegrasses, bluebunch or beardless wheatgrass, basin wildrye, and forbs. Black greasewood and Nuttall saltbush are important on some sites. Big sagebrush and black sagebrush, which grows on soils that are shallow to an indurated pan or to bedrock, are dominant. In the pinyon-juniper woodland, bitterbrush, serviceberry, and snowberry grow in association with Utah juniper and singleleaf pinyon.

The highest elevations support thickets of curl-leaf mountain mahogany and small amounts of mixed conifer forest with limber, bristlecone, or ponderosa pine, Douglas-fir, or white fir.

On bottom lands, basin wildrye, creeping wildrye, alkali sacaton, wheatgrasses, bluegrasses, sedges, and rushes are typical. Black greasewood, rubber rabbitbrush, and big sagebrush grow on the drier sites. Inland saltgrass, alkali sacaton, black greasewood, rubber rabbitbrush, and big saltbush typify the vegetation on strongly saline-alkali soils.

Some of the major wildlife species in this area are mule deer, coyote, bobcat, beaver, jackrabbit, cottontail, sage grouse, chukar, and quail. The species of fish in the area include trout, dace, shiners, and suckers.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—private, 5%; Federal, 75%
Forest—Federal, 20%

More than nine-tenths of this area is federally owned. The rest is mainly in farms and ranches. Livestock grazing of native grasses and shrubs on rangeland is the principal agricultural enterprise. In most of the area, the extent of the livestock industry is determined largely by the amount of hay, pasture, and grain that can be produced under irrigation from the small supply of local water. The irrigated land makes up 1 percent or less of the total area. About one-fifth of the area is pinyon-juniper woodland on mountain slopes.

The major soil resource concerns are the hazard of wind erosion, the content of salts and sodium in the soils, management of soil moisture, and forest and rangeland health. Other management concerns are the efficient use of the rangeland vegetation and limited water supplies and control of erosion in critical areas.

Conservation practices on cropland generally include irrigation water management, crop residue management, and toxic salt reduction. Conservation practices on rangeland include prescribed grazing, brush management, and development of watering facilities. Pasture and hay provide seasonal feed for livestock. In areas of forestland, forest stand improvement, forest site preparation, properly located forest trails and landings, and firebreaks can help to reduce the effects of catastrophic wildfires and the damage caused by insects and disease. ■

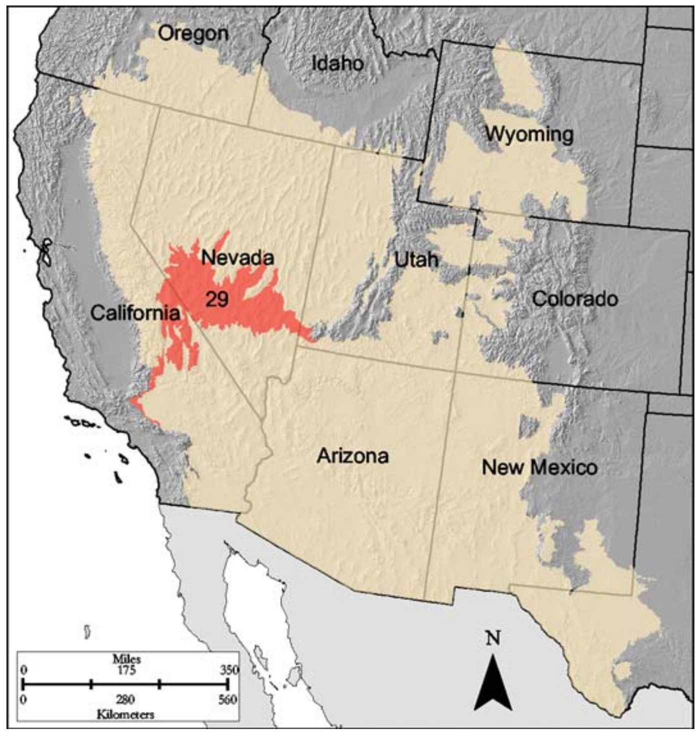

Figure 29-1: Location of MLRA 29 in Land Resource Region D.

29—Southern Nevada Basin and Range

This area (shown in fig. 29-1) is in Nevada (73 percent), California (25 percent), and Utah (2 percent). It makes up about 26,295 square miles (68,140 square kilometers). The towns of Lone Pine, California, and Tonopah, Nevada, are in this MLRA. U.S. Highways 6, 95, and 395 cross the area. Numerous national forests occur in the area, including the San Bernardino, Angeles, Sequoia, Inyo, Humboldt-Toiyabe, and Dixie National Forests. Many wilderness study areas and wildlife refuges are in this MLRA. Portions of Death Valley National Monument, the Nuclear Regulatory Commission's Nevada Test Site, the Hawthorne Ammunition Depot, and the

Nellis Air Force Range in Nevada and the China Lake Naval Weapons Center in California also are in this MLRA. The northeast part of the Paiute Indian Reservation and the southern third of the Walker River Indian Reservation are in the part of this MLRA in Nevada, and the Lone Pine, Fort Independence, and Big Pine Indian Reservations are in the part in California.

Physiography

This area is in the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. Owens Valley and Death Valley in California mark the farthest western extent of the Great Basin Section in the Basin and Range Province. This MLRA is an area of broad, nearly level, aggraded desert basins and valleys between a series of mountain ranges trending north to south. The basins are bordered by sloping fans and terraces. The mountains are uplifted fault blocks with steep side slopes. They are not well dissected because of a low amount of rainfall in the MLRA. Most of the valleys in this MLRA are closed basins containing sinks or playa lakes. Elevation ranges from 1,950 to 5,600 feet (595 to 1,705 meters) in the valleys. On some high mountain peaks, it is more than 9,400 feet (2,865 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Central Nevada Desert Basins (1606), 58 percent; Northern Mojave-Mono Lake (1809), 28 percent; Lower Colorado-Lake Mead (1501), 11 percent; Central Lahontan (1605), 2 percent; and Tulare-Buena Vista Lakes (1803), 1 percent. The Owens River and Owens Lake occur in this MLRA. Intermittent and ephemeral streams in Nevada typically end in dry playa lakes.

Geology

The mountains in this area are dominated by Pliocene and Miocene andesite and basalt rocks. Paleozoic and Precambrian carbonate rocks are prominent in the mountains. Scattered outcrops of older Tertiary intrusives and very young tuffaceous sediments (Pliocene and Miocene) are in the western and eastern thirds of this MLRA. The valleys consist mostly of alluvial fill, but playa deposits are at the lowest elevations in the closed basins. The alluvial valley fill consists of cobbles, gravel, and coarse sand near the mountains in the apex of the alluvial fans. Sands, silts, and clays are on the distal ends of the fans.

Climate

The average annual precipitation is 3 to 12 inches (75 to 305 millimeters) in most of this area. It ranges from 12 to 29 inches (305 to 735 millimeters), however, on the higher mountain slopes. Most of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. Summers are dry, but sporadic storms are common in July and August. The average annual temperature is 28 to 72 degrees F (-2 to 22 degrees C), decreasing with elevation. The freeze-free period averages 205 days and ranges from 80 to 335 days, decreasing in length with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 0.1%; ground water, 1.7%
Irrigation—surface water, 34.5%; ground water, 53.3%
Other—surface water, 0.6%; ground water, 9.7%

The total withdrawals average 220 million gallons per day (815 million liters per day). About 65 percent is from ground water sources, and 35 percent is from surface water sources. Precipitation is sparse. Most of the streams are small and intermittent and depend on sources in the higher mountains. The surface water from the mountains is generally of good quality, and its use is not limited near the mountains. The quality of this water is naturally degraded by dissolved salts picked up as streams cross areas of valley fill to their terminus in a playa lake. Irrigation return flows raise the levels of dissolved salts and suspended sediments in some streams, causing some contamination. Historically, the Owens River flowed into Owens Lake in this MLRA. Today, most of the Owens River is diverted into the Haiwee Reservoir, bypassing Owens Lake, and then is diverted into the Los Angeles Aqueduct for use as drinking water in southern California coastal cities.

Ground water in this area is scarce but is being rapidly developed. Most of the ground water in California is controlled by Los Angeles and is not available for local use. Shallow wells in the basin and valley fill aquifers provide almost all of the ground water used in this area. This shallow ground water generally contains less than 1,000 parts per million (milligrams per liter) total dissolved solids. On the alluvial fan deposits near the mountains, where the valley fill aquifers are recharged, ground water is much lower in dissolved salts (typically less than 500 parts per million). The ground water becomes almost saline near the playa lakes far away from the recharge zone.

A volcanic rock aquifer is in the south-central part of this area. It is used very little, and no data about quality of the water are available. The carbonate rocks in this area also are considered to be aquifers. Use of these aquifers is limited. Water from the carbonate rocks is suitable for most uses and is considered to be hard or very hard. The concentrations of total dissolved solids are generally less than the Nevada drinking water standard of 1,000 parts per million (milligrams per liter).

Soils

The dominant soil orders in this MLRA are Aridisols and Entisols. Mollisols also are important in the mountainous areas. The soils in the area dominantly have a mesic soil temperature regime, an aridic or xeric soil moisture regime, and mixed mineralogy. They generally are very shallow to very deep, well drained or somewhat excessively drained, and loamy-skeletal or sandy-skeletal. Haplargids formed in alluvium on alluvial fans and fan piedmonts (Ardivey and Unsel series) and in residuum and colluvium on hills, mountains, and plateaus (Downeyville, Gabbvally, and Stewval series). Haplocalcids (Candelaria series) formed in alluvium on ballenas and fan piedmonts. Haplocambids (Koyen series) formed in alluvium on fan piedmonts and alluvial fans. Argidurids (Handpah and Zadvar series) and Haplodurids (Ursine series) formed in alluvium on fan piedmonts and fan remnants. Torriorthents formed in residuum and colluvium on hills and mountains (Blacktop, Kyler, and Pintwater series) and in alluvium on alluvial flats, fans, and fan piedmonts (Gynelle and Wardenot series). Torrifluvents (Cirac series) formed in alluvium on alluvial flats and fans. Shallow Argixerolls formed in residuum and colluvium on hills and mountains (Bellehelen series).

Biological Resources

This area supports desert shrub vegetation. The major vegetation consists of saltbush and greasewood. Shadscale is widespread. It is associated with bud sagebrush, Bailey greasewood (in the west), gray molly kochia, spiny hopsage, wolfberry, ephedra, dalea, fourwing saltbush, winterfat, horsebrush, galleta, and Indian ricegrass. On the warmer sites, shadscale is associated with white bursage, spiny menodora, Joshua-tree, and blackbrush. Black greasewood is dominant on low-lying saline-alkali soils. In areas of higher precipitation, big sagebrush and black sagebrush are common and are associated with Indian ricegrass and galleta. Pinyon-juniper woodland is prevalent in the mountains. Associated plants include black sagebrush, big sagebrush, blackbrush, bitterbrush, cliffrose, and other shrubs and a variety of grasses and forbs.

Some of the major wildlife species in this area are mule deer, coyote, kit fox, bobcat, jackrabbit, cottontail, kangaroo rat, snakes, lizards, golden eagle, hawks, and chukar. The species of fish in the area include brook trout, brown trout, and bass.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—private, 4%; Federal, 86%
Forest—Federal, 9%
Other—private, 1%

Nearly all of this area is federally owned land, much of which is used for training and testing purposes by the Armed Forces and the Nuclear Regulatory Commission. Less than 1 percent of the area, mostly in the valleys, is irrigated. Much of the irrigated acreage is used for hay and grain for livestock. High mountain areas consist of pinyon-juniper woodland. Native grasses and shrubs in areas of rangeland are grazed by livestock.

The major soil resource concerns in this area are control of wind erosion and reduction of the content of salts and sodium in the soils. Management concerns include proper use of rangeland, erosion control, and efficient use of the scarce water supplies.

Conservation practices on cropland generally include irrigation water management and toxic salt reduction. Also, windbreaks and crop residue management reduce the hazard of wind erosion and increase the available water capacity of the soils. Development of watering facilities and prescribed grazing are important practices on rangeland. ■

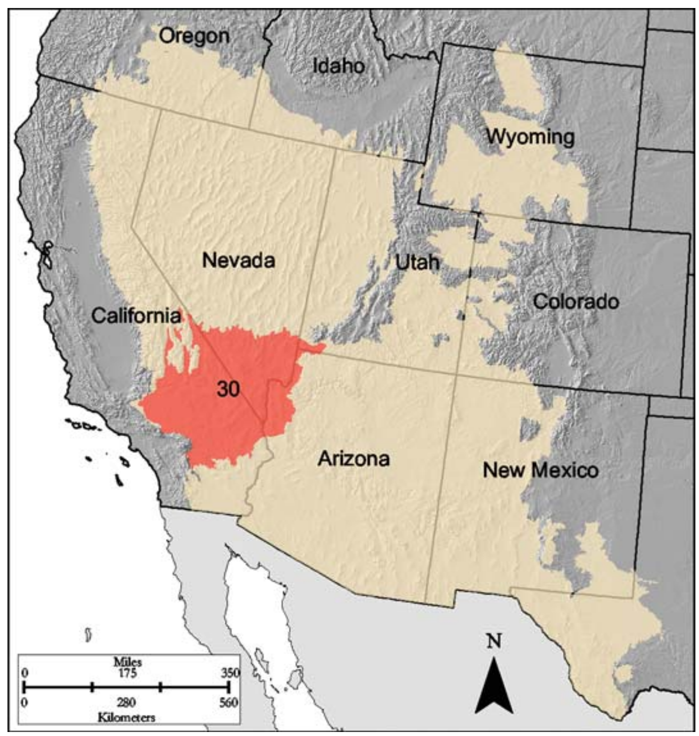

Figure 30-1: Location of MLRA 30 in Land Resource Region D.

30—Mojave Desert

This area (shown in fig. 30-1) is in California (59 percent), Nevada (28 percent), Arizona (12 percent), and Utah (1 percent). It makes up about 43,750 square miles (113,370 square kilometers). Lancaster, Palmdale, Victorville, Apple Valley, and Barstow, California, Bullhead City and Kingman, Arizona, and Las Vegas, Nevada, are in this MLRA. Interstate 15 connects

Las Vegas and Barstow in this area. Interstate 40 connects Kingman and Barstow. Interstate 40 terminates in Barstow, where it intersects with Interstate 15. The Lake Mead National Recreation Area is along the Colorado River, which forms the border between Nevada and Arizona in this MLRA. The Mojave National Preserve, Joshua Tree and Death Valley National Parks, and numerous wilderness study areas and recreational areas occur in this sparsely populated MLRA. Numerous military reservations are in the area, including Edwards Air Force Base, Fort Irwin, China Lake Naval Weapons Center, Goldstone Communications Complex, and Twenty-Nine Palms Marine Corps Base in California and Nellis Air Force Range and Nellis and Indian Springs Air Force Bases in Nevada.

Physiography

This area is in the Basin and Range Province of the Intermontane Plateaus. Most of the MLRA is in the Sonoran Desert Section of this province. The northern third is in the Great Basin Section, and the southeastern part is in the Mexican Highland Section. A small part of the southwest corner is in the Salton Trough Section. Broad basins, valleys, and old lakebeds make up most of the area, but widely spaced mountains trending north to south occur throughout the area. Isolated, short mountain ranges are separated by an aggraded desert plain. The mountains are fault blocks that have been tilted up. Long alluvial fans coalesce with dry lakebeds between some of the ranges. Elevation ranges from 282 feet (85 meters) below sea level in Death Valley to 3,950 feet (1,205 meters) above sea level in valleys and basins. The lowest elevation occurring on dry land in the world, 282 feet (85 meters) below sea level, occurs in the Badwater Basin in Death Valley. Some mountain ranges have peaks that exceed 11,100 feet (3,385 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Northern Mojave-Mono Lake (1809), 40 percent; Lower Colorado-Lake Mead (1501), 23 percent; Southern Mojave-Salton Sea (1810), 17 percent; Central Nevada Desert Basins (1606), 11 percent; and Lower Colorado (1503), 9 percent. The Colorado River crosses the eastern end of this area. Other rivers include the Armagosa and Mojave Rivers.

Geology

Most of this area is underlain by Quaternary (Pleistocene to Recent) alluvial deposits on alluvial fans and valley floors. Recent alluvial fans and remnant alluvial fan terraces typically grade from boulder-strewn deposits and coarse desert pavement near the fan apex to finer grained sands, silts, and clays at the distal ends. Playas are at the lowest elevations in the closed basins. They commonly have eolian accumulations along their downwind fringes. Water from shallow subsurface flow and from surface flows that periodically fill the playa basins evaporates, leaving accumulations of evaporite minerals, including salts and borates. Most of the domestic production of borate minerals and boron in the United States comes from surface and underground mines in this MLRA. Upland areas in the MLRA consist of isolated mountain ranges variably underlain by pre-Cenozoic metamorphic and igneous rocks, Paleozoic carbonates, Mesozoic granitics, and Cenozoic nonmarine sedimentary and volcanic deposits. Valuable deposits of silver, gold, talc, and other commodities occur throughout the area, particularly where granitic magma intruded into older sedimentary rocks.

The geology of this area is dynamic and complex. Cenozoic to Recent tectonic extension and crustal thinning have resulted in granitic and other igneous intrusions, geologically recent volcanism, and normal and detachment faulting and associated seismicity. The tectonic setting of this area includes translational movement occurring along the Garlock Fault and along right-lateral strike-slip faults that comprise the Eastern California Shear Zone.

Climate

The average annual precipitation is 2 to 8 inches (50 to 205 millimeters) in most of this extremely dry MLRA. It exceeds 37 inches (940 millimeters) in some scattered areas at the higher elevations in Nevada and southwestern Utah. Most of the rainfall occurs in the winter months as low-intensity precipitation from Pacific storms that are frontal in nature. High-intensity, convective thunderstorms can occur during the summer, but they contribute little to soil moisture. These storms occur more frequently in the eastern part of the area, where they contribute more to soil moisture. Snow is not very common and usually is on the ground for very short periods at the lower elevations, but the highest elevations may have snow for several weeks at a time in the winter. The average annual snowfall ranges from nearly 0 inches in the lowest deserts to more than 30 inches (760 millimeters) at the highest elevations of the Spring Mountains directly west of Las Vegas.

The average annual temperature ranges from 43 degrees F (6 degrees C) in the highest mountains to 76 degrees F (25 degrees C) in areas along the Colorado River in California, Nevada, and Arizona. Most of the lowest deserts have a growing season of nearly 365 days per year, especially along the Colorado River, whereas other desert areas have a freeze-free period of 200 to 330 days per year. In the higher mountains and the higher valleys in Nevada and extreme southwestern Utah, the freeze-free period typically is about 150 to 180 days per year. In the highest mountains, it is as short as 160 days per year.

Death Valley National Park is considered one of the hottest and driest areas in the Western Hemisphere. The average annual precipitation in the park is 1.96 inches (49.8 millimeters), and the summer air temperatures can be as high as 134 degrees F (56.7 degrees C).

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 20.1%; ground water, 12.2%
Livestock—surface water, 2.0%; ground water, 0.1%
Irrigation—surface water, 62.1%; ground water, 1.1%
Other—surface water, 1.9%; ground water, 0.4%

The total withdrawals average 2,565 million gallons per day (9,710 million liters per day). About 14 percent is from ground water sources, and 86 percent is from surface water sources. The low amount of rainfall in this area maintains the desert vegetation, but water is scarce. The public water supply and irrigation water for agriculture are obtained almost entirely from the Colorado and Mojave Rivers. This water is of good quality and is suitable for most uses. Some irrigation water is obtained from large springs in Nevada that typically contain about 1,000 parts per million (milligrams per liter) total dissolved solids.

Ground water is the only water available in Death Valley. In this water, concentrations of total dissolved solids are about 500 parts per million (milligrams per liter) and chloride levels are fairly high. Some public supply, domestic use, and irrigation water is obtained from wells in Nevada and in California. Mountain ranges tend to separate ground water basins (valley fill deposits) in the Mojave Desert. The median value of total dissolved solids is 375 parts per million (milligrams per liter). Total dissolved solids are lowest at the outer edges of the basins, where recharge occurs from surface runoff in the mountains. A level of total dissolved solids of more than 4,000 parts per million (milligrams per liter) is not uncommon under playa lakes in the low parts of the basins.

Ground water in the Las Vegas Valley basin fill aquifer typically exceeds 500 parts per million (milligrams per liter) total dissolved solids. Ground water in the southeast corner of the valley has a total dissolved solids content of more than 2,000 parts per million (milligrams per liter) because of deposits of gypsum and evaporites. This water also contains very high levels of arsenic, boron, and fluoride from natural sources. These contaminants exceed State and Federal standards for drinking water. All of the ground water in this MLRA is very hard.

Soils

The dominant soil orders in this MLRA are Aridisols and Entisols. The soils in the area dominantly have a thermic soil temperature regime, an aridic soil moisture regime, and mixed or carbonatic mineralogy. They generally are well drained to excessively drained, loamy-skeletal or sandy-skeletal, and shallow to very deep. Torriorthents formed in alluvium on fan pediments, alluvial fans, fan aprons, and flood plains (Arizo, Carrizo, Hesperia, and Yermo series) and in residuum and colluvium on limestone and dolomite hills and mountains (St. Thomas series), on volcanic hills and mountains (Sunrock series), and on granite hills and mountains (Dalvord and Goldroad series). Torripsamments (Cajon series), Haplocalcids (Gunsight, Huevi, Tonopah, and Weiser series), and Petrocalcids (Bard, Cave, and Mormon Mesa series) formed in alluvium on alluvial fans, fan aprons, mesas, and terraces.

Biological Resources

This area supports thin stands of desert vegetation. Creosotebush, white bursage, Joshua-tree, juniper, yucca, cactus, and Mormon tea are the major species. Numerous annual forbs and grasses grow during years of favorable moisture. Saltbush, saltgrass, alkali sacaton, and iodinebush grow on alkali flats. Indian ricegrass, Joshua-tree, desert needlegrass, and galleta grow on sandy soils.

Some of the major wildlife species in this area are antelope, coyote, kit fox, jackrabbit, cottontail, squirrel, roadrunner, Gambel's quail, mourning dove, gopher snake, sidewinder, and rattlesnake. Some water bodies contain various species of pupfish. The desert tortoise, a threatened species, is in parts of this MLRA.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—private, 13%; Federal, 65%
Forest—Federal, 2%
Urban development—private, 2%; Federal, 2%
Water—private, 1%; Federal, 2%
Other—private, 5%; Federal, 8%

About four-fifths of this area is federally owned. Much of the remainder is owned by local governments. Most of the land has a cover of desert vegetation. The area is used only locally for grazing because of low forage production and the lack of water for livestock. On sites intensively used for recreation, especially where motorcycles and off-road vehicles are driven, the hazards of wind erosion and water erosion are severe. In Utah, where an adequate water supply is available, much of the land that was irrigated cropland or hayland, as well as some of the adjacent rangeland, is undergoing urbanization.

The major soil resource concerns on rangeland are the productivity and sustainability of the soils and the hazards of wind erosion and water erosion. Compaction, soil tilth, management of soil moisture, and wind erosion are the major soil resource concerns on irrigated cropland. In urbanized areas and irrigated fields, differential settling resulting from the content of gypsum in the soils is a management concern, particularly in the area around St. George, Utah.

Conservation practices on irrigated cropland generally include irrigation system improvement, irrigation water management, nutrient management, and pest management.

Conservation practices on rangeland include prescribed grazing, development of watering facilities, and erosion control. ■

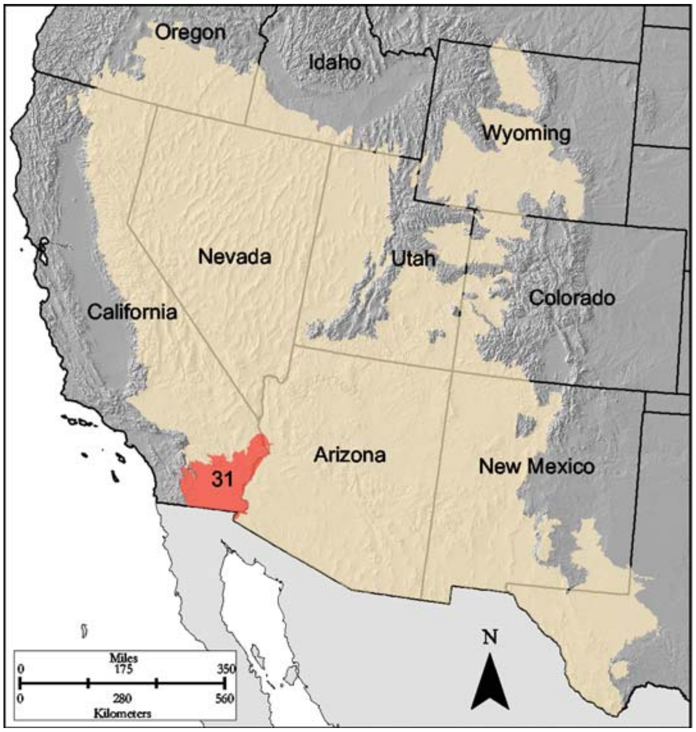

Figure 31-1: Location of MLRA 31 in Land Resource Region D.

31—Lower Colorado Desert

This area (shown in fig. 31-1) is in California (93 percent) and Arizona (7 percent). It makes up about 11,615 square miles (30,100 square kilometers). The most prominent towns in the area are Blythe, El Centro, Indio, and Oasis, California. Interstates 8 and 10 cross the southern and central parts of this area, respectively. Numerous national wilderness areas and State recreation areas and a small part of the Joshua Tree National Monument are in this MLRA. The El Centro Naval Air Facility is in the part of this area in California. The area also includes the Cabezon, Augustine, Torres-Martinez, and Fort Yuma Indian Reservations in California and the Cocopah Indian Reservation in Arizona. The Colorado River Indian Reservation straddles the State line between California and Arizona in this MLRA.

Physiography

This area is in the Basin and Range Province of the Intermontane Plateaus. It is mostly in the Salton Trough Section, but small portions of the area are in the Sonoran Desert and Mexican Highland Sections. This MLRA is west of the Colorado River, is east of the Peninsular Ranges, and is bordered on the north by a gradual ecotone around 34 to 35 degrees north latitude into the Mojave Desert. To the south, it extends into Baja California Norte in Mexico. Landforms consist of mountains, alluvial fans, alluvial fan remnants, and alluvial valleys, including active drainages and fluvial terraces, and internally drained basins, including dry lakes and lake terraces. The area is subdivided into the Imperial Valley, where intermittent streams, canals, and the New and Alamo Rivers drain into the Salton Sea; the lower Colorado River Valley; and smaller internally drained basins that terminate at playas, including those in the Chuckawalla Valley. The terminal sink basin in the Imperial Valley was occupied during the Pleistocene by Lake Cahuilla and is presently occupied by the Salton Sea, which was accidentally created in 1905 when the Colorado River passed uncontrolled through an irrigation diversion.

Elevation ranges from approximately 275 feet below sea level (-84 meters) at the lowest point of the Salton Trough below the southern part of the Salton Sea to 1,650 feet above sea level (505 meters) along low mountain ranges trending northwest and southeast within this area. The elevation in some mountain ranges exceeds 1,650 feet (505 meters), but higher elevations are more typical of MLRAs 30 and 29.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Southern Mojave-Salton Sea (1810), 68 percent, and Lower Colorado (1503), 32 percent.

Geology

Most of this area is underlain by Quaternary (Pleistocene to Recent) alluvial fan deposits and by alluvial and lacustrine deposits beneath the valley floors. Recent alluvial fans and alluvial fan remnants typically grade from boulder-strewn deposits and coarse desert pavement near the fan apex to finer grained sands, silts, and clays at the distal ends, where they interfinger with valley floor alluvium and basin fill. The lowest elevations are variably underlain by silty lacustrine and playa deposits of Pleistocene Lake Cahuilla, evaporitic playa deposits in internally drained basins, and relatively coarse grained alluvium along the Colorado River. Eolian deposits are typically along the downwind fringes of the playas. The aerially extensive Algodones dunes of the Sand Hills are along the southeast edge of the Imperial Valley.

Upland areas to the west are principally underlain by Mesozoic granites and pre-Cenozoic metamorphics of the Southern California Batholith, which form the Peninsular Ranges of California and Mexico. Portions of the lower uplands to the west are alternately underlain by moderately consolidated to loosely consolidated sedimentary deposits of Tertiary age. Uplands east of the Imperial Valley are variably underlain by Precambrian to Mesozoic igneous and metamorphic rocks and by Tertiary volcanics and sedimentary rocks.

The tectonic setting of this MLRA is dominated by oblique right-lateral strike slip motion along the South Branch San Andreas, Imperial Valley, and San Jacinto Fault Zones. Aligned from northwest to southeast, these zones pass through the western, south-central, and northeastern parts of the Imperial Valley, respectively.

Climate

The Colorado Desert has the lowest annual precipitation and the highest temperature in North America. The average annual precipitation is 3 to 22 inches (75 to 560 millimeters) and displays high temporal and spatial variability. Precipitation is bimodal in nature. The winter precipitation is from Pacific storms that are frontal in nature. The summer precipitation is from subtropical convection storms coming from the south. The winter precipitation decreases from west to east, whereas the summer rainfall decreases from east to west. The summer (July through September) precipitation makes up 20 to 35 percent of the total annual precipitation. It typically occurs as high-intensity storms that produce high runoff and contribute little to the soil moisture supply. The average annual temperature is 53 to 74 degrees F (12 to 24 degrees C). The freeze-free period averages 290 days and ranges from 220 to 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 2.0%; ground water, 0.0%
Irrigation—surface water, 90.5%; ground water, 2.3%
Other—surface water, 5.1%; ground water, 0.1%

The total withdrawals average 1,080 million gallons per day (4,105 million liters per day). About 2 percent is from ground water sources, and 98 percent is from surface water sources. The low rainfall in this area maintains the desert vegetation, but water is scarce. The public water supply and irrigation water for agriculture are obtained almost entirely from the Colorado River, but wells in river alluvium provide some irrigation water locally. The river water is of good quality and is suitable for most uses. It has 770 parts per million (milligrams per liter) total dissolved solids. This is equivalent to slightly more than 1 ton (910 kilograms) of salts per 325,850 gallons (1,233,340 liters) of water. The solids are dominantly neutral calcium salts.

Soils

The dominant soil orders in this MLRA are Entisols and Aridisols. The soils in the area have a hyperthermic soil temperature regime and an extremely aridic soil moisture regime. They generally are very deep, well drained to excessively drained, and coarse textured to fine textured. Level and nearly level, coarse textured to fine textured Torrifluvents formed in recent lacustrine sediments from igneous sources (Coachella series) or from mixed sources (Imperial series) in basins; in alluvium from mixed sources (Glenbar series) on flood plains and stream terraces; or in mixed alluvium (Antho, Holtville, Indio, and Ripley series) on flood plains and alluvial fans. Nearly level to gently sloping, coarse textured Torriorthents (Carrizo series) and coarse textured Torripsamments (Carsitas, Lagunita, Myoma, and Rositas series) formed in recent alluvium on alluvial fans. Nearly level, moderately fine textured Haplargids (Orita series) formed in recent alluvium from mixed sources on alluvial fan remnants. Nearly level, coarse textured Haplocalcids (Aco series) formed in recent alluvium from mixed sources on stream terraces.

Biological Resources

Plant growth in this area is typically both open and simple, reflecting the intense competition between plants for the scarce water resource. A large number of Colorado Desert plants are in the Mojave and Sonoran Deserts. The most widespread vegetative type in the area is dominated by creosotebush and white bursage. This type is typically on alluvial fan piedmonts, reaching the greatest development on coarse textured, somewhat excessively drained or well drained soils. Other common species include ocotillo, brittlebush, and white ratany. Important perennial grasses include big galleta, California threeawn, and fluffgrass. The most common species along large drainageways are frost-sensitive species, such as smoketree, desert ironwood, desert lavender, blue paloverde, and catclaw acacia. Several species occur only within this MLRA, including California lotebush, California indigobush, desert apricot, rose sage, and Vasey sage. The California fan palm, an endemic species, occurs only in isolated microhabitats.

Some of the major wildlife species of this area include desert bighorn sheep, southern mule deer, coyote, bobcat, and black-tailed jackrabbit. Rare animals include desert pupfish, desert tortoise, Coachella Valley fringe-toed lizard, and Le Conte's thrasher.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 7%
Grassland—private, 1%; Federal, 47%
Urban development—private, 3%
Water—private, 4%
Other—private, 26%; Federal, 12%

About three-fifths of the area is federally owned. Intensive agriculture is practiced in the Imperial Valley, in the Coachella

Valley, and on terraces along the Colorado River. All agricultural crops are grown under irrigation. Cotton, alfalfa hay, small grain, and row crops, such as lettuce, melons, onions, sweet corn, grain sorghum, squash, and sugar beets, are extensively grown in the Imperial Valley and on the terraces along the Colorado River. The Coachella Valley produces early table grapes, citrus fruit, winter vegetables, and dates, among other specialty crops. Irrigated, warm-season pasture grasses are being planted in the Imperial and Palo Verde Valleys, especially on fine textured soils affected by high salinity. Feedlots are a significant land use in the Imperial Valley. Winter pasture for sheep is provided by alfalfa and the residue of many other crops. Rangeland is primarily ephemeral. During favorable years, an adequate volume of forage to accommodate livestock grazing for a short period may be produced. Grazing strategies should be opportunistic and should be influenced by the environmental sensitivity of the area.

The major soil resource management concerns are irrigation-induced water erosion, wind erosion, the content of organic matter in the soils, the productivity and sustainability of the soils, irrigation water management, and maintenance of a favorable salinity status in the root zone. Wind abrasion is a critical problem on coarse textured soils during periods of crop establishment.

Conservation practices on cropland generally include crop rotations and minimum tillage. Also, crop residue management and windbreaks help to control wind abrasion. The amount of rainfall is too low to leach salts from the soils, so all leaching must be accomplished through the use of irrigation water. ■

32—Northern Intermountain Desertic Basins

This area (shown in fig. 32-1) is in Wyoming (96 percent) and Montana (4 percent). It makes up about 8,910 square miles (23,080 square kilometers). The towns of Riverton, Thermopolis, Worland, and Powell, Wyoming, are in this MLRA. U.S. Highways 14, 20, 26, and 310 cross this area. This MLRA has numerous wilderness study areas. The Wind River Indian Reservation is in the southern third of this area.

Physiography

The northern two-thirds of this MLRA is in the Bighorn Basin. It is in the Middle Rocky Mountains Province of the Rocky Mountain System. All of this part of the MLRA is an elevated, dissected basin surrounded by mountain ranges to the east, west, and south. The Owl Creek and Bridger Mountains

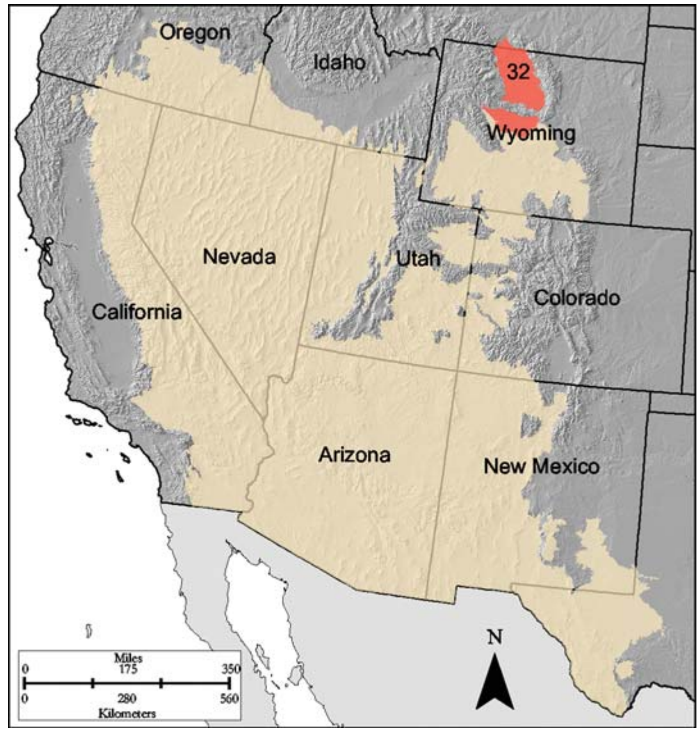

Figure 32-1: Location of MLRA 32 in Land Resource Region D.

separate the northern two-thirds of the MLRA from the southern third. The southern third is in the Wind River Basin, an elevated, dissected plain with mountains to the north, west, and south. This part of the MLRA is in the Wyoming Basin Province of the Rocky Mountain System. Some isolated low mountains are in each part of this MLRA. Elevation ranges from 3,900 to 5,900 feet (1,190 to 1,800 meters). Piedmont plains and pediments slope from the mountains to the stream terraces of the Wind River and Bighorn Basins. In some areas the plains are eroded to the clay shale bedrock, and there are areas of badlands.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Bighorn (1008), 93 percent, and Upper Yellowstone (1007), 7 percent. The Beaver and Wind Rivers join to form the Bighorn River in the southern third of this area. The Bighorn River cuts through the Owl Creek Mountains and continues into the northern part of this MLRA. The Shoshone and Greybull Rivers join the Bighorn River in the northern part of the area. Clark's Fork of the Yellowstone River exits the area in the northwest corner.

Geology

This area is in a syncline between anticlinal mountain ranges. The surface is covered with old deposits of sand and gravel washed into the basin by the streams and rivers draining the surrounding mountains. The present-day rivers and streams have excavated the old pediment surfaces, forming terraces. Alluvial fan deposits grade into the valley fill pediments. The igneous and sedimentary rocks exposed in the adjacent mountains occur beneath the surface of the Bighorn Basin. Tertiary sandstones and shales are exposed where the overlying alluvium has been eroded away. Older sandstones, shales, and carbonate rocks are exposed as steeply dipping beds on the mountainsides. The core of most of the mountain ranges is granite. The granite may be exposed at the higher elevations along the margin of the basins.

Climate

The average annual precipitation in most parts of the basins is 6 to 12 inches (150 to 305 millimeters). It is as high as 22 inches (560 millimeters) in the higher areas within the basins. The maximum precipitation from frontal storms occurs in spring and fall. The surrounding mountain ranges block many of the regional precipitation events. The average annual temperature is 39 to 48 degrees F (4 to 9 degrees C). The temperature can vary widely within short periods because of drainage of cooler mountain air into the basins. The freeze-free period averages 145 days and ranges from 110 to 180 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 0.0%; ground water, 0.0%
Irrigation—surface water, 99.8%; ground water, 0.0%
Other—surface water, 0.2%; ground water, 0.0%

The total withdrawals average 2,505 million gallons per day (9,480 million liters per day). Almost 100 percent is from surface water sources. The low and erratic precipitation provides only a small amount of the surface water used in this area. The Wind and Bighorn Rivers and their tributaries bring good-quality irrigation water into the area from the bordering mountains. A few reservoirs store water, but most of the surface water used is diverted directly from the streams. Supplies become scarce late in the growing season, from July through September.

Deep artesian wells provide some water for irrigation on the eastern side of the Bighorn Basin. These wells are finished either in sandstone units in the Dakota Formation or in the carbonate rocks of the Madison Group. The well water is very hard, but the median level of total dissolved solids is generally less than 300 parts per million (milligrams per liter). Ground water occurs in the alluvial basin fill deposits near the surface. This water can be soft to very hard and typically contains total dissolved solids of more than 1,000 parts per million (milligrams per liter). This ground water is not used in the area.

Soils

The dominant soil orders in this MLRA are Entisols and Aridisols. The soils in the area dominantly have a mesic soil temperature regime, an aridic soil moisture regime, and mixed mineralogy. They generally are shallow to very deep, well drained, and loamy. Torriorthents formed in alluvium on alluvial fans and flood plains (Apron and Kishona series) and in residuum and colluvium on hills and piedmonts (Chipeta, Greybull, Persayo, Shingle, and Worland series). Torrifluvents (Lostwells and Youngston series) and Natrargids (Uffens series) formed in alluvium on flood plains, alluvial fans, and stream terraces. Ustorthents (Spearfish series) formed in residuum and colluvium on hills.

Biological Resources

This area supports shrub-grass vegetation. Big sagebrush, Gardner's saltbush, rhizomatous wheatgrasses, Indian ricegrass, and needleandthread are the dominant species. Black sage, Gardner's saltbush, and bluebunch wheatgrass are common on shallow soils in the uplands.

Some of the major wildlife species in this area are antelope, coyote, jackrabbit, and sage grouse.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 6%
Grassland—private, 42%; Federal, 47%
Urban development—private, 2%
Water—private, 1%
Other—private, 1%; Federal, 1%

Nearly one-half of this area is federally owned. The rest is in farms and ranches. Most of the land is used for grazing. The rangeland consists of desert shrubs and short grasses. About 5 percent of the area is irrigated. Most of the irrigated areas are used for alfalfa and other feed crops, but dry beans, malt barley, sugar beets, and corn are important cash crops.

The major soil resource concerns are water erosion, water quality, rangeland health, and soil quality. Conservation practices on cropland generally include irrigation water management and installation of water-conserving irrigation systems. ■

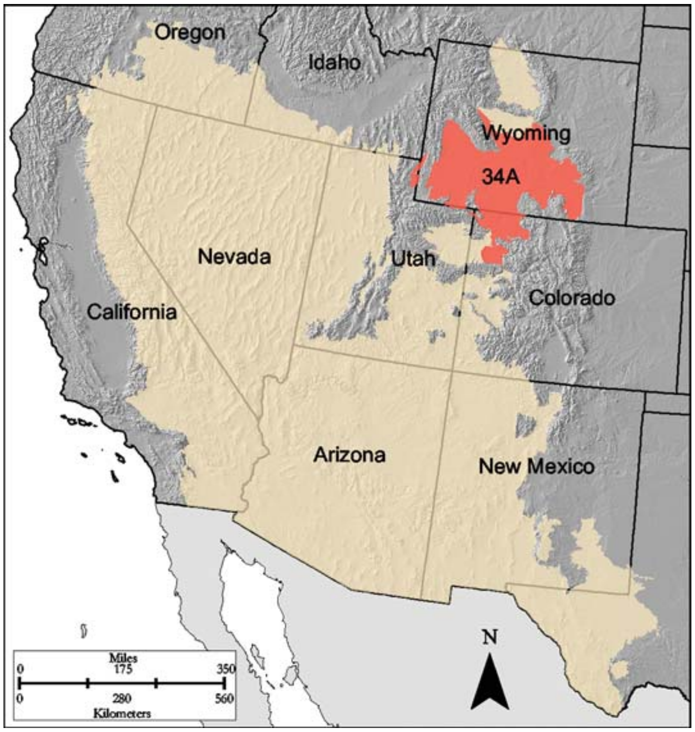

Figure 34A-1: Location of MLRA 34A in Land Resource Region D.

34A—Cool Central Desertic Basins and Plateaus

This area (shown in fig. 34A-1) is in Wyoming (85 percent), Colorado (13 percent), and Utah (2 percent). It makes up about 33,005 square miles (85,525 square kilometers). The cities of Laramie, Pinedale, Rawlins, and Rock Springs, Wyoming, and Craig and Meeker, Colorado, are in this MLRA. Interstate 80 bisects the northern part of the MLRA.

Physiography

About 85 percent of this area is in the Wyoming Basin Province of the Rocky Mountain System, 5 percent is in the Middle Rocky Mountains Province of the Rocky Mountain System, and 10 percent is in the Uinta Basin Section of the Colorado Plateaus Province of the Intermontane Plateaus. The part of the area in the Uinta Basin Section is in Colorado. The Wyoming Basin is bounded on most sides by mountains. The Owl Creek Mountains, the Big Horn Mountains, and the Wind River Range are to the north; the Salt Range and Wasatch Mountains are to the west; and the Laramie and Sierra Madre Mountains are to the east. The part of the MLRA in Colorado is bounded on the south by the Roan Plateau, on the east by the Elkhead Mountains, and on the west by Dinosaur National Monument. In most of the MLRA, elevation ranges from 5,200 feet (1,585 meters) to 7,500 feet (2,285 meters). Small mountainous areas have an elevation as high as 9,200 feet (2,805 meters).

The extent of the Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Great Divide-Upper Green (1404), 47 percent; North Platte (1018), 28 percent; White-Yampa (1405), 16 percent; Bighorn (1008), 6 percent; Bear (1601), 2 percent; and Powder-Tongue (1009), 1 percent. The Popo Agie, Sweetwater, Laramie, Green, and North Platte Rivers run through the northern part of this MLRA, and the Little Snake, Yampa, and White Rivers run through the southern part.

Geology

This area is dominated by residual basin-floor geologic materials. Shale and sandstone are the dominant rock types. The Tertiary-age Bridger, Laney, Green River, Wasatch, Wind River, and Browns Park Formations dominate the MLRA. Cretaceous-age formations occur as small areas throughout the MLRA. The dominant Cretaceous formations are the Lewis and Lance Formations and the members of the Mesa Verde Group. Quaternary alluvial and eolian deposits occur throughout the MLRA. Glacial deposits occur primarily on outwash terraces in the vicinity of Pinedale, Wyoming. The small mountain ranges in this MLRA are made up of Precambrian igneous and metamorphic rocks.

Climate

The average annual precipitation generally is 7 to 12 inches (180 to 305 millimeters), but it ranges from 7 to 32 inches (180 to 815 millimeters). Much of the precipitation occurs as snow from October through April and as rain from May through September. These precipitation events occur as a result of cold fronts moving through the area. Occasional convective thunderstorms produce small amounts of rain during the period June through September. The driest period is usually June through August. The average annual temperature generally is 40 to 44 degrees F (5 to 7 degrees C), but it ranges from 33 to 47 degrees F (0 to 8 degrees C). The freeze-free period averages 105 days and ranges from 45 to 160 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.3%; ground water, 0.3%
Livestock—surface water, 0.2%; ground water, 0.2%
Irrigation—surface water, 89.7%; ground water, 5.1%
Other—surface water, 2.8%; ground water, 1.4%

The total withdrawals average 2,590 million gallons per day (9,805 million liters per day). About 7 percent is from ground water sources, and 93 percent is from surface water sources.

Water is scarce in much of the MLRA. Irrigation water is available, however, along the few rivers that bring water into the area from the adjoining mountains. Numerous reservoirs store snowmelt runoff for later use in the growing season. The surface water is of good quality. It is suitable for almost all uses with minimal treatment.

Ground water supplies are meager and little developed in much of this area. A large area of irrigated cropland is along the Bear River, in the northwest corner of the part of this MLRA in Utah. Ground water from the unconsolidated valley fill is pumped for irrigation. This water typically contains less than 1,000 parts per million (milligrams per liter) total dissolved solids and is suitable for almost all uses.

Two aquifers are in the part of this area in Wyoming. One is a sand-and-gravel aquifer that is equivalent to the High Plains (Ogallala) aquifer farther east. Water from the sand-and-gravel aquifer contains less than 500 parts per million total dissolved solids (milligrams per liter) and is moderately hard. It is used for public and domestic supply, livestock, and irrigation. Water also occurs at greater depths in the structural basin aquifer, which is the most extensive and widely used aquifer in this area. It has lenticular beds of sandstone, coal, and shale that can exceed 5,000 feet in thickness. Because of a median level of 1,100 parts per million total dissolved solids (milligrams per liter), the water from this aquifer generally is unsuitable for public supplies. The water is used for domestic supply, livestock, and some irrigation.

Soils

The dominant soil orders in this MLRA are Aridisols and Entisols. Some representative suborders are Argids, Cambids, Calcids, Orthents, Fluvents, and Psamments. The most extensive and representative great groups are Haplargids (Forelle, Ryan Park, Ryark, and Maysprings series), Haplocambids (Poposhia, Kemmerer, and Chaperton series), Haplocalcids (Fiveoh, Langspring, and Tieside series), Torriorthents (Moyerson, Blazon, and Haterton series), Natrargids (Tisworth and Tismid series), Calciargids (Rock River and Cushool series), Torrifluvents (Cowestglen and Battlement series), and Torripsamments (Maybell and Kandaly series).

The dominant soil temperature regime is frigid, and the dominant soil moisture regime is aridic. The soils receiving less than 8 inches (205 millimeters) of precipitation annually have an aridic soil moisture regime. The soils receiving 8 to 14 inches (205 to 355 millimeters) have an aridic soil moisture regime that borders on ustic. The soils receiving 14 to 16 inches (355 to 405 millimeters) have an ustic soil moisture regime that borders on aridic. On the lower slopes of the minor mountain ranges, the soils that receive 16 to 20 inches (405 to 510 millimeters) of precipitation generally have a frigid soil temperature regime and an ustic soil moisture regime. The soils at the highest elevations in the small mountain ranges have a cryic soil temperature regime and a udic soil moisture regime that borders on ustic. Some soils with a mesic soil temperature regime occur at the lowest elevations in the southern part of the MLRA. Soils with mixed or smectitic mineralogy are dominant. Many of the soils are shallow or moderately deep to shale or sandstone bedrock. Many formed in slope alluvium or residuum derived from shale or sandstone. Soils that formed in stream- or river-deposited alluvium are near the major waterways. Most of the soils are well drained. Most are calcareous.

Biological Resources

The kind of vegetation varies from one precipitation zone to another in this MLRA.

The salt desert zone occurs in small areas receiving less than 8 inches (205 millimeters) of annual precipitation. The representative plant species are Gardner's saltbush, mat saltbush, greasewood, shadscale, bud sagebrush, winterfat, Indian ricegrass, and western wheatgrass. Wyoming big sagebrush may occur but only as a few widely spaced plants.

A semi-desert grass-shrub zone, the largest in the MLRA, is characterized by a vast sagebrush steppe. This zone occurs in the areas receiving 8 to 16 inches (205 to 405 millimeters) of annual precipitation. The representative vegetation includes Wyoming big sagebrush, early sagebrush, antelope bitterbrush, bluebunch wheatgrass, western wheatgrass, prairie junegrass, needleandthread, and Indian ricegrass. Utah juniper may occur in small areas. Cottonwood and willows grow in riparian zones along the major perennial streams and rivers.

A foothill-mountain zone in Wyoming is in the narrow mountain ranges that receive more than 16 inches (405 millimeters) of annual precipitation. The vegetation on these ranges includes ponderosa pine, limber pine, lodgepole pine, and Engelmann spruce and an understory of big sagebrush, Oregon-grape, Saskatoon serviceberry, antelope bitterbrush, bluebunch wheatgrass, and Idaho fescue.

Another small zone in this MLRA occurs on the high plains grasslands near Laramie, Wyoming. This zone is dominated by cool-season grasses, such as bluebunch wheatgrass, green needlegrass, muttongrass, and western wheatgrass. Big sagebrush is conspicuously absent in this area.

A lower foothill-mountain zone along the southern boundary of Wyoming and in Colorado occurs on the higher hills and mesas receiving more than 12 inches (305 millimeters) of annual precipitation. This zone is characterized by forested areas of Utah juniper with lesser amounts of pinyon pine and with an understory of Gambel oak, Wyoming big sagebrush, mountain mahogany, muttongrass, needleandthread, prairie junegrass, and Indian ricegrass.

Some of the major wildlife species in this MLRA are white-tailed prairie dog, white-tailed jackrabbit, desert cottontail rabbit, coyote, red fox, badger, pronghorn, mule deer, elk, sage grouse, golden eagle, bald eagle, screech owl, common raven, sage sparrow, Brewer's sparrow, western rattlesnake, and bull snake.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 2%
Grassland—private, 27%; Federal, 67%
Forest—Federal, 1%
Urban development—private, 1%
Other—private, 1%; Federal, 1%

A little more than two-thirds of this area is federally owned. The rest is in private ranches. Most of the land is used for grazing by sheep and cattle. Hunting also is an important land use. The rangeland consists of shrubs and cool-season grasses. About 2 percent of the area is cropland. Areas of irrigated hay and pasture occur mostly along the few large rivers or streams. Nonirrigated small grain crops are grown in small areas near Craig and Meeker, Colorado, where the annual precipitation is more than 13 inches (330 millimeters), the freeze-free period is more than 75 days, the soils commonly are deep, and grain-marketing facilities are nearby.

The major soil resource concerns are erosion, salinity, and water quality in streams and rivers. The availability of water for crops and livestock limits agricultural production. The main management concerns on rangeland are wind erosion, gully erosion, invasive species, and declining rangeland health. The main concerns on cropland are salinization and declining water tables.

Conservation practices on rangeland generally include erosion control, fencing, development of watering facilities, brush management, rangeland seeding, and proper grazing management. The conservation practices that are important on cropland are those that reduce the hazard of erosion and improve the efficiency of irrigation water use. Conservation practices on hayland and pasture are improvement of the efficiency of irrigation systems, irrigation water management, and forage harvest management. ■

34B—Warm Central Desertic Basins and Plateaus

This area (shown in fig. 34B-1) is in Utah (70 percent) and Colorado (30 percent). It makes up about 12,850 square miles (33,290 square kilometers). The cities of Vernal, Roosevelt, Price, and Duchesne, Utah, and Grand Junction, Delta, and Montrose, Colorado, are in this MLRA. U.S. Highway 40 bisects the northern part of the area, and Interstate 70 bisects the southern part. The Uintah and Ouray Indian Reservation and the western end of Dinosaur National Monument are in this MLRA.

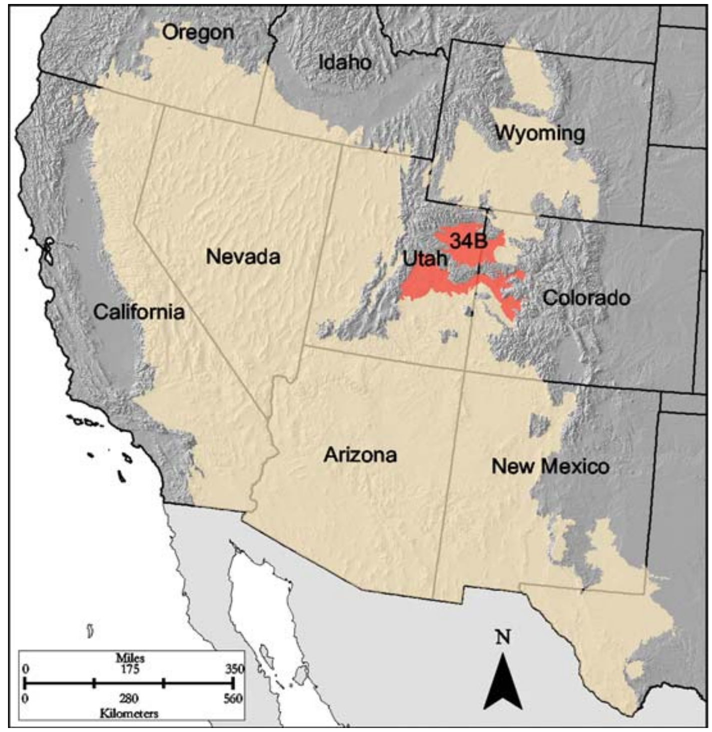

Figure 34B-1: Location of MLRA 34B in Land Resource Region D.

Physiography

This area is in the Canyon Lands (60 percent) and Uinta Basin (35 percent) Sections of the Colorado Plateaus Province of the Intermontane Plateaus. A small part of the area is in the High Plateaus of Utah Section of the Colorado Plateaus Province of the Intermontane Plateaus. Another small part is in the Middle Rocky Mountains Province of the Rocky Mountain System. This MLRA consists of broad intermountain basins bounded by plateaus and steep escarpments. The northern part of the MLRA occurs in the Uinta Basin Section, which is bounded by the Uinta Mountains to the north, the Wasatch Range to the west, the Roan Plateau to the south, and the Rabbit Hills to the east. The southern part of the MLRA occurs in the northern third of the Canyon Lands Section. This section is bounded by the Roan Plateau to the north, the Wasatch Plateau to the west, the southern end of the San Rafael Swell to the south, and the western slope of the Rocky Mountains to the east. Elevation ranges from 4,100 feet (1,250 meters) near Green River, Utah, to 7,500 feet (2,285 meters) at the base of the Wasatch Range and the Roan Plateau.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Green (1406), 51 percent; White-Yampa (1405), 18 percent; Colorado Headwaters (1401), 11 percent; Gunnison (1402), 9 percent; Upper Colorado-Dirty Devil (1407), 6 percent; and Upper Colorado-Dolores (1403), 5 percent. The

Colorado, Green, Gunnison, Price, and Uncompahgre Rivers run through the southern part of this MLRA. The Duchesne, Green, Strawberry, and White Rivers run through the northern part.

Geology

Most of this area is covered by residual basin-floor materials and materials washed in from the surrounding mountains and plateaus. Shale and sandstone are the dominant rock types. The Tertiary-age Green River, Uinta, and Duchesne Formations dominate the northern part of the MLRA. The southern part is dominated by Cretaceous-age materials with lesser amounts of Jurassic and Triassic materials. The dominant Cretaceous formations are Mancos Shale, Dakota Sandstone, and the members of the Mesa Verde Group. The dominant Jurassic formations are the Morrison, Entrada, and Navajo. The dominant Triassic formations are the Chinle and Moenkopi. Quaternary alluvial, eolian, and glacial deposits occur in both parts of the MLRA. Glacial deposits on outwash terraces occur primarily along the Uncompahgre and Gunnison Rivers in Colorado and on outwash terraces from the Uinta Mountains north of Duchesne, Utah. Permian Kaibab Limestone occurs on the crest of the San Rafael Swell, an Eocene anticline west of Green River, Utah, that is about 100 miles long from north to south and about 40 miles wide. Tertiary-age granodiorite intrusives occur off the southwest tip of the San Rafael Swell.

Climate

The average annual precipitation in most of this area ranges from 6 to 10 inches (150 to 255 millimeters). A small part of this area receives as much as 24 inches of annual precipitation. Much of the precipitation occurs as high-intensity, convective thunderstorms during the period July through September. May and June are usually the drier months. Precipitation is more evenly distributed throughout the year in the northern part of the MLRA than in the southern part, where there is a significant peak in late summer. The northern part of the MLRA receives more precipitation as snow during winter than the southern part. The average annual temperature ranges from 41 to 54 degrees F (5 to 12 degrees C). The freeze-free period averages 170 days and ranges from 110 to 235 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 4.0%; ground water, 0.3%
Livestock—surface water, 0.7%; ground water, 0.0%
Irrigation—surface water, 85.1%; ground water, 8.7%
Other—surface water, 1.0%; ground water, 0.3%

The total withdrawals average 1,440 million gallons per day (5,450 million liters per day). About 9 percent is from ground water sources, and 91 percent is from surface water sources. Precipitation is sparse in this area. There is a significant area of irrigated hayland and cropland in the Duchesne, Price, and San Rafael basins in the part of this area in Utah. The surface water is of good quality and is pumped or diverted from the rivers for irrigation. Water-supply concerns in these basins include Native American water rights and coal and oil-shale development. The Upper Colorado, White, and Gunnison Rivers in Colorado are used to irrigate hay meadows, orchards, and cropland. The river water is generally of good quality, except for short reaches that are contaminated with trace elements and metals from mining and naturally occurring sources. Water rights, salinity control, and water transfers to the eastern side of the Continental Divide are water-supply concerns in Colorado.

There are two sources of ground water in this MLRA. One is unconsolidated valley fill in the northern part of the area, and the second is a sandstone aquifer in the southern part. Dakota Sandstone, the Morrison Formation, and Entrada Sandstone are the Colorado equivalent of the sandstone aquifer in Utah. Water from the unconsolidated valley fill aquifer is of good quality and is used for both public supply and irrigation. Water from the sandstone aquifer also is used for public supply and irrigation, but its quality varies considerably. The ground water near recharge zones has the best quality. Deeper water may be saline.

Soils

The dominant soil orders in this MLRA are Aridisols and Entisols. Mollisols occur at the higher elevations, particularly in the northern part of the MLRA. Some of the most extensive and representative great groups are Torriorthents (Chipeta, Persayo, Cadrina, Killpack, and Gerst series), Haplocalcids (Walknolls, Abracon, Avalon, and Shalako series), Haplocambids (Gilston, Bullpen, and Sagers series), Calciargids (Solirec, Mesa, and Progresso series), Natrargids (Motto and Uffens series), Argiustolls (Cortyzack series), Torrifluvents (Ravola and Green River series), and Haplustolls (Moonset series).

The dominant soil temperature regime is mesic, and the dominant soil moisture regime is aridic. The soils receiving less than 8 inches (205 millimeters) of precipitation annually have an aridic soil moisture regime. The soils receiving 8 to 12 inches (205 to 305 millimeters) have an aridic soil moisture regime that borders on ustic. The soils receiving 12 to 16 inches (305 to 405 millimeters) generally have an ustic soil moisture regime that borders on aridic. Some soils with a frigid soil temperature regime and an ustic soil moisture regime occur at the highest elevations in the northern part of the MLRA. The dominant soil mineralogy is mixed. The soils that formed in material weathered from Mancos Shale tend to have active or semiactive clay activity classes. Most of the soils formed in slope alluvium or residuum derived from shale or sandstone. Soils that formed in alluvium occur near the major waterways, and soils that formed in colluvium occur generally on slopes of more than 35 percent. Many of the soils are shallow or moderately deep to shale or sandstone bedrock. Most are well drained. Most are calcareous. The soils at the lower elevations generally have significant amounts of calcium carbonate, salts, and gypsum.

Biological Resources

This area has three major land resource units. These are the desert-salt desert zone, the semi-desert zone, and the upland-foothill zone.

The largest and most dominant unit is the desert-salt desert zone. This zone occurs at the lower elevations receiving less than 8 inches of annual precipitation (205 millimeters). The representative vegetation includes Castlevalley saltbush, Gardner's saltbush, mat saltbush, greasewood, shadscale, bud sagebrush, winterfat, Indian ricegrass, salina wildrye, and galleta. Cottonwood and willows grow along riparian zones.

The semi-desert zone occurs as a narrow 8- to 12-inch (205- to 305-millimeter) precipitation band. This zone has two vegetative subzones. The more extensive subzone includes Wyoming big sagebrush, black sagebrush, shadscale, fourwing saltbush, Mormon tea, Indian ricegrass, and galleta. The other subzone occurs mostly in the area of the San Rafael Swell in Utah. This subzone is similar to the other subzone but lacks Wyoming big sagebrush and has more Utah juniper trees. Wyoming big sagebrush and pinyon pine may occur but only as a few widely scattered plants.

The upland-foothill zone occurs as a 12- to 16-inch (305- to 405-millimeter) precipitation band. Utah juniper and pinyon pine forests are dominant in this zone. The representative vegetation includes Utah juniper, pinyon pine, Wyoming big sagebrush, black sagebrush, prairie junegrass, muttongrass, and needleandthread. Gambel oak, Utah serviceberry, antelope bitterbrush, mountain mahogany, and bluebunch wheatgrass grow at the higher elevations.

Some of the major wildlife species in this MLRA are coyote, kit fox, white-tailed prairie dog, white-tailed jackrabbit, pronghorn, mule deer, elk, American kestrel, sage grouse, turkey vulture, screech owl, mourning dove, piñon jay, common raven, sage sparrow, bald eagle, golden eagle, western rattlesnake, bullsnake, fence lizard, sagebrush lizard, Colorado pike minnow, razorback sucker, bonytail, and humpback chub.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 1%
Grassland—private, 21%; Federal, 74%
Forest—Federal, 1%
Urban development—private, 1%
Other—private, 1%; Federal, 1%

About three-fourths of this area is federally owned. Most of the area is used for recreation or livestock grazing. Different types of surface or sprinkler irrigation are used in many of the valleys. The major crops grown throughout the area are silage corn, grain corn, alfalfa, and small grains. Cantaloupe and melons are grown near Green River, Utah, and lettuce, onions, dry beans, peppers and other small vegetable crops are grown in the Grand Valley and Uncompahgre areas. Many tracts of rangeland and cropland have been, and are continuing to be, subdivided for community development.

The major soil resource concerns are salinity, sodicity, leaching of selenium and salts into surface and ground water supplies, irrigation-induced erosion, and subsidence resulting from gypsum dissolution. Wind erosion is a hazard on light textured soils during periods when annual crops are grown and during periods of plant germination. It also is a hazard in areas of salt-desert shrub communities. The main management concerns on rangeland are wind erosion, gully erosion, invasive species, and declining rangeland health. The main management concerns in cultivated areas include salinization, declining water tables, and inadequate supplies of irrigation water.

Conservation practices on rangeland generally include erosion control, fencing, development of watering facilities, brush management, rangeland seeding, and proper grazing management. Conservation practices on cropland include improvement of the efficiency of irrigation systems, irrigation water management, and crop residue management. Conservation practices on hayland and pasture include improvement of the efficiency of irrigation systems, irrigation water management, and forage harvest management. ■

35—Colorado Plateau

This area (shown in fig. 35-1) is in Arizona (56 percent), Utah (22 percent), New Mexico (21 percent), and Colorado (1 percent). It makes up about 71,735 square miles (185,885 square kilometers). The cities of Kingman and Winslow, Arizona, Gallup and Grants, New Mexico, and Kanab and Moab, Utah, are in this area. Interstate 40 connects some of these cities, and Interstate 17 terminates in Flagstaff, Arizona, just outside this MLRA. The Grand Canyon and Petrified Forest National Parks and the Canyon de Chelly and Wupatki National Monuments are in the part of this MLRA in Arizona. The Zion, Capitol Reef, Canyonlands, and Arches National Parks and the Grand Staircase-Escalante, Natural Bridges, and Hovenweep National Monuments are in the part in Utah. The Aztec Ruins, El Morro, El Malpais, and Chaco Canyon National Monuments and the Chaco Culture National Historic Park are in the part in New Mexico. The Dixie, Manti-La Sal, Kaibab, Prescott, Coconino, Sitgreaves, Apache, and Cibola National Forests are in this MLRA. "Four Corners," the only place in America where four State boundaries meet at one point, is in this area. The Navajo and Hopi Nations make up a significant portion of this MLRA in eastern Arizona, western New Mexico, and southern Utah. Other Native American Nations in Arizona

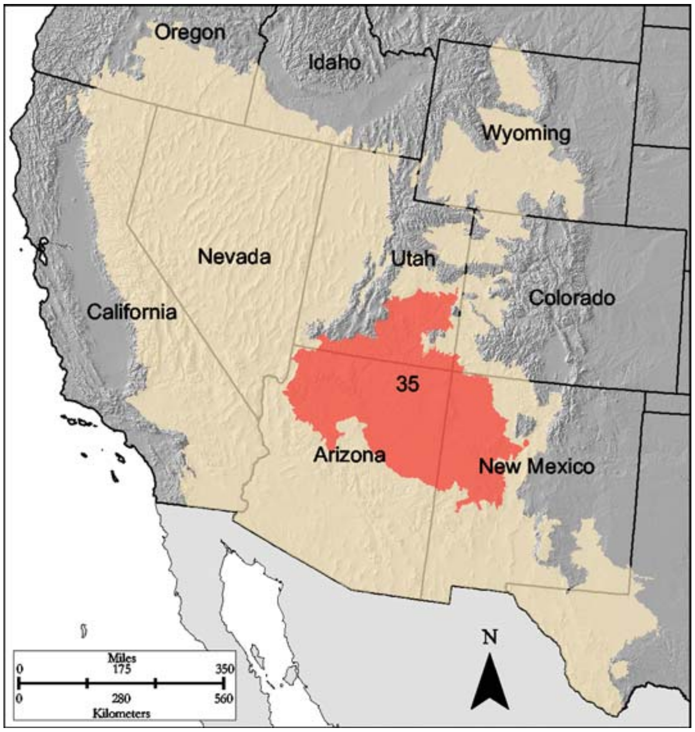

Figure 35-1: Location of MLRA 35 in Land Resource Region D.

include the Zuni, Havasupai, Hualapai, and Kaibab. The Ramah Nation and a small part of the Acoma Nation are in the part of this MLRA in New Mexico. Almost all of the part of this MLRA in Colorado is in the Ute Mountain Nation.

Physiography

This area is in the Colorado Plateaus Province of the Intermontane Plateaus. Different parts of this MLRA are in five of the six sections within the Colorado Plateaus Province. Most of the eastern and central parts of the MLRA are in the Navajo Section. The second largest part, to the west of the Navajo Section, is in the Grand Canyon Section. The northernmost part is in the Canyon Lands Section, and the northwest corner is in the High Plateaus of Utah Section. The southeast corner is in the Datil Section. In general, the surface consists of gently sloping to strongly sloping plains. Volcanic plugs that rise abruptly above the plains, steep scarps, or deeply incised canyons interrupt the surface of the plains. In most areas elevation is 4,250 to 4,950 feet (1,295 to 1,510 meters). Mt. Trumbull, on the north rim of the Grand Canyon, however, reaches a height of 8,028 feet (2,448 meters), and Navajo Mountain, on the Utah-Arizona State line, reaches a height of 10,388 feet (3,167 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Little Colorado (1502), 34 percent; San Juan (1408), 21 percent; Lower Colorado-Lake Mead (1501), 19 percent; Upper Colorado-Dirty Devil (1407), 14 percent; Rio Grande-Elephant Butte (1302), 4 percent; Salt (1506), 3 percent; Upper Colorado-Dolores (1403), 3 percent; and Lower Green (1406), 2 percent. The Colorado River and its tributary in Arizona, the Little Colorado River, are in this MLRA. The Glen Canyon Dam, on the Colorado River (Lake Powell), also is in this area. The Mancos and McElmo Rivers in Colorado are tributaries to the San Juan River in New Mexico. Parts of the Virgin, Sevier, Escalante, Otter, Dirty Devil, Green, and Paria Rivers are in the part of this MLRA in Utah. Rio Puerco is in the part in New Mexico.

Geology

This area is part of the Colorado Plateau, an area that has been structurally uplifted. Rivers flowing across the area cut down into the bedrock as it was being uplifted, resulting in spectacular geologic scenery. Areas of shale, sandstone, limestone, dolomite, and volcanic rock outcrop are extensive. Rocks representing almost the entire geologic timespan are exposed from the bottom of the Grand Canyon up to the present-day surface. Quaternary and Tertiary lava flows occur on the surface in the southwest part of this area. Older flows cap plateaus and mesas, and isolated volcanic cones and eroded volcanic necks occur throughout the area.

Climate

The average annual precipitation is 6 to 18 inches (150 to 455 millimeters) in almost all of this area, but it is less than 5 inches (125 millimeters) in a few basins on the west edge of the area. The highest average annual precipitation, 30 inches (760 millimeters), occurs in a few isolated mountains in southern Utah and near the Arizona-New Mexico State line. About half of the precipitation falls from July through September. April, May, and June are the driest months. Most of the rainfall occurs as high-intensity, convective thunderstorms late in summer. Light snow falls in winter, but it does not remain on the ground very long. The average annual temperature is 36 to 66 degrees F (2 to 19 degrees C), decreasing to the north and at the higher elevations. The freeze-free period averages 215 days and ranges from 105 to 320 days, decreasing in length to the north and at the higher elevations.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.4%; ground water, 2.7%
Livestock—surface water, 5.7%; ground water, 2.0%
Irrigation—surface water, 34.9%; ground water, 12.9%
Other—surface water, 24.3%; ground water, 17.2%

The total withdrawals average 560 million gallons per day (2,120 million liters per day). About 35 percent is from ground water sources, and 65 percent is from surface water sources. Water is scarce throughout the area. Many streams and rivers are ephemeral. The Little Colorado River drains the largest segment of the area, but its flow is intermittent. Water is stored in small reservoirs for irrigation purposes, but supplies are often inadequate. Some irrigation water is obtained from erratic streamflow. The surface water is suitable for almost all uses. A high sediment load is the primary water-quality problem.

The San Juan River basin in the part of this area in northwest New Mexico has the highest streamflow volume in the State. It is one area that relies almost entirely on surface water. The Navajo Reservoir and a few smaller reservoirs store water for use by residents in this area. The river water is of exceptional quality. It is suitable for a cold-water fishery. High salt and sediment loads from ephemeral tributaries on the south side of the basin degrade the river water.

Ground water is the primary source of drinking water in many areas. In places some irrigation water is obtained from deep wells. Ground water occurs in the Coconino, Navajo, and Dakota Sandstone aquifers. It is soft to hard water and generally contains less than 300 parts per million (milligrams per liter) total dissolved solids in Arizona. Median levels of total dissolved solids are closer to 1,000 parts per million (milligrams per liter) in Utah and New Mexico. Lower levels of total dissolved solids and fresher water occur near the recharge zones for these consolidated sediments. Very salty water occurs at depth and away from the recharge zones. Highly mineralized water leaks into these aquifers from older and younger marine sediments above and below the sandstone aquifers.

Some irrigation water is pumped from the valley fill in the San Juan River basin. It has a higher salt content than the river water but otherwise is very similar in quality. Use of the valley fill water is limited because seepage of salty water from the adjacent rocks containing soluble salts increases the sodium sulfate content.

Soils

The dominant soil orders in this MLRA are Alfisols, Aridisols, Entisols, and Mollisols. The soils in the area dominantly have a mesic soil temperature regime; an aridic soil moisture regime or an ustic moisture regime that borders on aridic; and carbonatic, mixed, or smectitic mineralogy. They generally are very shallow to very deep, well drained or somewhat excessively drained, and loamy or clayey.

Haplustalfs (Lykorly series) and Haplargids (Penistaja series) formed in mixed eolian deposits and alluvium on mesas, cuestas, hills, bajadas, and fan terraces. Calciargids (Millett series) formed in alluvium on fan terraces, piedmonts, and plains. Haplocalcids formed in mixed residuum and colluvium on benches, hills, and ridges (Mellenthin series) and in eolian deposits over alluvium (Winona series). Haplocambids formed in mixed eolian deposits and alluvium on mesas, cuestas, hills, and fan terraces (Begay series) and in alluvium on plateaus and mesas (Epikom series). Ustorthents formed in mixed residuum and colluvium on mesas and mountains (Menefee series) and in mixed eolian deposits and alluvium on ridges, hills, and mesas (Vessilla series). Torriorthents formed in mixed alluvium and residuum (Moenkopie series) and in mixed residuum and colluvium (Rizno series) on mesas, hills, benches, cuestas, and plateaus. Torripsamments (Sheppard series) formed in eolian deposits on benches, dunes, and terraces. Argiustolls (Luzena series) formed in residuum and colluvium on mesas, hills, and mountains.

Biological Resources

This area supports desert shrub and woodland vegetation. At high elevations, pinyon-juniper woodland and sagebrush have an understory of galleta, blue grama, black grama, and western wheatgrass. Galleta grass, alkali sacaton, Indian ricegrass, bottlebrush squirreltail, and needlegrasses intermixed with fourwing saltbush and winterfat are at the lower elevations. Greasewood and shadscale are part of the plant community on salty soils. Blackbrush may be dominant at the lower elevations.

Some of the major wildlife species in this area are elk, mule deer, antelope, mountain lion, coyote, fox, bobcat, badger, skunk, rabbit, prairie dog, bats, eagles, hawks, owls, crow, woodpecker, bluebird, and swallow.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 1%
Grassland—private, 48%; Federal, 27%
Forest—private, 8%; Federal, 6%
Urban development—private, 1%
Water—private, 1%
Other—private, 7%; Federal, 1%

About one-third of this area is federally owned. About three-fourths is rangeland. The rangeland is grazed by sheep and cattle. About 1 percent of the area, along the valleys of the major streams, is irrigated cropland. Alfalfa, small grains for hay, and corn for silage are the chief crops. Less than one-tenth of the area in scattered small tracts on Indian reservations is dry-farmed. Corn is the chief crop in the dry-farmed areas. More than one-tenth of the area is juniper and pinyon-juniper woodland. Firewood and pinyon nuts are products of this woodland, which also is grazed by cattle and sheep. If the areas are overgrazed, juniper invades the grassland. Severe gullying, overgrazing, and the lack of a dependable water supply are land use problems. Because of the mild climate and nearby recreational opportunities, the irrigated cropland near towns, such as Moab and Kanab, is being converted to housing developments.

The major soil resource concerns are maintenance of the content of organic matter in the soils, soil productivity, wind erosion, water erosion, salinity, and sodicity. These factors and the low rainfall result in soils that have little or no resilience after disturbance and a very low tolerance for soil loss by erosion.

Conservation practices on rangeland generally include brush management, rangeland seeding, prescribed grazing, prescribed burning, fencing, development of watering facilities, and erosion control. Conservation practices on cropland and hayland are crop rotation, crop residue management, minimum tillage, nutrient and pest management, land leveling, ditch lining, irrigation water management, soil salinity management, and pasture and hayland management. ■

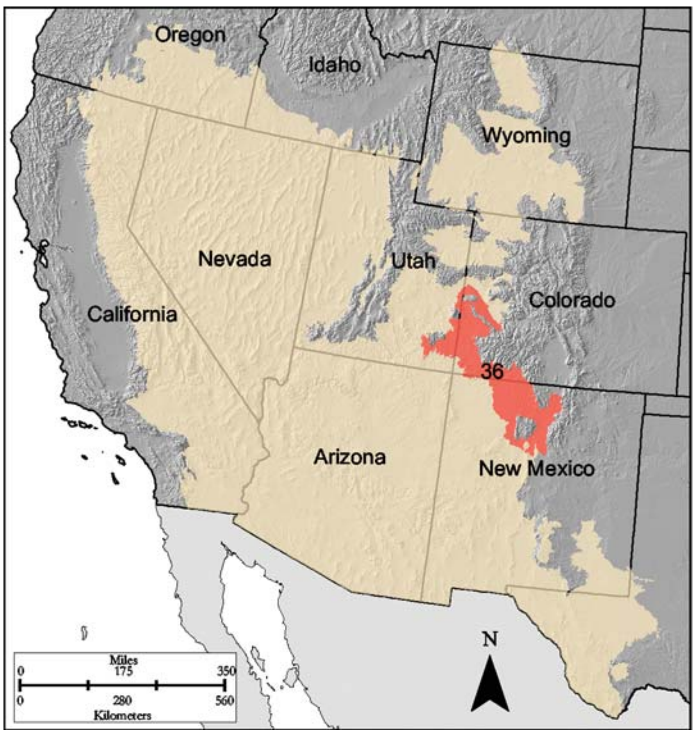

Figure 36-1: Location of MLRA 36 in Land Resource Region D.

36—Southwestern Plateaus, Mesas, and Foothills

This area (shown in fig. 36-1) is in New Mexico (58 percent), Colorado (32 percent), and Utah (10 percent). It makes up about 23,885 square miles (61,895 square kilometers). The major towns in the area are Cortez and Durango, Colorado; Santa Fe and Los Alamos, New Mexico; and Monticello, Utah. Grand Junction, Colorado, and Interstate 70 are just outside the northern tip of this area. Interstate 25 crosses the middle of the area, and U.S. Highway 550 runs along the southwest boundary of the area in New Mexico. Mesa Verde National Park and the Bandelier, Hovenweep, Natural Bridges, Yucca House, and Colorado National Monuments are in the area. Many Indian reservations are in this MLRA. The largest are the Southern Ute, Ute Mountain, and Jicarilla Apache Indian Reservations. Also in the area are the Cochiti, Jemez, Nambe, Navajo, Picuris, Pojoaque, San Felipe, San Ildefonso, San Juan, Sandia, Santa Ana, Santa Clara, Santa Domingo, Taos, Tesuque, and Zia Indian Reservations.

Physiography

This area is on the Intermontane Plateaus. It is mainly in the Canyon Lands and Navajo Sections of the Colorado Plateaus Province, is partly in the Mexican Highland Section of the Basin and Range Province, and extends marginally into the Southern Rocky Mountains Province. Landforms in most areas are controlled by the underlying sedimentary rock formations, but fluvial landforms are in the Rio Grande rift basin at the southeastern extent of the MLRA. Elevation commonly is 4,600 to 8,500 feet (1,400 to 2,590 meters). It generally is highest (as much as 9,300 feet, or 2,835 meters) in areas of the foothills and high mesas that border the Southern Rocky Mountains. Relief generally is less than 1,500 feet (455 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Rio Grande-Elephant Butte (1302), 47 percent; San Juan (1408), 32 percent; Upper Colorado-Dolores (1403), 15 percent; Gunnison (1402), 4 percent; Colorado Headwaters (1401), 1 percent; and Upper Colorado-Dirty Devil (1407), 1 percent. The upper reaches of the Rio Grande and San Juan Rivers and their tributaries are in the part of this MLRA near the Colorado and New Mexico State lines. Rio Puerco and Rio Chama are in the part of the MLRA in New Mexico. The Dolores and San Miguel Rivers are in the part in Colorado, and a short reach of the Colorado River crosses this MLRA near the Utah and Colorado State lines.

Geology

Most of the area is characterized by generally horizontal beds of Jurassic, Cretaceous, and Tertiary sedimentary rocks. Representative formations are the Morrison Formation; Dakota Sandstone, Mancos Shale, Cliff House Sandstone, and other members of the Mesa Verde Group; the Animas Formation; and the San Jose Formation. The sedimentary rocks have been eroded into plateaus, mesas, hills, and canyons. Thick deposits of eolian material of Pleistocene age mantle the top of the mesas in some areas. Small areas of Tertiary and Quaternary volcanic rocks, including cinder cones and lava flows, are in the Rio Grande rift basin in New Mexico. Wide valleys in the rift basin have accumulated deep alluvial sediments, and fan remnants are common.

Climate

The average annual precipitation in this area ranges from 8 to 31 inches (205 to 785 millimeters). It is dominantly 12 to 20 inches (305 to 510 millimeters). Much of the rainfall occurs as convective storms in late summer; about 20 to 35 percent of the total precipitation falls in July and August. This proportion increases from north to south within the area. About 15 to 25 percent of the precipitation is snow. Snowpacks are generally light and not persistent throughout the winter, except at the higher elevations. The average annual temperature ranges from 37 to 56 degrees F (3 to 14 degrees C). The freeze-free period averages 160 days and ranges from 105 to 210 days. The shortest freeze-free periods occur in the northern part of the area and at high elevations.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 2.1%; ground water, 3.6%
Livestock—surface water, 0.6%; ground water, 0.1%
Irrigation—surface water, 78.7%; ground water, 11.1%
Other—surface water, 0.1%; ground water, 3.7%

The total withdrawals average 1,130 million gallons per day (4,275 million liters per day). About 18 percent is from ground water sources, and 82 percent is from surface water sources. Water commonly is scarce in areas away from the major streams. The Dolores, Animas, and San Juan Rivers, which are perennial streams in the northern end of the area, are major sources of irrigation water. The headwater streams of the Rio Grande also have water of excellent quality. The Navajo, Heron, and El Vado Reservoirs store water for irrigation and recreation in this area. The San Juan River is a high-quality, cold-water fishery stream in northwestern New Mexico. It is used for municipal and industrial supplies as well as irrigation. High salt loads from southern tributary streams affect water quality in this area. The quality of some surface water has been degraded by the effects of upstream mining activities in the late 1800s. This mining occurred mainly in the upper reaches of the streams outside this MLRA.

Ground water is the primary source of drinking water in many areas. In places some irrigation water is obtained from deep wells. Cretaceous and Jurassic sediments (Dakota and Morrison Formations and Entrada Sandstone) provide some ground water of variable quality in southwestern Colorado. The ground water in New Mexico is in Tertiary sandstone and in the older sediments. It is soft to hard water and generally exceeds the national drinking water standard for total dissolved solids. Median levels of total dissolved solids are close to 1,000 parts per million (milligrams per liter) in New Mexico. Because of high sodium and sulfate levels, the water is of limited use for drinking in many areas. Fresher water with lower levels of total dissolved solids is near the recharge zones for these consolidated sediments. Very salty water is at depth and away from the recharge zones. Highly mineralized water leaks into these aquifers from older and younger marine sediments above and below the sandstone aquifers.

Some irrigation water is pumped from the valley fill in the larger river valleys. It has a higher salt content than the river water but otherwise is very similar in quality. Seepage of salty water from the adjacent rocks containing soluble salts can increase the sodium sulfate content, which limits the use of the valley fill water.

Soils

The dominant soil orders in this MLRA are Alfisols, Inceptisols, Mollisols, Entisols, and Aridisols. The soil moisture regime is mainly ustic, but an aridic regime that is marginal to ustic occurs in some areas. The soil temperature regime is mesic or frigid. Mineralogy is dominantly mixed or smectitic.

In the warmer areas, shallow Ustorthents (Menefee series) formed in residuum on shale hills and mesas. Shallow Haplustalfs (Arabrab series) and Torriorthents (Rizno series) formed in material weathered from sandstone on mesas, hills, and cuestas. Moderately deep, loamy Haplargids (Gapmesa series) and very deep, loamy Haplustalfs (Orlie series) formed in slope alluvium derived from sandstone and shale on mesas or fan remnants. Very deep, clayey Haplustepts (Roques series) formed in alluvium derived from shale on valley sides. Very deep, silty Haplustalfs (Cahona and Wetherill series) formed in eolian material on hills and mesas.

In the cooler areas, very deep, clayey Haplustalfs (Goldbug series) formed in slope alluvium derived from sandstone and shale on hills and mesas. Shallow Argiustolls (Fivepine series) formed in slope alluvium and residuum derived from sandstone. Moderately deep Argiustolls (Nortez series) formed in eolian material derived from sandstone on hills and mesas.

Biological Resources

The potential vegetation is grass and sagebrush at the lower elevations. Pinyon-juniper woodland and ponderosa pine forests are at mid elevations. Forests of Rocky Mountain Douglas-fir and white fir are at the higher elevations. Some common plants are Wyoming big sagebrush, western wheatgrass, galleta, needleandthread, and blue grama at the lower elevations; twoneedle pinyon, Utah juniper, Indian ricegrass, mountain mahogany, ponderosa pine, Gambel oak, Arizona fescue, and muttongrass at mid elevations; and Rocky Mountain Douglas-fir, white fir, mountain muhly, common snowberry, Parry's oatgrass, and mountain brome at the higher elevations.

Some of the major wildlife species in this area are mule deer, elk, coyote, black bear, mountain lion, black-tailed jackrabbit, Gunnison's prairie dog, badger, piñon jay, black-billed magpie, mountain chickadee, red-breasted nuthatch, white-breasted nuthatch, collared lizard, fence lizard, and western rattlesnake. Reservoirs and rivers provide most of the fish habitat in this area. The ones at the higher elevations have cold-water species, such as rainbow trout and brown trout, and the ones at the lower elevations may have warm-water species, such as bass, bluegill, crappie, and catfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 3%
Grassland—private, 41%; Federal, 39%
Forest—private, 7%; Federal, 5%
Urban development—private, 2%
Other—private, 3%

Nearly all of this area supports natural vegetation and is used as grazing land or forestland. Cropland also is a significant land use. Where irrigation water is available, irrigated crops, such as wheat, barley, beans, oats, alfalfa, and hay, are grown. An area in Colorado and Utah is used as nonirrigated cropland. The major crops grown on this nonirrigated cropland are beans and winter wheat. The pinyon-juniper woodlands are a source of fuel wood. At the higher elevations, commercial timber is harvested, principally ponderosa pine and Rocky Mountain Douglas-fir. Some urban development is occurring in the vicinity of Santa Fe.

The major soil resource concerns are wind erosion, water erosion, maintenance of the productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include crop residue management, minimum tillage, and irrigation water management. Proper grazing use is a concern on grazing lands. The primary concerns in timbered areas are controlling erosion along roads and skid trails and minimizing surface compaction during timber harvesting. ■

38—Mogollon Transition

This area (shown in fig. 38-1) is in Arizona (81 percent) and New Mexico (19 percent). It makes up about 18,985 square miles (49,195 square kilometers). The cities of Globe and Prescott, Arizona, and Silver City, New Mexico, occur in this MLRA. U.S. Highway 180 crosses this area in New Mexico, and Interstate 17 crosses the middle of the area in Arizona. Parts of the Prescott, Tonto, Gila, and Cibola National Forests are in this area. The MLRA has numerous wilderness areas and national forests. The Tuzigoot and Montezuma Castle National Monuments and the Hualapai, Yavapai, Camp Verde, Lower Camp Verde, and San Carlos Indian Reservations are in the part of this area in Arizona.

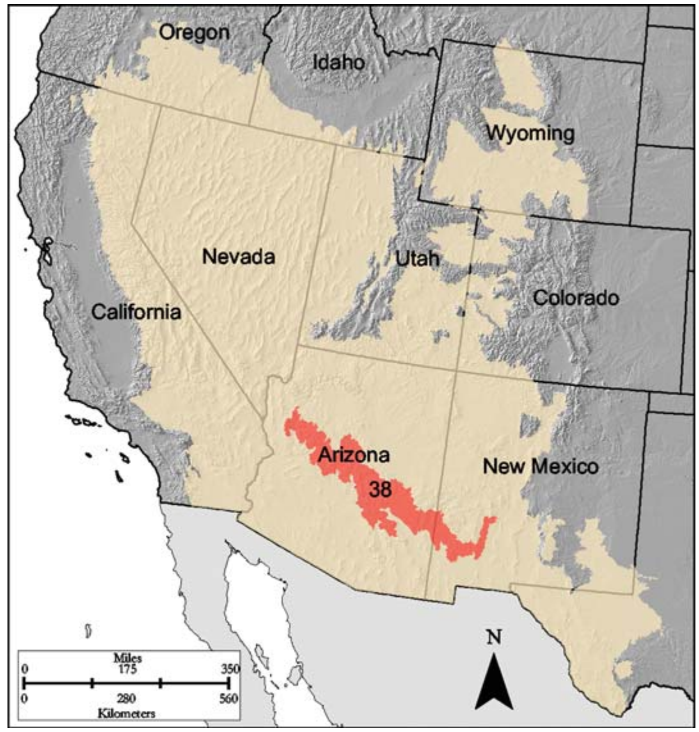

Figure 38-1: Location of MLRA 38 in Land Resource Region D.

Physiography

This area is in the Mexican Highland Section of the Basin and Range Province of the Intermontane Plateaus. The area consists of canyons and structural troughs and valleys. Examples of the many mountain ranges in the area are the Pinal, Sierra Ancha, and Mazatzal Mountains in Arizona and the Big Burro and Mimbres Mountains in New Mexico. Elevation ranges from 3,000 to 5,500 feet (915 to 1,675 meters) in most areas and from 5,100 to 7,500 feet (1,555 to 2,285 meters) in the mountains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Salt (1506), 37 percent; Upper Gila (1504), 25 percent; Lower Colorado (1503), 14 percent; Lower Gila (1507), 9 percent; Rio Grande-Mimbres (1303), 8 percent; and parts of many other hydrologic units, 7 percent. The Verde, Black, and Salt Rivers are tributaries to the Gila River in this MLRA. A reach of the Verde River has been designated a National Wild and Scenic River in Arizona.

Geology

Most of this area is covered by deep alluvium washed in from the adjacent mountains. These deposits of silt, sand, and gravel are very young in the present-day drainages and much older on the valley floors and terraces. This MLRA is an area of intensive volcanism. Isolated outcrops of granite are more than 1 billion years old. Most of the andesite and basalt flows are Tertiary in age, forming in the past 50 million years. Some basalts, however, formed around 4 million years ago, and another series of intrusive rocks appeared in the late Cretaceous to early Tertiary. Some outcrops of Paleozoic sediments are associated with the uplift in the vicinity of the older intrusive rock units. Some of these sediments have been metamorphosed.

Climate

The average annual precipitation is 10 to 37 inches (255 to 940 millimeters) in most of this area. More than half of the precipitation occurs as high-intensity, convective thunderstorms during July, August, and September. Because of Pacific frontal storms, a second rainy season occurs from December to March. Snow falls occasionally in winter. The average annual air temperature is 47 to 70 degrees F (8 to 21 degrees C). The freeze-free period averages 255 days and ranges from 145 to 365 days, decreasing in length with increasing elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 6.8%; ground water, 0.0%
Livestock—surface water, 13.7%; ground water, 0.1%
Irrigation—surface water, 19.1%; ground water, 13.7%
Other—surface water, 38.3%; ground water, 8.2%

The total withdrawals average 37 million gallons per day (140 million liters per day). About 22 percent is from ground water sources, and 78 percent is from surface water sources. This MLRA supplies water for much of the adjoining irrigated land. Because more than one-half of the annual precipitation occurs in winter, there is a general deficiency of moisture during the growing season. Several of the larger streams and a few of their larger tributaries are perennial streams. Much of the water is stored in reservoirs near or below the southern edge of the area and is used for irrigation and for municipal water supplies in the Sonoran Basin and Range MLRA to the south. Small natural and artificial lakes at the higher elevations are used for fishing and other kinds of recreation. Annual runoff into all reservoirs is highly variable, and most of the smaller lakes and reservoirs are dry in some years. The surface water is of good quality and is suitable for most uses with minimal treatment. A high load of suspended sediment is one of the primary water-quality issues in this MLRA.

Ground water is limited and generally occurs at great depth in alluvial deposits along some of the larger streams in this area. The quality of this water varies considerably, depending on the composition, location, and depth of the alluvium. Some alluvium has evaporite deposits, and some has high levels of sulfate. Some springs yield saline water. The median concentration of total dissolved solids is generally suitable for almost all uses in this area. Very little runoff or precipitation is available to recharge the alluvial aquifers in the area, so ground water levels have declined. A few windmills furnish water for livestock and wildlife. Some earthen water tanks are throughout the area. The fractures and joints in the igneous, metamorphic, and sedimentary bedrock have small amounts of ground water.

Soils

The dominant soil orders in this MLRA are Aridisols, Alfisols, and Mollisols. The soils dominantly have a thermic or mesic soil temperature regime, an aridic or ustic soil moisture regime, and smectitic or mixed mineralogy and formed in alluvium. They are very shallow to very deep and are well drained and somewhat excessively drained. Torrertic Haplustolls (Ashcreek series) and Torrertic Haplustalfs (Cloverdale series) formed on alluvial fans. Ustic Haplargids (Eskiminzin series) formed on hills and mountains. Pachic Haplustolls (Lanque series) formed on fan terraces and stream terraces. Cumulic Haplustolls (Rafter series) formed on flood plains and alluvial fans.

Biological Resources

This area supports forest, savanna, desert shrub, and grassland vegetation. Pine-oak woodlands are at the higher elevations, where ponderosa pine, Douglas-fir, live oak, New Mexico locust, Mexican pinyon, buckbrush, and manzanita grow with an understory of muhlys, bluegrasses, sedges, pine dropseed, and squirreltail. Evergreen woodland savannas are at intermediate elevations, where Mexican blue oak, Emory and Arizona white oaks, alligator and one-seed junipers, jojoba, and turbinella oak are the dominant species and cone beardgrass, sideoats grama, blue grama, Texas bluestem, plains lovegrass, sprucetop grama, threeawns, and needlegrass characterize the understory. Whitethorn, soaptree yucca, fourwing saltbush, mesquite, and ocotillo grow on the drier soils at the lower elevations. The understory at these elevations consists of Rothrock grama, blue grama, black grama, alkali sacaton, curly mesquite, plains bristlegrass, bush muhly, and lemongrass.

Some of the major wildlife species in this area are mule deer, white-tailed deer, mountain lion, coyote, bobcat, raccoon, skunk, white-throated woodrat, white-footed mouse, gopher snake, king snake, western diamondback rattlesnake, western whiptail lizard, side-blotched lizard, tree lizard, red-tailed hawk, Cooper’s hawk, golden eagle, prairie falcon, raven, turkey vulture, meadowlark, ladder-back woodpecker, ash-throated flycatcher, canyon wren, and rough-winged swallow.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—private, 38%; Federal, 40%
Forest—private, 8%; Federal, 10%
Urban development—private, 1%
Other—private, 3%

About one-half of thus area is federally owned. Most of the area is used for livestock grazing. Many tracts of rangeland are subdivided for community development. The main management concern on rangeland is controlling the distribution of grazing. Invasion of brushy species and local gully erosion are symptoms of overgrazing.

The major soil resource concerns are maintenance of the content of organic matter and productivity of the soils and the hazard of water erosion. Conservation practices on rangeland include fencing and development of watering facilities, which facilitate grazing management systems; brush management, which removes undesirable and introduced invasive species; and erosion control, which helps to prevent gullying and concentrated waterflow. ■

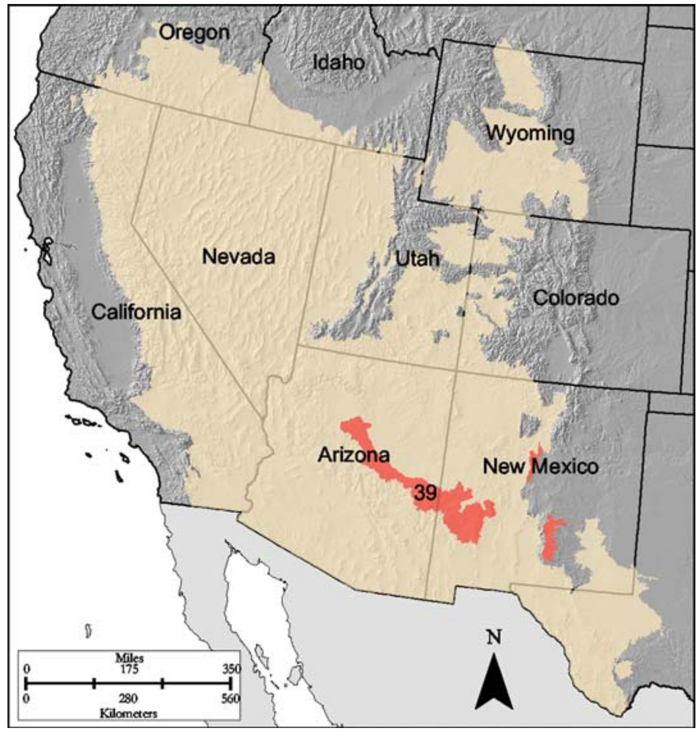

Figure 39-1: Location of MLRA 39 in Land Resource Region D.

39—Arizona and New Mexico Mountains

This area (shown in fig. 39-1) is in New Mexico (59 percent) and Arizona (41 percent). It makes up about 15,150 square miles (39,255 square kilometers). The cities of Flagstaff and Springerville, Arizona, and Reserve, Ruidoso, and Cloudcroft, New Mexico, occur in this MLRA. Interstates 17 and 40 intersect in this area, in Flagstaff, and U.S. Highway 180 crosses this area in New Mexico. Parts of the Kaibab, Coconino, Gila, Apache-Sitgreaves, and Cibola National Forests are in this area. The part of this area in Arizona includes Sunset Crater and Walnut Canyon National Monuments. It also includes a large part of the Fort Apache Indian Reservation. The Navajo Army Depot and Naval Observatory Station are west of Flagstaff.

Physiography

The western two-thirds of this area is primarily in the Grand Canyon Section of the Colorado Plateaus Province of the Intermontane Plateaus. The northern half of the eastern third of the area is in the Datil Section of the same province and division. The southern half of the eastern third of the area and part of the southern half of the western two-thirds are in the Mexican Highland Section of the Basin and Range Province of the Intermontane Plateaus. This MLRA is characterized by volcanic fields and gently dipping sedimentary rocks eroded into plateaus, valleys, and deep canyons. Elevation ranges from 4,000 to 7,000 feet (1,220 to 2,135 meters) in the southern half of the area. North of the Mogollon Rim, it rises to more than 7,500 feet (2,285 meters) and drops northward to 5,000 or 6,000 feet (1,525 to 1,830 meters). Included in this area are the two highest points in Arizona, Baldy Peak at 11,403 feet (3,476 meters) and Humphreys Peak at 12,670 feet (3,863 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Gila (1504), 26 percent; Little Colorado (1502), 21 percent; Salt (1506), 19 percent; Rio Grande-Elephant Butte (1302), 17 percent; Upper Pecos (1306), 8 percent; and parts of numerous other units, 9 percent. The Black, Blue, and Little Colorado Rivers are the major rivers in this MLRA.

Geology

Cenozoic volcanic rocks are an important feature of this area. These rocks are from large central type volcanoes, such as the San Francisco Peaks near Flagstaff, and from smaller, coalescing volcanoes that produced extensive sheets of lavas and pyroclastic rocks. Various sedimentary sections of the Colorado Plateau also are evident. They are characterized and affected by alternating resistant and weak rock strata that form ledges, cliffs, mesas, and benches separated by slopes and valleys. Relief is caused more by the cutting of deep canyons into moderately flat terrain than by the deformation of mountains and valleys. The southern and eastern parts of the MLRA include Permian and Cretaceous sedimentary rock over a Precambrian granite core that is exposed in places at the higher elevations.

Climate

The average annual precipitation is 15 to 30 inches (380 to 760 millimeters) in most of this area. It is 9 to 15 inches (230 to 380 millimeters) in a few of the lower areas along the edges of the MLRA. It can be as much as 43 inches (1,090 millimeters) in the mountains. More than half of the precipitation occurs as high-intensity, convective thunderstorms during July, August, and September. Because of Pacific frontal storms, a second rainy season occurs from December to March. Snow falls in winter. The average annual air temperature is 36 to 55 degrees F (2 to 13 degrees C). The freeze-free period averages 135 days and ranges from 60 to 205 days, decreasing in length with increasing elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 3.7%; ground water, 0.0%
Livestock—surface water, 9.1%; ground water, 2.5%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 17.2%; ground water, 67.4%

The total withdrawals average 13 million gallons per day (50 million liters per day). About 70 percent is from ground water sources, and 30 percent is from surface water sources. Since more than half of the annual precipitation occurs during winter, there is a general deficiency of moisture during the growing season.

This area has important watersheds that provide water to the central part of Arizona. Several of the larger streams, such as the Black, White, Verde, and Salt Rivers, and a few of their larger tributaries maintain perennial flow. Much of the water is stored in reservoirs near or below the southern edge of the area and is used for irrigation or municipal water supply in the MLRAs to the south. The municipal water supply for Flagstaff and Williams is in part obtained from small reservoirs. This MLRA has several lakes and reservoirs. Small natural or artificial lakes at the higher elevations are used for fishing and other kinds of recreation. Annual runoff into all reservoirs is highly variable, and most of the smaller lakes and reservoirs are dry during some years. The surface water is suitable for almost all uses. A high sediment load is the primary water-quality problem.

Limited amounts of ground water for livestock and domestic use generally are only in faulted and fractured bedrock in areas of this MLRA. The water generally has less than 1,000 parts per million (milligrams per liter) total dissolved solids. Fresher water with lower levels of total dissolved solids is near the recharge zones for the bedrock aquifers. Very salty water is at depth and away from the recharge zones. Some springs yield saline water.

Soils

The dominant soil orders in this MLRA are Inceptisols, Mollisols, Alfisols, and Entisols. Most of the soils in the area have a frigid or mesic soil temperature regime, depending mainly on elevation, but the soils at the highest elevations have a cryic temperature regime. Argiustolls (Brolliar, Sponseller, Ruidoso, and Ess series) formed in intrusive and extrusive volcanic materials, dominantly basalt. Examples of Haplustolls are the Tularosa and Blanca series. Examples of Ustolls with a cryic temperature regime are the Caballo and Supervisor series. At the lower elevations, Haplustalfs and Paleustalfs (Dandrea, McVickers, Overgaard, and Hogg series), Ustorthents (Mirabal and Telephone series), Haplustolls (Tortugas, Tularosa, and Ackmen series), and Calciustepts (Cibeque series) overlie different rock types.

Biological Resources

This area includes grasslands on the deeper soils; mixed shrub-grasslands on shallow, rocky soils; and timber on soils that are shallow to bedrock. Ponderosa pine occurs in the largest portion of the intermediate elevations in the area. At the higher elevations, spruce and fir dominate. Areas at the highest elevations, above 11,000 feet (3,350 meters), support alpine vegetation. At the lower elevations, ponderosa pine grades into stands of pinyon-juniper on north-facing slopes and woodland of mixed oak, pine, and juniper on south-facing slopes. The principal grasses are fescues, bluegrasses, bromegrass, and muhly at the higher elevations; needlegrass, western wheatgrass, bottlebrush squirreltail, and muttongrass at intermediate elevations; and grama grasses, spike muhly, junegrass, cane bluestem, and needlegrass at the lower elevations.

Some of the major wildlife species in this area are mule deer, white-tailed deer, mountain lion, coyote, bobcat, raccoon, wolf, black bear, and elk.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—private, 9%; Federal, 7%
Forest—private, 12%; Federal, 63%
Urban development—private, 2%
Water—Federal, 1%
Other—private, 1%; Federal, 5%

About three-fourths of this area is federally owned. Most of the area is used for timber production or livestock grazing. Many tracts of rangeland are subdivided for community development. The main management concern on rangeland is controlling the distribution of grazing. Invasion of brushy species and local gully erosion are symptoms of overgrazing.

The major soil resource concerns are maintenance of the content of organic matter and productivity of the soils and the hazard of water erosion. Conservation practices on rangeland include fencing and development of watering facilities, which facilitate grazing management systems; brush management, which removes undesirable and introduced invasive species; and erosion control, which helps to prevent gullying and concentrated waterflow. ■

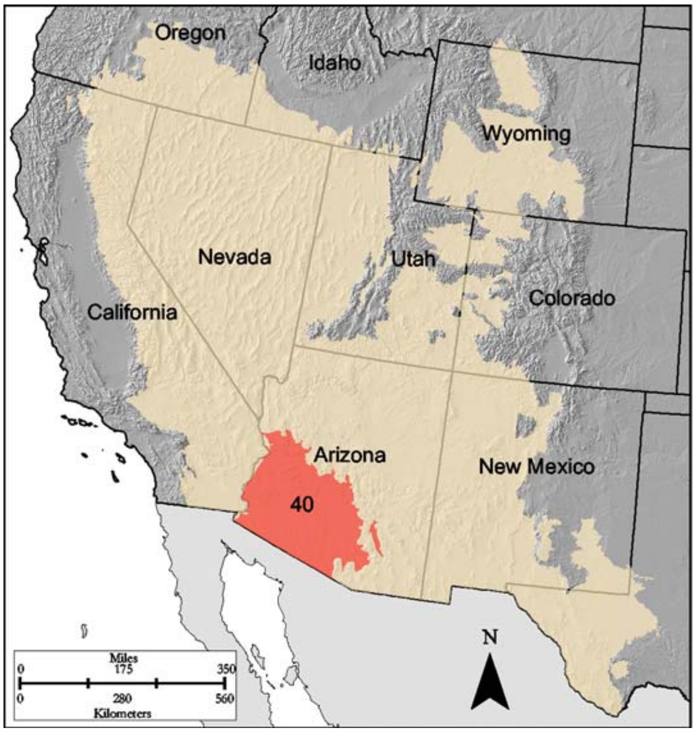

Figure 40-1: Location of MLRA 40 in Land Resource Region D.

40—Sonoran Basin and Range

This area is almost entirely in Arizona, but it includes a very small part of California (fig. 40-1). It makes up about 31,765 square miles (82,310 square kilometers). The cities of Yuma, Tucson, and Phoenix are in this MLRA. Interstate 10 crosses the center of this area and turns to the southeast outside of Phoenix. Interstate 17 ends in Phoenix. Interstate 19 runs from Tucson to the Mexican border. Interstate 8 crosses the southern part of the MLRA. It ends where it intersects Interstate 10 southeast of Phoenix. Many wilderness study areas occur in this MLRA. The Tonto and Prescott National Forests and Saguaro and Organ Pipe Cactus National Monuments also occur in this MLRA. The Yuma Proving Grounds, the Barry M. Goldwater Air Force Bombing Range, and the Tohono O'Odham, Colorado River, Salt River, and Gila River Indian Reservations are in the area.

Physiography

This area is in the Sonoran Desert Section of the Basin and Range Province of the Intermontane Plateaus. Many short, fault-block mountain ranges trending southeast to northwest rise abruptly from the smooth or gently sloping desert valley floors. These include the Painted Rock, Gila Bend, Big Horn, Copper, Granite, and Santa Rosa Mountains. Elevation ranges from 980 to 3,600 feet (300 to 1,100 meters) in most of this area, but it is as high as 4,590 feet (1,400 meters) in the mountains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Gila (1507), 41 percent; Middle Gila (1505), 25 percent; Lower Colorado (1503), 20 percent; Sonora (1508), 9 percent; and Salt (1506), 5 percent. The Salt River intersects the Gila River south of Phoenix. The Gila River then flows west across the southern part of the MLRA to the Colorado River.

Geology

Most of this area is covered by deep alluvium washed in from the adjacent mountains. These deposits of silt, sand, and gravel are very young in the present-day drainageways and much older on the valley floors and terraces. This MLRA is an area of intensive volcanism. Isolated outcrops of granite are more than 1 billion years old. Most of the andesite and basalt flows are Tertiary in age, forming in the past 50 million years. Some basalts, however, formed around 4 million years ago, and another series of intrusives appeared in the late Cretaceous to early Tertiary. Some outcrops of Paleozoic sediments are associated with the uplift in the vicinity of the older intrusives. Some of these sediments have been metamorphosed.

Climate

The average annual precipitation is 3 to 10 inches (75 to 255 millimeters) in most of this area. Rainfall can average 22 inches (560 millimeters) per year in the mountain ranges. Most of the rainfall occurs as high-intensity, convective thunderstorms, mainly from July to September, and as Pacific frontal storms from December to March. Snowfall is rare, except at the higher elevations. The average annual air temperature is 58 to 74 degrees F (15 to 23 degrees C). The freeze-free period averages 285 days and ranges from 205 to 365 days, decreasing in length with increasing elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 4.9%; ground water, 6.4%
Livestock—surface water, 0.5%; ground water, 0.2%
Irrigation—surface water, 52.7%; ground water, 31.7%
Other—surface water, 1.6%; ground water, 2.1%

The total withdrawals average 5,995 million gallons per day (22,690 million liters per day). About 40 percent is from ground water sources, and 60 percent is from surface water sources. Most of the population in Arizona lives in this MLRA, and a little over 90 percent of all the water used in the State is used in this area. Precipitation is sparse. Water for irrigation and other uses is stored in a reservoir system on the Salt River. No perennial streams originate or run through the area because the water of the larger drainages is impounded by reservoirs upstream from the cultivated lands. The surface water from the mountains generally is of good quality, and its use is not limited. The quality of the water is naturally degraded by dissolved salts picked up as streams cross various soil and geologic deposits. Irrigation return flows also raise the levels of dissolved salts and suspended sediments, causing local water-quality problems.

The alluvial aquifers in this area are the most productive in Arizona. Some of the more significant aquifers are in the Colorado, Salt (or Gila), and Lower Santa Cruz River basins and in the Yuma Valley and San Simon Wash basins. Water for irrigation is pumped from deep wells in the alluvial aquifers, and the ground water table continually drops. All of the surface water in Arizona is appropriated, and little water usually is left to recharge the alluvial aquifers. The quality of the ground water varies considerably, depending on the composition, location, and depth of the alluvium. Some alluvium contains evaporate deposits and volcanic rocks, and high levels of sulfate can occur where these rocks occur in abundance. The median concentration of total dissolved solids is typically less than 1,000 parts per million (milligrams per liter), so the ground water is of good enough quality for almost all uses.

Soils

The dominant soil orders in the MLRA are Aridisols and Entisols. The soils in the area dominantly have a thermic or hyperthermic soil temperature regime, an aridic soil moisture regime, and mixed mineralogy and formed in alluvium. They are very shallow to very deep and are well drained and somewhat excessively drained. Haplocambids (Denure and Hayhook series), Haplocalcids (Gunsight and Stagecoach series), Calciargids (Mohall and Pinaleno series), and Natrargids (Casa Grande series) formed on fan terraces and relict basin floors. Torrifluvents (Antho and Comoro series) formed on alluvial fans and flood plains. Shallow or very shallow Torriorthents (Cellar and Quilotosa series) formed on hills and mountains.

Biological Resources

This area supports desert shrub vegetation. The giant saguaro cactus is a major species. Bursage, desert wolfberry, ocotillo, cholla, desert saltbush, mesquite, brittlebush, burroweed, pricklypear, desert broom, and creosotebush are the dominant desert shrubs. Bush muhly, Arizona cottontop, threeawns, and fluffgrass are the main understory plants. Winter annuals can grow in some areas, depending on the amount of winter precipitation. Joshua-tree and littleleaf paloverde mixed with some honey mesquite are on stony or rocky sites. These sites have an understory of Mormon tea, pricklypear, cholla, ocotillo, desert saltbush, and grasses, such as tridens, bush muhly, tobosa, Arizona cottontop, and desert needlegrass. At the lower elevations, creosotebush, ironwood, mesquite, burroweed, and catclaw are associated with an understory of threeawns and annuals, such as red fescue, bluegrasses, fiddleneck, indianwheat, globemallow, and filaree.

Some of the major wildlife species in this area are mule deer, desert bighorn sheep, antelope, javelina, coyote, fox, raccoon, bats, rattlesnake, bullsnake, coachwhip, kingsnake, and quail.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 5%
Grassland—private, 36%; Federal, 47%
Urban development—private, 4%
Other—private, 4%; Federal, 4%

More than one-half of this area is federally owned. Most of the area is desert that can be used for limited grazing during periods of favorable moisture. Irrigated areas are used for cotton, alfalfa, barley, and other small grains. In areas where water supplies are favorable, lettuce, carrots, cabbage, cauliflower, melons, other market vegetables, and citrus are grown. Rapid urbanization around the larger communities is greatly reducing the acreage of cropland.

The major soil resource concern is the absence of soil sustainability, resulting in no soil loss tolerance within this extremely arid environment. Other resource concerns include declining water tables and accumulation of salts in the soils used for crops. Efficiently using the limited water supply is an important management concern. Conservation practices on cropland are crop rotation, crop residue management, minimum tillage, nutrient and pest management, land leveling, ditch lining, irrigation water management, and pasture and hayland management. ■

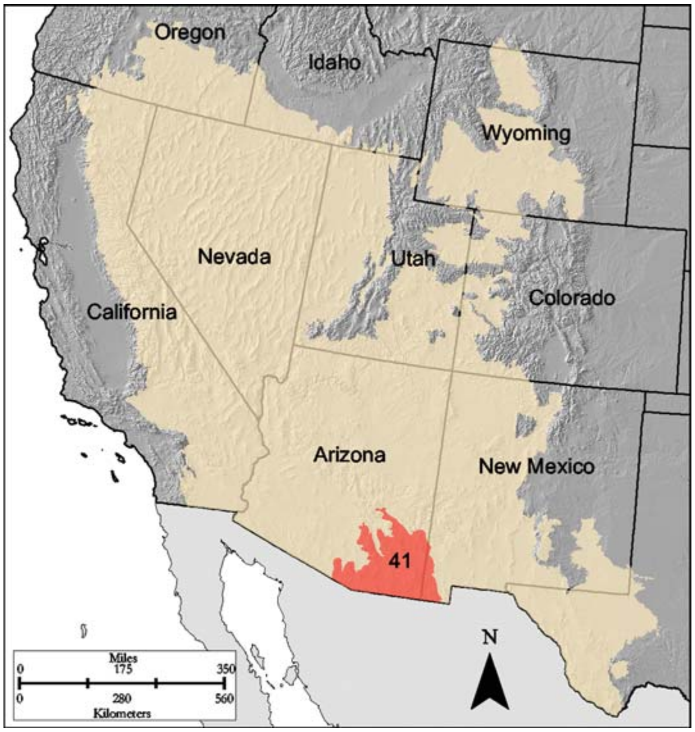

Figure 41-1: Location of MLRA 41 in Land Resource Region D.

41—Southeastern Arizona Basin and Range

This area (shown in fig. 41-1) is in Arizona (89 percent) and New Mexico (11 percent). It makes up about 15,730 square miles (40,765 square kilometers). The cities of Nogales, Bisbee, and Sierra Vista, Arizona, are in this MLRA. Interstate 10 bisects this area, and the towns of Benson and Willcox are along the freeway. The Coronado National Forest, the Fort Huachuca Military Reservation, the Fort Bowie National Historic Site, and the Chiricahua and Tumacacori National Monuments are in this MLRA. The eastern edge of the Papago Indian Reservation and the southern part of the San Carlos Indian Reservation also are in this MLRA.

Physiography

Most of this area is in the Mexican Highland Section of the Basin and Range Province of the Intermontane Plateaus. The eastern one-fifth of the area is in the Sonoran Desert Section of that same province and division. This MLRA has mountain ranges that trend southeast to northwest and has relatively smooth valleys between the mountains. Examples of the many mountain ranges are the Chiricahua, Dragoon, Swisshelm, and Pedregosa Mountains. In the vicinity of Willcox, there is a distinct closed basin called the Willcox Playa. The southeast boundary of the part of this MLRA in New Mexico is the Continental Divide. Elevation ranges from 2,620 to 4,590 feet (800 to 1,400 meters) in most areas. It generally ranges from 4,920 to 5,900 feet (1,500 to 1,800 meters) in the mountains. On some peaks, however, it can reach almost 8,900 feet (2,715 meters). On Mt. Graham, in Arizona, it reaches 10,717 feet (3,267 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Middle Gila (1505), 51 percent; Upper Gila (1504), 33 percent; Sonora (1508), 14 percent; and Rio Grande-Mimbres (1303), 2 percent. The Gila River runs through the northern end of this area. The San Francisco, San Simon, and San Pedro Rivers are tributaries to the Gila River in this MLRA.

Geology

Most of this area is covered by deep alluvium washed in from the adjacent mountains. These deposits of silt, sand, and gravel are very young in the present-day drainageways and much older on the valley floors and terraces. This MLRA is an area of intensive volcanism. Isolated outcrops of granite are more than 1 billion years old. Most of the andesite and basalt flows are Tertiary in age, forming in the past 50 million years. Some basalts, however, formed around 4 million years ago, and another series of intrusives appeared in the late Cretaceous to early Tertiary. Some outcrops of Paleozoic sediments are associated with the uplift in the vicinity of the older intrusives. Some of these sediments have been metamorphosed.

Climate

The average annual precipitation is 9 to 20 inches (230 to 510 millimeters) in most of this area, but it is as much as 45 inches (1,145 millimeters) at the higher elevations. More than half of the precipitation occurs as high-intensity, convective thunderstorms during July, August, and September. Because of Pacific frontal storms, a second rainy season occurs from December to March. Snow falls occasionally in winter. The average annual air temperature is 47 to 68 degrees F (8 to 20 degrees C). The freeze-free period averages 245 days and ranges from 160 to 335 days, decreasing in length with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.6%; ground water, 1.3%
Livestock—surface water, 1.8%; ground water, 1.3%
Irrigation—surface water, 16.6%; ground water, 60.6%
Other—surface water, 5.8%; ground water, 12.1%

The total withdrawals average 155 million gallons per day (585 million liters per day). About 75 percent is from ground water sources, and 25 percent is from surface water sources.

There are no lakes or reservoirs of consequence in this area. Surface water quality is generally satisfactory. Small artesian flows occur along parts of the San Pedro River.

Water for irrigation generally is obtained by pumping ground water from deep wells in the alluvial aquifers. Some of the more significant aquifers are in the Avra, Altar, and Upper Santa Cruz River basins and in the Safford and Wilcox basins. There has been a noticeable decline in the level of the ground water in all of these aquifers. Very little runoff or precipitation is available to recharge the alluvial aquifers in the area. The quality of the ground water varies considerably, depending on the composition, location, and depth of the alluvium. Some alluvium has evaporite deposits, and some has volcanic rocks, which produce high levels of sulfate. The median concentration of total dissolved solids in four of the five basins is typically less than 500 parts per million (milligrams per liter), so the ground water generally is of good quality for almost all uses in this area. In water from the Safford basin, in the northern part of this area, the median concentration of total dissolved solids exceeds 1,000 parts per million and the sulfate levels exceed the national drinking water standard of 250 parts per million (milligrams per liter).

Soils

The dominant soil orders in this MLRA are Aridisols, Entisols, Alfisols, and Mollisols. The soils in the area dominantly have a thermic soil temperature regime, an aridic or ustic soil moisture regime, and mixed mineralogy and formed in alluvium. They are very shallow to very deep and are well drained and somewhat excessively drained. Ustic Torrifluvents (Ubik and Keysto series) formed on flood plains. Calcids (Blakeney series) formed on terraces. Argids (Eloma and Forrest series) and Aridic Haplustalfs (Gardencan and Crowbar series) formed on fan terraces. Shallow and very shallow Haplustolls (Far and Yarbam series) formed on hills and mountains.

Biological Resources

This area supports forest, savanna, and desert shrub vegetation. Pine-oak woodlands are at the higher elevations, where ponderosa pine, Douglas-fir, live oak, New Mexico locust, Mexican pinyon, buckbrush, and manzanita grow along with an understory of muhlys, bluegrasses, sedges, pine dropseed, and squirreltail. Evergreen woodland savannas are at intermediate elevations, where Mexican blue oak, Emory oak, and turbinella oak are the dominant species and cone beardgrass, sideoats grama, blue grama, Texas bluestem, plains lovegrass, sprucetop grama, threeawns, and needlegrass characterize the understory. Whitethorn, soaptree yucca, fourwing saltbush, mesquite, and ocotillo grow on the drier soils at the lower elevations. The understory on these sites consists of Rothrock grama, black grama, alkali sacaton, curly mesquite, plains bristlegrass, bush muhly, and lemongrass.

Some of the major wildlife species in this area are mule deer, white-tailed deer, mountain lion, coyote, bobcat, raccoon, skunk, white-throated woodrat, white-footed mouse, gopher snake, king snake, western diamondback rattlesnake, prairie rattlesnake, coachwhip, patch-nosed snake, western whiptail lizard, side-blotched lizard, tree lizard, canyon tree frog, red-tailed hawk, Cooper's hawk, golden eagle, prairie falcon, raven, turkey vulture, meadowlark, ladder-back woodpecker, ash-throated flycatcher, canyon wren, and rough-winged swallow.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 2%
Grassland—private, 59%; Federal, 34%
Urban development—private, 2%
Other—private, 1%; Federal, 2%

About one-third of this area is federally owned. Most of the area is used for livestock grazing. Some areas are used for cotton, corn, alfalfa, small grains, or other farm crops. Many tracts of rangeland and cropland are subdivided for community development.

The major soil resource concerns are maintenance of the content of organic matter and productivity of the soils and the hazard of water erosion. Other resource concerns on cultivated land include declining water tables and a short supply of irrigation water.

Conservation practices on cropland generally include irrigation water management, solid-set sprinklers, micro irrigation with subsoil drip irrigation and micro sprinklers, uniform slope leveling, irrigation pipelines, crop rotation, pasture and hayland management, minimum tillage, and crop residue management.

The important conservation practices on rangeland generally include those that help to control the distribution and intensity of grazing. They also include fencing, development of watering facilities, and range management. Invasion of brushy species and local gully erosion are symptoms of overgrazing. ■

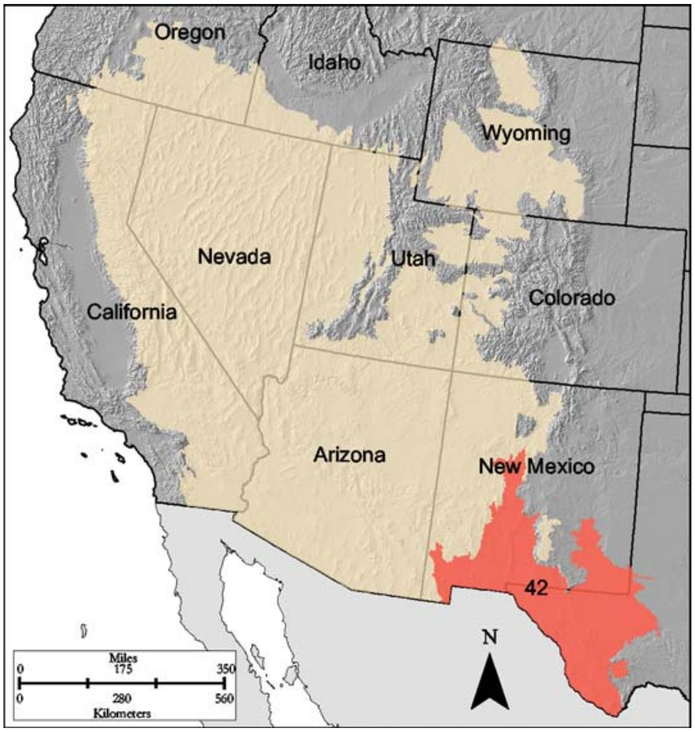

Figure 42-1: Location of MLRA 42 in Land Resource Region D.

42—Southern Desertic Basins, Plains, and Mountains

This area (shown in fig. 42-1) is in Texas (51 percent) and New Mexico (49 percent). It makes up about 55,970 square miles (145,040 square kilometers). Albuquerque, Deming, Las Cruces, Roswell, Artesia, and Carlsbad, New Mexico, and El Paso, Pecos, Alpine, and Fort Stockton, Texas, are in this MLRA. Interstates 10, 20, and 25 connect these towns. A small part of the Cibola National Forest is in this MLRA. The Big Bend National Park, in Texas, is in the southeastern tip of this area. The Fort Bliss Military Reservation is northeast of El Paso, Texas, and extends into New Mexico. Holloman Air Force Base is in this MLRA, and the White Sands Missile Range and National Monument is in the part of the MLRA in south-central New Mexico. The Sandia, Laguna, Canoncito, and Isleta Indian Reservations are near Albuquerque.

Physiography

Approximately three-fourths of this MLRA is in the Mexican Highland Section of the Basin and Range Province of the Intermontane Plateaus. A small area between the western two-thirds and eastern one-third of the MLRA is in the Sacramento Section of the same province and division. The northeastern and eastern parts of the MLRA are in three different sections of the Great Plains Province of the Interior Plains. From north to south, these are the Pecos Valley, High Plains, and Edwards Plateau Sections. The Pecos Valley Section makes up most of this part of the MLRA. This MLRA is distinguished by intermontane desert basins and broad valleys bordered by gently sloping to strongly sloping bajadas, alluvial fans, and terraces. Steep mountain ranges trending north to south occur in the western part of the area. Elevation ranges from 2,600 to 4,950 feet (795 to 1,510 meters) in areas on the plains and basins to more than 8,500 feet (2,590 meters) in the mountains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Pecos (1307), 26 percent; Rio Grande Closed Basins (1305), 21 percent; Rio Grande-Amistad (1304), 18 percent; Rio Grande-Mimbres (1303), 15 percent; Upper Pecos (1306), 9 percent; Rio Grande-Elephant Butte (1302), 9 percent; and Upper Gila (1504), 2 percent. The Rio Grande is the largest river in this area. It flows southeast from New Mexico and eventually forms the international boundary between Mexico and the United States. Elephant Butte and Caballo Reservoirs are on the part of the Rio Grande in New Mexico. The Pecos River flows through the southeastern portion of New Mexico and continues into Texas. Red Bluff Reservoir, on the Pecos River, is the point of lowest elevation in New Mexico.

Geology

The linear, isolated mountain ranges in this area are primarily tilted fault blocks modified by erosion. Mesozoic and Paleozoic sediments overlying granitic intrusions of Precambrian age are exposed in these tilted blocks. Tertiary volcanic and intrusive igneous rocks occupy about 2.5 million acres in the Texas Big Bend region. Quaternary and Tertiary continental sediments accumulated to form the aggraded desert plains lying between the mountain ranges. Some intermontane basins are bolsons (internally drained desert basins), although most are semi-bolsons (which are externally drained). Alluvial fan deposits are common at the bases of most mountains. Quaternary and Tertiary volcanic rocks consisting of basalt, andesite, and rhyolite also are in this area.

The Rio Grande flows through a series of interconnected grabens (down-dropped fault blocks that form a rift valley) called the Rio Grand Rift. The Rio Grand Rift is an area of extension and collapse within the North American continental plate. Sediments deposited by the Rio Grande include sands, gravel, and cobbles. Basalt flows and volcanic vents flanking the river system are indicators of volcanic activity associated with the formation of the rift valley.

Climate

The average annual precipitation is 8 to 14 inches (205 to 355 millimeters) in the eastern and southern parts of this area and 12 to 18 inches (305 to 455 millimeters) in the northern and western parts. It is as much as 24 inches (610 millimeters) in a few scattered mountains. Most of the rainfall occurs as high-intensity, convective thunderstorms from midspring to midautumn. This area does not receive significant amounts of winter precipitation. The average annual temperature is 50 to 71 degrees F (10 to 22 degrees C), decreasing to the north and in the higher elevations. The freeze-free period averages 230 days and ranges from 165 to 300 days, decreasing in length with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 2.1%; ground water, 9.0%
Livestock—surface water, 0.7%; ground water, 0.8%
Irrigation—surface water, 52.2%; ground water, 28.9%
Other—surface water, 1.4%; ground water, 4.9%

The total withdrawals average 1,955 million gallons per day (7,400 million liters per day). About 44 percent is from ground water sources, and 56 percent is from surface water sources. Scarce surface water and low precipitation are severe limitations on the rangeland in this MLRA. The Rio Grande and Pecos Rivers and a few of their larger tributaries are the only perennial streams. Reservoirs control flooding and allow timely delivery of irrigation water. Most of the surface water is used for irrigation. The Rio Grande has water that is suitable for most uses, but high salinity restricts use of water from the Pecos River. Suspended sediment loads, urban and industrial waste discharges, and saline irrigation return flows cause most of the water-quality problems in this area.

Ground water in deep valley and basin fill provides water for public supply, domestic use, livestock, and some irrigation. Unconsolidated sand and gravel sediments in basin fill are the primary aquifers in this area. Basin fill sediments in the southeast corner of New Mexico are actually part of the High Plains (Ogallala) aquifer. In Texas, water from the basin fill aquifer is typically hard or very hard and has a median concentration of about 770 parts per million (milligrams per liter) total dissolved solids. In New Mexico, this ground water has 400 to 700 parts per million total dissolved solids. The water tends to increase in salinity farther downstream because of recharge from irrigation return flows. About 40 percent of the samples tested from this aquifer in Texas contained levels of nitrate exceeding the national drinking water standard of 10 parts per million. Most of the samples tested in New Mexico showed nitrate levels of less than 4 parts per million.

The quality of the ground water in alluvium aquifers in the Rio Grande Valley is similar to the water quality in the basin fill deposits. Water in the Pecos River Valley alluvium is unsuitable for most uses because it is saline. Dissolution of evaporite deposits in the aquifer and in the adjacent Pecos River Valley Limestone aquifer are the primary sources of the salinity. Water from deeper halite (sodium chloride) deposits also seeps into the valley fill and contributes to the salinity problem.

Limestone in the Edwards-Trinity aquifer on the Edwards Plateau occurs in a small part of the southeast corner of this area, in Texas. It has water that is very similar in quality to the water in the Rio Grande alluvium and basin fill deposits. The ground water from the Edwards-Trinity aquifer, however, typically has higher levels of total dissolved solids than the Rio Grande Valley ground water and is used very little in this MLRA.

Soils

The dominant soil orders in this MLRA are Aridisols, Entisols, Mollisols, and Vertisols. The soils generally are moderately deep to very deep, well drained, and loamy or clayey. Some of the soils are shallow or very shallow over a petrocalcic horizon or bedrock. Most have a thermic soil temperature regime, an aridic soil moisture regime, and carbonatic or mixed mineralogy. Sizable tracts on the Trans-Pecos Texas Mixed Prairie have an ustic moisture regime. Soils on the highest mountain peaks have a mesic temperature regime, whereas soils along the Rio Grande in the Big Bend region are hyperthermic.

Calciargids (Berino and Stellar series) formed in alluvium on fan piedmonts, piedmonts, fan terraces, and stream terraces and in basins. Haplocalcids formed in limestone residuum on hills, mesas, and divides (Bissett, Santaelena, and Dozer series); in alluvium on fans, fan remnants, plains, and valley floors (Corazones, Chamberino, Stovall, and Stillwell series); and in eolian deposits on uplands (Wink series). Haplocambids (Pajarito series) formed in alluvium on plains, bajadas, and alluvial fans. Haplargids (Pyote series) formed in loamy eolian deposits or alluvium on uplands. Petrocalcids formed in gravelly alluvium on fan piedmonts, terraces, and ridges (Delnorte, Paisano, and Tencee series) and in loamy sediments on plains, mesas, and fans (Simona and Upton series). Torripsamments (Aguena, Copia, and Yturbide series) formed in eolian deposits on dunes and sand sheets. Haplustolls (Brewster series) and Argiustolls (Mainstay series) formed in colluvium underlain by igneous rock on hills and mountains. Haplotorrerts (Verhalen series) formed in clayey alluvium on terraces and alluvial plains.

Biological Resources

This area supports desert grass-shrub vegetation. Giant dropseed, mesa dropseed, and scattered shrubs, such as sand sagebrush and yuccas, grow on the sandier soils. Creosotebush, tarbush, and catclaw grow on gravelly, calcareous soils on footslopes. Giant sacaton, vine-mesquite, desertwillow, and brickellbush grow in drainageways and depressions. The dominant grass species include blue grama, black grama, and sideoats grama on prairie grasslands and mountain footslopes. Juniper, pinyon, and scattered ponderosa pine are on the upper mountain slopes.

Some of the major wildlife species in this area are mule deer, white-tailed deer, antelope, javelina, mountain lion, coyote, desert fox, gray fox, bobcat, badger, scaled quail, and mourning dove. The species of fish in the area include black bass, channel catfish, and sunfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 3%
Grassland—private, 64%; Federal, 26%
Forest—Federal, 1%
Urban development—private, 2%
Other—private, 1%; Federal, 3%

Federal land makes up nearly one-third of this area, primarily in New Mexico. The rest of the land is mainly in farms, ranches, or other private holdings. Two-thirds or more of the area is rangeland of low carrying capacity. Less than 1 percent of the cropland is irrigated. Cotton, cantaloupe, and vegetables are the principal crops. Grain sorghum, alfalfa, and other feed and forage crops also are grown.

The major soil resource concerns are wind erosion, water erosion, salinization of irrigated cropland, species diversity, and undesirable invasive species on rangeland. In this arid or semiarid MLRA, potential evaporation is often 10 times greater than precipitation. The soils dominantly have a coarse textured surface layer and a low content of organic matter, resulting in little resistance to erosive forces. The vegetative cover on rangeland is typically sparse, providing tenuous protection against wind erosion and water erosion.

Conservation practices on rangeland generally include fencing and development of watering facilities, which facilitate grazing management systems; brush management, which removes undesirable and introduced invasive species; and erosion control, which helps to prevent gullying and concentrated waterflow.

Conservation practices on irrigated cropland include crop rotations, which improve the condition of the soils and reduce the hazard of wind erosion; pest management, which reduces the extent of weed, insect, and disease infestation; irrigation water management, which helps to ensure that application timing and amounts meet crop needs and leaching requirements; and irrigation delivery systems, which reduce evaporation, canal seepage losses during conveyance, and consumption of water by undesirable species, such as saltcedar and Russian olive. ■

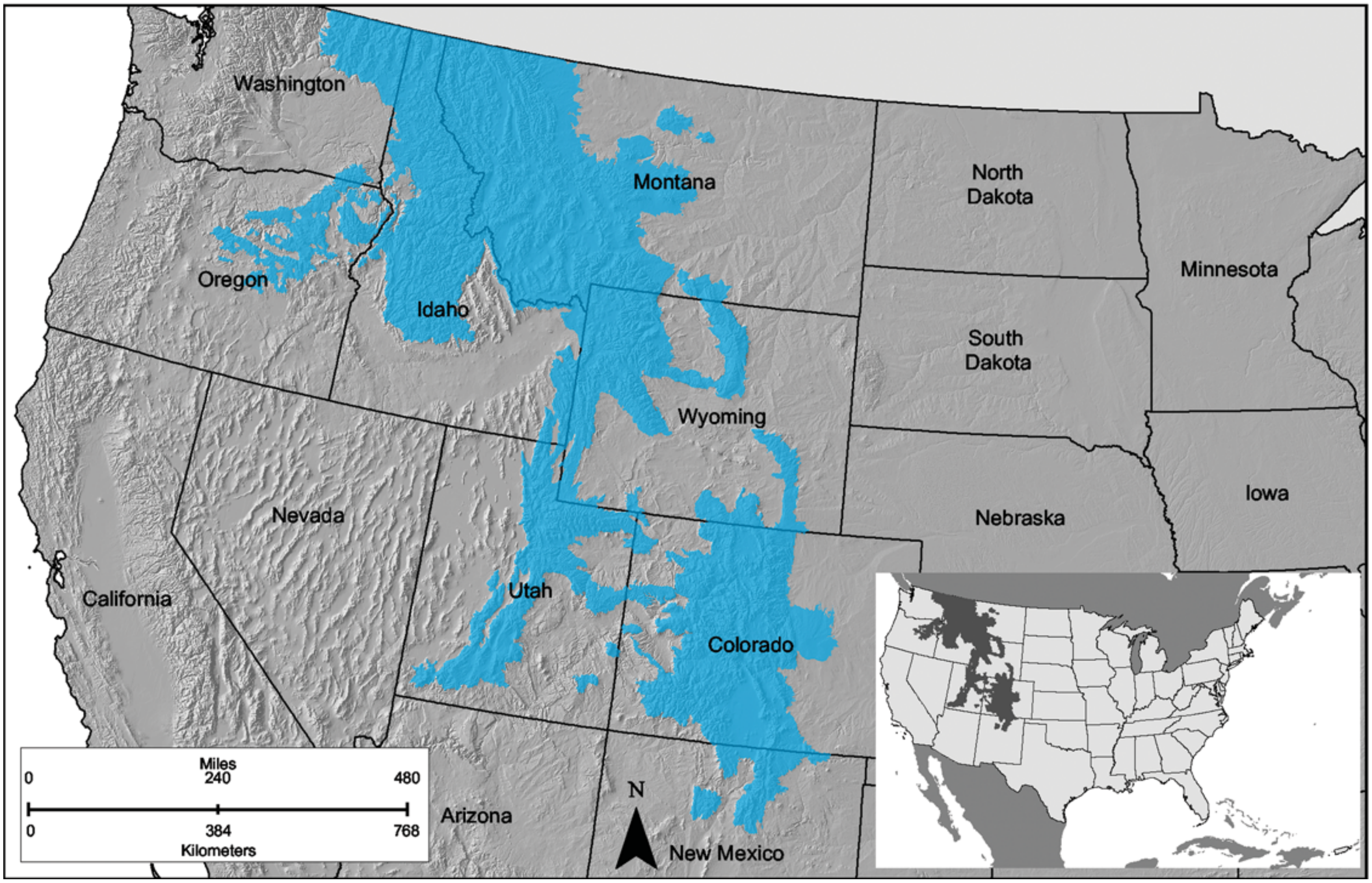

Figure E-1: Location of Land Resource Region E.

E—Rocky Mountain Range and Forest Region

This region (shown in fig. E-1) is in Montana (28 percent), Colorado (20 percent), Idaho (16 percent), Wyoming (13 percent), Utah (10 percent), Oregon (5 percent), Washington (4 percent), and New Mexico (3 percent). It makes up 236,510 square miles (612,875 square kilometers).

This region is characterized mainly by rugged mountains, but it has some broad valleys and remnants of high plateaus (fig. E-2). The average annual precipitation ranges from 9 inches (230 millimeters) in some of the valleys to 63 inches (1,600 millimeters) on some of the mountain peaks. The average annual temperature ranges from 32 to 50 degrees F (0 to 10 degrees C). The freeze-free period is 65 days or less in the high mountains, where freezing temperatures occur every month of the year. Some areas on the highest mountains are covered by glaciers. The ground is permanently frozen in these areas. The freeze-free period on the foothills in the southern part of the region is as long as 190 days.

The total withdrawals of freshwater in this region average about 11,680 million gallons per day (44,210 million liters per day). About 10 percent is from ground water sources, and 90 percent is from surface water sources. About 93 percent of the water is used for irrigation.

The soils in this region are dominantly Alfisols, Entisols, Inceptisols, and Mollisols. The dominant suborders are Ustepts, Ustolls, and Xerolls in valleys and on the lower mountain slopes and Cryalfs and Orthents on the upper mountain slopes and crests. The soils in the region dominantly have a frigid soil temperature regime, an ustic soil moisture regime, and mixed mineralogy.

About 60 percent of the land in this region is federally owned. The mountain slopes generally are forested, and the valleys are dominated by shrubs and grasses. Grazing is the leading land use in the valleys and mountains, but timber production is important on some of the forested mountain

Figure E-2: An area of Rocky Mountain National Park in Land Resource Region E.

slopes. Recreation is an important use throughout the region. Some of the valleys are irrigated, and some are dry-farmed. Grain and forage for livestock are the main crops. Beans, sugar beets, peas, and seed crops are grown in areas where soils, climate, and markets are favorable. The major soil resource concerns are water erosion; steep slopes; shallow, rocky soils; and a short growing season. ■

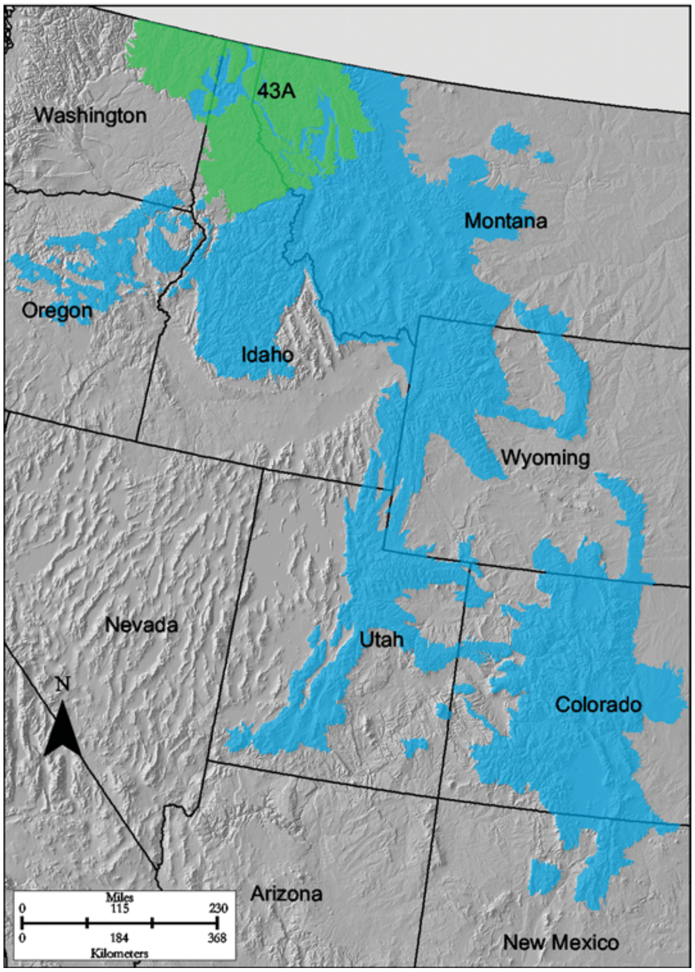

Figure 43A-1: Location of MLRA 43A in Land Resource Region E.

43A—Northern Rocky Mountains

This area (shown in fig. 43A-1) is in Montana (43 percent), Idaho (34 percent), and Washington (23 percent). It makes up about 31,435 square miles (81,460 square kilometers). It has no large cities or towns. U.S. Highway 2 crosses this area in Idaho and Montana, and U.S. Highway 395 goes to the Canadian border in the part of the area in Washington. This MLRA is made up of the Rocky Mountains. It has many national forests, including the Okanogan and Colville National Forests in Washington; the Kootenai, Lolo, and Flathead National Forests in Montana; and the Coeur d'Alene, St. Joe, Clearwater, and Lolo National Forests in Idaho. The Kaniksu National Forest is in all three States. Most of Glacier National Park is in the eastern part of the area, and the Coulee Dam National Recreation Area is in the western part. The Spokane, Colville, Coeur d'Alene, Kalispel, and Flathead Indian Reservations occur in this MLRA.

Physiography

This area is in the Northern Rocky Mountains Province of the Rocky Mountain System. It is characterized by rugged, glaciated mountains; thrust- and block-faulted mountains; and hills and valleys. Steep-gradient rivers have cut deep canyons. Natural and manmade lakes are common in the area. Franklin D. Roosevelt Lake, Flathead Lake, and Lake Koocanusa are examples of the larger lakes. Elevation is about 1,800 to 3,500 feet (550 to 1,065 meters) in the valleys. It is 5,000 to 7,000 feet (1,525 to 2,135 meters) on most mountain peaks, but it is 10,110 feet (3,082 meters) on Kintla Peak, which is in Glacier National Park, near the Canadian border.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Kootenai-Pend Oreille-Spokane (1701), 67 percent; Upper Columbia (1702), 18 percent; and Lower Snake (1706), 15 percent. Numerous rivers originate in or flow through this area, including, from west to east, the Sanpoil, Columbia, Pend Oreille, Kootenai, St. Joe, Thompson, and Flathead Rivers. The St. Joe and Middle Fork Flathead Rivers have been designated as National Wild and Scenic Rivers.

Geology

This area is underlain primarily by stacked slabs of layered sedimentary bedrock. The bedrock formations range from Precambrian to Cretaceous in age. The rocks consist of shale, sandstone, siltstone, limestone, argillite, quartzite, gneiss, schist, dolomite, basalt, and granite. The formations have been faulted and stacked into a series of imbricate slabs by regional tectonic activity. Pleistocene glaciers carved a rugged landscape that includes sculpted hills and narrow valleys filled with till and outwash.

Climate

The average annual precipitation is 25 to 60 inches (635 to 1,525 millimeters) in most of this area, but it is as much as 113 inches (2,870 millimeters) in the mountains and is 10 to 15 inches (255 to 380 millimeters) in the western part of the area. Summers are dry. Most of the precipitation during fall, winter, and spring is snow. The average annual temperature is 32 to 51 degrees F (0 to 11 degrees C) in most of the area, decreasing with elevation. In most of the area, the freeze-free period averages 140 days and ranges from 65 to 215 days. It is longest in the low valleys of Washington, and it decreases in length with elevation. Freezing temperatures occur every month of the year on high mountains, and some peaks have a continuous cover of snow and ice.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.3%; ground water, 0.4%
Livestock—surface water, 0.5%; ground water, 3.0%
Irrigation—surface water, 91.2%; ground water, 0.3%
Other—surface water, 2.5%; ground water, 1.8%

The total withdrawals average 355 million gallons per day (1,345 million liters per day). About 5 percent is from ground water sources, and 95 percent is from surface water sources. Moderate precipitation and many perennial streams and lakes provide ample surface water. About 90 percent of the water used within this area is diverted from streams to irrigate high mountain hay meadows. The remaining 10 percent is used mainly by the mining and timber industries. The surface water is of good quality. This area supplies water to the adjoining MLRAs for irrigation and other uses. Springs in the valleys provide some water for domestic use and for livestock.

Shallow wells in the alluvium and glacial outwash in intermountain valleys and in some fractured zones in the bedrock provide water for domestic use and for livestock. Elsewhere, the supplies of ground water are small and mostly untapped.

Soils

The dominant soil orders in this MLRA are Andisols, Inceptisols, and Alfisols. Many of the soils are influenced by Mount Mazama ash deposits. The soils in the area have a frigid or cryic soil temperature regime; have an ustic, xeric, or udic soil moisture regime; and dominantly have mixed mineralogy. They are shallow to very deep, are very poorly drained to well drained, and have most of the soil texture classes. The soils at the lower elevations include Udivitrands (Threebear series), Vitrixerands (Bonner series), and Haplustalfs (Crow series). The soils at the higher elevations include Dystrocryepts (Hun series), Eutrocryepts (Holloway series), Vitricryands (Manley series), and Haplocryalfs (Meadowport series). Cryorthents, Cryepts, and areas of rock outcrop are on ridges and peaks above timberline.

Biological Resources

This area is in the northern part of the Northern Rocky Mountains. Grand fir, Douglas-fir, western red cedar, western hemlock, western larch, lodgepole pine, subalpine fir, ponderosa pine, whitebark pine, and western white pine are the dominant overstory species, depending on precipitation, temperature, elevation, and landform aspect. The understory vegetation varies, also depending on climatic and landform factors.

Some of the major wildlife species in this area are white-tailed deer, mule deer, elk, moose, black bear, grizzly bear, coyote, fox, and grouse. Fish, mostly in the trout and salmon families, are abundant in streams, rivers, and lakes.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 3%
Grassland—private, 5%; Federal, 8%
Forest—private, 33%; Federal, 47%
Urban development—private, 1%
Water—private, 1%; Federal, 1%
Other—private, 1%

More than one-half of this area is federally owned and administered by the U.S. Department of Agriculture, Forest Service. Much of the privately owned land is controlled by large commercial timber companies. The forested areas are used for wildlife habitat, recreation, watershed, livestock grazing, and timber production. Meadows provide summer grazing for livestock and big game animals. Less than 3 percent of the area is cropland.

The major soil resource concerns are water erosion, the productivity of the soils, and surface compaction. Water resource concerns include degradation of water quality. Plant resource concerns are plant productivity, health, and vigor; noxious and invasive plants; and the hazard of wildfires. Animal resource concerns are inadequate food, cover, and shelter.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control compaction, the erosion caused by concentrated flow, and sediment delivery to streams. ■

43B—Central Rocky Mountains

This area (shown in fig. 43B-1) is in Montana (38 percent), Idaho (32 percent), and Wyoming (30 percent). Also, it is in a small area in Utah (82 square miles, or 213 square kilometers). It makes up about 75,915 square miles (196,715 square kilometers). The towns of Butte, Anaconda, and Deer Lodge, Montana, Ketchum, Idaho, and Jackson and Thermopolis, Wyoming, occur in this MLRA. Interstates 90 and 15 cross this area in Montana. This MLRA is made up of the Rocky Mountains. It has numerous national forests, including the Clearwater, Nez Perce, Bitterroot, Salmon, Challis, Payette, Boise, Targhee, and Sawtooth National Forests in Idaho; the

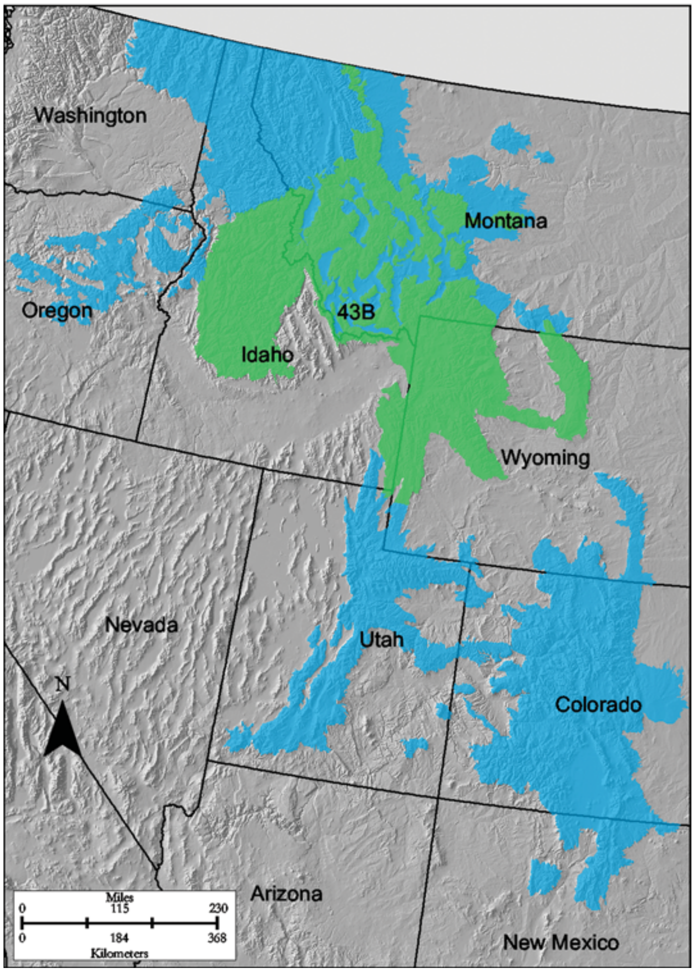

Figure 43B-1: Location of MLRA 43B in Land Resource Region E.

Lolo, Deerlodge, Beaverhead, Flathead, Helena, Bitterroot, and Gallatin National Forests in Montana; and the Bighorn, Shoshone, Bridger, and Teton National Forests in Wyoming. Many wilderness areas are in these national forests. Three of the largest are the Selway-Bitterroot, Frank Church River of No Return, and Sawtooth Wilderness Areas in Idaho. Part of the Wind River Indian Reservation is in the part of this MLRA in Wyoming. The Fossil Buttes National Monument and Yellowstone and Teton National Parks are in this MLRA.

Physiography

Most of this area is in the Northern Rocky Mountains Province of the Rocky Mountain System. Most of the southeastern part in Wyoming is in the Middle Rocky Mountains Province of the same division. This MLRA is characterized by rugged, glaciated mountains, thrust- and block-faulted mountains, hills, plateaus, and valleys. Steep-gradient rivers have cut deep canyons. Lakes are common, especially in glaciated areas. Most mountain peaks reach an elevation of 6,000 to 8,000 feet (1,830 to 2,440 meters), but peaks exceeding 10,000 feet (3,050 meters) are not uncommon. The highest points in Montana and Wyoming are in this MLRA. These are Granite Peak, which reaches an elevation of 12,799 feet (3,902 meters), and Gannett Peak, which reaches an elevation of 13,804 feet (4,208 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Snake (1706), 19 percent; Upper Snake (1704), 13 percent; Missouri Headwaters (1002), 13 percent; Bighorn (1008), 12 percent; Kootenai-Pend Oreille-Spokane (1701), 10 percent; Upper Yellowstone (1007), 9 percent; Missouri-Marias (1003), 8 percent; Middle Snake (1705), 6 percent; Great Divide-Upper Green (1404), 3 percent; Powder-Tongue (1009), 3 percent; Missouri-Musselshell (1004), 2 percent; Bear (1601), 1 percent; and Saskatchewan (1001), 1 percent. The Continental Divide runs through this area. The headwaters of the Columbia and Missouri Rivers are in this MLRA. Rivers draining the western slope of the Continental Divide in this area drain into the Pacific Ocean, and rivers on the eastern side drain into the Gulf of Mexico.

Geology

A variety of rock types from many different geologic eras are exposed in the Rocky Mountains. The rock types include igneous, metamorphic, limestone, and sandstone in the Belt Mountains of Montana; granite in Idaho; and quartzite and argillite in the Beaverhead Mountains and sedimentary rocks in the Big Horn Mountains of Wyoming. Glacial till and outwash are in most mountain valleys. Recent alluvium commonly covers the glacial deposits on the valley floors.

Climate

The average annual precipitation is 25 to 60 inches (635 to 1,525 millimeters) in most of this area, but it is as much as 121 inches (3,075 millimeters) at the higher elevations west of the Continental Divide and is 9 to 25 inches (230 to 635 millimeters) in the valleys and lower elevations at the edges of the area. Summers are typically dry, except for brief but intense convective thunderstorms that occur during most afternoons in the mountains. Most of the precipitation during fall, winter, and spring is snow. The average annual temperature is 24 to 49 degrees F (-4 to 9 degrees C). It is less than 38 degrees F (3 degrees C) in most of the area. The freeze-free period averages 105 days and ranges from 10 to 200 days. It is longest in the lower valleys and shortest in the mountains. Freezing temperatures occur every month of the year in the mountains, and some peaks have a continuous cover of snow and ice.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 1.0%; ground water, 0.7%
Livestock—surface water, 0.3%; ground water, 1.4%
Irrigation—surface water, 78.0%; ground water, 12.8%
Other—surface water, 3.7%; ground water, 2.1%

The total withdrawals average 1,415 million gallons per day (5,355 million liters per day). About 17 percent is from ground water sources, and 83 percent is from surface water sources. Moderate precipitation and many perennial streams and lakes provide ample surface water. About 75 percent of the water used within this area is diverted from streams and used to irrigate hay meadows. Some of the water is used by the mining and logging industries or for public supplies in tourist centers. The surface water is of good quality. This area supplies water to the adjoining MLRAs for irrigation and other uses. Springs in the valleys provide some water for domestic use and for livestock.

Shallow wells in the alluvium and glacial outwash on valley floors provide water for domestic use, livestock, and some irrigation. Elsewhere, the supplies of ground water are small and mostly untapped.

Soils

The dominant soil orders in this area are Inceptisols, Alfisols, and Mollisols. The soils in the area dominantly have a frigid or cryic soil temperature regime and an ustic, udic, or xeric soil moisture regime. Soils on mountain side slopes and ridges formed in colluvium, residuum, and glacial till and have mixed mineralogy. The dominant suborders are Cryepts (Jughandle and Garlet series), Ustepts (Kadygulch and Winkler series), Ustalfs (Yreka and Mocmont series), Cryalfs (Worock and Sapphire series), Cryolls (Starley and Povey series), and Xerepts (Packerjohn series). Areas of rock outcrop and rubble land are on ridges and peaks above timberline. Most of the soils are skeletal and are medium textured to coarse textured.

Biological Resources

This area supports coniferous forests. Forests of ponderosa pine, lodgepole pine, Douglas-fir, subalpine fir, and spruce are common. Alpine grasses, forbs, and shrubs and scattered stands of subalpine fir, spruce, and whitebark pine occur at high elevations.

Some of the major wildlife species in this area include elk, mule deer, white-tailed deer, moose, grizzly bear, black bear, mountain lion, bobcat, lynx, bighorn sheep, mountain goat, coyote, gray wolf, mountain grouse, and numerous songbirds.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 1%
Grassland—private, 14%; Federal, 51%
Forest—private, 6%; Federal, 25%
Water—private, 1%; Federal, 1%
Other—private, 1%

More than three-fourths of this area is federally owned and administered by the U.S. Department of Agriculture, Forest Service. Large commercial timber companies own most of the private land in the area. All of the forested areas are used for wildlife habitat, recreation, watershed, and timber production. Meadows on the upper mountain slopes and crests above timberline provide summer grazing for livestock and big game animals. Less than 1 percent of the MLRA is cropland.

The major soil resource concerns are water erosion, the productivity of the soils, and surface compaction. Water resource concerns include degradation of water quality. Plant resource concerns are plant productivity, health, and vigor; noxious and invasive plants; and the hazard of wildfires. Animal resource concerns are inadequate food, cover, and shelter.

Conservation practices on forestland generally include forest stand improvement, erosion control, and firebreaks. Control of noxious and invasive plants is needed. ■

43C—Blue and Seven Devils Mountains

This area (shown in fig. 43C-1) is in Oregon (84 percent), Idaho (11 percent), and Washington (5 percent). It makes up about 14,000 square miles (36,275 square kilometers). It has no large cities or towns. Interstate 84 crosses the area from the southeast corner in Idaho to the northern part of the area in Oregon. U.S. Highway 395 crosses the western part of the area. National forests are in most of this area, especially in Oregon. Some of these forests include the Umatilla, Wallowa-Whitman, Malheur, and Ochoco National Forests in Oregon and parts of the Payette and Nez Perce National Forests in Idaho. The forests have numerous national wilderness areas. The Hells Canyon National Recreation Area, along the Snake River, is in the eastern part of this area.

Physiography

Most of this area is in the Blue Mountain Section of the Columbia Plateaus Province of the Intermontane Plateaus. The western end in Oregon and the northern end in Washington and Idaho are in the Walla Walla Plateau Section of the same province and division. The southernmost part in Oregon

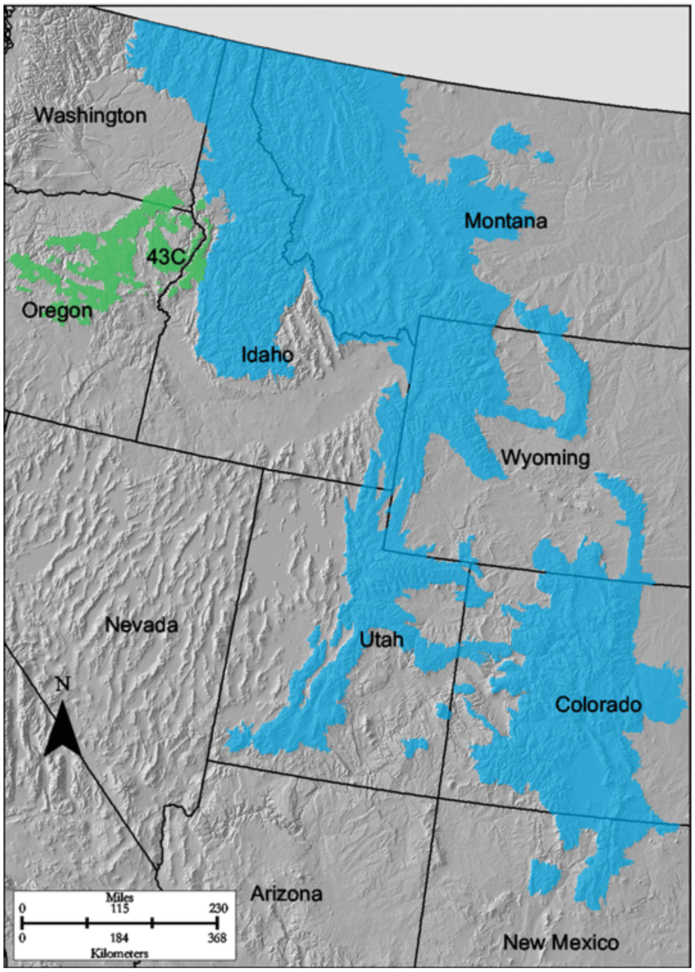

Figure 43C-1: Location of MLRA 43C in Land Resource Region E.

extends into the Harney Section and the southern part in Idaho extends into the Payette Section of the same province and division. The middle part of the area in Idaho is in the Northern Rocky Mountains Province of the Rocky Mountain System. The Snake River and the Central Rocky and Blue Mountain Foothills separate the Idaho and Oregon parts of this MLRA.

Thrust- and block-faulted mountains and deep canyons characterize this area. The central and eastern parts of the area have the steepest mountain slopes, whereas the western and northern parts have more gently rolling mountains. The highest peaks have been sculpted by alpine glaciation, leaving steep slopes and sharp crests. Most of the area is cut by narrow valleys with steep gradients. Some of the larger rivers draining the mountains have wide valley floors. Lakes are common, especially in glaciated areas. Elevation is mainly 1,300 to 7,900 feet (395 to 2,410 meters) but is more than 9,800 feet (2,990 meters) at the top of Mount Sacajawea and the Matterhorn.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Middle Columbia (1707), 40 percent; Lower Snake (1706), 34 percent; Middle Snake (1705), 18 percent; and Oregon Closed Basins (1712), 8 percent. The headwaters for the John Day, Grande Ronde, and Umatilla Rivers are in this area. The Salmon River crosses the part of this area in Idaho just upstream from its confluence with the Snake River. The Minam and Rapid Rivers, in the eastern part of the area, have been designated as National Wild and Scenic Rivers.

Geology

This area consists of a complex collection of bedrock types that have been faulted and uplifted. These bedrock types include sedimentary, metasedimentary, and volcanic rocks. They range from Mesozoic limestones to Cenozoic volcanics. The rocks consist of limestone, serpentine, greenstone (metamorphic lava), schist, granite, andesite, and basalt. The Wallowa and Seven Devils Mountains are made up dominantly of greenstone (metamorphosed lavas) with some peaks and ridges of limestone. The Wallowa Mountains and the northern end of the Elkhorn Mountains have a core of granite. The Strawberry Mountains are dominantly andesite. The northern one-third of the Blue Mountains has Columbia River Basalt. The lower elevations include Columbia River Basalt and the Clarno and John Day Formations. Pleistocene glaciation has sculpted the higher peaks and filled many of the valleys with glacial till and outwash.

Climate

The average annual precipitation in most of this area is 12 to 43 inches (305 to 1,090 millimeters), but it can be as much as 82 inches (2,085 millimeters) in the mountains. Summers are dry, except for occasional high-intensity, convective thunderstorms, especially at the higher elevations. Most of the precipitation, in the form of snow, occurs during the fall, winter, and spring. The average annual temperature generally is 34 to 45 degrees F (1 to 7 degrees C), decreasing with elevation. It can be as high as 52 degrees F (11 degrees C) in some of the deeper canyons. The freeze-free period averages 140 days and ranges from 55 to 225 days. The shortest freeze-free periods occur in the mountains, and the longest occur in some of the deeper canyons. Freezing temperatures occur every month of the year in the mountains, and some of the highest peaks have a continuous cover of snow and ice.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 0.5%; ground water, 0.5%
Irrigation—surface water, 81.0%; ground water, 7.1%
Other—surface water, 10.1%; ground water, 0.7%

The total withdrawals average 495 million gallons per day (1,875 million liters per day). About 8 percent is from ground water sources, and 92 percent is from surface water sources. Moderate precipitation and many perennial streams and lakes provide ample surface water. Streams and reservoirs supply water to the adjoining MLRAs for irrigation and other uses. Springs in the valleys provide water for domestic use and for livestock. The surface water is of very good quality. Adequate waterflow and water quality are needed year-round for the local fish populations and for anadromous fish migration and spawning.

Ground water occurs in two aquifers in this MLRA. One is in the basin fill and alluvial aquifer occurring in most stream and river valleys throughout the area. Water from this aquifer has a median level of total dissolved solids of 170 parts per million (milligrams per liter) and is moderately hard. It is generally of very good quality and is used for domestic supply, livestock, and some irrigation. The second aquifer is the basalt flows from the Columbia River and Idaho Batholiths. Interbedded layers of sediments and pyroclastics between the basalt flows and joints, bedding planes, and rubble zones within the basalt itself contain water. The ground water in the basalt has a median level of total dissolved solids of 230 parts per million (milligrams per liter) and is moderately hard. It is generally of very good quality and is used for domestic supply, livestock, and irrigation. The supplies of ground water are minimal and mostly untapped in the steep mountains.

Soils

The dominant soil orders in this MLRA include Mollisols and Andisols. The soils in the area have a mesic soil temperature regime at the lower elevations and a frigid or cryic soil temperature regime at the higher elevations. They have a xeric or udic soil moisture regime. Most of the soils have a component of volcanic ash from Mount Mazama, which is the present-day Crater Lake, in south-central Oregon. The soils are shallow to very deep, are very poorly drained to well drained, and have most of the soil texture classes.

The soils at the lower elevations in the drier parts of the area are typically Argixerolls, Palexerolls, and Haploxerolls with smectitic mineralogy and are either fine textured (Hankins series) or clayey-skeletal (Yawkey series). The soils at the slightly higher elevations or in the more protected areas retain the influence of volcanic ash and are Vitrandic Haploxerolls (Egyptcreek series) or Vitrandic Argixerolls (Klickson series). The volcanic plateaus in the northeastern part of the area have Argialbolls (Cowsly series). The soils in the meadows and on bottom lands are Fluvaquentic Haploxerolls (Damore series) and Cumulic Cryaquolls (Silvies series). Cryorthents, Cryepts, and areas of rock outcrop are on ridges and peaks above timberline.

Biological Resources

This area has a highly diverse biological population. The distribution of vegetation is related to climate, especially the effective precipitation and aspect. At the lower elevations, which are the driest and warmest, the south aspects are typified by an overstory of western juniper and a sagebrush-bunchgrass plant community in the understory. The north and east aspects at these lower elevations support ponderosa pine with an understory of either bunchgrasses or pinegrass. At the slightly higher elevations, there is an increase in precipitation and the vegetation is dominated by an overstory of Douglas-fir with an understory of either snowberry or ninebark. At the high elevations, subalpine fir, Engelmann spruce, and whitebark pine are evident. Lodgepole pine and western larch are seral species, especially in the areas where grand fir is the potential overstory species. The understory in the cooler, more moist areas is typically Clintonia and big huckleberry. Grasses, forbs, and sedges dominate the high alpine meadows.

Some of the major wildlife species in this area are elk, mule deer, black bear, mountain lion, bobcat, bighorn sheep, mountain goat, coyote, grouse, and songbirds. Streams provide habitat for several species of trout. Some of the major streams provide valuable spawning grounds for salmon and steelhead.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 1%
Grassland—private, 13%; Federal, 4%
Forest—private, 20%; Federal, 57%
Water—Federal, 1%
Other—Federal, 4%

This area is used primarily for timber production, livestock grazing, wildlife habitat, recreation, and watershed. Only a very small area in the valleys is cropland, most of which is irrigated. A large percentage of the area is federally owned and administered by the U.S. Department of Agriculture, Forest Service.

The major soil resource concerns are erosion, surface compaction, and sedimentation of streams. The quality of surface water resources also is a major concern.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control surface compaction, the erosion caused by concentrated flow, and sediment delivery to streams. Prescribed grazing is an important conservation practice in areas that are used for livestock grazing.

Conservation systems on cropland are used to control erosion and preserve water quality. They generally include such practices as cover crops, conservation crop rotation, crop residue management, waste utilization, nutrient management, pest management, filter strips, grassed waterways, and irrigation water management.

Conservation practices on pasture and hayland generally include prescribed grazing, forage harvest management, nutrient management, waste utilization, and filter strips. These practices protect water quality and aquatic habitat for fish and wildlife by reducing the movement of nutrients and pesticides to surface water and ground water. ■

44—Northern Rocky Mountain Valleys

This area (shown in fig. 44-1) is in Montana (79 percent), Idaho (13 percent), and Washington (8 percent). It makes up about 12,830 square miles (33,245 square kilometers). The cities of Spokane, Washington, Coeur d'Alene, Idaho, and Kalispell, Missoula, Bozeman, and Helena, Montana, are in this MLRA. Interstate 90 connects Spokane and Bozeman, and Interstate 15 runs north and south through the eastern part of the MLRA. Although most of the valley floors are privately owned, the valley borders commonly are part of numerous national forests, including the Kaniksu and Colville National Forests in Washington and Idaho and the Kootenai, Lolo, and Beaverhead National Forests in Montana.

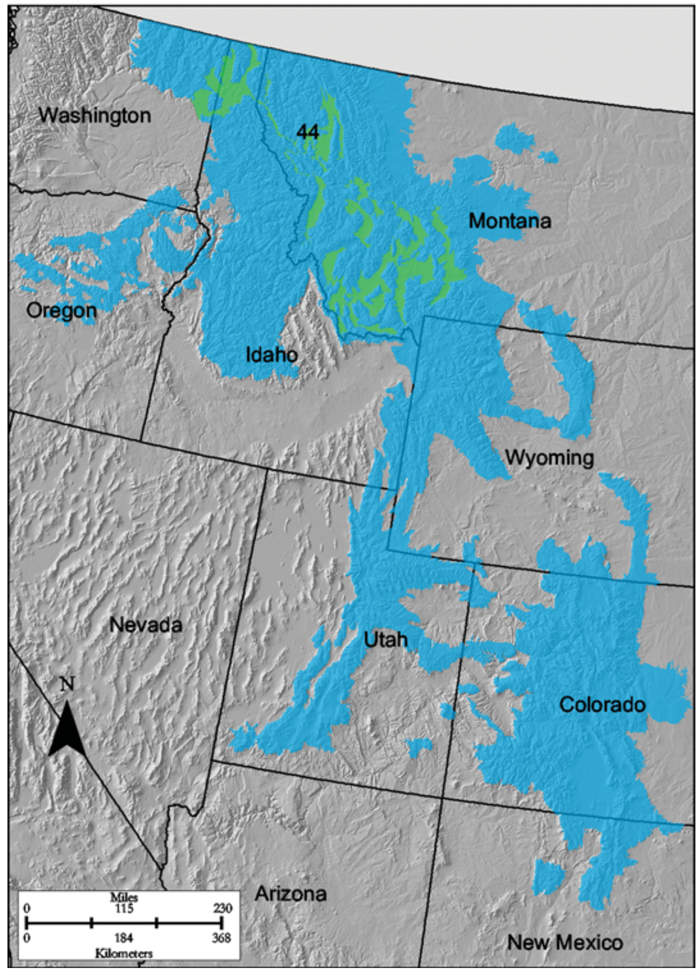

Figure 44-1: Location of MLRA 44 in Land Resource Region E.

Physiography

This area is in the Northern Rocky Mountains Province of the Rocky Mountain System. It is an area of deeply dissected mountain valleys. The deep valleys are typically bordered by mountains trending north to south. In the valleys, nearly level, broad flood plains are bordered by gently sloping to strongly sloping terraces and alluvial fans. In many areas, the valleys have been modified somewhat by glaciation. In the northern part of the area, glacial debris dams created lakes in the valleys for a period of time in the past. In these areas, lacustrine sediments cover much of the valley floors. Elevation ranges from 1,750 feet (535 meters) to as much as 6,900 feet (2,105 meters). The highest valleys are in the part of this MLRA in southwestern Montana.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Kootenai-Pend Oreille-Spokane (1701), 49 percent; Missouri Headwaters (1002), 35 percent; Missouri-Marias (1003); 9 percent; and Upper Yellowstone (1007), 7 percent. Numerous rivers run through the different mountain valleys in this MLRA. The Spokane River connects Spokane, Washington, and Coeur d'Alene, Idaho. The Kootenai, Bitterroot, Clark's Fork, and Flathead Rivers are in the larger valleys in Montana. The headwaters of the Missouri River at historic Three Forks, Montana, occur in this MLRA. The Madison, Jefferson, and Gallatin Rivers join here to form the Missouri River, the largest tributary to the Mississippi River.

Geology

The mountains bordering the valleys in this MLRA are uplifted fault blocks that have been recently glaciated. Streams eroding the mountains have created alluvial fans at the edges of the valleys and have deposited silt, sand, and gravel as alluvial valley fill throughout the area. Modern streams have reworked the valley fill deposits, creating terraces and flood plains at the lower elevations in the valleys. Glacial lake deposits occur in some of the valleys in the northwestern part of the MLRA.

Climate

The average annual precipitation is 12 to 16 inches (305 to 405 millimeters) in most of this area, but it is about 9 inches (230 millimeters) in parts of Montana and is as much as 44 inches (1,120 millimeters) in northern Idaho. Precipitation is fairly evenly distributed throughout fall, winter, and spring but is low in summer. Rainfall occurs as high-intensity, convective thunderstorms during spring and fall. Most of the precipitation in winter is snow. The average annual temperature is 33 to 49 degrees F (1 to 9 degrees C). The freeze-free period averages 120 days and ranges from 50 to 185 days in much of the area. It is 80 days or less at the highest elevations and 130 days or more at the lowest.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.8%; ground water, 0.7%
Livestock—surface water, 0.2%; ground water, 0.2%
Irrigation—surface water, 94.3%; ground water, 3.3%
Other—surface water, 0.5%; ground water, 0.2%

The total withdrawals average 4,390 million gallons per day (16,615 million liters per day). About 4 percent is from ground water sources, and 96 percent is from surface water sources. Precipitation is adequate for some dryfarming at the higher elevations and throughout the part of this MLRA in northern Idaho. Perennial streams flowing into the area from surrounding mountains are the principal water sources. The amount of water usually is adequate but depends on snow accumulation in the mountains. This water is of good quality, and its use is not limited.

Ground water of very good quality is abundant in the deeper, unconsolidated alluvial valley fill. Some of this water is used for irrigation. The median value of total dissolved solids in the water is about 250 parts per million (milligrams per liter). The calcium-bicarbonate type of water is hard or very hard. The ground water in the glacial lake deposits in the valleys in the northwestern part of the MLRA appears to be very similar in quality to the ground water in the alluvial valley fill.

The carbonate rocks in the Madison Group are considered to be an aquifer on the eastern margins of this area. The use of this bedrock aquifer is limited, however, because deep wells are required to reach the aquifer. Beneath the valley floors, the water quality in the Madison Group is marginal for most uses. The median value of total dissolved solids exceeds 1,600 parts per million (milligrams per liter), and the water has very high levels of sulfate. This calcium-sulfate type of water is very hard. Near the recharge zones in the mountains, water quality is much better.

Soils

The dominant soil orders in this MLRA are Inceptisols, Mollisols, and Andisols. The soils in the area dominantly have a frigid soil temperature regime at the lower elevations and a cryic soil temperature regime at the higher elevations, an ustic or xeric soil moisture regime, and mixed mineralogy. They generally are very deep, well drained, and loamy or loamy-skeletal. Calciustepts (Amesha, Brocko, Crago, Kalsted, Musselshell, and Scravo series) formed in mixtures of alluvium, colluvium, and eolian sediments on alluvial fans, stream terraces, plains, and hills. Haploxerolls (Bigarm series) formed in alluvium, colluvium, and till on stream terraces, alluvial fans, and hills. Argiustolls (Nuley series) formed in residuum on hills and plains. Calciustolls (Trimad series) and Argiustolls (Varney series) formed in alluvium on alluvial fans, terraces, and hills. Vitrixerands (Bonner and Eloika series) formed in glacial outwash or ablation till on stream terraces, terrace escarpments, and till plains. Haploxerepts (Avonville series) formed in glacial outwash on outwash plains and outwash terraces.

Biological Resources

This area supports conifer forests and grassland vegetation. Bluebunch wheatgrass, rough fescue, Idaho fescue, and bearded wheatgrass are the major species on the grassland in the valleys and foothills. Douglas-fir, ponderosa pine, grand fir, western red cedar, western hemlock, pinegrass, common snowberry, mallow ninebark, and white spirea are the major forest species.

Some of the major wildlife species in this area are elk, mule deer, white-tailed deer, antelope, coyote, bobcat, badger, beaver, mink, otter, muskrat, cottontail, ground squirrel, pheasant, gray partridge, sharp-tailed grouse, sage grouse, blue grouse, spruce grouse, and ruffed grouse. The species of fish in the area include rainbow, brown, and brook trout.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 17%
Grassland—private, 45%; Federal, 8%
Forest—private, 14%; Federal, 3%
Urban development—private, 6%
Water—private, 4%; Federal, 1%
Other—private, 2%

More than one-half of this area is in farms and ranches. As much as one-third of the land in some valleys is irrigated. Potatoes, sugar beets, and peas are important cash crops, but a larger acreage is used for hay, grain, or pasture for livestock feed. In areas where precipitation is adequate, dry-farmed wheat is grown. About one-half of the area is rangeland with native grasses and shrubs. Beef cattle and sheep are the principal kinds of livestock, but dairying is an important enterprise near the larger towns. Much of the part of this MLRA in northern Idaho is forested. Elsewhere, many steep and stony soils are forested.

These forests are of value to the lumber industry and also are grazed.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Because of freezing and thawing, the soils are susceptible to erosion. Water resource concerns include failure to meet plant needs because of the inefficient use of water on irrigated cropland. They also include excessive amounts of pesticides, nutrients, and organic material in surface and ground waters. Plant resource concerns are deterioration of plant condition, productivity, health, and vigor and noxious and invasive plants. Animal resource concerns are inadequate food, cover, and shelter.

The most important conservation practices on rangeland are prescribed grazing, fencing, and development of watering facilities. Establishment of food plots and rangeland improvement practices benefit wildlife. Establishment of early and late season pastures supplements forage production and keeps livestock off rangeland during critical growth periods.

Conservation practices on cropland generally include crop residue management, minimum tillage, cover crops, nutrient management, and pest management. The practices on irrigated cropland include irrigation water management, irrigation water delivery systems, and on-farm irrigation practices, such as sprinklers. Noxious and invasive plants can be controlled by pest management and prescribed grazing. ■

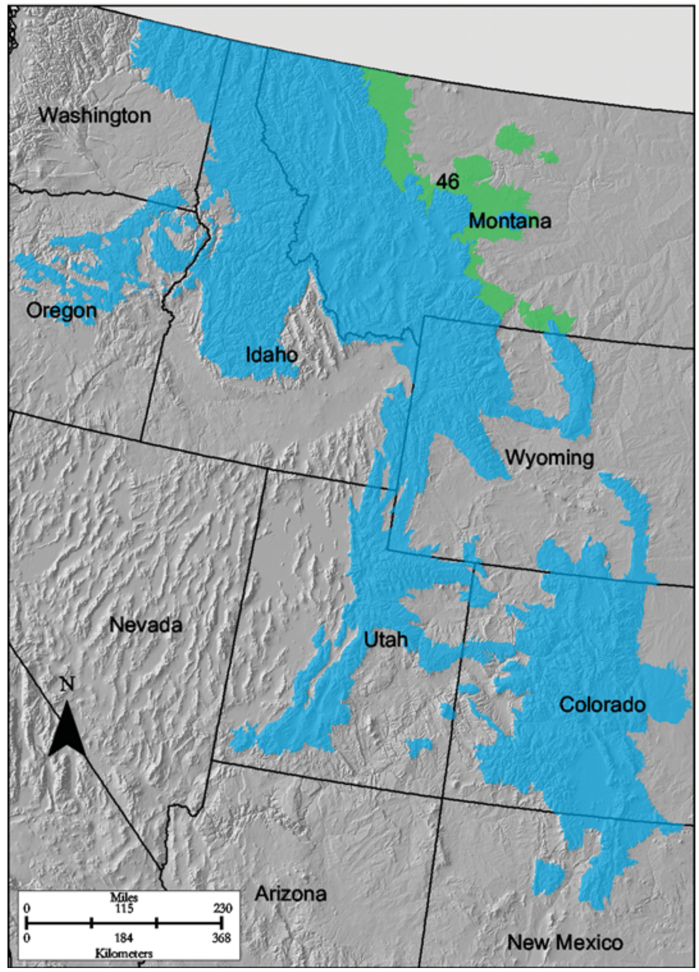

Figure 46-1: Location of MLRA 46 in Land Resource Region E.

46—Northern Rocky Mountain Foothills

This area is entirely in Montana (fig. 46-1). It makes up about 15,100 square miles (39,130 square kilometers). Interstate 90 crosses the southern tip of the area, and Interstate 15 parallels the Missouri River where the area pinches down to a narrow section bisecting the northern and southern halves of the MLRA. This MLRA includes parts of the Lewis and Clark, Gallatin, and Custer National Forests. The Crow and Blackfeet Indian Reservations are in the southern and northern ends of the MLRA, respectively.

Physiography

The north quarter of this MLRA is in the Missouri Plateau, Glaciated, Section of the Great Plains Province of the Interior Plains. The rest of the MLRA is in the Missouri Plateau, Unglaciated, Section of the same province and division. These two sections have similar landforms. The glaciated parts in the north are on the extreme western edge of the southern extent of continental glaciation, so few glacial landforms and minor glacial deposits occur in the area. The foothills east of the Northern Rocky Mountains are on an old plateau of uplifted marine sediments. The rugged hills and low mountains are cut by many narrow valleys that have steep gradients. Broad flood plains and fans border a few of the major rivers. Elevation ranges from 3,600 to 5,900 feet (1,100 to 1,800 meters) in the northern part of the area, increasing gradually to 5,900 to 7,870 feet (1,800 or 2,400 meters) in the southern part.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Missouri-Marias (1003), 37 percent; Missouri-Musselshell (1004), 35 percent; Upper Yellowstone (1007), 11 percent; Milk (1005), 8 percent; Bighorn (1008), 7 percent; and Saskatchewan (1001), 2 percent. The Missouri River bisects this area. Numerous tributary streams to the Missouri River cross the area. Clark's Fork of the Yellowstone River flows north across the southern part of the area on its way to join the Yellowstone River just outside this MLRA.

Geology

Almost all of this area is characterized by Upper Cretaceous to Jurassic marine sediments of the Montana and Colorado

Groups and the Kootenai Formation. These rocks are primarily sandstones and shales with some layers of chalk and conglomerate. Dinosaur bones have been found in some of the shales. Tertiary continental sediments are in the southern part of the area. These river-laid sediments contain some coal. The Madison Group occurs at the edges of the central and southern parts of the MLRA, where faults have brought older bedrock units to the surface.

Climate

The average annual precipitation is 12 to 20 inches (305 to 510 millimeters) in most of this area. It is as high as 53 inches (1,345 millimeters), however, at the highest elevations and is as low as 8 inches (205 millimeters) in some basins. Most of the rainfall occurs as high-intensity, convective thunderstorms. In the northern part of the area, the minimum precipitation occurs in spring. In the southern part, however, precipitation is lowest in early summer. Winter precipitation is snow. The average annual temperature is 34 to 48 degrees F (1 to 9 degrees C). The town of Cut Bank, known for having the coldest temperature in the continental United States on many winter days, is in the northern part of the area. The freeze-free period averages 125 days and ranges from 70 to 180 days, decreasing in length with elevation and from south to north.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 0.3%; ground water, 0.1%
Irrigation—surface water, 98.4%; ground water, 0.6%
Other—surface water, 0.5%; ground water, 0.2%

The total withdrawals average 865 million gallons per day (3,275 million liters per day). About 1 percent is from ground water sources, and 99 percent is from surface water sources. The amount of precipitation is too low for good crop growth in some parts of this MLRA. In other parts, however, it is adequate for grain farming and forage production. The major rivers provide most of the water for irrigation, but small streams furnish local supplies. The surface water generally is of good quality and is suitable for most uses.

Ground water is abundant in the alluvial fill in some valleys. It is of good quality and is suitable for all uses. Mesozoic aquifers, Eagle Sandstone, and the Kootenai Formation occur in this area, but they have little or no ground water. The Madison Group aquifer occurs at depth in this area. Although the quantity of water is not a problem in the Madison Group, deep wells are required and the water quality generally is poor.

Soils

The dominant soil orders in this MLRA are Mollisols and Entisols. The soils in the area dominantly have a frigid soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep, generally well drained, and loamy or clayey. Argiustolls formed in residuum or colluvium on uplands (Absarokee and Reeder series), in alluvium and/or colluvium on alluvial fans and terraces (Danvers and Fairfield series), and in till on till plains and hills (Vida series). Haplustolls (Castner and Winifred series) and Ustorthents (Cabba and Wayden series) formed in residuum and/or colluvium on hills, plains, and mountains. Calciustolls (Judith, Rothiemay, and Windham series) formed in alluvium and colluvium on alluvial fans and terraces.

Biological Resources

This area supports grass vegetation in the valleys and foothills and forest vegetation at the higher elevations. Bluebunch wheatgrass, rough fescue, Idaho fescue, and western wheatgrass are the major grass species. Ponderosa pine, limber pine, Rocky Mountain juniper, common snowberry, and skunkbrush sumac are the dominant species in forested areas.

Some of the major wildlife species in this area are white-tailed deer, mule deer, pronghorn antelope, coyote, badger, raccoon, fox, skunk, ground squirrel, pocket gopher, cottontail rabbit, ring-necked pheasant, gray partridge, sharp-tailed grouse, and sage grouse.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 24%
Grassland—private, 65%; Federal, 4%
Forest—private, 4%
Urban development—private, 1%
Water—private, 1%
Other—private, 1%

Less than 5 percent of this area is federally owned. The rest is in farms and ranches. Nearly 70 percent of the area is rangeland with short and mid grasses and some shrubs. Many of the valleys are irrigated, but they make up only 1 or 2 percent of the total area. Grain and forage for livestock are the main crops, but potatoes, sugar beets, peas, and some other crops are grown in the warmer valleys. About one-fifth of the area, mainly along the northeastern side, is used for dry-farmed wheat. Some of the highest hills are forested.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, management of soil moisture, and control of saline seeps. Water resource concerns include failure to meet plant needs because of the inefficient use of water on irrigated cropland. They also include excessive amounts of pesticides, nutrients, and organic material in surface and ground waters. Plant resource concerns are deterioration of plant condition, productivity, health, and vigor; noxious and invasive plants; and the hazard of wildfires. Animal resource concerns are inadequate food, cover, and shelter.

The most important conservation practices on rangeland are prescribed grazing, fencing, and development of watering facilities. Establishment of food plots and rangeland improvement practices benefit wildlife. Establishment of early and late season pastures supplements forage production and keeps livestock off rangeland during critical growth periods.

Conservation practices on cropland generally include crop residue management, minimum tillage, cover crops, wind stripcropping, nutrient management, soil salinity management, and pest management. The practices on irrigated cropland include irrigation water management, irrigation water delivery systems, and on-farm irrigation practices, such as sprinklers. Noxious and invasive plants can be controlled by pest management and prescribed grazing.

Conservation practices on forestland include forest stand improvement and firebreaks. These practices reduce the hazard of wildfires and improve forest growth, quality, health, and productivity. ■

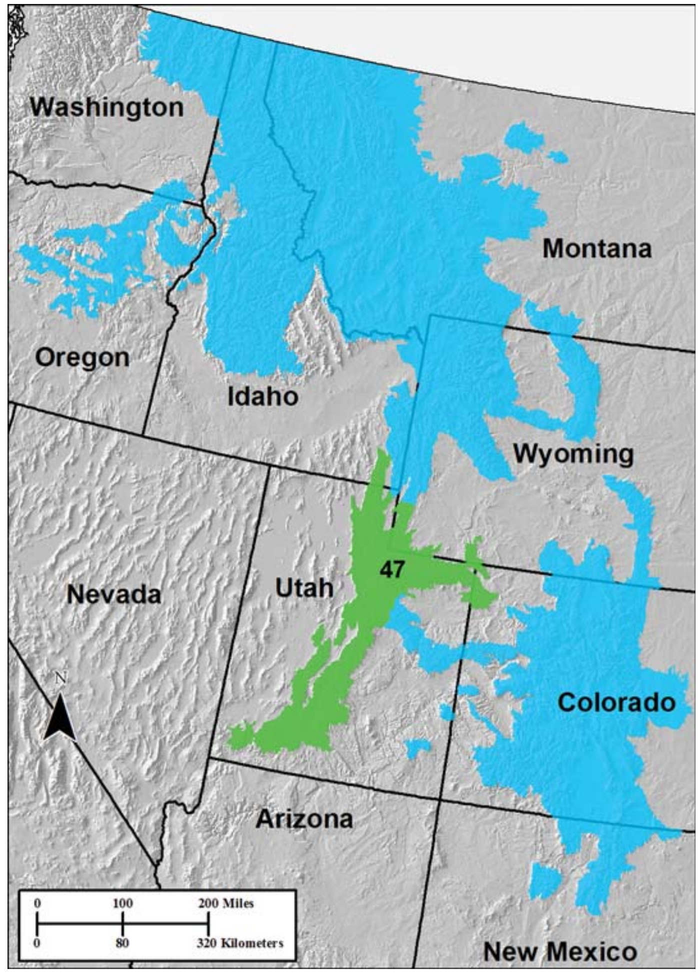

Figure 47-1: Location of MLRA 47 in Land Resource Region E.

47—Wasatch and Uinta Mountains

This area (shown in fig. 47-1) is in Utah (86 percent), Wyoming (8 percent), Colorado (4 percent), and Idaho (2 percent). It makes up about 23,825 square miles (61,740 square kilometers). Coalville, Heber City, Panguitch, and Park City, Utah, and Evanston, Wyoming, are in this MLRA. Interstates 84, 80, and 70 cross this area. Most of Zion and Bryce Canyon National Parks and Cedar Breaks and Dinosaur National Monuments are in this area. This MLRA includes the Uinta Wilderness in Utah and numerous wilderness study areas. It has numerous national forests, including the Ashley, Caribou, Dixie, Fishlake, Manti-La Sal, Uinta, and Wasatch-Cache National Forests. The northern part of the Uinta-Ouray Indian Reservation and the southern part of the Flaming Gorge National Recreation Area in Utah are in this area. Most of the Paiute Indian Reservation is in the southern part of the area.

Physiography

The northern half of this area is in the Middle Rocky Mountains Province of the Rocky Mountain System. The southern half is in the High Plateaus of Utah Section of the Colorado Plateaus Province of the Intermontane Plateaus. Parts of the western edge of this MLRA are in the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. The MLRA includes the Wasatch Mountains, which trend north and south, and the Uinta Mountains, which trend east and west. The steeply sloping, precipitous Wasatch Mountains have narrow crests and deep valleys. Active faulting and erosion are a dominant force in controlling the geomorphology of the area. The Uinta Mountains have a broad, gently arching, elongate shape. Structurally, they consist of a broadly folded anticline that has an erosion-resistant quartzite core. Some of the mountain areas that are above 7,500 feet (2,285 meters) and all of the areas above 10,000 feet (3,050 meters) have been subject to alpine or mountain glaciation. There are arêtes, horns, cirques, all types of moraines, and outwash features. In the southern part of the MLRA, there are rolling mountains and thrust-faulted plateaus that are broad, gently sloping surfaces with steep side slopes that have deep canyons cut into them. The Wasatch and Uinta Mountains have an elevation of 4,900 to about 13,500 feet (1,495 to 4,115 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Escalante Desert-Sevier Lake (1603), 25 percent; Great Salt Lake (1602), 18 percent; Lower Green (1406), 18 percent; Bear (1601), 13 percent; Great Divide-Upper Green (1404), 11 percent; Upper Colorado-Dirty Devil (1407), 9 percent; Lower Colorado-Lake Mead (1501), 4 percent; and White-Yampa (1405), 2 percent. The Duchesne River and many other tributaries to the Green River run through the northeastern part of the MLRA. The Sevier River is in the central and southern parts. The headwaters of the Virgin River are in the southern part.

Geology

The mountains in this area are primarily fault blocks that have been tilted up. Alluvial fans at the base of the mountains are recharge zones for the basin fill aquifer and are significant sources of sand and gravel for construction. An ancient shoreline of historic Lake Bonneville is evident on the footslopes along the western edge of the area. Rocks exposed in the mountains are mostly Mesozoic and Paleozoic sediments, but Precambrian rocks are exposed in the Uinta Mountains. The Uinta Mountains are among the few ranges in the United States that are oriented west to east. Younger igneous rocks (ash and lava) are throughout the area. Lava-capped mesas are common in the southern part of the area. The southern Wasatch Mountains consist of Tertiary volcanic rocks occurring as extrusive lava and intrusive crystalline rocks. Eroded volcanic cones are in the southwestern part of the MLRA.

Climate

The average annual precipitation in most of this area is 15 to 30 inches (380 to 760 millimeters). In some valleys between mountain ranges in the southern part of the area, in Utah, it is 6 to 10 inches (150 to 255 millimeters). It is 10 to 15 inches (255 to 380 millimeters) in some areas in the southern part of the MLRA (in Utah) and in the northeastern part of the MLRA, in Colorado and Wyoming. It can be as much as 73 inches (1,855 millimeters) at the higher elevations. In the northern and western parts of the area, peak precipitation occurs in the winter months. The southern and eastern parts have a greater incidence of high-intensity summer thunderstorms; hence, a significant amount of the precipitation occurs during summer. The higher elevations receive significant amounts of snowfall each year. The average annual temperature is 30 to 58 degrees F (-1 to 15 degrees C). The freeze-free period averages 140 days and ranges from 60 to 220 days, generally decreasing in length with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.1%; ground water, 0.1%
Livestock—surface water, 4.1%; ground water, 1.0%
Irrigation—surface water, 69.7%; ground water, 17.4%
Other—surface water, 3.7%; ground water, 4.0%

The total withdrawals average 380 million gallons per day (1,440 million liters per day). About 22 percent is from ground water sources, and 78 percent is from surface water sources. Streams, lakes, and ground water supply enough water for the grazing and forestry enterprises in most of the area. Reservoirs in the mountains of this area store water for downstream use. The mountain water is of excellent quality. Perennial streams from the Wasatch Mountains in this area provide irrigation and municipal and industrial water for most of the population in Utah. The Green and Sevier Rivers provide irrigation water away from the population centers. Almost 99 percent of the flow within the Sevier River basin in the southern end and middle of this MLRA is used for irrigation and some public supply. Salinity in irrigation return flows is a problem in the rivers in the southern part of the area.

Ground water in this area is primarily in the unconsolidated deposits of sand and gravel filling the major river valleys in the interior of the area and similar deposits filling the basins on the western edge of the area. Water from these aquifers is very hard but typically contains less than 1,000 parts per million (milligrams per liter) total dissolved solids. Low levels of salts occur in the ground water closest to the recharge areas along the base of the mountains, while briny water occurs in the deeper parts of these deposits.

Soils

The dominant soil orders in this MLRA are Aridisols, Entisols, Inceptisols, and Mollisols. The soils in the area dominantly have a frigid soil temperature regime on plateaus and the lower mountain slopes and a cryic soil temperature regime at the higher elevations. They have a mesic soil temperature regime at the lowest elevations, on south-facing slopes, and in some of the valleys in southern Utah. The soil moisture regime is typically xeric in the northern part of the area but grades to ustic in the extreme eastern and southern parts. Mineralogy is typically mixed. The soils are very shallow to very deep, generally well drained, and loamy or loamy-skeletal.

Haplocalcids (Amtoft and Hiko Peak series) formed in slope alluvium, colluvium, and residuum derived from sedimentary and igneous rocks on mountains and hills. Torriorthents (Tebbs and Alldown series) formed in alluvium and slope alluvium on alluvial fans and valley floors. Haploxerolls (Agassiz series) and Argicryolls (Skutum series) formed in slope alluvium, colluvium, and residuum on mountain slopes. Calcixerolls (Lizzant series) formed in slope alluvium or colluvium on fan remnants and hillslopes. Argixerolls (Ant Flat, Henefer, and Yeates Hollow series) formed in slope alluvium or colluvium on fan terraces, piedmonts, and hills. Palecryolls (Lucky Star series) formed in till or colluvium on moraines or mountain slopes.

Biological Resources

This area supports conifer, aspen, grass, mountain shrub, and sagebrush-grass vegetation. The composition of the vegetation varies with elevation. The zone above an elevation of about 13,000 feet (3,965 meters) supports alpine meadow. Coniferous forests of Engelmann spruce, white fir, subalpine fir, and Rocky Mountain Douglas-fir dominate the mid to high elevations. The most common understory plants in these forests are Oregon-grape, myrtle pachystima, and heartleaf arnica. The part of the MLRA in the Uinta Mountains includes significant amounts of lodgepole pine, and the southern part of the Wasatch Mountains includes significant amounts of ponderosa pine. Forests of quaking aspen commonly have an understory that includes blue wildrye, mountain brome, Fendler meadowrue, and aspen peavine. Bluebunch wheatgrass, bearded wheatgrass, blue wildrye, mountain brome, and numerous forbs grow in the understory in areas of Gambel oak, curl-leaf and birchleaf mountain mahogany, snowberry, and serviceberry. Big sagebrush and bluebunch wheatgrass are the dominant species in the sagebrush-grass plant communities that are common at the lowest elevations. The abundance of warm-season herbaceous species increases significantly in the southern part of the MLRA.

Some of the major wildlife species in this area are moose, elk, mule deer, coyote, red fox, bobcat, beaver, porcupine, snowshoe hare, jackrabbit, sage grouse, chukar, sharp-tailed grouse, gray partridge, ruffed grouse, and blue grouse. The species of fish in the area include rainbow trout, brown trout, brook trout, cutthroat trout, catfish, and sucker.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 2%
Grassland—private, 25%; Federal, 35%
Forest—private, 7%; Federal, 25%
Urban development—private, 1%
Water—private, 1%; Federal, 1%
Other—private, 1%; Federal, 2%

Less than one-third of this area is in farms and ranches. The rest of the area generally is federally owned. Grassland and woodland are grazed in summer. Some dense forests are on moist sites. Recreation and mining are important land uses. A few valleys are irrigated. Forage for livestock is the main crop.

The major soil resource concerns are wind erosion, water erosion, maintenance of the productivity of the soils, and maintenance of the quality of surface water. Maintaining a vegetative cover, maintaining the content of organic matter, and preventing excessive compaction are important. Mass movement of the soils also is a concern. Proper grazing use is a concern on grazing lands. In timbered areas, the primary concerns during timber harvesting are controlling erosion along roads and skid trails and minimizing the compaction caused by harvesting equipment.

Conservation practices on rangeland generally include brush management, rangeland seeding, prescribed grazing, prescribed burning, fencing, and development of watering facilities.

Conservation practices on dry-farmed cropland include terraces, sediment-control basins, summer fallow tillage, crop residue management, and pest management.

Conservation practices on irrigated cropland and hayland include irrigation system improvement, irrigation water management, conservation tillage, crop rotation, crop residue management, forage harvest management, and nutrient management.

Conservation practices on irrigated pasture include irrigation system improvement, irrigation water management, pasture planting, development of watering facilities, fencing, prescribed grazing, and nutrient management. ■

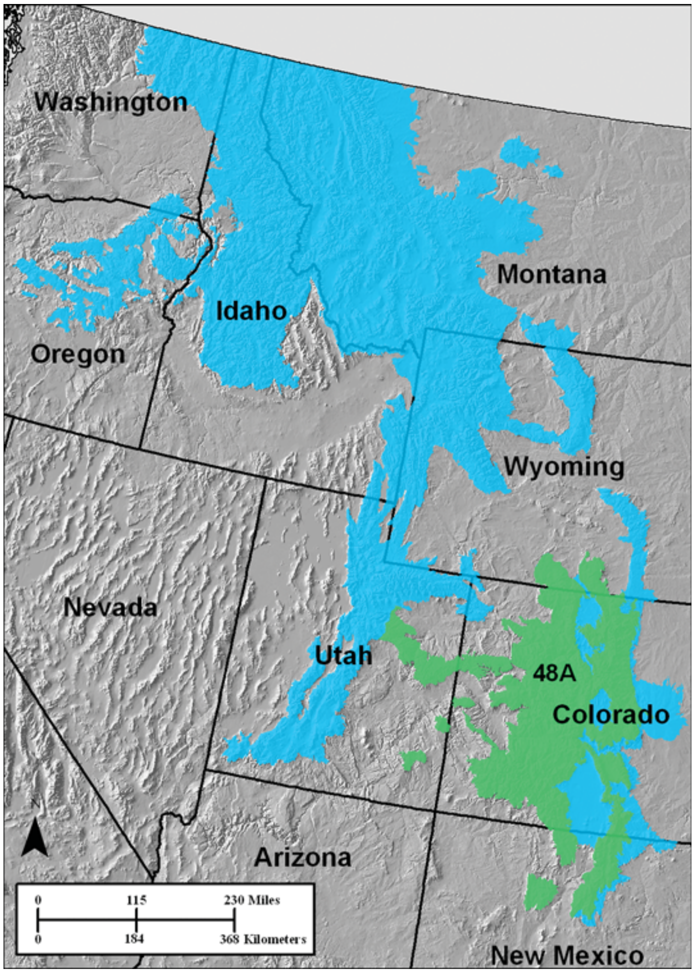

Figure 48A-1: Location of MLRA 48A in Land Resource Region E.

48A—Southern Rocky Mountains

This area (shown in fig. 48A-1) is in Colorado (76 percent), New Mexico (11 percent), Utah (8 percent), and Wyoming (5 percent). It makes up about 45,920 square miles (119,000 square kilometers). The towns of Steamboat Springs, Glenwood Springs, Aspen, Leadville, and Gunnison, Colorado, are in this MLRA. Interstate 70 crosses the northern half of the area. This MLRA has numerous national forests, including the Medicine Bow National Forest in Wyoming; the Routt, Arapaho, Roosevelt, Pike, San Isabel, White River, Gunnison, Grand Mesa, Uncompahgre, Rio Grande, and San Juan National Forests in Colorado; the Carson National Forest and part of the Santa Fe National Forest in New Mexico; and parts of the Manti-La Sal and Ashley National Forests in Utah. Rocky Mountain National Park also is in this MLRA. The Pole Mountain Military Reservation is in the Medicine Bow National Forest. The Jemez, Picuris, Santa Clara, Uintah and Ouray, and Taos Indian Reservations are in this MLRA. The Black Canyon of the Gunnison National Monument and the Curecanti National Recreation Area are directly west of Gunnison, Colorado, in this area. Florissant Fossil Beds National Monument is in this MLRA, west of Colorado Springs.

Physiography

Most of this area is in the Southern Rocky Mountains Province of the Rocky Mountain System. The western extension of the MLRA into Utah is in the Uinta Basin Section of the Colorado Plateaus Province of the Intermontane Plateaus. Small parts of the southwest corner and some isolated areas farther west are in the Canyon Lands Section of the same province and division. The Southern Rocky Mountains consist primarily of two belts of strongly sloping to precipitous mountain ranges trending north to south. Several basins, or parks, are between the belts. Some high mesas and plateaus are included. The ranges include the Sangre de Cristo Mountains, the Laramie Mountains, and the Front Range in the east and the San Juan Mountains and the Sawatch and Park Ranges in the west. The ranges are dissected by many narrow stream valleys having steep gradients. In some areas the upper mountain slopes and broad crests are covered by snowfields and glaciers. High plateaus and steep-walled canyons are fairly common, especially in the west.

Elevation typically ranges from 6,500 to 14,400 feet (1,980 to 4,390 meters) in this area. The part of this MLRA in central Colorado includes the highest point in the Rockies, Mount Elbert, which reaches an elevation of 14,433 feet (4,400 meters). More than 50 peaks in the part of the MLRA in Colorado are at an elevation of more than 14,000 feet (4,270 meters). Many small glacial lakes are in the high mountains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Colorado Headwaters (1401), 17 percent; Gunnison (1402), 13 percent; White-Yampa (1405), 11 percent; South Platte (1019), 10 percent; Upper Arkansas (1102), 9 percent; Rio Grande Headwaters (1301), 9 percent; Rio Grande-Elephant Butte (1302), 7 percent; North Platte (1018), 6 percent; Lower Green (1406), 5 percent; San Juan (1408), 5 percent; Upper Colorado-Dolores (1403), 5 percent; and Upper Canadian (1108), 3 percent. The headwaters of many of the major rivers on the High Plains and the Colorado Plateau are in this area. The Continental (or Great) Divide also is in this area. The North and South Platte, Arkansas, and Rio Grande Rivers drain toward the Atlantic Ocean, and the Green, Yampa, and Colorado Rivers drain toward the Pacific Ocean. The Rio Grande is a National Wild and Scenic River in northern New Mexico, which is in the southern part of this MLRA.

Geology

The mountains in this area were formed mainly by crustal uplifts during the late Cretaceous and early Tertiary periods. The Rockies on the east side of this area are called the “Front

Range," which is a fault block that has been tilted up on edge and uplifted. It was tilted up on the east edge, so there is a steep front on the east and the west side is more gently sloping. The rocks exposed in the mountains are mostly Precambrian igneous and metamorphic rocks, which in many places are flanked by steeply dipping Mesozoic sedimentary rocks. Younger igneous rocks, primarily basalt and andesitic lava flows, tuffs, breccias, and conglomerates, are throughout this area. Representative formations in this area are the Silver Plume and Pikes Peak granites, San Juan Volcanics, and Mancos Shale. Many of the highest mountain ranges were reshaped by glaciation during the Pleistocene. Alluvial fans at the base of the mountains are recharge zones for local basin and valley fill aquifers. They also are important sources of sand and gravel.

Climate

The average annual precipitation ranges from 7 to 63 inches (180 to 1,600 millimeters) but is dominantly 14 to 32 inches (355 to 815 millimeters). Summer rainfall commonly occurs as high-intensity, convective thunderstorms. About half of the annual precipitation occurs as snow in winter; this proportion increases with elevation. In the mountains, deep snowpacks accumulate throughout the winter and generally persist into spring or early summer, depending on elevation. Some permanent snowfields and small glaciers are on the highest mountain peaks. In the valleys at the lower elevations, snowfall is lighter and snowpacks can be intermittent. The average annual temperature is 26 to 54 degrees F (-3 to 12 degrees C). The freeze-free period averages 135 days and ranges from 45 to 230 days, decreasing in length with elevation. The climate of this area is strongly dependent upon elevation; precipitation is greater and temperatures are cooler at the higher elevations.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 8.5%; ground water, 0.0%
Livestock—surface water, 2.7%; ground water, 0.4%
Irrigation—surface water, 77.7%; ground water, 5.6%
Other—surface water, 2.9%; ground water, 2.1%

The total withdrawals average 845 million gallons per day (3,200 million liters per day). About 8 percent is from ground water sources, and 92 percent is from surface water sources. Water from the streams and lakes is abundant and generally of excellent quality. In some places, mining activities in the late 1800s have contributed to the degraded quality of surface water, mainly because of elevated levels of metals. The lower valleys depend on streamflow from this area for irrigation water. Most of the streamflow is from snowmelt, which typically occurs from March to June, so reservoirs or a source of ground water is needed to supply water for irrigation late in the growing season. This MLRA provides most of the water for the Denver metropolitan area, which lies just to the east.

This area has only two extensive aquifers. One is the unconsolidated to consolidated silt, sand, and gravel of the High Plains and equivalent aquifers in the southern part of Carbon County, Wyoming. The other is the Leadville Limestone aquifer in Colorado. The water from the High Plains aquifer is of good quality, and high-yielding wells are common in areas of this aquifer. The water is used for irrigation, livestock, domestic supply, oil and gas exploration, and mining. It is hard or moderately hard and has a median concentration of about 300 parts per million (milligrams per liter) total dissolved solids. The Leadville Limestone has salty water at depth, but the level of total dissolved solids is generally less than 500 parts per million (milligrams per liter). Because of ample supplies of surface water and the lower quality of this ground water, the Leadville Limestone aquifer has not been extensively developed in this area.

Limited quantities of ground water occur in the basin and valley fill sediments in most of the streams and rivers at the lower elevations in this area. These aquifers are directly connected with the streams, so water quality is similar to that in the surface runoff. The water is generally of good quality and is suitable for all uses.

Soils

The dominant soil orders in this MLRA are Mollisols, Alfisols, Inceptisols, and Entisols. The soils in the area dominantly have a frigid or cryic soil temperature regime and an ustic or udic soil moisture regime. Mineralogy is typically mixed, smectitic, or paramicaceous. In areas with granite, gneiss, and schist bedrock, Glossocryalfs (Seitz, Granile, and Leadville series) and Haplocryolls (Rogert series) formed in colluvium on mountain slopes. Dystrocryepts (Leighcan and Mummy series) formed on mountain slopes and summits at the higher elevations. In areas of andesite and rhyolite bedrock, Dystrocryepts (Endlich and Whitecross series) formed in colluvium on mountain slopes. In areas of sedimentary bedrock, Haplustolls (Towave series) formed on mountain slopes at low elevations and with low precipitation. Haplocryolls (Lamphier and Razorba series), Argicryolls (Cochetopa series), and Haplocryalfs (Needleton series) formed in colluvium on mountain slopes at high elevations.

Biological Resources

The potential vegetation in this area is grass and sagebrush at the lower elevations, montane and subalpine coniferous forest and some grassland at the mid and high elevations, and alpine tundra on the mountain peaks above timberline (at an elevation of about 11,500 feet, or 3,505 meters). Some common plants are mountain big sagebrush, western wheatgrass, and needleandthread at the lower elevations; ponderosa pine, Rocky Mountain Douglas-fir, white fir, Arizona fescue, mountain muhly, common snowberry, Parry's oatgrass, and mountain brome at mid elevations; Engelmann spruce, subalpine fir, corkbark fir, lodgepole pine, limber pine, bristlecone pine, grouse whortleberry, elk sedge, and Thurber's fescue at the higher elevations; and kobresia, alpine bluegrass, alpine clover, and golden avens above timberline.

Wildlife species in the alpine tundra include white-tailed ptarmigan, rosy finch, pika, yellow-bellied marmot, long-tailed weasel, bighorn sheep, and mountain goats. In the slightly lower, montane to subalpine forested sites, typical species include chickaree, Albert's squirrel, golden-mantled ground squirrel, beaver, black bear, elk, mule deer, moose, Steller's jay, golden eagle, blue grouse, black-billed magpie, mountain chickadee, Clark's nutcracker, and common raven. There is considerable overlap of species between the montane and lower shrub-grassland habitats; however, typical species in these lower areas include bobcat, coyote, mountain lion, sage grouse, western rattlesnake, bullsnake, Merriam's turkey, golden eagle, and piñon jay.

Habitats for fish are varied in this area and include streams and rivers, small alpine lakes, and larger lakes and reservoirs. The species of fish in streams and lakes at the higher elevations are rainbow, brown, cutthroat, brook, and lake trout; kokanee; and mountain whitefish. These species also occur at the lower elevations, and some waters at the lower elevations also contain northern pike, yellow perch, and a variety of nongame species.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 1%
Grassland—private, 16%; Federal, 22%
Forest—private, 11%; Federal, 41%
Urban development—private, 1%
Water—Federal, 1%
Other—private, 2%; Federal, 5%

Nearly 70 percent of this area is federally owned. The rest consists of farms, ranches, or other private holdings. Nearly all of the land in this MLRA is in natural vegetation. Grazing, forestry, recreation, and watershed are the main uses. Small areas of hayland and pasture, some of it irrigated, are in some valleys. Local ranchers commonly graze livestock in national forests during the summer and then move the livestock to lower elevations in the winter. The large areas of public land provide excellent opportunities for outdoor recreation, particularly hunting, fishing, skiing, camping, hiking, boating, and sightseeing. The spectacular mountain scenery in many parts of this MLRA contributes to the popularity of these activities and attracts tourists from distant regions. Recreation supports a significant tourism industry upon which many local economies are dependent.

The major soil resource concerns are erosion by wind and water and maintenance of the productivity of the soils. Minimizing the sediment that reaches watercourses also is a concern. Proper grazing use is a concern in areas of grazing land. In timbered areas, the primary concerns during timber harvesting are controlling erosion on roads and skid trails and minimizing soil compaction caused by harvesting equipment. ■

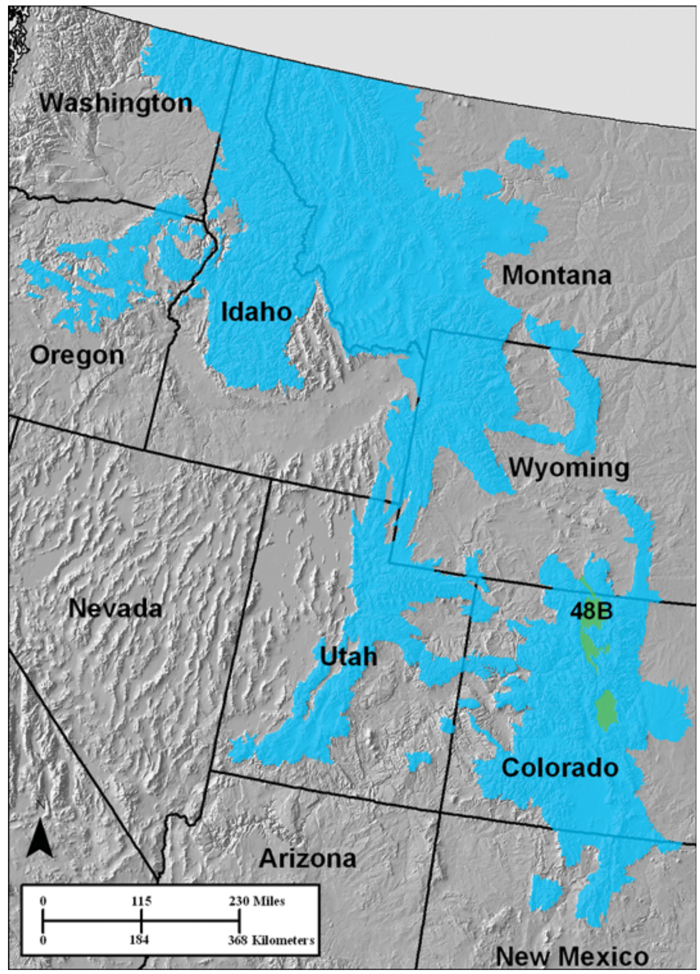

Figure 48B-1: Location of MLRA 48B in Land Resource Region E.

48B—Southern Rocky Mountain Parks

This area (shown in fig. 48B-1) is in Colorado (96 percent) and Wyoming (4 percent). It makes up about 2,325 square miles (6,020 square kilometers). The town of Walden, in the northern part of this MLRA, is in a wide valley locally known as North Park. The town of Kremmling is in a valley locally known as Middle Park. The town of Hartsel, in the center of the southern part of the MLRA, is in a broad intermontane basin locally known as South Park. Interstate 70 passes between the northern and southern parts of the MLRA. The northern part is bordered by the Medicine Bow, Routt, and Arapaho National Forests, and the southern part is bordered by the San Isabel and Pike National Forests. The Arapaho National Wildlife Refuge is directly south of the town of Walden.

Physiography

This area is within the Southern Rocky Mountains Province of the Rocky Mountain System. It consists of nearly level to rolling mountain parks and valleys and a few narrow mountain ridges. It occurs as two separate parts in the center of the Southern Rockies. The southern half of the northern part is on the west side of the Continental Divide, and the rest of the MLRA is on the east side of the divide. Elevation ranges from 7,850 to 10,850 feet (2,395 to 3,310 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: North Platte (1018), 41 percent; South Platte (1019), 35 percent; Colorado Headwaters (1401), 23 percent; and Upper Arkansas (1102), 1 percent. The North Platte River leaves Colorado and enters Wyoming in the northern half of the northern part of the MLRA (North Park). The Colorado River is in the southern half of the northern part of the MLRA (Middle Park). The South Platte River is in the southern part of the MLRA (South Park).

Geology

The mountain valleys and parks that are characteristic of this MLRA are surrounded by high mountain peaks of the adjacent Southern Rocky Mountains MLRA. Steep slopes give rise to steep-gradient streams that are able to move cobbles and gravel from the mountain slopes down into the valleys. The coarse textured sediments on the surface of this area were deposited by either glacial meltwater or present-day rivers. Buried deep beneath the sediments is a complex of sedimentary and igneous rocks. Residuum from sedimentary rocks is on the steeper slopes that were not covered by alluvium and glacial outwash.

Climate

The average annual precipitation is mainly 10 to 16 inches (255 to 405 millimeters), but it is as high as 28 inches (710 millimeters) at the higher elevations that border the Southern Rocky Mountains MLRA. Precipitation generally increases with elevation. Rainfall occurs as high-intensity, convective thunderstorms during the growing season. About half of the annual precipitation falls as snow. Soil moisture is unevenly distributed within short distances because of snowdrifts. The amount of precipitation is highly influenced by rain shadows. The surrounding peaks receive most of the precipitation as storm systems traverse the area. The average annual temperature is 35 to 42 degrees F (1 to 6 degrees C). The freeze-free period averages 95 days and ranges from 70 to 120 days, decreasing in length with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 0.2%; ground water, 0.0%
Irrigation—surface water, 91.1%; ground water, 8.3%
Other—surface water, 0.3%; ground water, 0.1%

The total withdrawals average 300 million gallons per day (1,135 million liters per day). About 8 percent is from ground water sources, and 92 percent is from surface water sources. Perennial streams originating from snowmelt in the adjacent high mountains furnish an abundance of water for irrigation of hay meadows in June and July. In August, the streams are often short of water. Large reservoirs in the area store water for domestic use, power supply, and irrigation outside the area. The surface water from the mountain runoff is of good quality and is generally suitable for all uses.

Some ground water is available locally in valley fill deposits under the larger streams and rivers in this area. The ground water and surface water in the valleys are connected, and the quality of the ground water is almost the same as that of the surface water.

Soils

The dominant soil order in this MLRA is Mollisols. Alfisols are of lesser extent. The soils are very shallow to deep, generally well drained, and loamy or clayey and have mixed or smectitic mineralogy. The soil temperature regime is dominantly cryic, but it is frigid in some small areas, primarily on south- or west-facing slopes. The soil moisture regime is mainly ustic, but a marginal aridic regime has been identified in areas where the average annual precipitation is less than about 12 inches (305 millimeters). The most extensive great group is Argicryolls (Hodden, Lucky, Parlin, Tiagos, and Cabin series), which commonly formed in outwash and slope alluvium on outwash terraces, fan remnants, hills, and mountain slopes. Haplocryolls (Redcloud and Tealson series) formed in outwash and slope alluvium on outwash terraces, valley side slopes, hills, and ridges. Haplocryalfs (Gebson and Harsha series) formed in slope alluvium and outwash on outwash terraces, fan remnants, hills, ridges, and mountain slopes. Cryaquolls (Dobrow and Randman series) formed in alluvium on stream terraces and flood plains.

Biological Resources

This area supports grass and grass-shrub vegetation. Mountain big sagebrush, Idaho fescue, bluebunch wheatgrass, streambank wheatgrass, and muttongrass are the common plants in North Park and Middle Park. Western wheatgrass, Arizona fescue, mountain muhly, needleandthread, and Parry's oatgrass are common in South Park.

Some of the major wildlife species in this area are black bear, elk, mule deer, antelope, coyote, beaver, snowshoe hare, jackrabbit, and sage grouse. Moose were introduced in North Park and flourished as their range expanded to the south.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 6%
Grassland—private, 59%; Federal, 26%
Forest—private, 3%; Federal, 1%
Urban development—private, 3%
Water—private, 1%
Other—private, 1%

About one-fourth of this area is Federal land leased to ranchers for grazing by cattle and sheep. The rest consists mainly of privately owned ranches. Irrigated pastures and hayland adjacent to rivers and streams produce most of the forage in the area. The hay consists mainly of grasses and sedges and a small amount of clover. Grazing land is sparsely vegetated with grasses and shrubs and produces a low amount of forage because of inadequate rainfall and low temperatures.

The major soil resource concerns are water erosion, a short growing season, steep slopes, and shallow and rocky soils. Conservation practices on hayland and pasture generally include management of crop residue, nutrients, pesticides, and irrigation water. Forage harvest management is important on the rangeland and pasture in the area. ■

49—Southern Rocky Mountain Foothills

This area (shown in fig. 49-1) is in Colorado (58 percent), Wyoming (27 percent), and New Mexico (15 percent). It makes up about 11,130 square miles (28,845 square kilometers). The major cities in or adjacent to this MLRA are Laramie, Wyoming; Fort Collins, Boulder, Denver, Colorado Springs, and Pueblo, Colorado; and Santa Fe and Las Vegas, New Mexico. Interstates 25, 70, and 80 cross the MLRA. Part of the Medicine Bow National Forest is in the northern tip of this area, in Wyoming; parts of the Roosevelt, Pike, and San Isabel National Forests are in this area in Colorado; and part of the Santa Fe National Forest is in the southern end of this area, in New Mexico. The Rocky Flats Nuclear Arsenal, Peterson Air Force Base, most of the Air Force Academy grounds, and part of the Fort Carson Military Reservation are in the part of this area in Colorado.

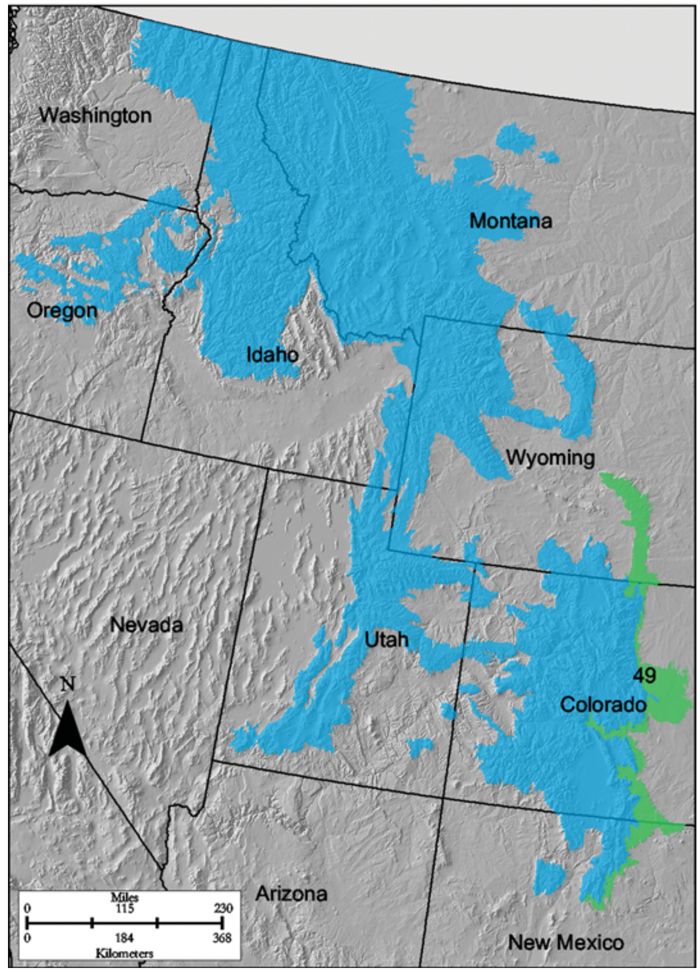

Figure 49-1: Location of MLRA 49 in Land Resource Region E.

Physiography

Almost half of this area is in the Southern Rocky Mountains and Wyoming Basin Provinces in the Rocky Mountain System. The rest is in the Colorado Pediment, Raton, and High Plains Sections of the Great Plains Province of the Interior Plains. The northern part of the MLRA consists of the Laramie Mountains. The central and southern parts generally are bounded on the east by the Great Plains and on the west by the Southern Rocky Mountains. Elevation ranges from 5,000 feet (1,525 meters) to 8,000 feet (2,440 meters) in most of the MLRA, but small mountains in the area are as high as 10,000 feet (3,050 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Arkansas (1102), 36 percent; South Platte (1019), 27 percent; North Platte (1018), 22 percent; Upper Canadian (1108), 11 percent; Upper Pecos (1306), 3 percent; and Upper Cimarron (1104), 1 percent. The Laramie and North Platte Rivers and their associated tributaries are the principal streams in the Wyoming portion of the MLRA. The Cache La Poudre, Big Thompson, Saint Vrain, South Platte, Arkansas, Saint Charles, Huerfano, Cucharas, and Purgatoire Rivers, Clear Creek, Fountain Creek, and their associated tributaries are the principal streams in the Colorado portion. The Vermejo, Cimarron, Pecos, and Mora Rivers and their associated tributaries are the principal streams in the New Mexico portion.

Geology

This area has been impacted by the geologic processes of uplift, folding, and faulting and by subsequent erosion and deposition. The Southern Rocky Mountains were uplifted 50 to 70 million years ago during the Laramide uplift. Most of this MLRA is adjacent to this uplift and was also affected. The uplift induced erosion of the relatively soft Late Pennsylvanian to Cretaceous sedimentary rocks from the uplands and dissected the underlying crystalline Precambrian rocks. The relief of the area was reduced by a combination of erosion of uplands and alluvial filling. Approximately 7 million years ago, a large portion of the area was uplifted again to elevations of 14,000 feet (4,270 meters) or more at the core of the Laramide uplift. Since then, precipitation occurring as both rain and snow led to the renewal of erosion and subsequent alluvial fills. The Wyoming portion of the MLRA, the Laramie Mountains, consists primarily of Precambrian plutonic rocks with Pennsylvanian and Permian sedimentary rocks folded and faulted at the margin of the range. The Colorado and New Mexico portions of the area consist primarily of remnants of the uplifted and folded Pennsylvanian through Cretaceous sedimentary rocks forming hogbacks, ridges, and hills, the ranges of which trend in a general north-south direction, parallel to the uplifted Southern Rocky Mountains. Tertiary volcanic flows filled valleys in some areas. After extensive erosion, these more resistant volcanic rocks now form prominent mesas, such as North and South Table Mountains near Golden, Colorado, and Fishers Peak Mesa near the Colorado-New Mexico border. Stream erosion from the eastern front of the Southern Rocky Mountains fostered the creation of a sequence of large alluvial fan remnants, pediments, and terrace deposits in this MLRA.

Climate

The average annual precipitation is 12 to 25 inches (305 to 635 millimeters) in most of this area, but it ranges from 10 to 35 inches (255 to 890 millimeters), generally increasing with elevation. The highest precipitation occurs in the Laramie Mountains, in Wyoming, and the lowest precipitation occurs in the Arkansas River Valley, above Salida, Colorado. Most of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. Winter precipitation occurs as snow. The average annual temperature is 36 to 54 degrees F (2 to 12 degrees C). The freeze-free period averages 140 days and ranges from 90 to 195 days, decreasing in length with elevation and from south to north.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 59.1%; ground water, 7.3%
Livestock—surface water, 0.7%; ground water, 0.2%
Irrigation—surface water, 22.6%; ground water, 4.5%
Other—surface water, 4.5%; ground water, 1.0%

The total withdrawals average 330 million gallons per day (1,250 million liters per day). About 13 percent is from ground water sources, and 87 percent is from surface water sources. The numerous major streams crossing this area provide some public supply water and irrigation water for narrow belts of cropland in the stream valleys. The only limitation affecting the quality of the surface water in this area is a high sediment load. Both surface water and ground water are scarce in the part of this area in New Mexico.

Alluvium in the South Platte River and its tributaries provides some water for irrigation, livestock, and domestic use in the northern part of this area. Water from this aquifer is hard. It is a calcium-sulfate type of water, and its level of total dissolved solids typically exceeds 1,000 parts per million (milligrams per liter). Alluvium in the valleys of Fountain Creek and Black Squirrel Creek, in the middle of this area, provides some ground water for agricultural and domestic uses. This water is moderately hard to very hard but typically contains less than 550 parts per million (milligrams per liter) total dissolved solids. Another source of ground water is the Denver Basin Aquifer System southeast of Denver. Consolidated sandstone and conglomerate beds in this aquifer provide water that is slightly less hard than the water from the river alluvium, and it generally contains less than 1,000 parts per million (milligrams per liter) total dissolved solids.

Soils

The dominant soil orders in this MLRA are Mollisols, Alfisols, Inceptisols, and Entisols. The soils in the Colorado and New Mexico portions of the MLRA dominantly have a frigid or mesic soil temperature regime. Those in the Wyoming portion have a frigid or cryic soil temperature regime. A few of the higher peaks and some north aspects have a cryic soil temperature regime. Most of the soils in the area have an ustic soil moisture regime, but those on the higher peaks and on some north aspects have a udic soil moisture regime. The soils in the area dominantly have smectitic or mixed mineralogy. They are very shallow to very deep and are dominantly well drained. The texture is dominantly loamy in soils that formed in material weathered from igneous and metamorphic rocks and is dominantly loamy or clayey in soils that formed in material weathered from sedimentary rocks. Some of the most extensive and representative great groups are Haplustolls (Baller series), Argiustolls (Nederland, Nunn, Santa Fe, and Enmedio series), Haplustalfs (Fort Collins, Stoneham, and Dargol series), Haplustepts (Stout series), Ustorthents (Lorencito and Saruche series), and Paleustolls (Flatirons series).

Biological Resources

This area supports grassland, shrub-grassland, and forestland vegetation. Grassland that supports blue grama, buffalograss, and wheatgrasses is common at the lower elevations. Pinyon pine, juniper, true mountain mahogany, blue grama, needleandthread, and wheatgrasses are common in the southern Colorado and New Mexico portions of the MLRA. Ponderosa pine, Gambel oak, Douglas-fir, white fir, kinnikinnick, Parry's oatgrass, and Arizona fescue are common at the higher elevations and in the Wyoming portion of the MLRA. Cottonwood grows along the major streams.

Some of the major wildlife species in this area are elk, mule deer, antelope, jackrabbit, cottontail, and mourning dove. Waterfowl inhabit areas near perennial streams, lakes, and reservoirs.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 4%
Grassland—private, 48%; Federal, 11%
Forest—private, 25%; Federal, 5%
Urban development—private, 6%
Other—private, 2%

About 75 percent of this area consists of privately owned farms, ranches, and forestland. The rest is mostly Federal land. About 30 percent of the area is forestland. Less than 5 percent is irrigated cropland. The major crops are small grains and hay. The native rangeland is grazed in spring and summer. Firewood and fenceposts are produced on the forestland.

The major soil resource concerns are water erosion, steep slopes, shallow and rocky soils, and a high shrink-swell potential. Conservation practices on cropland generally include management of crop residue, nutrients, pesticides, and irrigation water. Forage harvest management is important on the rangeland and pasture in the area. ■

51—High Intermountain Valleys

This area (shown in fig. 51-1) is in Colorado (89 percent) and New Mexico (11 percent). It makes up about 4,030 square miles (10,445 square kilometers). The part of this area in Colorado is known locally as the San Luis Valley. The area has no major cities or interstate highways. U.S. Highway 160 is the major east-west road, and U.S. Highway 285 is the major north-south road. The town of Alamosa, Colorado, is in this area, and Taos, New Mexico, is directly south of the area. Parts of the Great Sand Dunes National Park are in and adjacent to this MLRA, and the Monte Vista and Alamosa National Wildlife Refuges are in the MLRA.

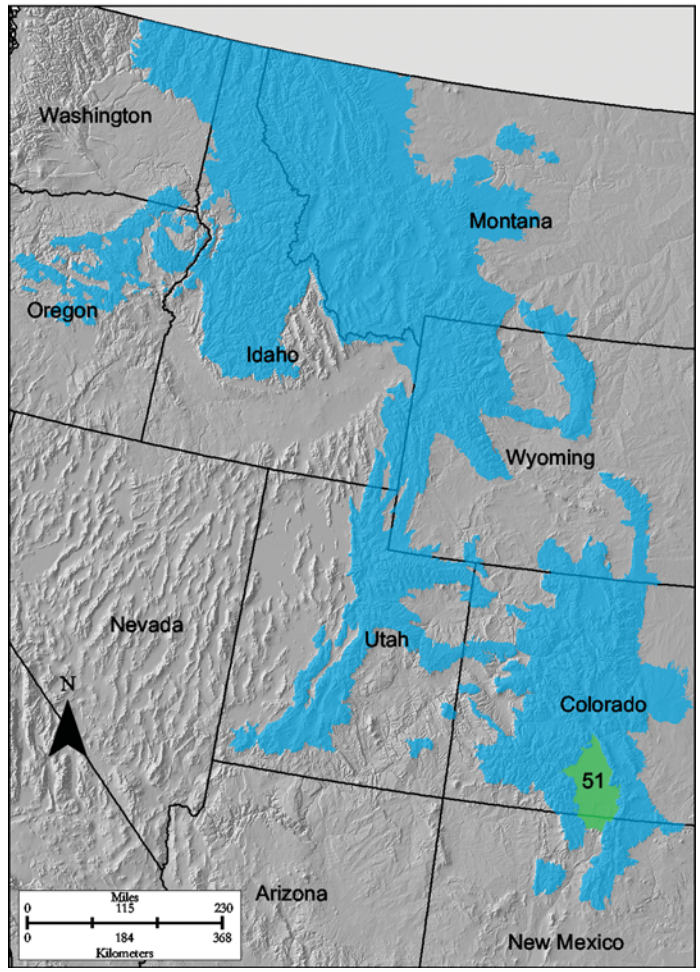

Figure 51-1: Location of MLRA 51 in Land Resource Region E.

Physiography

This MLRA is in the Southern Rocky Mountains Province of the Rocky Mountain System. It is an isolated, high mountain valley bounded by the Sangre de Cristo Mountains on the east and the La Garita and San Juan Mountains on the north and west. Much of the MLRA consists of nearly level to gently sloping areas of old valley fill. Most of the southern end consists of gently sloping to steep hills underlain by volcanic rocks. Elevation ranges from 6,900 to 8,860 feet (2,105 to 2,700 meters). Local relief generally is slight, but it is as much as 330 feet (100 meters) in the southern tip of the area.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Rio Grande Headwaters (1301), 88 percent, and Rio Grande-Elephant Butte (1302), 12 percent. The headwaters of the Rio Grande are in the mountains west of this area. The Alamosa, Trinchera, Culebra, and Chama Rivers join the Rio Grande in this MLRA.

Geology

Most of this area is covered with old alluvial deposits washed into the valley from the adjacent mountains. Because of a low amount of precipitation, these old deposits commonly have not been reworked. The only river that has a well-defined flood plain and some terraces is the Rio Grande. The southern end of the area has basalt flows with some associated volcanic cones at the surface. Also, it has some scattered outcrops of tuff and rhyolite.

Climate

The average annual precipitation is mainly 7 to 10 inches (180 to 255 millimeters), but it ranges to 21 inches (535 millimeters) in areas that border the mountains. It increases with elevation from the town of Center, where the lowest precipitation in the area occurs. Most of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. Winter precipitation occurs as snow. The average annual temperature ranges from 38 to 46 degrees F (4 to 8 degrees C). The freeze-free period averages 130 days and ranges from 110 to 155 days, decreasing in length with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 0.0%; ground water, 0.0%
Irrigation—surface water, 82.5%; ground water, 17.4%
Other—surface water, 0.1%; ground water, 0.1%

The total withdrawals average 2,305 million gallons per day (8,725 million liters per day). About 18 percent is from ground water sources, and 82 percent is from surface water sources. Because of low precipitation, most of the MLRA supports only a sparse cover of rangeland plants, but rainfall at the higher elevations is adequate for a good cover of grass and shrubs. The Alamosa and Rio Grande Rivers and small reservoirs on intermittent streams flowing into the area from the surrounding mountains provide drinking water. The Chama River is an important source of water in the southern part of the area. The content of dissolved salts is low where the surface water comes out of the mountains, but it increases quickly downstream as salt-laden runoff and irrigation tailwater from the valley floor flow into the rivers. The surface water is generally of good enough quality for irrigation and drinking. Acid mine drainage has decreased the pH of some streams draining mined lands in the western part of this MLRA.

Wells that tap ground water in the deep valley fill are important sources of water for irrigation and domestic use. The valley fill aquifer in Colorado is known locally as the San Luis Valley aquifer system. The upper 130 feet of this aquifer contains unconfined ground water, but where clay, fine sand, or volcanic rock layers occur in the alluvium, ground water beneath those layers is confined. The quality of the confined ground water is better than that of the unconfined water. The median value of total dissolved solids is 184 parts per million (milligrams per liter) in the confined aquifer and exceeds 310 parts per million in the shallow, unconfined aquifer. The valley fill aquifer in New Mexico is called the Rio Grande Valley, north, aquifer. The total dissolved solids in this water average about 230 parts per million (milligrams per liter). Water in both aquifers can be soft or hard. Salinity is a problem in much of the area. Ground water contains much lower levels of total dissolved salts near the recharge areas close to the mountains than in down-gradient areas lower in the valley. Salts are dissolved from soils during periods of natural runoff and irrigation return flows.

Soils

The dominant soil orders in this MLRA are Aridisols and Entisols. The soils in the area dominantly have a frigid soil temperature regime, an aridic soil moisture regime, and mixed mineralogy. They generally are deep or very deep and somewhat excessively drained to somewhat poorly drained. The texture varies. Haplocalcids formed in alluvium on alluvial fans, fan remnants, and valley sides (Garita and Luhon series) and on valley dunes and ridges (Space City series). Haplargids (Graypoint and San Arcacio series) formed in alluvium on alluvial fans, fan remnants, and stream terraces. Haplocambids (Travelers series) formed in residuum on basalt flows and mesas. Natrargids (Hooper, Mosca, and San Luis series) and Psammaquents (Gunbarrel series) formed in alluvium on flood plains, alluvial fans, and stream terraces.

Biological Resources

This area supports desert shrub-grassland vegetation. The common plants are greasewood, rabbitbrush, fourwing saltbush, saltgrass, alkali sacaton, western wheatgrass, sedges, and rushes at the lower elevations and twoneedle pinyon, oneseed juniper, Indian ricegrass, blue grama, needleandthread, western wheatgrass, and muttongrass at the higher elevations. Big sagebrush is common on the east side of the MLRA. Narrowleaf cottonwood is along the major streams.

Some of the major wildlife species in this area are elk, mule deer, antelope, jackrabbit, cottontail, pheasant, mourning dove, and waterfowl.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 16%
Grassland—private, 58%; Federal, 18%
Forest—private, 1%
Urban development—private, 2%; Federal, 1%
Water—private, 1%; Federal, 1%
Other—private, 2%

About 75 percent of this area consists of privately owned farms and ranches. The rest is mostly Federal land. Desert shrubs and short grasses cover most of the area. About 16 percent of the area is irrigated cropland. The major crops are potatoes, malt barley and other small grains, field peas, cool-season vegetables, and hay. The native rangeland is grazed in summer, but it has a low carrying capacity.

The major soil resource concerns are water erosion, wind erosion, and saline and sodic soils. Also, a high water table is a concern in some areas. Conservation practices on cropland generally include management of crop residue, nutrients, pesticides, and irrigation water. Forage harvest management is important on the hayland and pasture in this area. ■

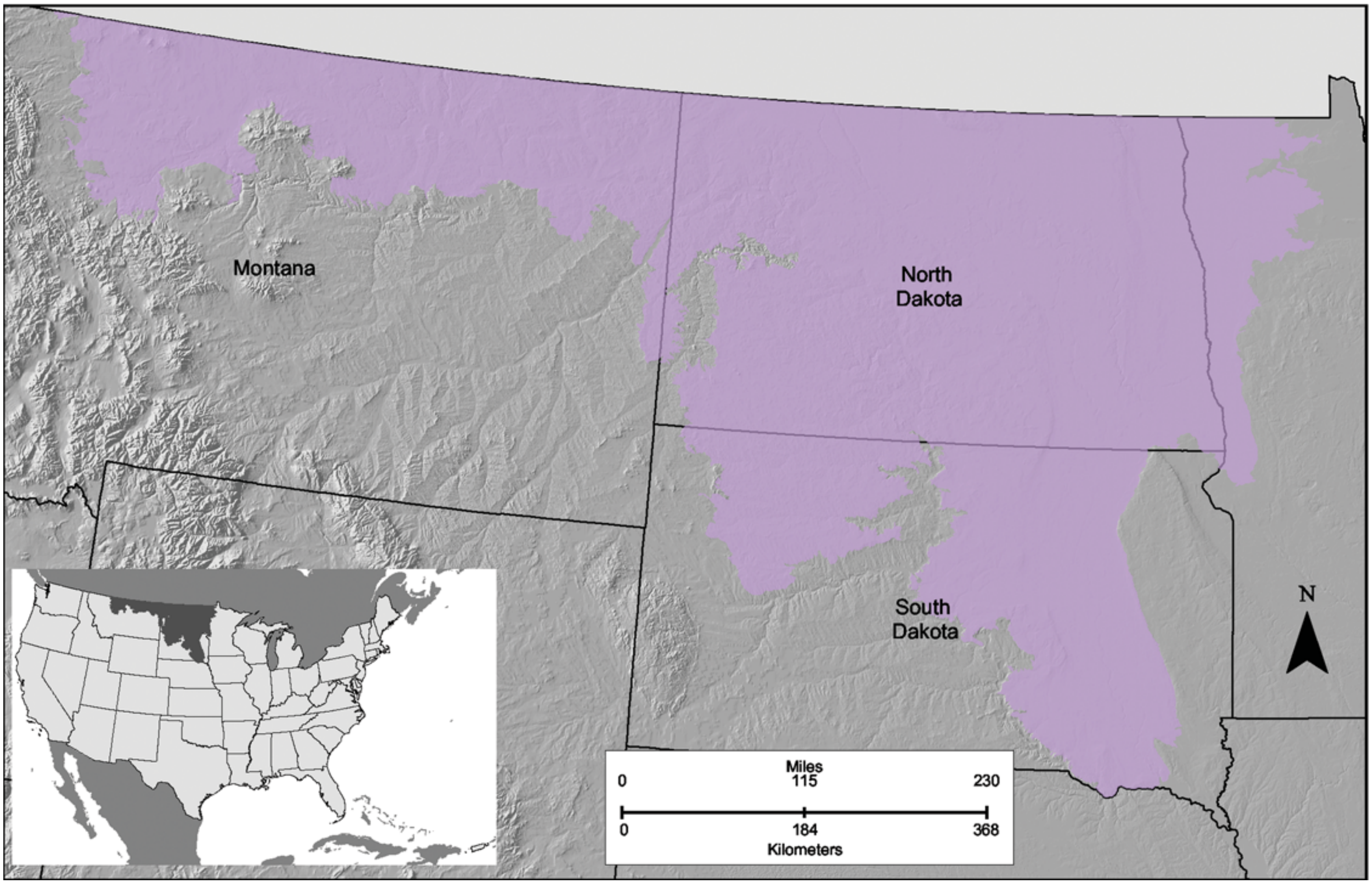

Figure F-1: Location of Land Resource Region F.

F—Northern Great Plains Spring Wheat Region

This region (shown in fig. F-1) is in North Dakota (48 percent), Montana (23 percent), South Dakota (23 percent), and Minnesota (6 percent). It makes up 142,225 square miles (368,535 square kilometers).

Much of this region has been topographically smoothed by continental glaciation and is blanketed by undulating till and level to gently rolling lacustrine deposits. The Red River Valley, in the eastern part of the region, is dominated by lacustrine deposits, as are other areas where ancient glacial lakes occurred. The surficial geology in the southwestern part of the region consists mainly of residual sediments weathered from sedimentary rocks. Alluvial deposits are along drainageways.

Fertile soils and dominantly smooth topography in this region favor agricultural uses (fig. F-2), but relatively low precipitation and a short growing season severely limit the choice of crops that can be grown. The climate is dry and continental, characterized by short, hot summers and long, cold winters. High winds are an important climatic factor. The region also is subject to periodic intense droughts. The mean annual precipitation in most of the region is 14 to 21 inches (355 to 535 millimeters). About 30 percent of the annual precipitation occurs as snow during the winter, and the rest occurs during the growing season. In most of the region, the mean annual air temperature is 39 to 45 degrees F (4 to 7 degrees C) and the freeze-free period ranges from 130 to 170 days. The mean annual air temperature and length of the freeze-free period increase from north to south.

The total withdrawals of freshwater in this region average 3,005 million gallons per day (11,375 million liters per day). About 92 percent is from surface water sources, and 8 percent is from ground water sources. About 80 percent of the water is used for cooling thermoelectric power plants.

The soils in this region are dominantly Mollisols. Ustolls and Aquolls are the dominant suborders. Ustolls are on uplands, and Aquolls are in low wet areas and along streams. Aquolls are extensive in the Red River Valley. Some of the Ustolls have a high content of sodium, and some of the Aquolls have a high

Figure F-2: Cropland, pasture, and rangeland in an area of Land Resource Region F.

content of sodium and lime. Other important soils are Orthents on the steeper slopes. The soils in the region dominantly have a frigid soil temperature regime, an ustic or aquic soil moisture regime, and mixed or smectitic mineralogy.

About 96 percent of the land in this region is privately owned. The native vegetation consists mainly of mixed and tall prairie grasses. The main crop is spring wheat, which is grown by dryfarming methods. Other spring-planted grains, flax, and hay also are grown. Potatoes, sugar beets, soybeans, and corn are important crops in the Red River Valley. The main management concerns in areas of cropland are a reduced nutrient content, increasing salinity, and susceptibility to water erosion and wind erosion. ■

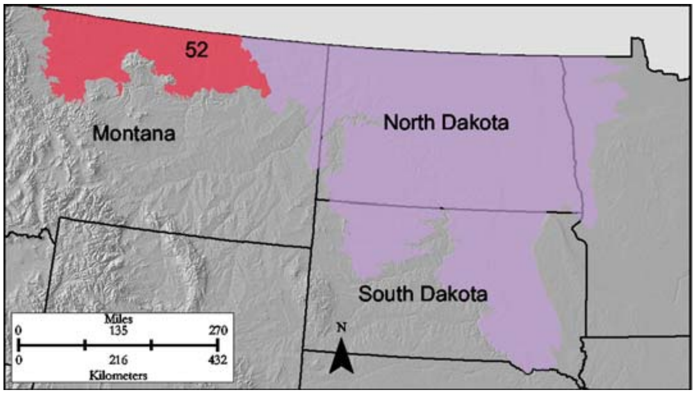

Figure 52-1: Location of MLRA 52 in Land Resource Region F.

52—Brown Glaciated Plain

This area is entirely in Montana (fig. 52-1). It makes up about 23,040 square miles (59,700 square kilometers). It includes the cities of Great Falls and Havre. Interstate 15 crosses the west end of the MLRA. Ft. Peck Dam, the first dam on the Missouri River, is in the southeast corner of this MLRA. The Malmstrom Air Force Base and Blackfeet, Rocky Boy's, Fort Belknap, and Fort Peck Indian Reservations are in this MLRA. This area has numerous national wildlife refuges, including Lake Thibadeau, Benton Lake, and Bowdoin National Wildlife Refuges.

Physiography

Almost the entire MLRA is in the Missouri Plateau, Glaciated, Section of the Great Plains Province of the Interior Plains. Part of the southwest corner of the area is in the Missouri Plateau, Unglaciated, Section. Elevation generally ranges from 1,970 to 4,600 feet (600 to 1,400 meters), increasing from east to west. The glaciated plain in this area generally is nearly level to gently rolling, but belts of steep slopes border some of the larger rivers. The Milk River has extensive flood plains, but the flood plains along other streams are narrow and discontinuous.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Milk (1005), 59 percent; Missouri-Marias (1003), 31 percent; Missouri-Musselshell (1004), 6 percent; and Missouri-Poplar (1006), 4 percent. The Teton, Marias, and Milk Rivers occur in this area. A short reach of the Missouri River that flows through the southwest corner of the area is part of the Missouri Breaks National Wild and Scenic River.

Geology

Almost all of this MLRA is covered by glacial till plains. Some glacial lacustrine deposits occur, and shale may be exposed on some uplands in the west. Alluvial deposits are extensive along the Milk River but occur in narrow and discontinuous strips along other streams and rivers. Low terraces occur along the major rivers, and some alluvial fans occur at the western boundary of the area and around the Sweetgrass Hills, just outside the northern boundary.

Climate

The average annual precipitation is 10 to 17 inches (255 to 430 millimeters) in most of this area. Some of the higher elevations in the far west part of the area receive 21 inches (535 millimeters) of annual precipitation. About 70 percent of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. The maximum precipitation occurs from spring through early summer. Precipitation in winter occurs as snow. This area typically receives 25 to 50 inches (635 to 1,270 millimeters) of snow each year. The average annual temperature is 38 to 45 degrees F (4 to 7 degrees C). The freeze-free period averages 140 days and ranges from 120 to 165 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 1.9%; ground water, 0.0%
Livestock—surface water, 0.3%; ground water, 0.3%
Irrigation—surface water, 94.7%; ground water, 1.1%
Other—surface water, 0.6%; ground water, 1.0%

The total withdrawals average 1,085 million gallons per day (4,105 million liters per day). About 2 percent is from ground water sources, and 98 percent is from surface water sources. Most of the area depends on precipitation for water for both range and crops. The Milk and Teton Rivers provide irrigation water to their flood plains and to areas adjacent to the flood plains. In the uplands, water for livestock is stored in small reservoirs. The surface water generally is suitable for most uses, except during periods of low flow. The seasonal variation in quantity of surface water generally poses more of a problem for use than water quality.

Some ground water is pumped from the alluvial fill in the lower half of the Milk River. Alluvial deposits and terrace gravel deposits are the primary sources of ground water in eastern Montana. The ground water is very hard and exceeds national drinking water standards for dissolved solids and sulfate. It is still used for drinking water, livestock, and irrigation. The glacial drift yields a moderate amount of ground water that is hard but otherwise of good quality. This MLRA is underlain by Mesozoic sedimentary rock aquifers consisting of sandstone, siltstone, shale, and limestone. Eagle Sandstone under the western half provides soft water, and the Judith River Formation under the eastern half provides hard water. The content of dissolved solids in both aquifers exceeds national drinking water standards. Water from the glacial drift is a calcium bicarbonate type, and water from the Milk River alluvium and the Mesozoic sediments is a sodium sulfate type.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, and Mollisols. The soils in the area dominantly have a frigid soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They generally are very deep, well drained, and loamy or clayey. Natrustalfs (Elloam and Thoeny series) and Haplustalfs (Phillips series) formed in till on till plains. Ustorthents (Hillon and Sunburst series) formed in till on till plains and hills. Argiustolls formed in till on till plains and hills (Bearpaw, Joplin, Scobey, Telstad, and Vida series) and in alluvium on alluvial fans, stream terraces, and hills (Ethridge and Evanston series).

Biological Resources

This area supports grassland vegetation. Bluebunch wheatgrass, needleandthread, western wheatgrass, green needlegrass, and basin wildrye are the dominant species.

Some of the major wildlife species in this area are elk, mule deer, white-tailed deer, antelope, coyote, badger, beaver, raccoon, mink, jackrabbit, cottontail rabbit, ground squirrel, pheasant, Hungarian partridge, sharp-tailed grouse, sage grouse, ducks, geese, and swans. The species of fish in the area include trout, walleye, northern pike, sauger, and perch.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 45%
Grassland—private, 36%; Federal, 16%
Urban development—private, 1%
Water—private, 1%
Other—private, 1%

Nearly all this area is in farms and ranches. Level tracts, mostly in the western part of the area, are used as cropland, which makes up almost one-half of the total area. Spring wheat is the major cash crop, but feed grains and hay also are grown on most farms. Most of the land in the eastern part of the area is rangeland, but gently sloping soils are used for dry-farmed wheat. Narrow, discontinuous strips along the Milk River are irrigated. Feed grains, corn silage, hay, and tame pasture are grown on much of the irrigated land, and sugar beets are an important cash crop.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, management of soil moisture, and control of saline seeps. Inefficient water use on irrigated cropland is a water resource concern. Plant resource concerns are deterioration of plant condition, productivity, health, and vigor; noxious and invasive plants; and wildfires. Animal resource concerns are inadequate food, cover, and shelter.

Conservation practices on cropland generally include crop residue management, minimum tillage, cover crops, stripcropping, nutrient management, soil salinity management, and pest management. Conservation practices that improve water use and distribution on irrigated cropland generally include irrigation water management, irrigation water delivery systems, and on-farm irrigation practices, such as land leveling, land smoothing, water-control structures, and sprinklers. Noxious and invasive plants can be controlled by pest management and prescribed grazing. Firebreaks reduce the hazard of wildfires.

Conservation practices on rangeland generally include prescribed grazing, fencing, and water developments. Establishment of early and late season pastures supplements forage production and helps to keep livestock off the rangeland during critical growth periods. Range improvement practices and the establishment of food plots benefit wildlife. ■

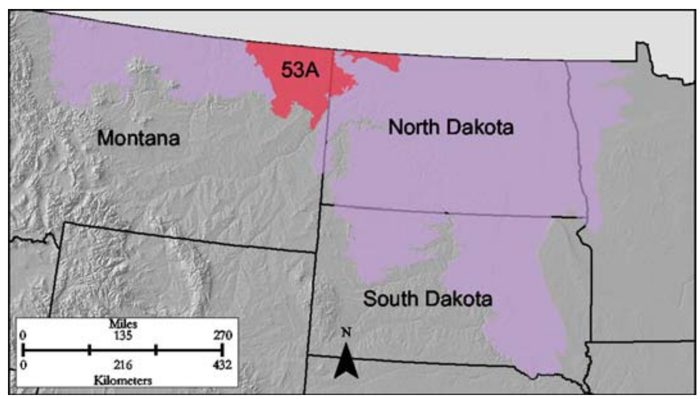

Figure 53A-1: Location of MLRA 53A in Land Resource Region F.

53A—Northern Dark Brown Glaciated Plains

This area (shown in fig. 53A-1) is in Montana (89 percent) and North Dakota (11 percent). It makes up about 9,220 square miles (23,885 square kilometers). The towns of Wolf Point and Sidney, Montana, and Williston, North Dakota, are in this MLRA. U.S. Highways 2 and 85 intersect directly west of Williston. Most of the Fort Peck Indian Reservation is in this MLRA. Medicine Lake and Lake Zahl National Wildlife Refuges also are in this MLRA. Fort Union National Historic Site and Fort Buford State Historical Site are on the southern edge of the area.

Physiography

This MLRA is in the Missouri Plateau, Glaciated, Section of the Great Plains Province of the Interior Plains. Elevation ranges from 1,950 to 2,950 feet (595 to 900 meters), increasing gradually from southeast to northwest. The gently undulating to rolling till plains in this area are interrupted by more strongly rolling and steep slopes adjacent to kettle holes, kames, moraines, and major stream valleys.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Missouri-Poplar (1006), 84 percent; Missouri-Little Missouri (1011), 7 percent; Lower Yellowstone (1010), 6 percent; and Milk (1005), 3 percent. The Missouri River bisects the southern part of this MLRA, and the Yellowstone River joins the Missouri River just inside the North Dakota border. The Poplar and Big and Little Muddy Rivers, all tributaries of the Missouri River, occur in this area.

Geology

This area is covered by glacial till plains. Glacial features, such as kettle holes, kames, and moraines, are common throughout the plains. Some alluvial deposits are along the Missouri River and its major tributaries. Unconsolidated sand and gravel deposits are on high and low terraces along the Missouri River and on low terraces along the other rivers in the area.

Climate

The average annual precipitation in this area is 12 to 15 inches (305 to 380 millimeters). About 70 percent of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. Winter precipitation typically is snow. The annual snowfall is 25 to 50 inches (635 to 1,270 millimeters). The average annual temperature is 38 to 44 degrees F (3 to 7 degrees C). The freeze-free period averages 135 days and ranges from 120 to 155 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 0.5%; ground water, 2.6%
Irrigation—surface water, 77.6%; ground water, 5.7%
Other—surface water, 5.9%; ground water, 7.6%

The total withdrawals average 105 million gallons per day (395 million liters per day). About 16 percent is from ground water sources, and 84 percent is from surface water sources. In most years moisture is inadequate for maximum crop production. In some areas dug ponds provide water for livestock. The Missouri River is the only dependable source of water for irrigation. Thus, only a small acreage is irrigated. The Missouri River water is of good quality and is suitable for most uses with minimal treatment.

There is a limited supply of ground water in the glacial till deposits and the underlying Cenozoic Fort Union Formation. This formation consists of soft, calcareous shales, siltstones, and sandstones. Water from these aquifers is very hard and high in total dissolved solids. The water from the Fort Union Formation is a sodium sulfate type.

Soils

The dominant soil orders in this MLRA are Inceptisols and Mollisols. The soils in the area dominantly have a frigid soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They generally are very deep, moderately well drained or well drained, and clayey or loamy. Calciustepts (Zahill series), Natrustolls (Niobell series), and Calciustolls (Zahl series) formed in till on till plains and moraines. Haplustolls (Tally series) formed in eolian deposits, alluvium, or glaciofluvial deposits on fans, terraces, and outwash plains and in drainageways. Argiustolls formed in till (Vida and Williams series) and mixed till and alluvium (Bowbells series) on till plains, moraines, and hills. Argiustolls also formed in alluvium or eolian deposits over till (Dooley series), alluvium (Turner series), and alluvium, lacustrine deposits, or glaciofluvial deposits (Farnuf series) on lake plains, fans, and terraces and in drainageways.

Biological Resources

This area supports natural prairie vegetation characterized by western wheatgrass, needleandthread, green needlegrass, and blue grama. Little bluestem is an important species on the more sloping and shallower soils. Prairie cordgrass, northern reedgrass, and slim sedge are important species on wet soils. Western snowberry, stiff goldenrod, echinacea, and prairie rose are commonly interspersed throughout the area.

The major wildlife species in this area are mule deer, white-tailed deer, antelope, pheasant, sharp-tailed grouse, Hungarian partridge, Canadian goose, mallard, blue-winged teal, pintail, pelican, and shorebirds.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 56%
Grassland—private, 39%; Federal, 1%
Urban development—private, 1%
Water—private, 1%
Other—private, 2%

Most of this area is in farms and ranches. Slightly more than one-half of the area is dry-farmed cropland. Spring wheat is the chief crop, but flax, oats, and barley are grown on some farms. The more sloping soils support native grasses and are used as rangeland.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, management of soil moisture, and control of saline seeps. Water resource concerns are inefficient water use on irrigated cropland and excessive amounts of pesticides, nutrients, and organic material in surface and ground waters. Plant resource concerns are deterioration of plant condition, productivity, health, and vigor; noxious and invasive plants; and wildfires. Animal resource concerns are inadequate food, cover, and shelter.

Conservation practices on cropland generally include crop residue management, minimum tillage, cover crops, stripcropping, nutrient management, soil salinity management, and pest management. Conservation practices that improve water use and distribution on irrigated cropland generally include irrigation water management, irrigation water delivery systems, and on-farm irrigation practices, such as land leveling, land smoothing, water-control structures, sprinklers, and applications of anionic polyacrylamide (PAM) for erosion control. Noxious and invasive plants can be controlled by pest management and prescribed grazing. Forest stand improvement and firebreaks reduce the hazard of wildfires.

Conservation practices on rangeland generally include prescribed grazing, fencing, and water developments. Establishment of early and late season pastures supplements forage production and helps to keep livestock off the rangeland during critical growth periods. Range improvement practices and the establishment of food plots benefit wildlife. ■

53B—Central Dark Brown Glaciated Plains

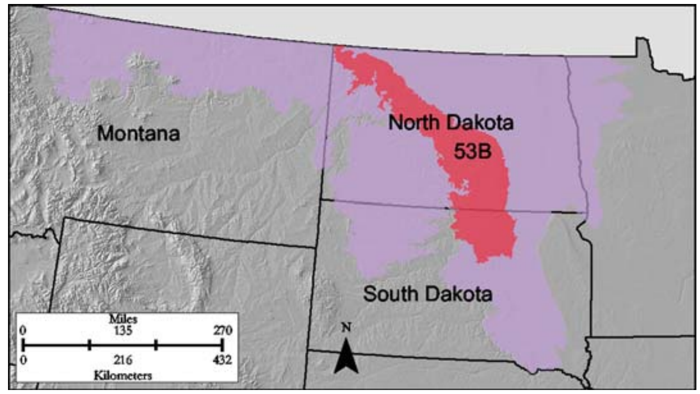

Figure 53B-1: Location of MLRA 53B in Land Resource Region F.

This area (shown in fig. 53B-1) is in North Dakota (77 percent) and South Dakota (23 percent). It makes up about 19,640 square miles (50,900 square kilometers). The city of Bismarck, North Dakota, is in this MLRA, and Interstate 94 crosses the area, passing through Bismarck. Part of the Fort Berthold Indian Reservation is in this MLRA. The Lostwood, Long Lake, Des Lacs, Upper Souris, Lost Lake, Audubon, Canfield Lake, and Pocasse National Wildlife Refuges are in this area. Garrison Dam, on the Missouri River north of Bismarck, formed Lake Sakakawea on the western border of the MLRA.

Physiography

Almost the entire MLRA is in the Missouri Plateau, Glaciated, Section of the Great Plains Province of the Interior Plains. Small portions of the northeast and southeast corners of the area are in the Western Lake Section of the Central Lowland Province of the Interior Plains. Elevation ranges from 1,640 to 1,970 feet (500 to 600 meters), increasing gradually from southeast to northwest. The nearly level to rolling till plains in this MLRA include kettle holes, kames, moraines, and small glacial lakes. Moderately steep and steep slopes are adjacent to the major stream valleys. The southeast corner of the MLRA consists of nearly level terrain on the west edge of a glacial lake plain.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Missouri-Oahe (1013), 47 percent; James (1016), 24 percent; Missouri-Little Missouri (1011), 23 percent; Souris (0901), 4 percent; Red (0902), 1 percent; and Missouri-Poplar (1006), 1 percent. The Missouri River runs parallel with the western boundary along most of this MLRA. The Des Lacs and Upper Souris Rivers just touch the northeast corner of the MLRA.

Geology

Almost all of this MLRA is covered by glacial till plains. Some glaciolacustrine deposits also occur. Kettle holes, kames, moraines, and small glacial lakes break up the nearly level terrain. Alluvial deposits are extensive along the Missouri, Des Lacs, and Souris Rivers but occur in narrow and discontinuous strips along other streams and rivers. Low terraces occur along the major rivers.

Climate

The average annual precipitation is 14 to 20 inches (355 to 510 millimeters). About 75 percent of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. Winter precipitation is typically snow. The annual snowfall is 25 to 50 inches (635 to 1,270 millimeters). The average annual temperature is 38 to 45 degrees F (3 to 7 degrees C). The freeze-free period averages 145 days and ranges from 130 to 165 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.6%; ground water, 0.0%
Livestock—surface water, 1.1%; ground water, 0.9%
Irrigation—surface water, 7.4%; ground water, 3.0%
Other—surface water, 85.6%; ground water, 1.5%

The total withdrawals average 545 million gallons per day (2,060 million liters per day). About 5 percent of the water is from ground water sources, and 95 percent is from surface water sources. In most years moisture is inadequate for maximum crop production. The Missouri River is the only dependable source of water for irrigation. Thus, only small areas close to the river and to Lake Sakakawea are irrigated. Missouri River water is of good quality. The city of Bismarck obtains its drinking water from the river. In areas away from the Missouri River, ponds are a source of water for livestock. Surface water quality outside of the Missouri River is fair or poor. Limited quantities and high amounts of dissolved solids limit the use of this water. Rural water systems are improving the quality of water available for domestic use. These systems typically obtain their water from the Missouri River and its reservoirs.

There is a limited supply of ground water in surficial, unconsolidated aquifers and in the Cenozoic sedimentary bedrock aquifers beneath the till plains. The unconsolidated aquifers consist of alluvial deposits in stream valleys and glacial drift and outwash deposits. Water in the unconsolidated aquifers is generally very hard and high in sodium and sulfate. It is used as drinking water in some rural areas. The high salinity limits its use for irrigation. The sedimentary bedrock aquifers are the Fort Union aquifer system in the northern two-thirds of the MLRA and the Hell Creek-Fox Hills aquifer system in the southern third. Both of these bedrock aquifer systems contain soft water with high levels of sodium and dissolved solids. High salinity limits the use of the water for irrigation. Naturally occurring selenium levels in the Fort Union aquifer system are much greater than the recommended levels for drinking water.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a frigid soil temperature regime, an ustic or aquic soil moisture regime, and mixed or smectitic mineralogy. They generally are very deep, well drained to very poorly drained, and clayey or loamy. Endoaquolls (Southam series) and Argiaquolls (Parnell series) formed in alluvium in depressions on till plains, moraines, and lake plains. Argialbolls (Tonka series) formed in alluvium over till in depressions on till plains and lake plains. Natrustolls (Niobell and Noonan series) and Calciustolls (Zahl series) formed in till on till plains and moraines. Haplustolls formed in alluvium (Bowdle and Lehr series) and glaciofluvial deposits (Wabek series) on outwash plains and terraces, in till (Max series) on till plains, and in silty drift or loess (Bryant series) on uplands. Argiustolls formed in till (Vida and Williams series) and mixed till and alluvium (Bowbells series) on till plains, moraines, and hills.

Biological Resources

This area supports natural prairie vegetation characterized by western wheatgrass, needleandthread, green needlegrass, and big bluestem. Little bluestem is an important species on the more sloping and shallower soils. Prairie cordgrass, northern reedgrass, and slim sedge are important species on wet soils. Western snowberry, stiff goldenrod, echinacea, and prairie rose are commonly interspersed throughout the area.

Some of the major wildlife species in this area are white-tailed deer, red fox, raccoon, muskrat, mink, jackrabbit, cottontail rabbit, fox squirrel, pheasant, gray partridge, sharp-tailed grouse, mourning dove, geese, and ducks. The species of fish in the area include northern pike, walleye, trout, catfish, bass, bluegill, perch, and bullhead.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 56%
Grassland—private, 36%; Federal, 1%
Urban development—private, 2%
Water—private, 2%
Other—private, 3%

Most of this area is in farms and ranches. Slightly more than one-half of the area is dry-farmed cropland. Spring wheat is the chief crop, but flax, oats, barley, and alfalfa are grown on many farms. The more sloping soils support native grasses and are used as rangeland.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management and no-till systems that conserve moisture and improve soil quality. Other practices include vegetative wind barriers, wind stripcropping, grassed waterways, and nutrient management. ■

Figure 53C-1: Location of MLRA 53C in Land Resource Region F.

53C—Southern Dark Brown Glaciated Plains

This area is entirely in South Dakota (fig. 53C-1). It makes up about 3,990 square miles (10,340 square kilometers). It has no major population centers. U.S. Highways 14, 83, and 212 cross the area, and a portion of the Crow Creek Indian Reservation is in the area. The area is generally bounded by the Missouri Breaks to the west and the James Valley Lowlands to the east and south.

Physiography

The entire MLRA is in the Missouri Plateau, Glaciated, Section of the Great Plains Province of the Interior Plains. Elevation ranges from 1,300 to 2,300 feet (395 to 700 meters). The nearly level to gently rolling till plains include many areas of potholes. A terminal moraine occurs in the southern end of the MLRA, north and west of Wessington Springs. Local relief is about 390 feet (120 meters) from the top of the moraine to the outwash and till plain to the east. Moderately steep and steep slopes are adjacent to the major valleys.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Missouri-White (1014), 55 percent; Missouri-Oahe (1013), 35 percent; and James (1016), 10 percent. The headwaters of many creeks in central South Dakota occur in this high-lying MLRA.

Geology

This area is covered by glacial till plains broken by numerous potholes. A terminal moraine occurs in the southern end of the area. Cretaceous Pierre Shale lies beneath the glacial deposits in the MLRA.

Climate

The average annual precipitation is 15 to 25 inches (380 to 635 millimeters). About 70 percent of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. The annual snowfall is typically 25 to 45 inches (635 to 1,145 millimeters). The average annual temperature is 43 to 49 degrees F (6 to 9 degrees C). The freeze-free period averages 150 days and ranges from 140 to 160 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 10.9%; ground water, 0.0%
Livestock—surface water, 52.6%; ground water, 15.8%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 15.3%; ground water, 5.5%

The total withdrawals average 9 million gallons per day (34 million liters per day). About 21 percent is from ground water sources, and 79 percent is from surface water sources. In most years moisture is inadequate for maximum crop production. Most of the water for livestock comes from dug ponds. Rural water systems in the area supply domestic water to an increasing number of farms and communities. Water for these systems comes from the Missouri River, which has water of very good quality.

There is a limited supply of ground water in the glacial drift and alluvial aquifers that occur near the ground surface. These aquifers consist of unconsolidated sand and gravel. The fresh to saline water is hard and is a calcium, bicarbonate, and sulfate type. The aquifers provide water primarily for domestic use and livestock. The level of total dissolved solids typically exceeds the recommended levels for drinking water. Many private wells have high levels of nitrate plus nitrite. Most of this contamination occurs where the wells are located downslope from septic tank absorption fields, feedlots, barnyards, and fertilizer storage areas.

Soils

The dominant soil orders in this MLRA are Mollisols and Inceptisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They are very deep, generally well drained or moderately well drained, and loamy or clayey. Haplustolls and Natrustolls (Cavo and Java series) formed in till on till plains. Argiustolls formed in loess on uplands (Agar series), in till on till plains and uplands (Glenham, Prosper, and Raber series), in colluvium and/or alluvium on footslopes and in swales (Mobridge and Onita series), and in silty sediments on uplands (Eakin and Highmore series). Natraquolls (Hoven series) formed in alluvium in basins. Argialbolls (Tetonka series) formed in alluvium in depressions. Calciustepts (Betts series) formed in till on moraines.

Biological Resources

This area supports natural prairie vegetation. Western wheatgrass, big bluestem, needleandthread, and green needlegrass are the dominant species. Little bluestem, sideoats grama, and prairie sandreed are important species on the steeper sites. Western snowberry and prairie rose are commonly interspersed throughout the area.

Some of the major wildlife species in this area are mule deer, white-tailed deer, coyote, bobcat, cottontail, sharp-tailed grouse, gray partridge, mourning dove, pheasant, geese, and ducks. The species of fish in the area include largemouth bass, bluegill, bullhead, and yellow perch.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 54%
Grassland—private, 41%
Urban development—private, 2%
Water—private, 1%
Other—private, 2%

Most of this area is in farms and ranches. Slightly more than one-half of the area is dry-farmed cropland. Winter wheat is the chief cash crop. Corn, sunflowers, grain sorghum, oats, and alfalfa are grown on many farms. The more sloping soils are used as rangeland.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management and no-till systems that conserve moisture and improve soil quality. Other practices include windbreaks, vegetative wind barriers, wind stripcropping, and nutrient management. ■

54—Rolling Soft Shale Plain

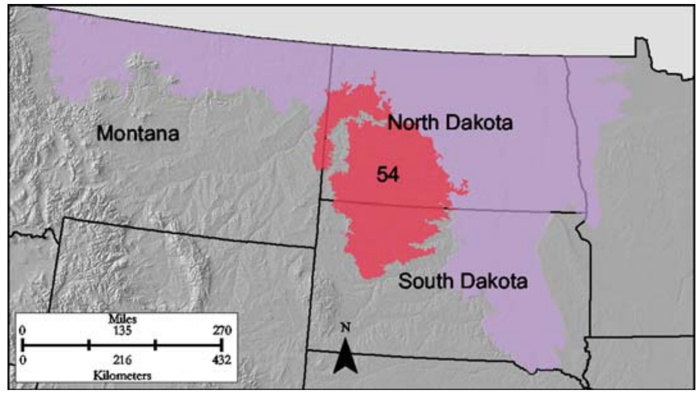

Figure 54-1: Location of MLRA 54 in Land Resource Region F.

This area (shown in fig. 54-1) is in North Dakota (64 percent), South Dakota (33 percent), and Montana (3 percent). It makes up about 29,280 square miles (75,870 square kilometers). The cities of Dickinson and Mandan, North Dakota, and the towns of Lemmon and Faith, South Dakota, are in this MLRA. Interstate 94 crosses the northern half of the area, and U.S. Highways 12, 85, and 212 are in the area. The Missouri River is at the eastern edge of the area, and Lake Sakakawea, formed by the Garrison Dam, is the northeastern boundary of the area. Grand River National Grasslands, most of the Standing Rock Indian Reservation, and the northwest third of the Cheyenne River Indian Reservation are in the southern part of the area.

Physiography

This area is in the Missouri Plateau, Unglaciated, and Missouri Plateau, Glaciated, Sections of the Great Plains Province of the Interior Plains. It is dominantly unglaciated, but the eastern and northern edges have been glaciated. The area is on an old, moderately dissected, rolling plain with some local badlands, buttes, and isolated hills. Terraces are adjacent to broad flood plains along most of the major drainages. Elevation is 1,650 feet (505 meters) in the east with a gradual slope to about 3,600 feet (1,100 meters) in the west. Maximum local relief is about 330 feet (100 meters), but relief is considerably lower in most of the area.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Missouri-Oahe (1013), 73 percent; Missouri-Little Missouri (1011), 17 percent; Cheyenne (1012), 6 percent; and Lower Yellowstone (1010), 4 percent. The Knife, Heart, Cannonball, and Cedar Rivers, which are major tributaries of the Missouri River in North Dakota, drain this area. Also, the Grand and Moreau Rivers in South Dakota drain the southern part of the area.

Geology

This area is underlain by soft, calcareous shales, siltstones, and sandstones of the Tertiary Fort Union Formation and the Fox Hills and Hell Creek units. The principal sources of ground water in the area are in these rocks. Impermeable Cretaceous shale underlies these aquifers. The northern and eastern parts of the area have a glacially modified topography and in places are covered by thin layers of glacial drift.

Climate

The average annual precipitation is 14 to 18 inches (355 to 455 millimeters). Most of the rainfall occurs as convective thunderstorms during the growing season. About half of the annual precipitation occurs as snow in winter. The average annual temperature is 38 to 46 degrees F (3 to 8 degrees C). The freeze-free period averages 150 days and ranges from 130 to 165 days. It is shortest in the southern part of the area and longest in the northern part.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 1.1%; ground water, 1.3%
Livestock—surface water, 1.3%; ground water, 0.3%
Irrigation—surface water, 6.3%; ground water, 6.7%
Other—surface water, 82.5%; ground water, 0.6%

The total withdrawals average 415 million gallons per day (1,570 million liters per day). About 9 percent is from ground water sources, and 91 percent is from surface water sources. In most years the supply of moisture is inadequate for maximum crop production. Water for irrigation is available in quantity only from the Missouri River and a few of its larger tributaries. The surface water is generally soft and is typically a sodium bicarbonate type. Water for livestock is stored primarily in small reservoirs. The Missouri River water is used dominantly as cooling water for thermoelectric power generation.

Small areas of sand and gravel buried beneath valley floors in this MLRA yield moderate quantities of hard water. Ground water from the Tertiary units is generally hard or very hard. Sodium, sulfate, and bicarbonate are the major ions in the ground water. The Fort Union Formation in North Dakota yields soft water, but the water is high in content of selenium. The content of molybdenum is high in the water in the shallow aquifers in South Dakota. High levels of selenium and molybdenum affect the health of humans and livestock. Ground water is scarce or does not occur in areas underlain by shale. Farms, ranches, and small communities use ground water for most purposes, except for irrigation.

Soils

The dominant soil orders in this MLRA are Mollisols and Entisols. The soils in the area dominantly have a frigid soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep, generally somewhat excessively drained to moderately well drained, and loamy or clayey. Haplustolls formed in residuum on uplands (Amor and Vebar series) and in alluvium on stream terraces and in upland drainageways (Parshall series). Natrustolls (Belfield, Daglum, and Rhoades series) formed in residuum and/or alluvium on uplands and stream terraces and in upland drainageways. Calciustolls (Chama series), Ustorthents (Cabba series), and Ustipsamments (Flasher series) formed in residuum and/or colluvium on uplands. Argiustolls formed in residuum on uplands (Morton, Reeder, and Regent series) and in till on till plains and moraines (Williams series).

Biological Resources

This area supports natural prairie vegetation characterized by western wheatgrass, needleandthread, green needlegrass, and blue grama. Little bluestem, prairie sandreed, and sideoats grama are important species on shallow soils. Prairie rose, leadplant, and patches of western snowberry are interspersed throughout the area. Green ash, chokecherry, and buffaloberry occur in draws and narrow valleys.

Some of the major wildlife species in this area are white-tailed deer, mule deer, pronghorn antelope, red fox, coyote, white-tailed jackrabbit, prairie dog, ring-necked pheasant, gray partridge, sharp-tailed grouse, ducks, and geese. The species of fish in the area include rainbow trout, walleye, smallmouth bass, bluegill, yellow perch, and northern pike. Fishing is limited mostly to rivers and constructed impoundments.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 38%; Federal, 1%
Grassland—private, 50%; Federal, 4%
Forest—private, 1%
Urban development—private, 1%
Water—private, 3%
Other—private, 2%

Farms and ranches make up nearly all of this area. They produce a combination of cash-grain crops and livestock. More than one-half of the area supports native grasses and shrubs that are grazed. About one-third of the area is used for dry-farmed small grains, such as wheat, barley, oats, rye, and flax. Corn for grain and silage, sunflowers, and alfalfa also are important crops. Some small tracts on the bottom land along the Missouri River are irrigated.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, management of soil moisture, and control of saline seeps. Conservation practices on cropland generally include systems of crop residue management and minimum-till and no-till systems that reduce the need for summer fallow tillage. Other practices include cover crops, windbreaks, vegetative wind barriers, wind stripcropping, nutrient management, and soil salinity management. Conservation practices on rangeland generally include prescribed grazing, fencing, and water developments. ■

Figure 55A-1: Location of MLRA 55A in Land Resource Region F.

55A—Northern Black Glaciated Plains

This area is entirely in North Dakota (fig. 55A-1). It makes up about 12,765 square miles (33,075 square kilometers). Minot and Devils Lake are in this MLRA. The International Peace Garden is in the north-central part of the area, on the Canadian border. The Geographical Center of North America is in the south-central part of the MLRA. The Turtle Mountains and Fort Totten (or Devils Lake Sioux) Indian Reservations are in this MLRA. The Upper Souris, J. Clark Salyer, Rock Lake, Brumba, Silver Lake, and Lake Alice National Wildlife Refuges also are in this MLRA.

Physiography

All of this area is in the Western Lake Section of the Central Lowland Province of the Interior Plains. Elevation ranges from 1,200 to 2,550 feet (365 to 775 meters), increasing from east to west. The mostly nearly level to gently rolling till plains include areas of kettle holes, kames, and moraines. Some of the depressions contain lakes. Also in the area are nearly level glacial lake plains and some steep slopes adjacent to streams. The Turtle Mountains, in the north-central part of the MLRA, on the Canadian border, are approximately 1,950 to 2,550 feet (595 to 775 meters) in elevation, rising approximately 500 feet (150 meters) above the adjacent till plain.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Souris (0901), 56 percent, and Red (0902), 44 percent. The Souris River is in this MLRA. The headwaters of the Sheyenne River, a major tributary to the Red River of the North, are in the south-central part of this area.

Geology

This MLRA is covered by glacial till plains. It also has some glaciolacustrine deposits, kettle holes, kames, moraines, and glacial lake plains. The Turtle Mountains are remnants of a glacial moraine in this MLRA. Alluvial deposits are extensive along the Souris River but occur in narrow and discontinuous strips along other streams and rivers. Low terraces are along the major rivers.

Climate

The average annual precipitation is 14 to 19 inches (355 to 485 millimeters). About 75 percent of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. Winter precipitation is typically snow. The annual snowfall is 25 to 50 inches (635 to 1,270 millimeters). The average annual temperature is 36 to 41 degrees F (2 to 5 degrees C). The freeze-free period averages 140 days and ranges from 125 to 155 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.3%; ground water, 0.1%
Livestock—surface water, 0.3%; ground water, 0.4%
Irrigation—surface water, 0.4%; ground water, 0.4%
Other—surface water, 97.4%; ground water, 0.6%

The total withdrawals average 760 million gallons per day (2,875 million liters per day). About 2 percent is from ground water sources, and 98 percent is from surface water sources. In some years precipitation is inadequate for maximum crop production. The few perennial streams in the area are widely spaced and are little used for irrigation. Water for livestock is stored in ponds and small reservoirs on individual farms and ranches. There are a number of reservoirs on the Souris River. Some of the reservoir water is used for cooling thermoelectric power plants. The surface water is of good quality but at times is limited in quantity in most of the area.

Ground water is plentiful in unconsolidated sand and gravel deposits in glacial drift, but the water is very hard and generally has a mixture of calcium bicarbonate and sodium bicarbonate or chloride. It is used as drinking water in rural areas. The sedimentary bedrock aquifers are the Hell Creek-Fox Hills aquifer system in the western half of the MLRA and the Great Plains (Dakota) aquifer system in the eastern half. The Hell Creek-Fox Hills aquifer system contains soft water with high levels of sodium and dissolved solids. High salinity limits the use of this water for irrigation. The shale directly under the glacial deposits in the eastern half of the MLRA is not an aquifer. The Great Plains (Dakota) aquifer system is a sandstone unit beneath the shale. It yields large quantities of highly mineralized artesian water. Few wells have been drilled into this unit, however, because of its depth and poor-quality water.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a frigid soil temperature regime, a udic or aquic soil moisture regime, and mixed or smectitic mineralogy. They generally are very deep, well drained to poorly drained, and loamy or clayey. Hapludolls formed in glacial till on till plains and moraines (Barnes, Emrick, and Heimdal series), in sandy sediments on lake plains and outwash plains (Arvilla and Hecla series), in mixed till and alluvium on till plains (Svea series), and in loamy sediments on uplands (Swenoda series). Calciudolls (Buse series) formed in glacial till on till plains and moraines. Calciaquolls formed on lake plains (Bearden and Hegne series) and on till plains (Hamerly and Vallers series). Argiaquolls (Parnell series) and Argialbolls (Tonka series) formed in local alluvium in depressions on till plains.

Biological Resources

This area supports natural prairie vegetation characterized by western wheatgrass, green needlegrass, needleandthread, and blue grama. Little bluestem is an important species on the more sloping and shallower soils. Prairie cordgrass, northern reedgrass, big bluestem, and slough sedge are important species on wet soils. Western snowberry, leadplant, and prairie rose are commonly interspersed throughout the area. A small part of the area can support forest vegetation characterized by oak and aspen.

Some of the major wildlife species in this area are white-tailed deer, coyote, red fox, badger, beaver, raccoon, skunk, muskrat, mink, snowshoe hare, white-tailed jackrabbit, cottontail, fox squirrel, sharp-tailed grouse, gray partridge, ruffed grouse, mourning dove, pheasant, geese, and ducks. The species of fish in the area include northern pike, walleye, perch, trout, and bullhead.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 75%
Grassland—private, 14%; Federal, 2%
Forest—private, 2%
Urban development—private, 2%
Water—private, 2%
Other—private, 2%

Nearly all of this area is in farms and ranches. About three-fourths of the area is dry-farmed cropland. Cash-grain wheat production is the principal enterprise on many farms, but other cash grains and feed grains, such as wheat, durum, barley, oats, and flax, also are grown. Other crops grown include hay, canola, peas, forage crops, corn for grain and silage, and sunflowers. The more sloping and shallower or sandy soils are used as native range. Less than one-tenth of the area is forested.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, management of soil moisture, salinity around wetland borders, and aggregate stability. Conservation practices on cropland generally include crop residue management, no-till and other conservation tillage systems, conservation cropping systems that eliminate the need for fallowing, cover crops, nutrient management, and pest management. ■

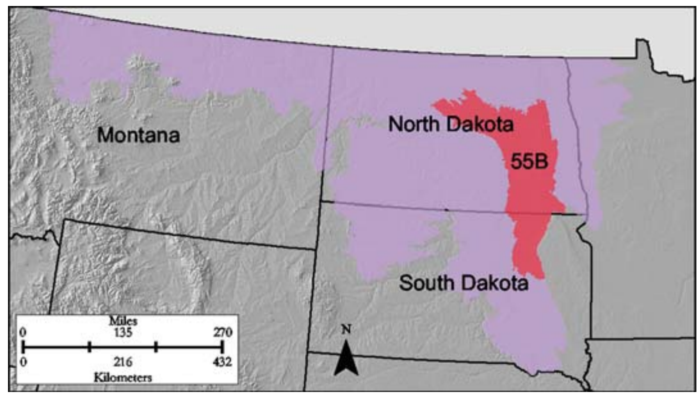

Figure 55B-1: Location of MLRA 55B in Land Resource Region F.

55B—Central Black Glaciated Plains

This area (shown in fig. 55B-1) is in North Dakota (79 percent) and South Dakota (21 percent). It makes up about 17,155 square miles (44,455 square kilometers). The cities of Jamestown, North Dakota, and Aberdeen, South Dakota, are in this MLRA. Interstate 94 passes through Jamestown in the northern half of the area. Numerous national wildlife refuges are in this MLRA, including the Lambs Lake, Johnson Lake, Sibley Lake, Buffalo Lake, Arrowwood, Tewaukon, Chase Lake, and Lake George National Wildlife Refuges in North Dakota and the Sand Lake National Wildlife Refuge in South Dakota.

Physiography

Almost the entire MLRA is in the Western Lake Section of the Central Lowland Province of the Interior Plains. Elevation ranges from 1,000 to 2,050 feet (305 to 625 meters), increasing from east to west. This area is characterized by nearly level to gently rolling till plains and many poorly defined drainage channels. Steep slopes adjacent to the main streams and the glacial lake plains break up the nearly level to gently rolling terrain. The eastern edge of the part of the area in North Dakota and the part of the area in South Dakota are adjacent to glacial Lake Agassiz. A continental drainage divide occurs in the east-central part of the MLRA.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Red (0902), 48 percent; James (1016), 46 percent; and Souris (0901), 6 percent. The James River flows south through all of this area and joins the Missouri River, and the Sheyenne River flows east and north and joins the Red River of the North. The James River is the longest unnavigable river in the United States.

Geology

This MLRA is covered by glacial till plains that include glacial lacustrine deposits. Glacial deposits in kettle holes, kames, and moraines break up the till plain. One of the major river systems in this area is the James River, which was carved by floodwaters draining glacial Lake Dakota. Its valley is filled with glacial outwash and alluvial deposits. A high terrace scarp separates the valley floor from the surrounding land. Alluvial deposits and low terraces occur along the Sheyenne River.

Climate

The average annual precipitation in most of this area is 16 to 21 inches (405 to 535 millimeters). Almost 75 percent of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. Winter precipitation is typically snow. The annual snowfall is 25 to 50 inches (635 to 1,270 millimeters). The average annual temperature is 37 to 44 degrees F (3 to 7 degrees C). The freeze-free period averages 150 days and ranges from 135 to 165 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 2.3%; ground water, 1.2%
Livestock—surface water, 0.1%; ground water, 0.7%
Irrigation—surface water, 2.8%; ground water, 4.4%
Other—surface water, 87.5%; ground water, 1.1%

The total withdrawals average 685 million gallons per day (2,590 million liters per day). About 7 percent is from ground water sources, and 93 percent is from surface water sources. In some years precipitation is inadequate for maximum crop production. Perennial streams are few and widely spaced and are little used for irrigation. Water for livestock is stored in ponds and small reservoirs on individual farms and ranches. The surface water is of fair or good quality but at times is limited in quantity. Most of the surface water in this MLRA is used as cooling water in the generation of electricity from burning fossil fuels.

Ground water occurs in consolidated rocks and glacial drift in this area. The water from the glacial drift is typically fresh or saline and hard or very hard. The freshwater is high in calcium, bicarbonate, and sulfate. The saline water is high in sodium and sulfate. Shallow ground water is used as drinking water in some rural areas. The high salinity in some aquifers limits the use of the water for irrigation, but the aquifers provide water for livestock. One sedimentary bedrock aquifer is Dakota Sandstone in North Dakota. It is about 1,000 feet (305 meters) beneath the land surface.

Two additional sedimentary bedrock aquifers, the Niobrara-Codell and Dakota-Newcastle, occur at a depth of about 1,100 feet (335 meters) in South Dakota. Hell Creek-Fox Hills sedimentary bedrock is under the glacial deposits in the northwest corner of the MLRA. This aquifer system contains soft water with high levels of sodium and dissolved solids. High salinity limits the use of the water for irrigation. The sedimentary bedrock aquifers yield large quantities of slightly saline or moderately saline artesian water. Water from the Niobrara-Codell aquifer is used for domestic purposes and for livestock, but the level of total dissolved solids is too high for the water to be used for irrigation. Water from the Dakota-Newcastle aquifer is used only for livestock.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a frigid soil temperature regime, a udic or aquic soil moisture regime, and mixed or smectitic mineralogy. They generally are very deep, well drained to poorly drained, and loamy or clayey. Hapludolls and Argiudolls formed in glacial till on till plains and moraines (Barnes, Emrick, and Forman series), in sandy sediments on lake plains and outwash plains (Arvilla and Hecla series), in silty lacustrine deposits on lake plains (Great Bend, Beotia, and Harmony series), in mixed till and alluvium on till plains (Svea series), and in loamy sediments on uplands (Swenoda series). Calciudolls (Buse series) formed in glacial till on till plains and moraines. Calciaquolls formed on lake plains (Bearden and Hegne series) and on till plains (Hamerly and Vallers series). Argiaquolls (Parnell series) and Argialbolls (Tonka series) formed in local alluvium in depressions on till plains.

Biological Resources

This area supports natural prairie vegetation characterized by western wheatgrass, green needlegrass, needleandthread, and blue grama. Little bluestem and sideoats grama are important species on the more sloping and shallower soils. Prairie cordgrass, northern reedgrass, big bluestem, and slough sedge are important species on wet soils. Western snowberry, leadplant, and prairie rose are common shrub species interspersed throughout the area.

Some of the major wildlife species in this area are white-tailed deer, coyote, red fox, badger, raccoon, muskrat, mink, white-tailed jackrabbit, cottontail rabbit, pheasant, gray partridge, sharp-tailed grouse, mourning dove, geese, various species of grassland birds, shore birds, amphibians, and ducks. The species of fish in the area include northern pike, perch, walleye, crappie, bluegill, and smallmouth bass.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 76%
Grassland—private, 15%; Federal, 1%
Urban development—private, 3%
Water—private, 1%
Other—private, 4%

About three-fourths of this area is dry-farmed cropland. Cash-grain production is the principal enterprise on many farms. Less than one-fifth of the area, consisting of the more sloping and shallower soils, is used for livestock production on native range or woodland. The dry-farmed crops are principally small grains, such as wheat, durum, and barley, corn for grain, and soybeans. Flax, canola, peas, dry edible beans, sunflowers, forage crops, and corn for silage also are grown.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, management of soil moisture, and salinity around wetland borders. Conservation practices on cropland generally include crop residue management, no-till and other conservation tillage systems, conservation cropping systems that eliminate the need for fallowing, cover crops, nutrient management, and pest management. ■

55C—Southern Black Glaciated Plains

This area is entirely in South Dakota (fig. 55C-1). It makes up about 10,835 square miles (28,075 square kilometers). The cities of Huron, Mitchell, and Yankton are in this MLRA. Interstate 90 bisects the area. The Lake Andes National Wildlife Refuge and the Yankton Indian Reservation are in this MLRA.

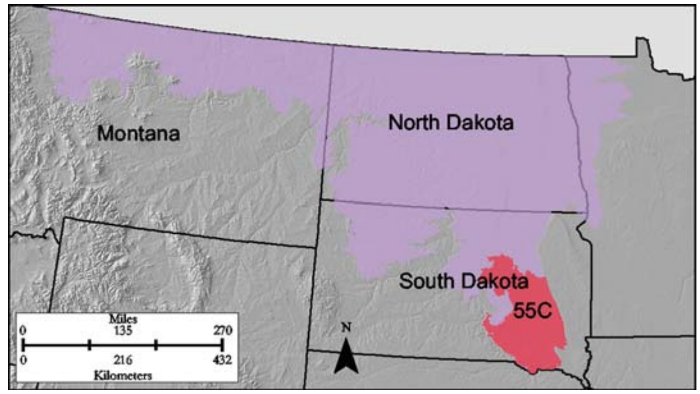

Figure 55C-1: Location of MLRA 55C in Land Resource Region F.

Physiography

Three-fourths of this MLRA is in the Western Lake Section of the Central Lowland Province of the Interior Plains. The southwest quarter is in the Missouri Plateau, Glaciated, Section of the Great Plains Province of the Interior Plains. Elevation ranges from 1,310 to 1,970 feet (400 to 600 meters). Most of the area consists of nearly level to undulating till plains with potholes and moraines. Steep slopes are adjacent to the major streams.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: James (1016), 66 percent; Missouri-Big Sioux (1017), 19 percent; and Missouri-White (1014), 15 percent. The Missouri River runs along the southwest edge of this MLRA, and the James River flows north to south down the center of the MLRA.

Geology

Most of this MLRA is on nearly level to undulating glacial till plains interrupted by steeper slopes adjacent to streams and moraines. Minor moraines are in scattered areas throughout the MLRA, and stagnation moraines are dominant in the southwestern part. Small areas of outwash are adjacent to the minor moraines. The James River is an under-fit stream. Its valley was carved by floodwaters draining glacial Lake Dakota and is filled with glacial outwash and alluvial deposits. The Missouri River flows in a trench cut by glacial meltwater in the adjacent MLRA 63B. A high terrace scarp separates the valley floor along the Missouri and James Rivers from the surrounding land. The transitional area between the uplands and the valley floors of the two rivers is deeply eroded. This area is called the "breaks" along the Missouri River.

Climate

The average annual precipitation is 18 to 25 inches (455 to 635 millimeters). About 70 percent of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. Winter precipitation is typically snow. The annual snowfall is 23 to 46 inches (585 to 1,170 millimeters). The average annual temperature is 43 to 49 degrees F (6 to 10 degrees C). The freeze-free period averages 165 days and ranges from l40 to 190 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 5.6%; ground water, 6.9%
Livestock—surface water, 0.7%; ground water, 2.4%
Irrigation—surface water, 21.5%; ground water, 52.9%
Other—surface water, 1.0%; ground water, 9.0%

The total withdrawals average 90 million gallons per day (340 million liters per day). About 71 percent is from ground water sources, and 29 percent is from surface water sources. In most years precipitation is inadequate for maximum crop production. Perennial streams are few and widely spaced and are little used for irrigation. Water for livestock is stored in ponds and small reservoirs on individual farms and ranches. The surface water is of fair or poor quality. Limited quantities and high amounts of dissolved solids limit the use of the water. Missouri River water is of good quality. It meets national drinking water standards. Water from reservoirs on the Missouri River is used for irrigation on the adjacent upland soils.

There is a limited supply of ground water in the shallow, unconsolidated sand and gravel deposits that make up the glacial drift and alluvial aquifers. A significant glacial outwash deposit is beneath the flood plain along the lower reaches of the James River in the southern part of the MLRA. A significant acreage is irrigated by this local aquifer. The fresh or saline water is hard and is a calcium, bicarbonate, and sulfate type. The ground water is used primarily for domestic supply, livestock, and irrigation. The level of total dissolved solids typically exceeds the recommended levels for drinking water. Many private wells have high levels of nitrate plus nitrite. Most of this contamination occurs in areas where the wells are located downslope from septic tank absorption fields, feedlots, barnyards, and fertilizer storage areas.

A confining layer of shale beneath the glacial deposits overlies two sedimentary bedrock aquifers in this MLRA, the Niobrara-Codell and Dakota-Newcastle. These aquifers are at a depth of about 1,100 feet (335 meters). The shale lying directly beneath the glacial deposits is not an aquifer. The sedimentary bedrock aquifers yield large quantities of slightly saline or moderately saline artesian water. The water is very hard and is typically a sodium sulfate type. The Niobrara-Codell aquifer provides water for domestic uses and livestock, but the level of total dissolved solids is too high for the water to be used for irrigation. Water from the Dakota-Newcastle aquifer is used only for livestock.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They generally are very deep, well drained to poorly drained, and clayey or loamy. Calciustolls (Ethan series) and Calciustepts (Betts series) formed in till on moraines and the steeper slopes. Natrustolls (Dudley, Stickney, and Jerauld series) formed in till on till plains. Haplustolls formed in till on till plains (Bonilla and Clarno series), in glaciofluvial deposits on outwash plains (Hand, Delmont, and Enet series), and in sandy eolian material (Forestburg series). Argiustolls formed in till (Beadle, Houdek, and Prosper series), silty drift (Highmore series), and a silty mantle over till (Eakin series) on till plains and hills and in alluvium (Onita series) on fans and footslopes and in swales. Argialbolls (Tetonka series), Argiaquolls (Worthing series), and Natraquolls (Hoven series) formed in alluvium in depressions on till plains.

Biological Resources

This area supports natural prairie vegetation characterized by western wheatgrass, green needlegrass, needleandthread, and porcupinegrass. Big bluestem is an important species on soils that receive beneficial overflow or are subirrigated. Prairie cordgrass, reed canarygrass, and western wheatgrass are dominant on the poorly drained soils.

Some of the major wildlife species in this area are mule deer, white-tailed deer, fox, beaver, raccoon, opossum, muskrat, mink, cottontail, tree squirrel, pheasant, partridge, bobwhite quail, mourning dove, geese, and ducks. The species of fish in the area include bluegill, bass, carp, shad, channel catfish, black bullhead, crappie, walleye, and northern pike.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 58%
Grassland—private, 34%; Federal, 1%
Urban development—private, 3%
Water—private, 1%
Other—private, 3%

Nearly all this area is in farms and ranches. Slightly more than one-half of the area is dry-farmed cropland. Corn, soybeans, small grains, and alfalfa are the principal crops. Grain sorghum also is grown. About one-third of the area is used as native range or tame pasture.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management and no-till systems that conserve moisture and improve soil quality. Other practices include vegetative wind barriers, wind stripcropping, grassed waterways, and nutrient management. ■

Figure 56-1: Location of MLRA 56 in Land Resource Region F.

56—Red River Valley of the North

This area (shown in fig. 56-1) is primarily in Minnesota (57 percent) and North Dakota (43 percent), but a small portion (61 square miles, or 158 square kilometers) is in South Dakota. The area makes up about 16,300 square miles (42,235 square kilometers). The cities of Grand Forks and Fargo, North Dakota, and the towns of Thief River Falls, Crookston, and Moorhead, Minnesota, are in this MLRA. Interstate 29 parallels the west bank of the Red River of the North along the length of this area. This MLRA has numerous State parks, the Ardoch and Kellys Slough National Wildlife Refuges, and the Sheyenne National Grasslands.

Physiography

This area is in the Western Lake Section of the Central Lowland Province of the Interior Plains. It is on a nearly level glacial lake plain bordered on the east by outwash plains, gravelly beaches, and dunes. Elevation is generally 1,000 feet (305 meters), but it gradually decreases to 650 feet (200 meters) to the north.

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is Red (0902). The Red River bisects this MLRA. It is formed where the Otter Tail and Bois de Sioux Rivers meet at Wahpeton, North Dakota. The Sheyenne River is the largest tributary to the Red River in the part of the area in North Dakota, and the Red Lake River is the largest tributary in the part in Minnesota.

Geology

This area is the bed of glacial Lake Agassiz. It is a glacial lake plain with remnants of gravelly beaches marking its eastern border. The erosion resistance of the gravel causes the beaches to appear as ridges in an otherwise flat landscape. Some dunes have formed in areas near the beaches where sand has been deposited.

Climate

The average annual precipitation in this area is 18 to 23 inches (455 to 585 millimeters). About 70 percent of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. Winter precipitation typically occurs as 25 to 50 inches (630 to 1,270 millimeters) of snow, which accounts for about 15 percent of the annual precipitation. The average annual temperature is 36 to 44 degrees F (2 to 7 degrees C), decreasing from south to north. The freeze-free period averages 145 days and ranges from 125 to 170 days. It is shortest in the northern part of the area and longest in the southern part.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 8.8%; ground water, 6.3%
Livestock—surface water, 0.5%; ground water, 1.0%
Irrigation—surface water, 2.8%; ground water, 4.3%
Other—surface water, 76.1%; ground water, 0.3%

The total withdrawals average 330 million gallons per day (1,250 million liters per day). About 12 percent is from ground water sources, and 88 percent is from surface water sources. In years of normal precipitation, moisture is sufficient for the crops commonly grown in the area, but some areas are irrigated. Surface water is more abundant in Minnesota than in North Dakota. The surface water is used primarily for municipal, commercial, and industrial supplies, but some is used for irrigation. Water from the Red River and its tributaries in North Dakota is generally suitable for drinking. Most of the tributaries on the Minnesota side of the Red River are saline. The water in the Wild Rice and Goose Rivers, for example, exceeds the drinking water standard for sulfate. Late winter and early spring flooding along the Red River is a constant threat. In the southern part of the area, thaws occur earlier in spring, while the river's outlet in Canada is still frozen. The flat slope of the Red River exacerbates the flooding problems. In most areas drainage systems are needed so that farming operations can be started when the temperature is favorable.

Ground water is not used to a great extent in this MLRA because of the relative abundance of better quality surface water. Almost all of the rural domestic water used in the MLRA, however, is ground water. The city of Fargo pumps public water from a buried glacial deposit of sand and gravel. The surficial and buried glacial outwash deposits are the primary aquifers in this area. Ground water from these aquifers is hard or very hard, and much of the ground water in the area exceeds the secondary national drinking water standard of 500 parts per million (milligrams per liter) total dissolved solids. The water in the Cretaceous sedimentary bedrock aquifers that lie beneath the glacial deposits and the Precambrian crystalline igneous and metamorphic rocks that lie beneath the sedimentary rocks is unsuitable for most uses, except for livestock watering. The latter aquifer has low-yield wells.

Soils

The dominant soil orders in this MLRA are Mollisols and Vertisols. The soils in the area dominantly have a frigid soil temperature regime, an aquic or udic soil moisture regime, and mixed or smectitic mineralogy. They are very deep, somewhat poorly drained to very poorly drained, and loamy or clayey. Calciaquolls formed in lacustrine or outwash sediments on glaciolacustrine and outwash plains (Bearden, Colvin, Glyndon, Grimstad, Ulen, and Wheatville series) and in till on till plains (Hamerly, Vallers, Roliss, and Kratka series). Argiudolls (Doran series) formed in water-worked till or lacustrine sediments over till on glaciolacustrine plains. Hapludolls (Embden, Gardena, and Overly series), Epiaquerts (Fargo and Northcote series), Calciaquerts (Hegne series), and Epiaquolls (Perella series) formed in lacustrine sediments on glaciolacustrine plains.

Biological Resources

This area supports natural prairie vegetation characterized by big bluestem, switchgrass, Indiangrass, and little bluestem. Bur oak, American basswood, American elm, eastern cottonwood, green ash, and willows grow in drainageways. Shrubs include American plum, common chokecherry, and western snowberry.

Some of the major wildlife species in this area are white-tailed deer, red fox, raccoon, muskrat, mink, jackrabbit, cottontail, tree squirrel, pheasant, gray partridge, sharp-tailed grouse, mourning dove, geese, and ducks. The species of fish in the area include perch, bullhead, northern pike, walleye, and catfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 79%
Grassland—private, 4%; Federal, 2%
Forest—private, 6%
Urban development—private, 3%
Water—private, 1%
Other—private, 5%

Nearly all of this area is in farms and ranches. More than three-fourths of the area is dry-farmed cropland. Important cash crops are spring wheat, soybeans, potatoes, sugar beets, corn, oil-producing crops, and edible beans. Less than one-tenth of the area is forested. The forestland is in the northeastern part of the area.

The major soil resource concerns in this area are wind erosion, deposition of sediment by floodwater, maintenance of the content of organic matter and productivity of the soils, management of soil moisture, salinity in selected areas, surface compaction, and aggregate stability. The efficient use of water is a major concern on irrigated land. Conservation practices on cropland generally include crop residue management, conservation tillage systems, conservation cropping systems, field windbreaks, herbaceous wind barriers, filter strips, cover crops, nutrient management, and pest management. ■

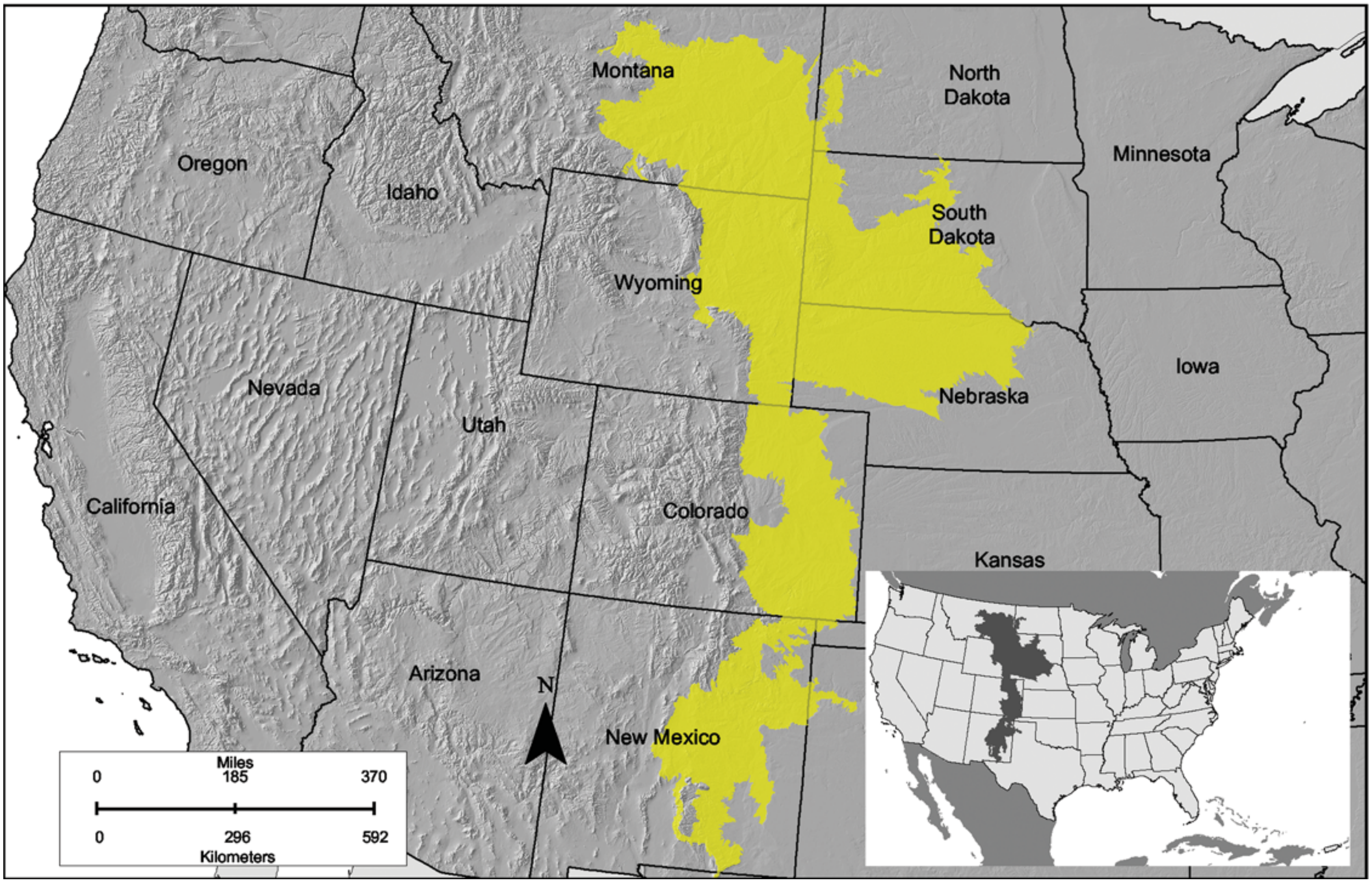

Figure G-1: Location of Land Resource Region G.

G—Western Great Plains Range and Irrigated Region

This region (shown in fig. G-1) is in Montana (22 percent), New Mexico (16 percent), South Dakota (16 percent), Colorado (15 percent), Nebraska (15 percent), Wyoming (14 percent), North Dakota (1 percent), and Texas (1 percent). Very small portions of Oklahoma and Kansas also are in this region. The region makes up 213,945 square miles (554,395 square kilometers).

This region forms the western edge of the Great Plains (fig. G-2). It butts up against the foothills of the Rocky Mountains. It is an elevated piedmont plain dissected by numerous rivers flowing to the east. Slopes generally are gently rolling or rolling. Flat-topped, steep-sided buttes commonly rise above the general level of the plain. Badlands occur in some areas.

The amount of precipitation in this region typically is low because much of the region is on the leeward side of mountains. The average annual precipitation is 13 to 22 inches (330 to 560 millimeters) in most of the region. Most of the precipitation falls during spring thunderstorms and winter snowfalls. The average annual temperature ranges from 44 to 51 degrees F (7 to 11 degrees C) in most of the region. The freeze-free period ranges from 135 to 185 days, increasing in length from north to south.

The total withdrawals of freshwater in this region average about 13,830 million gallons per day (52,345 million liters per day). About 77 percent is from surface water sources, and 23 percent is from ground water sources. About 84 percent of the water is used for irrigation.

The soils in this region are dominantly Entisols and Mollisols. Other notable orders are Alfisols, Aridisols, Inceptisols, and some Vertisols. The dominant suborders are Ustorthents, Torriorthents, Haplustolls, and Argiustolls. Other notable suborders are Haplargids, Haplustalfs, and Haplustepts. Most of the soils in the region have a mesic or frigid soil temperature regime and an ustic or aridic soil moisture regime. Most have mixed or smectitic mineralogy, but some have carbonatic mineralogy.

About 88 percent of the land in this region is privately owned. The native vegetation consists mainly of short prairie grasses, but some large areas support mid and tall prairie grasses. Ponderosa pine and pinyon-juniper forests occur at the

Figure G-2: An area of Land Resource Region G.

higher elevations. The dominant land use is grazing by cattle and by some sheep. Dry-farmed winter wheat and other small grains are grown either for cash or for feed. Irrigated crops are grown along many of the major streams. These crops primarily include corn, alfalfa, forage crops, and sugar beets.

The major soil resource concerns in this region are overgrazing and the wind erosion and water erosion that occur where the ground cover has deteriorated. The invasion of undesirable plant species is a concern on rangeland. Wind erosion, water erosion, maintenance of the content of organic matter in the soils, and soil moisture management are major resource concerns on cropland. The quality of surface water also is a concern. Sediment, nutrients, pesticides, and organic material are the major nonpoint sources of surface- and ground-water pollution. Control of saline seeps on rangeland and salt management on irrigated land are needed in some areas. ■

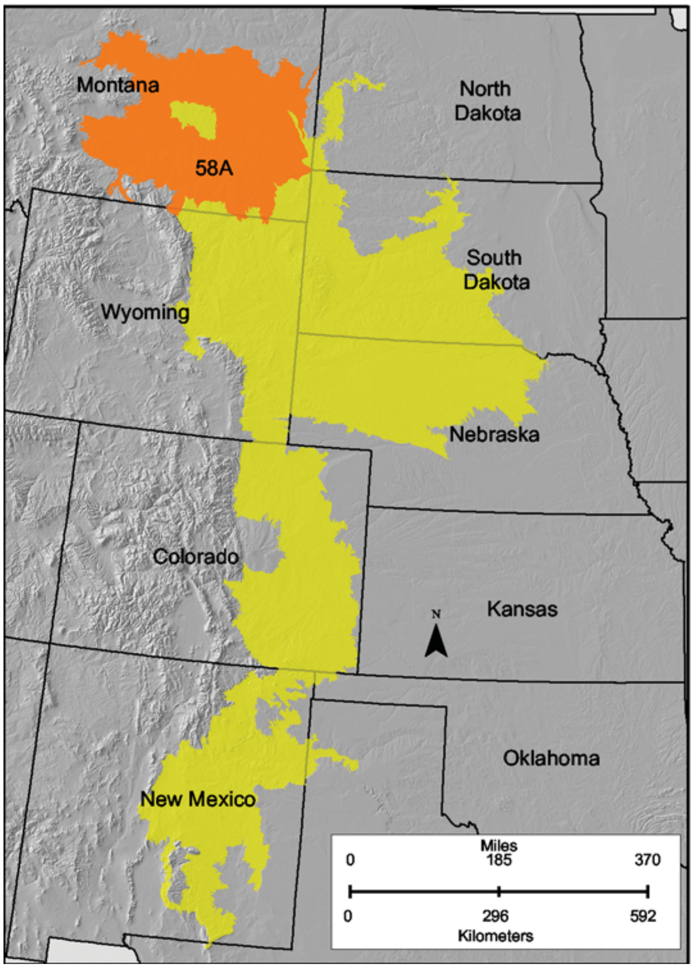

Figure 58A-1: Location of MLRA 58A in Land Resource Region G.

58A—Northern Rolling High Plains, Northern Part

This area (shown in fig. 58A-1) is in Montana (99 percent) and Wyoming (1 percent). It makes up about 42,350 square miles (109,740 square kilometers). From east to west, the cities of Glendive, Miles City, and Billings, Montana, are along Interstate 94 in this MLRA. Interstate 94 ends near Billings, at the junction with Interstate 90. This area has numerous national wildlife refuges, including the Charles M. Russell, U.L. Bend, Hailstone, Lake Mason, and Halfbreed Lake National Wildlife Refuges. The Custer National Forest and the Crow and Northern Cheyenne Indian Reservations are in the area.

Physiography

This area is in the Missouri Plateau, Unglaciated, Section of the Great Plains Province of the Interior Plains. It is an area of old plateaus and terraces that have been eroded. Slopes generally are gently rolling to steep, and wide belts of steeply sloping badlands border a few of the larger river valleys. Local relief is mainly 10 to 100 feet (3 to 30 meters). In some areas flat-topped, steep-sided buttes rise sharply above the general level of the plains. Elevation generally ranges from 2,950 to 3,280 feet (900 to 1,000 meters), increasing from east to west and from north to south. In a few mountains, it is as high as 6,900 feet (2,105 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Missouri-Musselshell (1004), 35 percent; Lower Yellowstone (1010), 27 percent; Powder-Tongue (1009), 15 percent; Upper Yellowstone (1007), 11 percent; Bighorn (1008), 6 percent; Missouri-Poplar (1006), 4 percent; and Missouri-Little Missouri (1011), 2 percent. The Missouri and Yellowstone Rivers run through this area. There are no dams for more than 800 miles along the Yellowstone River, one of the longest free-flowing rivers in the United States. Fort Peck Dam was built in 1937 and was the first dam on the Missouri River. Ft. Peck Lake also occurs in this MLRA.

Geology

Tertiary continental shale, siltstone, and sandstone underlie the eastern one-third to one-half of this area. These stream deposits are part of the Fort Union Formation. This formation also contains coalbeds. Marine and continental sediments of the Cretaceous Montana Group underlie the rest of the MLRA, generally at the higher elevations. The Montana Group includes the Bearpaw shale; the Judith River sandstone, siltstone, and shale; the Claggett shale; the Eagle sandstone; and the Telegraph Creek sandy shale. A group of younger Cretaceous sediments occurs between the higher elevation Montana Group sediments and the lower elevation Tertiary sediments. These younger deposits include the Hell Creek sandstone and shale, the St. Mary River mudstone, and the volcaniclastics of the Livingston Group.

Climate

The average annual precipitation is 8 to 22 inches (205 to 560 millimeters) in most of this area but is as much as 30 inches (760 millimeters) in the mountains. It fluctuates widely from year to year. Most of the rainfall occurs as frontal storms early in the growing season, in May and June. Some high-intensity, convective thunderstorms occur in July and August, and some rain falls in autumn. Precipitation in winter occurs as snow. The average annual temperature is 41 to 49 degrees F (5 to 10 degrees C). The freeze-free period averages 155 days and ranges from 115 to 190 days, decreasing in length with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.7%; ground water, 0.6%
Livestock—surface water, 0.6%; ground water, 0.3%
Irrigation—surface water, 94.4%; ground water, 1.4%
Other—surface water, 1.3%; ground water, 0.8%

The total withdrawals average 2,865 million gallons per day (10,845 million liters per day). About 3 percent is from ground water sources, and 97 percent is from surface water sources. The surface water generally is suitable for all uses, but adequate supplies away from the Missouri and Yellowstone Rivers are scarce. The low and erratic precipitation is the principal source of water for agriculture. Water for livestock is stored in small reservoirs, but supplies are inadequate for significant irrigation. Irrigation water in quantity is available from the Missouri and Yellowstone Rivers and one or two of the larger tributaries of these rivers.

Ground water is scarce in most of this area, but local sand and gravel deposits and coalbeds in the Cenozoic Fort Union Formation yield small to moderate amounts. Small amounts of ground water are available in the alluvial and terrace deposits along the Missouri and Yellowstone Rivers. The ground water is a sodium bicarbonate or sulfate type and generally is hard or very hard. The level of total dissolved solids, typically more than 1,000 parts per million (milligrams per liter), generally exceeds standards for drinking water.

Saline seeps are a problem in the areas of cropland in this MLRA. Management practices promote infiltration of precipitation into shallow aquifers. As the shallow water table rises to the ground surface, evaporation of the water leaves concentrations of salts behind. The level of total dissolved solids in the water from saline seeps commonly is more than 4,000 parts per million (milligrams per liter).

Soils

The dominant soil orders in this MLRA are Entisols and Inceptisols. The soils in the area dominantly have a frigid soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They generally are shallow to very deep, well drained, and clayey or loamy. Ustorthents formed in residuum on hills and ridges (Bainville, Cabba, Cabbart, Neldore, and Yawdim series) and in alluvium on fans and terraces (Lambert series). Ustifluvents (Havre series) formed in alluvium on fans, terraces, and flood plains. Haplustepts (Busby, Cherry, Delpoint, Lonna, and Yamacall series) formed in alluvium, eolian deposits, and residuum on terraces, fans, and hills. Calciustepts (Cambeth series) formed in alluvium, colluvium, and residuum on fans, hills, and plains. Natrustalfs (Gerdrum series) and Haplustolls (Shambo series) formed in alluvium and glaciofluvial deposits on fans and terraces and in drainageways.

Biological Resources

This area supports grassland vegetation. Western wheatgrass, bluebunch wheatgrass, green needlegrass, and needleandthread are the dominant species. In the eastern part of the area, little bluestem replaces bluebunch wheatgrass as the dominant species.

Some of the major wildlife species in this area are mule deer, white-tailed deer, antelope, coyote, fox, badger, beaver, raccoon, jackrabbit, cottontail, muskrat, mink, ground squirrel, pheasant, sharp-tailed grouse, Hungarian partridge, sage grouse, geese, and ducks.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 15%
Grassland—private, 61%; Federal, 15%
Forest—private, 2%; Federal, 2%
Urban development—private, 1%
Water—private, 2%
Other—private, 2%

More than one-half of this area consists of privately owned ranches generally dominated by livestock production. Incidental cash or feed small grains and irrigated cropland are concentrated along the major streams. Some areas in the southern part of the area consist of forestland in Tribal, national forest, or private holdings. More than three-fourths of the area supports native grasses, shrubs, and limited timber and is grazed by cattle and sheep. The rest is used mainly for dry-farmed wheat. Sugar beets, alfalfa and other hay crops, and corn for silage are important crops on the irrigated land. Some of the land is used as tame pasture. Open woodland is on the upper slopes and the tops of some of the higher buttes and mountains.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, management of soil moisture, and the control of saline seeps. Water resource concerns are inefficient water use on irrigated cropland and excessive amounts of pesticides, nutrients, and organic material in surface and ground waters. Plant resource concerns are deterioration of plant condition, productivity, health, and vigor; noxious and invasive plants; and the hazard of wildfires. Animal resource concerns are inadequate food, cover, and shelter.

Conservation practices on cropland generally include crop residue management (especially minimum tillage), cover crops, stripcropping, nutrient management, soil salinity management, and pest management. Practices that improve water use and distribution on irrigated cropland are irrigation water management, irrigation water delivery systems, and on-farm irrigation practices, such as land leveling, land smoothing, water-control structures, and sprinklers. Noxious and invasive plants can be controlled by pest management and prescribed grazing. Forest stand improvement and firebreaks reduce the hazard of wildfires and improve forest growth, quality, health, and productivity.

The most important conservation practices on rangeland generally include prescribed grazing, fencing, and water developments. The establishment of food plots and range improvement practices benefit wildlife. The establishment of early and late season pastures supplements forage production and keeps livestock off the rangeland during critical growth periods. ■

58B—Northern Rolling High Plains, Southern Part

This area (shown fig. 58B-1) is in Wyoming (95 percent) and Montana (5 percent). It makes up about 19,265 square miles (49,915 square kilometers). The cities of Sheridan, Gillette, and Casper, Wyoming, are in this MLRA. Interstate 90 crosses the northern third of this area from east to west, and Interstate 25 crosses the western third from north to south. The Naval Petroleum Reserve Military Reservation and the Thunder Basin National Grasslands are in this area. Most of the Powder River Basin is in this area. This basin contains important coal, oil, and gas deposits.

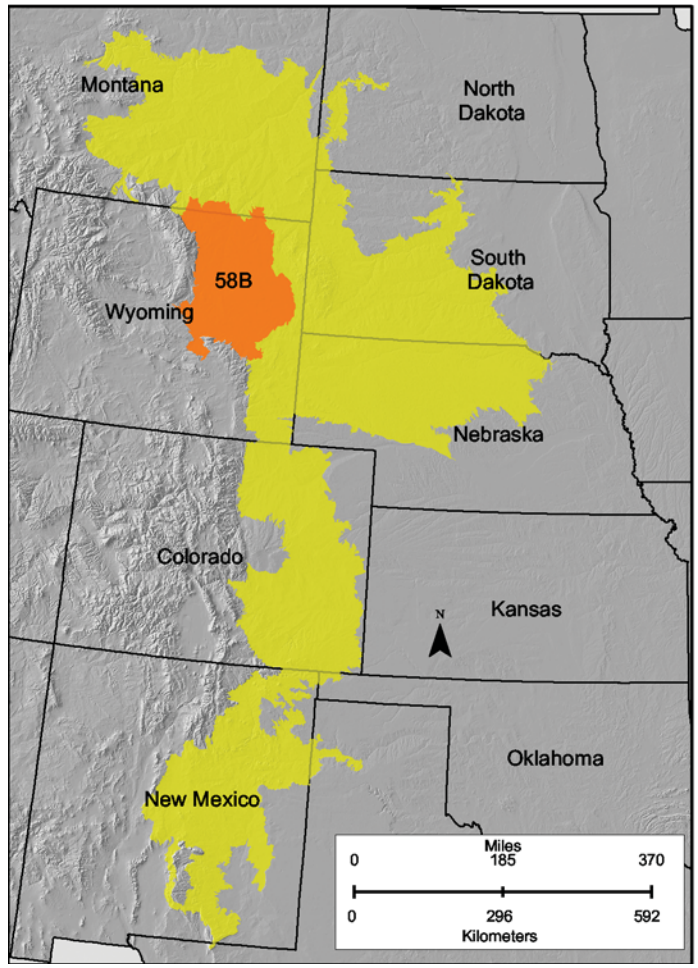

Figure 58B-1: Location of MLRA 58B in Land Resource Region G.

Physiography

This area is in the Missouri Plateau, Unglaciated, Section of the Great Plains Province of the Interior Plains. It is an area of old plateaus and terraces that have been deeply eroded. Elevation generally ranges from 2,950 to 5,900 feet (900 to 1,800 meters), increasing gradually from north to south. On a few buttes, it is as high as 6,890 feet (2,100 meters). Typically, local relief is about 150 to 250 feet (45 to 75 meters). Slopes generally are gently rolling to steep, and wide belts of steeply sloping badlands border a few of the larger river valleys. Terraces are common along most of the major river systems in the area. In places flat-topped, steep-sided buttes rise sharply above the general level of the plains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Powder-Tongue (1009), 49 percent; Cheyenne (1012), 34 percent; North Platte (1018), 16 percent; and Missouri-Little Missouri (1011), 1 percent. The North Platte River runs through the southern part of this MLRA. The upper reaches of the Powder, Tongue, Belle Fourche, and Cheyenne Rivers drain the northern half of the area.

Geology

The middle third of this area is underlain by Tertiary continental sediments consisting of shale, siltstone, and sandstone. Cretaceous marine and continental sediments underlie the northwestern third and southeastern third of the area. These older units consist of interbedded layers of shale, siltstone, and sandstone. This MLRA is an important mining (coal and uranium) and petroleum district. The largest deposits of coal in the United States occur in this area.

Climate

The average annual precipitation is 9 to 27 inches (230 to 685 millimeters) in most of this area. It fluctuates widely from year to year. The higher precipitation occurs at the higher elevations. Most of the rainfall occurs as frontal storms early in the growing season, in May and June. Some high-intensity, convective thunderstorms occur in July and August, and some rain falls in autumn. Precipitation in winter occurs as snow. The average annual temperature is 41 to 48 degrees F (5 to 9 degrees C). The freeze-free period averages 145 days and ranges from 115 to 170 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 3.1%; ground water, 2.5%
Livestock—surface water, 0.4%; ground water, 0.2%
Irrigation—surface water, 83.8%; ground water, 1.4%
Other—surface water, 6.9%; ground water, 1.7%

The total withdrawals average 715 million gallons per day (2,705 million liters per day). About 6 percent is from ground water sources, and 94 percent is from surface water sources. The surface water generally is suitable for all uses, but adequate supplies away from the North Platte, Powder, and Tongue Rivers are scarce. The low and erratic precipitation is the principal source of water for agriculture. Water for livestock is stored in small reservoirs, but supplies are inadequate for significant irrigation. Narrow strips of land along the perennial streams are irrigated with water from the North Platte, Powder, and Tongue Rivers and some of the larger tributaries of these rivers.

The Structural Basin aquifer underlies almost all of this area. This is the most extensively used aquifer in Wyoming. It consists of lenticular beds of sandstone, coal, and shale. The ground water is confined, so flowing wells are common. Because the median concentration of total dissolved solids is 1,100 parts per million (milligrams per liter), this water is unsuitable for drinking, but it is used for some irrigation and for livestock. The ground water is a sodium bicarbonate or sulfate type and is soft or moderately hard.

Small amounts of ground water are available in the alluvial and terrace deposits along the North Platte, Powder, and Tongue Rivers. This water is a sodium bicarbonate or sulfate type and is generally hard or very hard. The level of total dissolved solids typically exceeds drinking water standards. The ground water in Wyoming has naturally high levels of flouride, iron, manganese, selenium, and radionuclides.

Soils

The dominant soil orders in this MLRA are Aridisols and Entisols. The soils in the area dominantly have a mesic soil temperature regime, an aridic soil moisture regime that borders on ustic, and mixed or smectitic mineralogy. They are shallow to very deep, generally well drained, and loamy or clayey. Haplargids formed in alluvium (Cambria, Forkwood, and Ulm series) and in mixtures of alluvium, eolian sediments, and residuum (Bowbac, Cushman, and Hiland series). Torriorthents formed in alluvium on alluvial fan remnants, fan piedmonts, stream terraces, hills, and plateaus (Kishona series) and in residuum or colluvium on hills (Samday, Shingle, Tassel, and Theedle series). Mollisols and Alfisols occur in areas that have an ustic soil moisture regime that borders on aridic.

Biological Resources

This area supports grassland vegetation. Rhizomatous wheatgrasses, green needlegrass, needleandthread, and blue grama are the dominant species on deep soils. Rhizomatous wheatgrasses, bluebunch wheatgrass, Indian ricegrass, and needleandthread are the major species on shallow soils on hills and ridges. Basin wildrye, green needlegrass, rhizomatous wheatgrasses, and shrubs are dominant along bottom land and streams. Big sagebrush is the dominant shrub.

Some of the major wildlife species in this area are elk, deer, antelope, coyote, beaver, muskrat, jackrabbit, cottontail rabbit, sage grouse, and turkey. The species of fish in the area include rainbow trout, brown trout, brook trout, and cutthroat trout.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 4%
Grassland—private, 76%; Federal, 16%
Forest—private, 1%
Urban development—private, 1%
Other—private, 2%

More than 90 percent of this area supports native grasses and shrubs grazed by cattle and sheep. About 4 percent is dry-farmed in a wheat-summer fallow rotation. The dry-farmed areas occur mainly on gently sloping, deep soils. Narrow strips of land along the Tongue, Powder, and Platte Rivers and some of their tributaries are irrigated. Alfalfa, other hay crops, and feed grains are the principal crops. Some tracts are used as tame pasture. Open stands of ponderosa pine are on the higher buttes and steep slopes that receive higher amounts of precipitation.

The major resource concerns are the quantity and quality of water and soil quality. Conservation practices on rangeland generally include prescribed grazing, fencing, and water developments. The establishment of food plots and range improvement practices benefit wildlife. The establishment of early and late season pastures supplements forage production and keeps livestock off the rangeland during critical growth periods. Conservation practices on cropland generally include those that minimize wind erosion and maximize the amount of soil moisture available for crops. ■

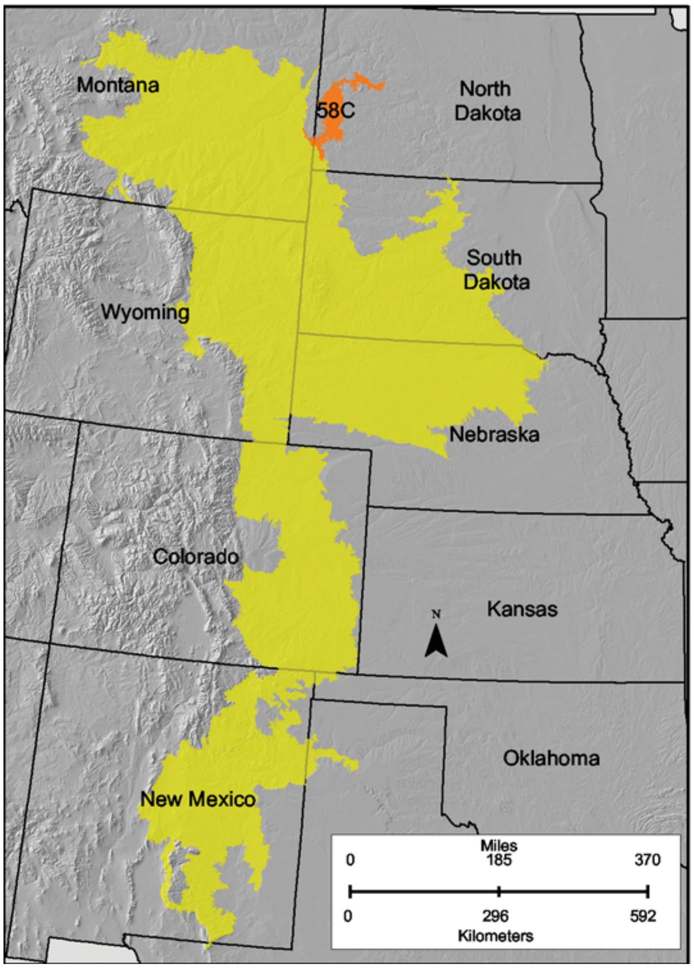

Figure 58C-1: Location of MLRA 58C in Land Resource Region G.

58C—Northern Rolling High Plains, Northeastern Part

This area (shown in fig. 58C-1) is in North Dakota (96 percent) and Montana (4 percent). It makes up about 2,320 square miles (6,015 square kilometers). It has no major cities. Interstate 94 extends in an east-west direction through the area near the south unit of Theodore Roosevelt National Park. Parts of the Fort Berthold Indian Reservation and the Little Missouri National Grasslands are in this area.

Physiography

Most of this area is in the Missouri Plateau, Unglaciated, Section of the Great Plains Province of the Interior Plains. The northeastern part is in the Missouri Plateau, Glaciated, Section of the same province and division. It has some glacially modified topography, but it is very similar to the unglaciated parts. This MLRA is known as the Little Missouri Badlands, which were formed when the Little Missouri River was diverted along a steeper course by Pleistocene glaciers. The MLRA is an area of old plateaus and terraces that have been cut by the Little Missouri River and its tributaries. Much of the area consists of rolling hills with some badlands. Moderately steep and steep slopes occur along the Little Missouri River and its tributaries. Some isolated mountains, such as the Killdeer Mountains, are in the area. Elevation is generally about 1,970 to 3,280 feet (600 to 1,000 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Missouri-Little Missouri (1011), 99 percent, and Lower Yellowstone (1010), 1 percent. The Little Missouri River flows through the entire length of this MLRA. It empties into Lake Sakakawea, formed by Garrison Dam on the Missouri River, in the northeast corner of the area.

Geology

Tertiary marine sediments, shale, siltstone, and sandstone occur in most of this area. The White River Group probably represents isolated remnants of the old plateau surface at the higher elevations. The Sentinel Butte Formation occurs in most of the eastern half of this area, and successively older sediments occur to the west (Bullion Creek Formation) and south (Slope and Ludlow Formations) at the lower elevations. The Cretaceous Hell Creek Formation may be exposed in the southern tip of this area, along the Little Missouri River. The northeastern part of the area, at the lower end of the Little Missouri River, has a glacially modified topography. Thin layers of glacial drift cover the marine sediments in this area. Deposits of river sand and gravel occur on the valley floors of the larger streams and on the valley floor and terraces along the Little Missouri River.

Climate

The average annual precipitation in this area is 14 to 17 inches (355 to 430 millimeters). Most of the rainfall occurs as frontal storms early in the growing season, in May and June. Some high-intensity, convective thunderstorms occur in July and August, and some rain falls in autumn. More than half of the precipitation falls during the growing season. Precipitation in winter occurs as snow. The average annual temperature is 41 to 44 degrees F (5 to 7 degrees C). The freeze-free period averages 145 days and ranges from 130 to 160 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 12.0%; ground water, 8.1%
Irrigation—surface water, 29.5%; ground water, 29.5%
Other—surface water, 9.8%; ground water, 11.2%

The total withdrawals average 1 million gallons per day (3.8 million liters per day). About 49 percent is from ground water sources, and 51 percent is from surface water sources. Most of the surface water is used in the generation of electric power as Lake Sakakawea drains through Garrison Dam. In most years, the supply of moisture is inadequate for maximum crop production. The Little Missouri River and Lake Sakakawea are the principal sources of surface water in the area. This water is of good quality and is used for what little irrigation occurs in the area on the flood plains and terraces along the Little Missouri River. Some livestock water is stored in ponds.

Farms and ranches obtain their drinking water and some of their livestock water from the Fort Union aquifer. The water in this aquifer is soft, but a high level of total dissolved solids and salinity limit use of the water for irrigation. The water also contains naturally high levels of selenium. Ground water is scarce or does not occur in areas underlain by shale.

Soils

The dominant soil orders in this MLRA are Entisols, Inceptisols, and Mollisols. The soils in the area dominantly have a frigid soil temperature regime, an ustic soil moisture regime that borders on aridic, and mixed mineralogy. They are shallow to very deep, generally well drained, and loamy. Ustorthents formed in residuum on hills and plains (Cabbart series) and in alluvium on alluvial fans and in swales (Patent series). Ustifluvents (Havre series) and Haplustolls (Kremlin series) formed in alluvium on flood plains, stream terraces, and alluvial fans. Ustipsamments (Fleak series) formed in residuum on hills. Haplustepts formed in colluvium on uplands (Arikara series) and in alluvium on alluvial fans, stream terraces, and flood plains (Lonna series).

Biological Resources

This area supports natural prairie vegetation characterized by western wheatgrass, needleandthread, green needlegrass, blue grama, and threadleaf sedge. Little bluestem and sideoats grama are important species on sloping, shallow soils. Big bluestem and sideoats grama, along with scattered green ash, chokecherry, and western snowberry, are important species in swales. North-facing slopes support Rocky Mountain juniper, green ash, and chokecherry and an understory of little bluestem, porcupinegrass, and needleandthread.

Some of the major wildlife species in this area are mule deer, white-tailed deer, antelope, coyote, prairie dog, jackrabbit, reptiles, amphibians, sharp-tailed grouse, hawks, turkeys, and grassland birds of various species.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 5%
Grassland—private, 37%; Federal, 42%
Forest—private, 1%; Federal, 2%
Water—private, 2%
Other—private, 11%

The “other” category includes large areas of barren badland. Grazing and recreation are the dominant land uses. About four-fifths of the area is rangeland that is used for ranching. The principal livestock enterprise consists of cow-calf operations. The principal dry-farmed crops are small grains, such as wheat, barley, and oats. Alfalfa, flax, forage crops, and corn for silage are grown on irrigated land along the major streams.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and conservation of soil moisture. Conservation practices on rangeland generally include prescribed grazing, fencing, and water developments. The establishment of food plots and range improvement practices benefit wildlife. The establishment of early and late season pastures supplements forage production and keeps livestock off the rangeland during critical growth periods. Conservation practices on cropland generally include crop residue management; conservation tillage systems, such as no-till; conservation cropping systems that eliminate the need for fallowing; nutrient management; and pest management. ■

58D—Northern Rolling High Plains, Eastern Part

This area (shown in fig. 58D-1) is in South Dakota (65 percent), Montana (21 percent), and North Dakota (14 percent). It makes up about 2,755 square miles (7,145 square kilometers). It has no major cities. U.S. Highway 85 traverses this area from north to south. The Little Missouri National Grasslands and Custer National Forest occur in this area.

Physiography

This area is in the Missouri Plateau, Unglaciated, Section of the Great Plains Province of the Interior Plains. Elevation ranges from 2,300 to 4,000 feet (700 to 1,220 meters), increasing gradually from east to west. Harding Peak, the highest point in the MLRA, reaches an elevation of 4,019 feet (1,225 meters). Slopes generally are gently rolling to steep.

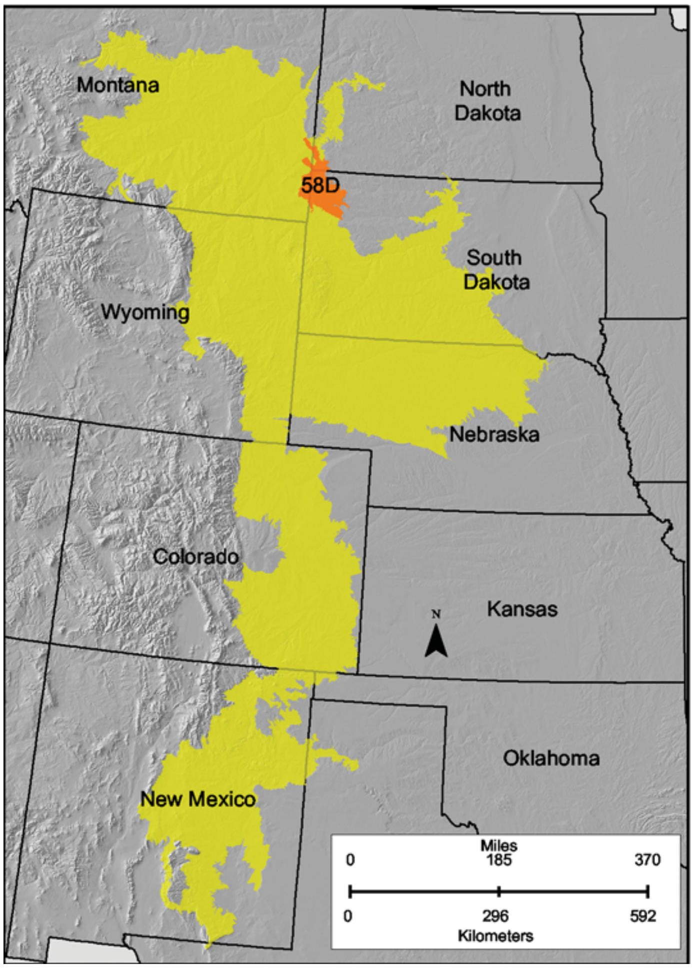

Figure 58D-1: Location of MLRA 58D in Land Resource Region G.

Local relief is mainly 80 to 330 feet (25 to 100 meters). In places flat-topped, steep-sided buttes rise sharply above the general level of the plains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Missouri-Little Missouri (1011), 52 percent; Missouri-Oahe (1013), 46 percent; and Lower Yellowstone (1010), 2 percent. The Little Missouri River and the headwaters of the major tributaries that eventually form the Grand and Moreau Rivers in South Dakota are in this area.

Geology

Cretaceous marine and continental sediments of shale, siltstone, and sandstone occur in the majority of this MLRA. The continental and marine Hell Creek Formation occurs in approximately 85 percent of the MLRA, and the Fox Hills Sandstone forms the southern boundary of the MLRA. Tertiary deposits also occur in scattered areas throughout the MLRA. These deposits are made up of the Paleocene Ludlow and Tongue River Formations, the Oligocene White River Group, and the Miocene Arikaree Group. These resistant Paleocene, Oligocene, and Miocene beds stand above the Cretaceous beds. Ponderosa pine growing on these Tertiary beds further distinguishes them from the other formations in the MLRA. Quaternary river sand and gravel deposits occur on the valley floors and on the terraces along the larger rivers in the area. A large Quaternary eolian deposit occurs directly south of the town of Buffalo.

Climate

The average annual precipitation is 14 to 17 inches (355 to 430 millimeters) in most of this area. It fluctuates widely from year to year. Most of the rainfall occurs as frontal storms early in the growing season, in May and June. Some high-intensity, convective thunderstorms occur in July and August. Precipitation in winter occurs as snow. The average annual temperature is 42 to 45 degrees F (6 to 7 degrees C). The freeze-free period averages 140 days and ranges from 130 to 150 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 3.4%; ground water, 2.4%
Irrigation—surface water, 59.1%; ground water, 21.1%
Other—surface water, 8.7%; ground water, 5.3%

The total withdrawals average 2.5 million gallons per day (9.5 million liters per day). About 29 percent is from ground water sources, and 71 percent is from surface water sources. The low and erratic precipitation is the principal source of water for agriculture. Most of the surface water in this MLRA is of good quality and is used for limited irrigation on the flood plains and terraces along the major streams. Water for livestock is stored in small ponds or dugouts.

Some wells in the Fort Union-Fox Hills-Hell Creek aquifer provide water for domestic use and livestock. High levels of total dissolved solids and salinity limit the use of this ground water for irrigation. Naturally high levels of selenium and molybdenum occur in the water from the Fort Union sediments. These elements can cause health problems in livestock.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Inceptisols, and Mollisols. The soils in the area dominantly have a frigid soil temperature regime, an ustic soil moisture regime that borders on aridic, and mixed mineralogy. They are shallow to very deep, generally well drained, and loamy or clayey. Natrustalfs formed in residuum on hills and ridges (Bullock and Parchin series) and in alluvium or fluvial deposits on fans, terraces, and till plains (Absher and Gerdrum series). Ustorthents (Cabbart and Delridge series) and Torriorthents (Blackhall series) formed in residuum on hills and plains. Haplustepts (Twilight series) formed in alluvium or eolian sediments over residuum on hills and ridges. Argiustolls formed in alluvium or fluvial deposits (Assinniboine series) or mixed alluvium and colluvium (Eapa series) on fans, terraces, and till plains and in residuum on hills and ridges (Marmarth series). Haplustolls formed in residuum on hills and ridges (Rhame series).

Biological Resources

The native vegetation in this area consists primarily of grasses and forbs. Some trees and shrubs are along streams. The area supports mixed prairie vegetation characterized by western wheatgrass, green needlegrass, blue grama, and buffalograss. Threadleaf sedge, buffalograss, blue grama, and some little bluestem grow on shallow soils. Needleandthread and prairie sandreed grow on sandy soils. Big bluestem grows along streams, especially where the soil has an effective water table. The most common forbs are purple coneflower, prairie coneflower, American vetch, dotted gayfeather, Missouri goldenrod, breadroot scurfpea, silverleaf scurfpea, scarlet globemallow, heath aster, desert biscuitroot, and cudweed sagewort.

Shrubs, such as buffaloberry, silver sagebrush, western snowberry, and chokecherry, are common. Big sagebrush grows in the driest areas of the western part of the MLRA. Boxelder, green ash, and plains cottonwood are the principal trees along streams and drainageways. Ponderosa pine forests occur on the upper slopes and on the top of some of the higher buttes in Custer National Forest. These forests stand out from the normal native grass vegetation in the northwestern part of the MLRA. Silver sagebrush and big sagebrush grow on clayey soils in the western part of the MLRA.

Some of the major wildlife species in this area are mule deer, white-tailed deer, antelope, coyote, fox, bobcat, rattlesnake, badger, raccoon, porcupine, beaver, skunk, mink, jackrabbit, prairie dog, golden eagle, ferruginous hawks, pheasant, sharp-tailed grouse, sage grouse, gray partridge, magpie, and lark bunting.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 12%
Grassland—private, 81%; Federal, 3%
Urban development—private, 1%
Water—private, 1%
Other—private, 2%

More than four-fifths of this area is in private ranches. The dominant land uses are rangeland and hayland. Less than 5 percent of the area is federally owned. Most of the area supports native grasses and shrubs grazed by cattle and sheep. Gently sloping, deep and moderately deep soils, making up 10 to 15 percent of the area, are used for dry-farmed wheat or alfalfa. Some tracts are used as tame pasture. Open woodland is on the upper slopes and the top of some of the higher buttes.

The major soil resource concerns are wind erosion and soil quality on cropland, especially where wheat-fallow is the principal crop rotation. Surface water quality also is a resource concern. Wind erosion and soil quality are resource concerns on continuously overgrazed rangeland.

The most important conservation practices on rangeland are prescribed grazing, fencing, and water developments. The establishment of food plots and range improvement practices benefit wildlife. The establishment of early and late season pastures supplements forage production and keeps livestock off the rangeland during critical growth periods. The conservation practices that are important on cropland are no-till and other conservation tillage systems, contour farming, and crop residue management. ■

60A—Pierre Shale Plains

This area (shown in fig. 60A-1) is in South Dakota (70 percent), Wyoming (20 percent), Nebraska (8 percent), and Montana (2 percent). It makes up about 10,150 square miles (26,295 square kilometers). It encircles the Black Hills and the Dakota Hogback. The eastern half of Rapid City and the town of Belle Fourche, South Dakota, are in this area. Interstate 90 bisects part of the area as it parallels the northern border of the Badlands National Park, near Cactus Flat, and enters Rapid City on the east. It then skirts the Black Hills as it leaves South Dakota and enters Wyoming in the northwest part of the area. This MLRA includes the Oglala National Grasslands and parts of the Thunder Basin and Buffalo Gap National Grasslands. Small parts of the Pine Ridge Indian Reservation, the Badlands National Park, and the Black Hills National Forest occur in this MLRA. Ellsworth Air Force Base is just outside Rapid City.

Physiography

This area is in the Missouri Plateau, Unglaciated, Section of the Great Plains Province of the Interior Plains. It is an area of old plateaus and terraces that have been deeply eroded. Elevation is generally 2,620 to 3,610 feet (800 to 1,100 meters) on uplands, but it ranges to 4,260 feet (1,300 meters). The shale plains have long, smooth slopes and generally are gently sloping to strongly sloping. Slopes are moderately steep or steep along drainages and streams. Extensive terraces occur along many of the major streams draining the Black Hills.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows:

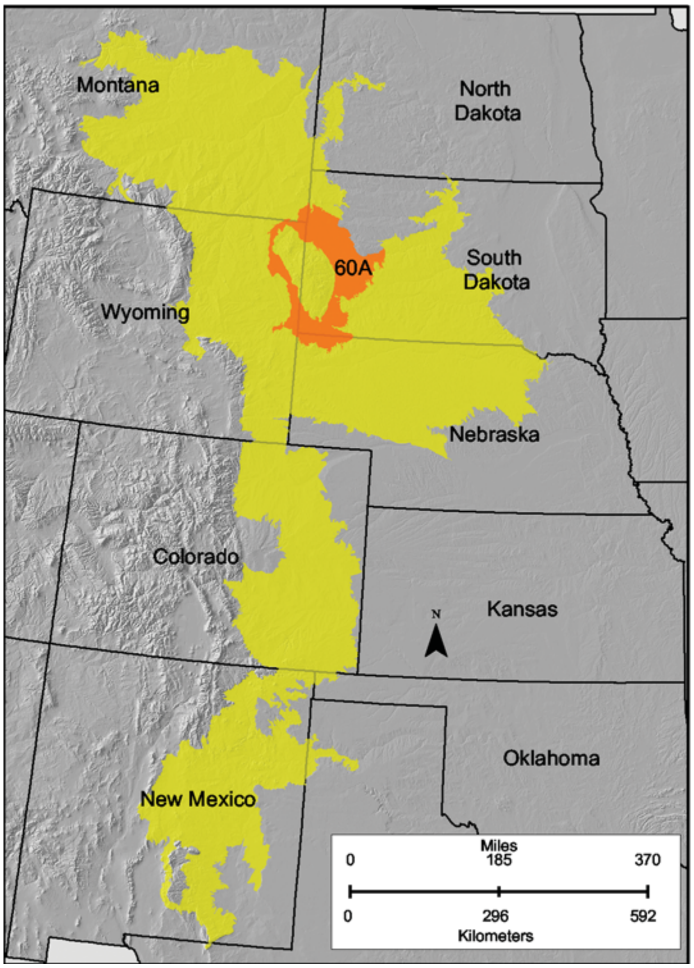

Figure 60A-1: Location of MLRA 60A in Land Resource Region G.

Cheyenne (1012), 82 percent; Missouri-White (1014), 9 percent; Missouri-Oahe (1013), 5 percent; and Missouri-Little Missouri (1011), 4 percent. The Cheyenne and Belle Fourche Rivers occur in this MLRA.

Geology

Cretaceous Pierre Shale underlies almost all of this area. This is a marine sediment having layers of volcanic ash that has been altered to smectitic clay. This clay shrinks as it dries and swells as it gets wet, causing significant problems for road and structural foundations. Cretaceous shale of the Belle Fourche, Mowry, and Skull Creek Formations is adjacent to the Dakota Hogback. These formations, along with Newcastle Sandstone, make up what is called the Graneros Group. Tertiary river gravel, deposited by streams carrying erosional debris from the Black Hills following their uplift, caps the ridges separating the streams draining the Black Hills.

Climate

The average annual precipitation in this area is 13 to 22 inches (330 to 560 millimeters). Most of the rainfall occurs as frontal storms early in the growing season, in May and June. Some high-intensity, convective thunderstorms occur in July and August. Precipitation in winter occurs mainly as snow that usually is accompanied by high winds that cause much drifting. The average annual temperature is 43 to 49 degrees F (6 to 9 degrees C). The freeze-free period averages about 150 days and ranges from 130 to 170 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.9%; ground water, 5.4%
Livestock—surface water, 4.2%; ground water, 0.3%
Irrigation—surface water, 76.1%; ground water, 4.5%
Other—surface water, 7.5%; ground water, 1.2%

The total withdrawals average 110 million gallons per day (415 million liters per day). About 11 percent is from ground water sources, and 89 percent is from surface water sources. Because of the limited amount of precipitation, the production of dry-farmed crops is marginal. Most of the soils are moist or wet early in spring and are deficient in moisture during much of the growing season. In irrigated areas along the Belle Fourche River in the northern part of the area and the Cheyenne River in the southern part, surface water is drawn from the Belle Fourche and Angostura Reservoirs, respectively. Some areas along Rapid Creek are irrigated. Water for livestock comes mainly from runoff that flows into dams. Surface runoff from the forested Black Hills is of good quality. Stream runoff seeps into the cavernous Pahasapa limestone within the Black Hills. Springs occur at the edges of the Black Hills when this water discharges at the surface. This water is of excellent quality and is used for public supply.

Pierre Shale underlies almost all of this area, so ground water is scarce. A few areas have shallow water wells for domestic use, but the water is of marginal quality for drinking. Some shallow wells also draw domestic water from alluvial sand and gravel under the larger stream valleys. This water is of much better quality than the shallow ground water in the Pierre Shale.

Soils

The dominant soil orders in this MLRA are Entisols, Alfisols, Vertisols, and Inceptisols. Mollisols are of lesser extent. The soils in the area dominantly have a mesic soil temperature regime, an ustic soil moisture regime, and smectitic or mixed mineralogy. They are shallow to very deep, generally well drained, and clayey. Paleustalfs (Jaywest series) formed in alluvium on alluvial fans. Haplustalfs (Leiter series) formed in alluvium and residuum on hills, alluvial fans, and fan remnants. Ustorthents (Fairburn, Grummit, Lismas, and Samsil series) and Haplusterts (Pierre, Kyle, and Swanboy series) formed in residuum and local alluvium on plains and hills. Haplustepts formed in residuum and alluvium on stream terraces and uplands (Bufton series) and in alluvium and residuum on hills, alluvial fans, and fan remnants (Echeta and Cromack series). Argiustolls (Nunn and Satanta series) are on old alluvial terraces along many of the streams that drained the Black Hills.

Biological Resources

The native vegetation in this MLRA consists primarily of grasses and forbs. Some trees and shrubs occur along streams. This area supports mixed natural prairie vegetation characterized by grasses, such as western wheatgrass, green needlegrass, blue grama, and buffalograss. Little bluestem, buffalograss, and sideoats grama grow on the shallow soils. Big bluestem grows along streams, especially where the soils have an effective water table. The most common forbs are purple coneflower, prairie coneflower, American vetch, dotted gayfeather, Missouri goldenrod, breadroot scurfpea, silverleaf scurfpea, scarlet globemallow, heath aster, desert biscuitroot, and cudweed sagewort. Shrubs include sand sagebrush on sandy soils and silver sagebrush, western snowberry, and leadplant on clayey soils in the western part of the area. Big sagebrush grows in the driest part of the MLRA, in southwestern Fall River County and extending into Wyoming. Boxelder, green ash, and plains cottonwood are the principal trees along streams and drainageways. Eastern redcedar occurs in scattered areas throughout the uplands, especially along the Cheyenne River. Bur oak and ponderosa pine commonly occur in areas of the acid shale of the Graneros Group.

Some of the major wildlife species in this area are mule deer, white-tailed deer, antelope, coyote, bobcat, badger, beaver, raccoon, skunk, muskrat, mink, jackrabbit, cottontail, prairie dog, turkey, pheasant, sharp-tailed grouse, Hungarian partridge, sage grouse, mourning dove, mallard, long-billed curlew, killdeer, yellow-headed blackbird, and red-winged blackbird. The species of fish in the area include walleye, channel catfish, white bass, largemouth black bass, bluegill, and northern pike.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 11%
Grassland—private, 59%; Federal, 23%
Forest—private, 1%
Urban development—private, 1%
Water—private, 1%
Other—private, 4%

The dominant land uses are rangeland and hayland. Practically all of this area is in farms and ranches. Most of it supports native grasses and is grazed by livestock. Approximately 10 percent of the area is used for small grain grown for grain and livestock feed. Some small areas of nearly level to moderately sloping soils are used for winter wheat or feed crops for livestock.

The major resource concerns are wind erosion and surface water quality. The major soil resource concerns are wind erosion and soil quality on cropland, especially where wheat-fallow is the principal crop rotation. Wind erosion and soil quality also are concerns on continuously overgrazed rangeland.

Conservation practices on rangeland generally include prescribed grazing, fencing, and water developments. The establishment of food plots and range improvement practices benefit wildlife. The establishment of early and late season pastures supplements forage production and keeps livestock off the rangeland during critical growth periods. Conservation practices on cropland generally include no-till and other kinds of conservation tillage, contour farming, and crop residue management. ■

60B—Pierre Shale Plains, Northern Part

This area (shown in fig. 60B-1) is almost entirely in Montana (94 percent) and Wyoming (6 percent). A very small part of the area is in North Dakota. The area makes up about 3,375 square miles (8,750 square kilometers). It occurs in the uplands between most of the major rivers in southeastern Montana and northeastern Wyoming. It has no major cities. U.S. Highway 212 cuts across the southern end of the area. The Custer National Forest occurs in this area.

Physiography

This area is in the Missouri Plateau, Unglaciated, Section of the Great Plains Province of the Interior Plains. It is an area of old plateaus and terraces that have been deeply eroded. Elevation ranges from 2,950 to 3,300 feet (900 to 1,005 meters) on uplands. The shale plains have long, smooth, gentle to strong slopes. Slopes along drainageways and streams are moderately steep or steep.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Missouri-Little Missouri (1011), 53 percent; Powder-Tongue (1009), 27 percent; and Lower Yellowstone (1010), 20 percent. The MLRA has no major rivers.

Geology

Marine and continental sediments of the Cretaceous Montana Group underlie most of this MLRA, generally at the

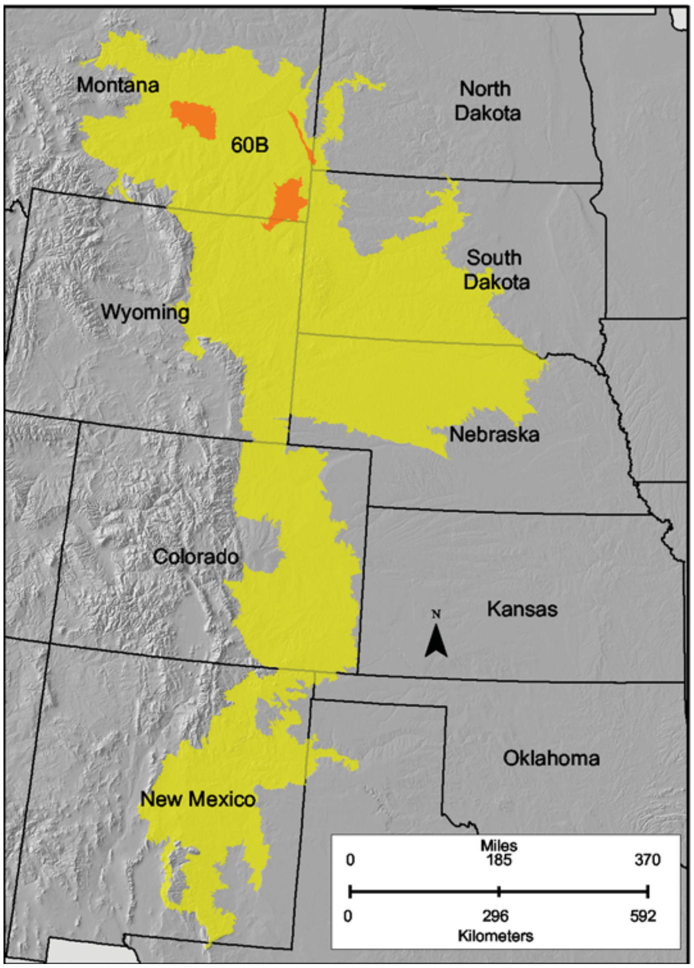

Figure 60B-1: Location of MLRA 60B in Land Resource Region G.

higher elevations. The Montana Group in this part of Montana includes Fox Hills Sandstone and Pierre Shale. A group of younger Cretaceous sediments occurs at the lower elevations at the north and west ends of the area. These younger deposits include Hell Creek sandstone and shale, St. Mary River mudstone, and the volcaniclastics of the Livingston Group. The older Cretaceous Niobrara shale and chalk beds occur at the higher elevations in the southeast corner of this MLRA.

Climate

The average annual precipitation in this area is 11 to 15 inches (280 to 380 millimeters). Most of the annual precipitation occurs as high-intensity, convective thunderstorms during the growing season. Precipitation in winter occurs mainly as snow, which usually is accompanied by high winds that cause much drifting. The average annual temperature is 43 to 46 degrees F (6 to 8 degrees C). The freeze-free period averages 140 days and ranges from 130 to 155 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 0.3%; ground water, 0.7%
Irrigation—surface water, 62.9%; ground water, 31.4%
Other—surface water, 2.0%; ground water, 2.6%

The total withdrawals average 3 million gallons per day (11 million liters per day). About 35 percent is from ground water sources, and 65 percent is from surface water sources. Because of the limited amount of precipitation, the production of dry-farmed crops is marginal. Most of the soils are moist or wet early in spring and are deficient in moisture during much of the growing season. The quality of the surface water is good, but the quantity typically is inadequate. Some limited irrigation occurs along the larger streams on the edges of this area. Water for livestock comes mainly from runoff that flows into dams.

Ground water is scarce in most of the area, but local deposits of sand and gravel in the Fox Hills Sandstone and Hell Creek Formation yield small to moderate amounts of domestic and livestock water. This ground water is a sodium bicarbonate or sulfate type and generally is hard or very hard. The level of total dissolved solids, typically more than 1,000 parts per million (milligrams per liter), exceeds the standards for drinking water. The water from alluvial deposits in areas of flood plains and terraces is of much better quality than the water in the bedrock aquifers. Shallow wells provide a limited amount of water for irrigation, domestic use, and livestock.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, and Vertisols. The soils in the area dominantly have a frigid soil temperature regime, an ustic soil moisture regime, and smectitic mineralogy. They are shallow to very deep, generally well drained, and clayey. Natrustalfs (Absher and Gerdrum series) formed in alluvium, glaciofluvial deposits, and till on alluvial fans, stream terraces, and plains. Haplusterts formed in alluvium and/or residuum on alluvial fans, stream terraces, and plains (Bascovy and Bickerdyke series) and in alluvium and lacustrine deposits on alluvial fans, stream terraces, and lake plains (Marias and Marvan series). Ustorthents formed in mixed residuum, alluvium, and colluvium on hills and plains (Neldore, Orinoco, and Yawdim series) and in alluvium, lacustrine deposits, and glaciofluvial deposits on alluvial fans, stream terraces, and plains (Vanda series).

Biological Resources

This area supports mixed natural prairie vegetation characterized by western wheatgrass, green needlegrass, and blue grama. Little bluestem and sideoats grama grow on shallow soils. Some areas in the southern part of the MLRA support pine forests. Oak species grow in some protected draws.

Some of the major wildlife species in this area are mule deer, white-tailed deer, antelope, coyote, fox, bobcat, rattlesnake, badger, raccoon, porcupine, beaver, skunk, mink, jackrabbit, prairie dog, golden eagle, ferruginous hawks, pheasant, sharp-tailed grouse, sage grouse, gray partridge, magpie, and lark bunting.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 5%
Grassland—private, 63%; Federal, 29%
Forest—private, 1%; Federal, 1%
Urban development—private, 1%

Practically all of this area is in farms or ranches. Most of it is rangeland used for grazing by livestock. Some small areas of nearly level to moderately sloping soils are used for winter wheat or for livestock feed crops.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, management of soil moisture, and control of saline seeps. Water resource concerns include failure to meet plant needs because of inefficient water use on irrigated cropland. They also include excessive amounts of pesticides, nutrients, and organic material in surface and ground waters. Plant resource concerns are deterioration of plant condition, productivity, health, and vigor; noxious and invasive plants; and wildfires. Animal resource concerns are inadequate food, cover, and shelter.

Conservation practices on cropland generally include crop residue management (especially minimum tillage), cover crops, stripcropping, nutrient management, soil salinity management, and pest management. Practices that improve water use and distribution on irrigated cropland generally include irrigation water management, irrigation water delivery systems, and on-farm irrigation practices, such as sprinklers. Noxious and invasive plants can be controlled by pest management and prescribed grazing. Forest stand improvement and firebreaks reduce the hazard of wildfires and improve forest growth, quality, health, and productivity.

Conservation practices on rangeland generally include prescribed grazing, fencing, and water developments. The establishment of food plots and range improvement practices benefit wildlife. The establishment of early and late season pastures supplements forage production and keeps livestock off the rangeland during critical growth periods. ■

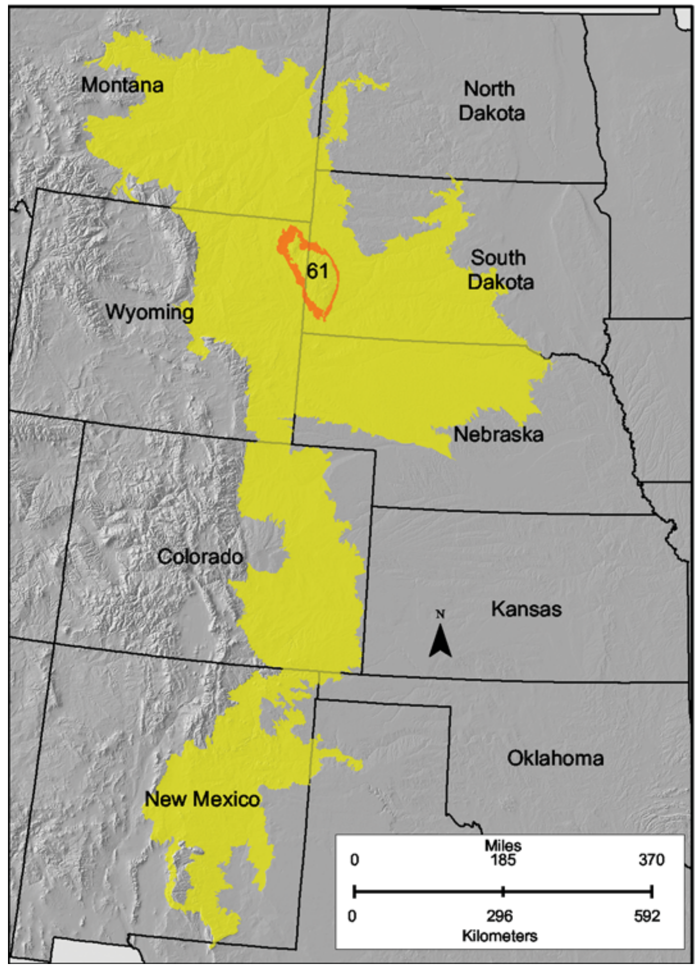

Figure 61-1: Location of MLRA 61 in Land Resource Region G.

61—Black Hills Foot Slopes

This area (shown in fig. 61-1) is in Wyoming (58 percent) and South Dakota (42 percent). It makes up about 1,865 square miles (4,840 square kilometers). The cities of Spearfish, Sturgis, and Hot Springs, South Dakota, and Sundance and Newcastle, Wyoming, are in this area. Rapid City, South Dakota, is on the eastern edge of the MLRA. Wind Cave National Park, Devil's Tower National Monument, and parts of the Thunder Basin National Grasslands and the Black Hills National Forest occur in this MLRA.

Physiography

This area is in the Black Hills Section of the Great Plains Province of the Interior Plains. It is an area of steeply dipping rocks circling the maturely dissected domed mountains of the Black Hills. As the mountains were uplifted, older sediments were tipped up, so they dip away from the core of the mountains. Elevation is mainly 2,950 to 3,940 feet (900 to

1,200 meters) but ranges to 5,580 feet (1,700 meters). Slopes generally are hilly but are nearly level to moderately sloping where shale red beds occur in the middle of this area. They are steep along both edges of the area where rocks that are more erosion resistant occur. The drainage pattern is well defined.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Cheyenne (1012), 98 percent, and Missouri-Little Missouri (1011), 2 percent. The Belle Fourche River is the only river flowing through this MLRA, but many creeks draining the Black Hills cross the area. The creeks are the headwaters of the Cheyenne River, one of the major rivers in western South Dakota.

Geology

This area consists of marine sediments older than the Cretaceous Pierre Shale on the high plains surrounding this area. The older rocks were brought closer to the surface during the uplift that formed the Black Hills. The Lower Cretaceous Fall River and Lakota (Inyan Kara Group) sandstones occur on the outside boundary of the area and are referred to as the Dakota Hogback. Permian limestone and shale of the Minnekahta limestone form the inside boundary and occur in the mountains of the Black Hills (MLRA 62). The Triassic red beds of the Spearfish shale form a low valley, the “red valley,” surrounding the Black Hills between the two ridges formed by the Inyan Kara and Minnekahta Formations. Native Americans called these red beds the “Great Race Track.” The red beds have gypsum and anhydrous layers. Ground-water seepage can dissolve these layers, creating sinkholes on the surface.

Climate

The average annual precipitation in this area is 14 to 24 inches (355 to 610 millimeters). Most of the rainfall occurs as frontal storms early in the growing season, in May and June. Some high-intensity, convective thunderstorms occur in July and August. The average snowfall in winter is 24 to 39 inches (60 to 100 centimeters), increasing with elevation. The average annual temperature is 40 to 49 degrees F (5 to 9 degrees C). The freeze-free period averages 140 days and ranges from 115 to 165 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 13.1%; ground water, 78.9%
Livestock—surface water, 1.6%; ground water, 0.3%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 5.3%; ground water, 0.8%

The total withdrawals average 7.5 million gallons per day (28 million liters per day). About 80 percent is from ground water sources, and 20 percent is from surface water sources. Flowing streams, shallow wells, and springs provide almost all of the domestic and public water. The surface water is of good quality during high runoff periods. At low flows, however, much of the surface water does not meet drinking water standards because of pollution and high levels of total dissolved solids. Much of the water used in this area is for public supply for the numerous cities and towns that were built on the level ground that forms the core of the area. Crop production in the area is marginal because of the limited amount of precipitation. Some limited irrigation occurs along the major streams that headwater in the Black Hills and cross the area. Most of the soils suitable for cultivation are dry during much of the growing season. Ground water is scarce because of the shale under most of the area. Many cities obtain public supply water from large springs in the Pahasapa limestone on the inside edge of this area.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, and Mollisols. The soils in the area dominantly have a frigid or mesic soil temperature regime, an aridic or ustic soil moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep, generally well drained, and loamy. Haplustalfs (Larkson series) and Hapludalfs (Lakoa series) formed in residuum on hills and valley walls. Haplustolls (Tilford series) formed in silty sediments on valley floors. Argiustolls formed in silty sediments (Boneek and Vale series) and eolian and alluvial deposits (Satanta and Nunn series) on stream terraces and uplands. Ustorthents formed in residuum on uplands (Butche and Spearfish series) and in alluvium and colluvium on stream terraces and uplands (Nevee and Gypnevee series). Torriorthents formed in residuum on hills and foothills (Canyon, Crownest, Gaynor, Shingle, and Tassel series) and in basins (Enning, Fairburn, and Mittenbutte series).

Biological Resources

This area supports open grassland, forest, and savanna vegetation. The grassland is characterized by native grasses, such as little and big bluestem, prairie junegrass, Indian ricegrass, sand dropseed, green needlegrass, western wheatgrass, and needleandthread. The most common forbs are white beartongue, ballhead gilia, white milkwort, dotted gayfeather, rush skeletonplant, purple coneflower, prairie coneflower, and trailing fleabane. The most common shrubs are silver sagebrush, rubber rabbitbrush, and broom snakeweed. Ponderosa pine grows in scattered stands of open forest. Bur oak grows throughout the area, and in places it grows in nearly pure stands. Quaking aspen and eastern hophornbeam are throughout the forested areas. Scattered green ash, boxelder, and American elm grow along with big bluestem in areas along stream bottoms.

Some of the major wildlife species in this area are elk, mule deer, white-tailed deer, antelope, coyote, fox, bobcat, mountain lion, wild turkey, sage grouse, ruffed grouse, and sharp-tailed grouse.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 8%
Grassland—private, 54%; Federal, 7%
Forest—private, 19%; Federal, 5%
Urban development—private, 6%
Other—private, 1%

Most of this area is privately owned land in farms and ranches. The native grasses are used mainly for grazing by livestock. Some of the less sloping areas are used for alfalfa and small grain for livestock feed. Ponderosa pine grows in some areas adjacent to the Black Hills. Urban expansion is a growing concern.

The major resource concerns in this area are water quality and urban expansion. The major soil resource concerns are wind erosion, water erosion, and urban expansion.

Conservation practices on rangeland generally include prescribed grazing, fencing, and water developments. The establishment of food plots and range improvement practices benefit wildlife. Conservation practices on cropland generally include contour farming, crop rotations that include grasses and legumes, and crop residue management. The Grassland Reserve Program is an increasingly important tool that helps to limit urban expansion. Forest stand improvement and firebreaks reduce the hazard of wildfires and improve forest growth, quality, health, and productivity. ■

62—Black Hills

This area (shown in fig. 62-1) is in South Dakota (74 percent) and Wyoming (26 percent). It makes up about 3,040 square miles (7,875 square kilometers). The towns of Lead, Deadwood, Hill City, and Custer, South Dakota, are in this area. U.S. Highways 16 and 385 cross the MLRA. The Black Hills National Forest, Custer State Park, Mt. Rushmore National Monument, Wind Cave National Park, and Jewel Cave National Monument are in this MLRA. A large-scale mountain carving, the privately owned Crazy Horse Monument, also is in this area. The Black Hills is a major tourist destination in the United States.

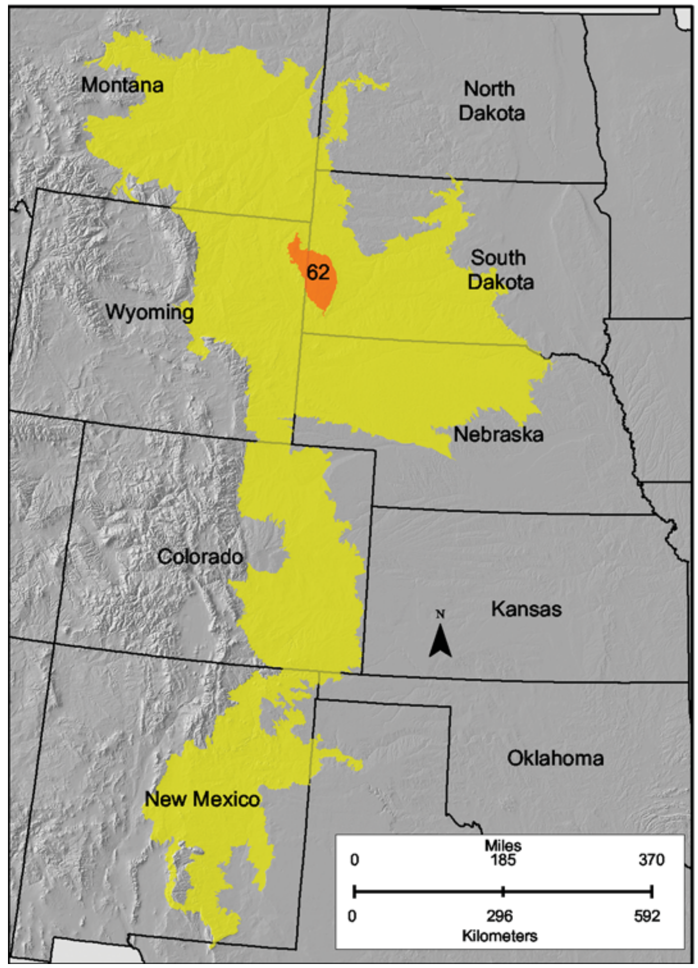

Figure 62-1: Location of MLRA 62 in Land Resource Region G.

Physiography

This area forms the core of the Black Hills Section of the Great Plains Province of the Interior Plains. It is an area of maturely dissected domed mountains. Elevation is mainly 3,600 to 6,565 feet (1,100 to 2,000 meters), but it is 7,242 feet (2,208 meters) on Harney Peak, the highest point in the United States east of the Rocky Mountains. Slopes range from moderately sloping on some of the high plateaus to very steep along drainageways and on peaks and ridges. Narrow valleys generally are gently sloping to strongly sloping.

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is Cheyenne (1012). Many streams that drain the MLRA, including Box Elder, Castle, French, Rapid, Spearfish, and Spring Creeks, are popular destinations for trout fishermen.

Geology

The core of the Black Hills is a plutonic mass of granite with steeply dipping metamorphic rocks, primarily slate and schist, directly surrounding it. A plateau of Mississippian limestone surrounds the igneous and metamorphic rock core. This Pahasapa (Madison) limestone is broken around the outer edges of the uplifted area. The Permian Minnekahta limestone forms the outermost boundary of the area. Many other tilted sandstone, shale, and limestone units are exposed like a bathtub ring inside the steeply dipping Pahasapa limestone. These older units are also exposed on the valley walls along the major drainages that cut through the rock layers.

There are two unique geologic features in the Black Hills. One is the loss of water in the creeks that flow across the cavernous Pahasapa limestone ringing the Black Hills. This water is discharged to the surface again in major springs that occur at the margins of the Black Hills. The other feature involves a series of Tertiary igneous intrusives, aligned east to west across the northern third of the Black Hills. Gold deposits formed in the country rock adjacent to these igneous rocks. The largest gold mine in North America, the Homestake Gold Mine in Lead, South Dakota, operated for 120 years in this area. The mine closed in 2001. Scientists across the country are working on converting some of the mined levels into underground laboratories for the study of nuclear particles.

Climate

The average annual precipitation in this area is 16 to 37 inches (405 to 940 millimeters), increasing with elevation and decreasing from west to east and north to south. Most of the rainfall occurs as frontal storms early in the growing season, in May and June. Some high-intensity, convective thunderstorms occur in July and August. Precipitation in winter occurs mostly as snow. The annual snowfall ranges from about 60 inches (150 centimeters) at the lower elevations to as much as 140 inches (355 centimeters) at the higher elevations. The average annual temperature is 36 to 48 degrees F (2 to 9 degrees C). The freeze-free period averages 125 days and ranges from 85 to 165 days. It is shortest at the higher elevations and in the northwestern part of the area.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 33.1%; ground water, 16.6%
Livestock—surface water, 13.0%; ground water, 2.5%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 26.7%; ground water, 8.0%

The total withdrawals average 2.4 million gallons per day (9 million liters per day). About 27 percent is from ground water sources, and 73 percent is from surface water sources. In most years soil moisture is adequate for normal plant growth. Precipitation, perennial streams, springs, and shallow wells provide adequate water for domestic use. The surface water is plentiful and of good quality. Most public supply water for towns in the Black Hills comes from streams. Small hydroelectric plants are on Spearfish Creek.

Most of the granitic and metamorphic rocks in this area are not principal aquifers. Some of the purest water in South Dakota, however, comes from springs in the granite rocks around the Mt. Rushmore National Monument. The metamorphic rocks have joints and bedding and cleavage planes that allow for transmission of water at the lower elevations. These rocks commonly are the source of the domestic supply in the Black Hills. The water from the metamorphic rocks is much more mineralized than the water in the granite. The Pahasapa (Madison) limestone and younger sandstone and limestone sediments are the primary aquifers in this MLRA. The ground water is plentiful and is used primarily for irrigation and livestock. It has high levels of total dissolved solids and is mostly a sodium sulfate type.

Soils

The dominant soil orders in this MLRA are Alfisols and Mollisols. The soils in the area dominantly have a frigid or cryic soil temperature regime, a udic or ustic soil moisture regime, and mixed, micaceous, or smectitic mineralogy. They are shallow to very deep, generally well drained, and loamy or clayey. Hapludalfs (Buska, Citadel, Pactola, Vanocker, and Virkula series), Haplocryalfs (Stovho and Trebor series), and Ustorthents (Sawdust series) formed in residuum on mountains. In some areas the residuum is mixed with alluvium or colluvium. Haplustalfs (Mocmont series) formed in colluvium or alluvium on fans, hills, and mountains. Haplustolls formed in alluvium on fan aprons and piedmonts (Cordeston series) and in residuum on mesas and hills (Paunsaugunt series). Rock outcrop is common throughout this area.

Biological Resources

This area supports open to dense forest vegetation. Ponderosa pine is the dominant species. Black Hills spruce grows at the higher elevations and along the major drainageways. Paper birch and quaking aspen are on sites that have been burned over by wildfire or cleared by logging. Junegrass, fuzzyspike wildrye, green muhly, prairie dropseed, roughleaf ricegrass, green needlegrass, poverty oatgrass, Richardson's needlegrass, and Canada wildrye are the most common native grasses under open forest stands. The most common native forbs and shrubs are spreading dogbane, Indian hemp, low larkspur, prairie star, Richardson's alumroot, sulfur paintbrush, bearberry, common juniper, grouse berry, redosier dogwood, poison ivy, Saskatoon serviceberry, red raspberry, chokecherry, creeping blackberry, wild spirea, and western red currant.

Some of the major wildlife species in this area are elk, mule deer, white-tailed deer, coyote, red fox, gray fox, bobcat, mountain lion, raccoon, porcupine, skunk, beaver, red squirrel, northern flying squirrel, mink, bald eagle, golden eagle, red-tailed hawk, turkey, ruffed grouse, and sharp-tailed grouse.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 2%
Grassland—private, 22%; Federal, 25%
Forest—private, 19%; Federal, 28%
Urban development—private, 2%
Other—private, 2%

The forestland in this area is used mainly for timber production, recreation, and grazing. About half of the area is in the Black Hills National Forest. The Black Hills area, an important tourist attraction, is used for logging, mining, recreation, and hunting. Some areas, especially in the northern part of the Black Hills, are mined for gold and other minerals. Scattered small farms and ranches, rural homes, and summer homes on small acreages are throughout the area. Small ranches and farms depend on the Black Hills National Forest for summer grazing.

The major resource concerns are the erosion and surface compaction caused by logging, mining, wildfires, grazing, and urban expansion. The quality of ground water and surface water is another concern, especially in the northern part of the Black Hills, because of contamination from mine waste and septic systems in areas of rural development and urban expansion.

The major erosion-control practices are critical area planting and proper tree harvesting on disturbed or burned sites and proper grazing management. Conservation practices on rangeland generally include prescribed grazing, fencing, and water developments. Forest stand improvement and firebreaks reduce the hazard of wildfires and improve forest growth, quality, health, and productivity. ■

63A—Northern Rolling Pierre Shale Plains

This area is primarily in South Dakota, but a very small part is in North Dakota (fig. 63A-1). The area makes up about 10,160 square miles (26,330 square kilometers). The towns of Murdo, Philip, Fort Pierre, and Pierre, the capital of South Dakota, are in this MLRA. Interstate 90 crosses the southernmost part of this area. The Fort Pierre and Buffalo Gap National Grasslands are in this MLRA. Several Indian reservations, including the Cheyenne River, Lower Brule, and Standing Rock Indian Reservations, are in this area.

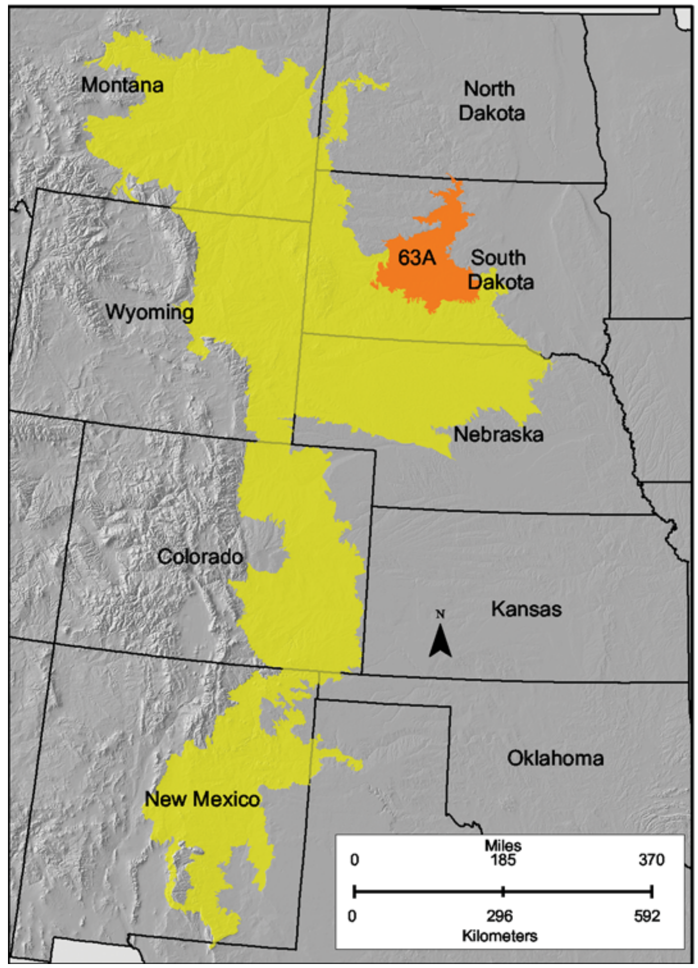

Figure 63A-1: Location of MLRA 63A in Land Resource Region G.

Physiography

This area is primarily in the Missouri Plateau, Unglaciated, Section of the Great Plains Province of the Interior Plains. This is an area of old plateaus and terraces that have been deeply eroded. Parts of the eastern edge of this area are in the Missouri Plateau, Glaciated, Section of the Great Plains Province of the Interior Plains. Isolated remnants of glacial till are in the glaciated section. Glacial erratics have been found as far west as the center of this area. Elevation ranges from 1,300 to 1,640 feet (395 to 500 meters) on the bottom land along the Missouri River to 1,640 to 2,950 feet (500 to 900 meters) on the shale plain uplands. The areas that are cropped are mainly at elevations of about 1,640 to 2,620 feet (500 to 800 meters). These areas are nearly level to rolling and have long, smooth slopes and a well defined dendritic drainage system. River and creek valleys have smooth floors and steep walls.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Missouri-White (1014), 50 percent; Missouri-Oahe (1013), 34 percent; and Cheyenne (1012), 16 percent. The Missouri River is mostly inside this area along its east edge. All five of the major rivers draining western South Dakota cross this area. From north to south, these are the Grand, Moreau, Cheyenne, Bad, and White Rivers. With the exception of the White River, the confluence of all these rivers with the Missouri River occurs in this area. Three of the four lakes created by main-stem dams on the Missouri River are in this area—Lake Oahe, Lake Sharpe, and Lake Francis Case.

Geology

Cretaceous Pierre Shale underlies almost all of this area. This is a marine sediment having layers of volcanic ash that has been altered to smectitic clays. These clays shrink as they dry and swell as they get wet, causing significant problems for road and structural foundations. Fox Hills Sandstone occurs at the higher elevations in the northern and western parts of the area. Tertiary and Quaternary river deposits, remnants of erosion from the Black Hills following their uplift, cap isolated highs in this area. Deposits of alluvial sand and gravel occur on the valley floors adjacent to the major streams in the area.

Climate

The average annual precipitation in this area is 14 to 19 inches (355 to 485 millimeters). Most of the precipitation falls during the growing season as frontal storms in spring and as high-intensity, convective thunderstorms in summer. Precipitation in winter occurs mostly as snow. The annual snowfall is typically 20 to 48 inches (50 to 120 centimeters). The average annual temperature is 43 to 49 degrees F (6 to 10 degrees C). The freeze-free period averages 160 days and ranges from 145 to 180 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 4.6%; ground water, 0.0%
Livestock—surface water, 6.8%; ground water, 0.4%
Irrigation—surface water, 68.8%; ground water, 4.6%
Other—surface water, 13.9%; ground water, 0.9%

The total withdrawals average 90 million gallons per day (340 million liters per day). About 6 percent is from ground water sources, and 94 percent is from surface water sources. In most years precipitation is inadequate for maximum plant growth. Some irrigated land is along the Missouri River and on the flood plains along its major tributaries. The surface water is generally of good quality. It is a sodium bicarbonate type and is soft.

This area has few shallow water developments. Most of the water for livestock comes from surface runoff that flows into dams or from deep artesian flows from wells finished in Dakota Sandstone. Because of high amounts of dissolved solids, mostly sodium, chloride, and sulfate, the well water is slightly saline or moderately saline. It is very hard and is suitable only for watering livestock. High levels of selenium and molybdenum in the runoff from the shale plains may cause some health problems for livestock. Rural water systems are improving the quality of the water available for domestic use. The Missouri River is the source of water for these systems.

Soils

The dominant soil orders in this MLRA are Entisols, Inceptisols, Mollisols, and Vertisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic soil moisture regime, and smectitic mineralogy. They are shallow to very deep, generally well drained, and clayey. Ustorthents (Okaton and Sansarc series) formed in residuum on breaks, hills, and ridges. In some areas the residuum is mixed with alluvium. Ustifluvents (Wendte series) and Argiustolls (Kirley series) formed in alluvium on flood plains and terraces. Haplustepts (Chantier and Dupree series) and Calciustepts (Lakoma series) formed in residuum on plains and ridges. Haplustolls (Ottumwa series) formed in clayey sediments on uplands. Haplusterts formed in alluvium on fans, terraces, and valley floors (Bullcreek series); in residuum on uplands (Millboro and Opal series); and in clayey sediments on uplands, fans, and terraces (Promise series).

Biological Resources

The vegetation in this area is a transition between tall prairie grasses and mixed prairie grasses. Green needlegrass, western wheatgrass, needleandthread, porcupinegrass, little bluestem, and big bluestem are the major species. Bluestems, buffalograss, sedges, and sideoats grama are dominant on the shallower soils. Bur oak, buffaloberry, and prairie rose are common along the major streams. Prairie cottonwood and a variety of willow species are common on the flood plains along the major streams.

Some of the major wildlife species in this area are mule deer, white-tailed deer, antelope, turkey, pheasant, sharp-tailed grouse, and prairie chicken.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 23%
Grassland—private, 63%; Federal, 6%
Forest—private, 1%
Urban development—private, 1%
Water—private, 5%
Other—private, 1%

Most of this area is in farms or ranches. Urban expansion is limited. The area is used mainly for livestock production and cash-grain farming. Alfalfa, sorghum, and hay are the principal crops grown for livestock feed. Winter wheat is the main cash crop; spring wheat and sunflowers are grown to a lesser extent. Dryfarming soils that are not suited to cultivation is destroying the native grassland.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems that reduce the need for summer fallow tillage), cover crops, windbreaks, vegetative wind barriers, wind stripcropping, and nutrient management.

The most important conservation practice on rangeland is prescribed grazing. Generally, cultural treatments are not used to increase forage production on the rangeland in this area. Cool-season tame pastures are established to supplement forage production. Haying commonly provides feed during the winter. ■

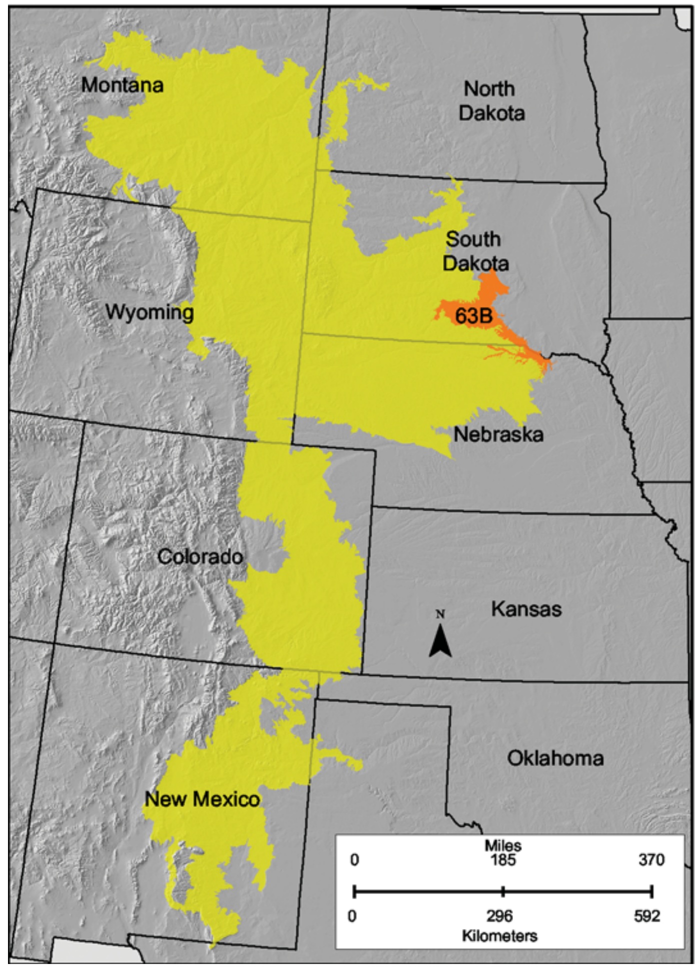

Figure 63B-1: Location of MLRA 63B in Land Resource Region G.

63B—Southern Rolling Pierre Shale Plains

This area (shown in fig. 63B-1) is in South Dakota (82 percent) and Nebraska (18 percent). It makes up about 4,460 square miles (11,565 square kilometers). The towns of Winner, Kennebec, Chamberlain, and Pickstown, South Dakota, are in this area. Interstate 90 crosses the northernmost part of the area. Several Indian reservations are in this MLRA, including the Lower Brule, Crow Creek, Santee, and Yankton Indian Reservations.

Physiography

Almost all of this area is in three different sections of the Great Plains Province of the Interior Plains. Most of the area is in the Missouri Plateau, Unglaciated, Section. This part of the MLRA is an area of old plateaus and terraces that have been deeply eroded. It is nearly level to rolling and has long, smooth slopes and a well defined dendritic drainage system. Rivers and creek valleys have smooth floors and steep walls.

The northeast corner of the MLRA, east of the Missouri River, is in the Missouri Plateau, Glaciated, Section, and the southwest tip is in the High Plains Section. The glaciated section is very similar to the unglaciated section. Some of the higher areas have deposits of glacial drift. The topography of the High Plains Section is typified by nearly level and broad intervalley remnants of smooth fluvial plains.

The southeast tip of the MLRA is in the Dissected Till Plains Section of the Central Lowland Province of the Interior Plains. The topography is very similar to that of the Missouri Plateau, Glaciated, Section, but the original surface is a till plain rather than an old plateau.

Elevation ranges from 1,310 to 1,640 feet (400 to 500 meters) on the bottom land along the Missouri River and from 1,310 to 1,970 feet (400 to 600 meters) on the shale plain uplands. The areas that are cropped are mainly at an elevation of about 1,640 feet (500 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Missouri-White (1014), 79 percent; Niobrara (1015), 15 percent; and Missouri-Big Sioux (1017), 6 percent. The Missouri River and the breaks along the river are in this MLRA. The river runs through the north part of the MLRA and then along the east edge. The confluence of the White and Missouri Rivers is in this area. The lower reach of the Niobrara River, in Nebraska, also is in this area. Lake Francis Case, Fort Randall Dam, and Lewis and Clark Lake are in this MLRA. Lewis and Clark Lake formed behind Gavins Point Dam, which is outside this MLRA, in an area near Yankton, South Dakota. Gavins Point Dam is the last and farthest downstream of the five main-stem dams on the Missouri River.

Geology

Cretaceous Pierre Shale underlies most of this area. This is a marine sediment having layers of volcanic ash that have been altered to smectitic clays. These clays shrink as they dry and swell as they become wet, causing significant problems for road and structural foundations. The younger Niobrara Chalk is in the southern part of this area. Some glacial drift remnants are in the northeast corner of the area, east of the Missouri River. Alluvial sand and gravel underlie the valley floors along the major streams.

Climate

The average annual precipitation in this area is 17 to 25 inches (430 to 635 millimeters). Most of the precipitation falls during the growing season as frontal storms in spring and as high-intensity, convective thunderstorms in summer. Precipitation in winter occurs mostly as snow. The annual snowfall is typically 16 to 46 inches (40 to 115 centimeters). The average annual temperature is 45 to 50 degrees F (7 to 10 degrees C). The freeze-free period averages 165 days and ranges from 145 to 185 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 5.6%; ground water, 2.7%
Irrigation—surface water, 33.8%; ground water, 7.9%
Other—surface water, 45.9%; ground water, 4.0%

The total withdrawals average 57 million gallons per day (215 million liters per day). About 15 percent is from ground water sources, and 85 percent is from surface water sources. In most years precipitation is inadequate for maximum plant growth. Some irrigated land is along the Missouri River and on the flood plain along the White River. The water in the Missouri River generally is of good quality. It is a sodium bicarbonate type and is soft. High loads of suspended sediments cause water-quality problems in the White River and in some of the smaller tributaries to the Missouri River.

There are few shallow water developments in this area, and most of the water for livestock comes from surface runoff that flows into dams or from deep artesian flows from wells finished in Dakota Sandstone. Because of high amounts of dissolved solids, mostly sodium, chloride, and sulfate, the well water is slightly saline or moderately saline. It is very hard and is suitable only for watering livestock. Rural water systems are improving the quality of water available for domestic use. The Missouri River is the source of water for these systems.

Soils

The dominant soil orders in this MLRA are Entisols, Inceptisols, Mollisols, and Vertisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep, generally well drained, and loamy or clayey. Ustorthents formed in residuum (Okaton and Sansarc series) or loess (Crofton series) on uplands and breaks. Haplustepts (Labu series) formed in residuum on uplands. Haplustolls (Nora and Thurman series) formed in eolian sediments. Argiustolls (Bazile and Reliance series) formed in loess and other silty sediments on uplands and stream terraces. Well drained Argiustolls (Canning and Ree series) formed on isolated high terraces along rivers and creeks. Haplusterts (Promise and Opal series) formed in clayey sediments weathered from clayey shale. Poorly drained Epiaquerts (Kolls series) formed in upland depressions.

Biological Resources

The vegetation in this area is a transition between tall prairie grasses and mixed prairie grasses. Green needlegrass, porcupinegrass, and big bluestem are the major species. Little bluestem, buffalograss, sideoats grama, and sedges are dominant on the shallow soils. Buffaloberry, skunkbush sumac, and prairie rose are common on steep slopes along the major streams. Prairie cottonwood and a variety of willow species are common on flood plains along the major streams. Green ash, boxelder, chokecherry, bur oak, and buffaloberry occur in draws and narrow valleys.

Some of the major wildlife species in this area are mule deer, coyote, bobcat, sharp-tailed grouse, magpie, mallard, gadwall, pintail, and blue-winged teal.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 27%
Grassland—private, 59%; Federal, 2%
Forest—private, 3%
Urban development—private, 1%
Water—private, 6%
Other—private, 2%

Most of this area is in ranches or farms. About three-fifths of the area is rangeland that is grazed primarily by livestock. A little more than one-fourth of the area is cropland. The major enterprise is cash-grain farming. Winter wheat is the main crop, and sunflowers, soybeans, and spring wheat are grown to a lesser extent. In other parts of the area, the crops are grown mainly as feed and forage for livestock. Irrigated corn is grown in areas where the supply of water is adequate and the soils are suitable.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture.

Conservation practices on cropland generally include systems of crop residue management (especially no-till systems that reduce the need for summer fallow tillage), cover crops, windbreaks, vegetative wind barriers, wind stripcropping, and nutrient management. The most important conservation practice on rangeland is prescribed grazing. Generally, cultural treatments are not used to increase forage production on the rangeland in this area. Cool-season, tame pastures are established to supplement forage production. Haying commonly provides supplemental feed during winter. Forest stand improvement and firebreaks reduce the hazard of wildfires on forestland and improve forest growth, quality, health, and productivity. ■

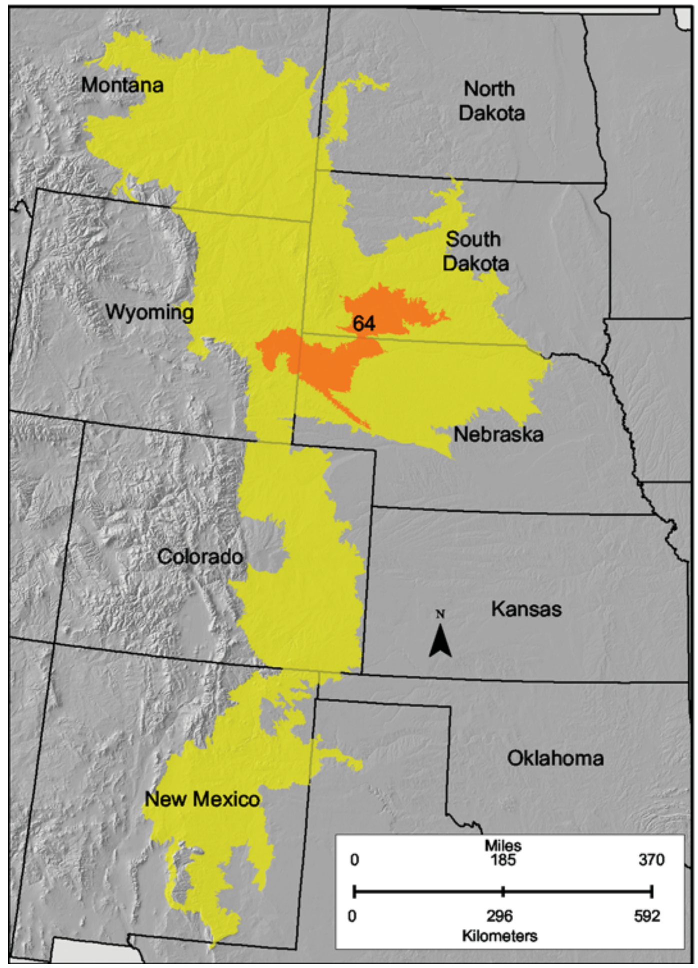

Figure 64-1: Location of MLRA 64 in Land Resource Region G.

64—Mixed Sandy and Silty Tableland and Badlands

This area (shown in fig. 64-1) is in South Dakota (42 percent), Nebraska (41 percent), and Wyoming (17 percent). It makes up about 11,895 square miles (30,825 square kilometers). The town of Kadoka, South Dakota, is in the northern part of this area. The towns of Pine Ridge, South Dakota, and Chadron, Alliance, and Scottsbluff, Nebraska, are in the southern part of the area. The town of Lusk, Wyoming, is in the southwestern part of the area. Interstate 90 goes through the northernmost part of the area, in South Dakota. The Nebraska National Forest, the Badlands National Park, parts of the Oglala and Buffalo Gap National Grasslands, the Agate Fossil Beds National Monument, Chadron State Park, Fort Robinson State Park, and the Pine Ridge Indian Reservation are in this MLRA. The Badlands are internationally renowned for their Oligocene vertebrate fossils.

Physiography

The northern half of this MLRA is in the Missouri Plateau, Unglaciated, Section of the Great Plains Province of the Interior Plains. This part of the MLRA is an area of old plateaus and terraces that have been deeply eroded. The southern half of the MLRA is in the High Plains Section of the same province and division. The topography in this part of the MLRA is typified by nearly level and broad intervalley remnants of smooth fluvial plains. The Pine Ridge escarpment separates the two areas. The area north of the escarpment is strongly sloping but becomes less sloping as distance from the escarpment increases. Local relief is generally less than 30 feet (9 meters).

In the Pine Ridge and Badlands regions, however, relief is 100 to 300 feet (30 to 90 meters), and the bottom land along the Niobrara River is 100 to 200 feet (30 to 60 meters) below the surrounding hills and escarpments. Elevation ranges from 2,950 to 3,940 feet (900 to 1,200 meters), increasing gradually from east to west. It is highest on a nearly level to gently sloping tableland south of the narrow, steep-walled valleys near Pine Ridge. The Badlands consist of eroded walls and escarpments, small grass-covered tablelands and mesas, and basins in which there are scattered eroded buttes. Slopes range from nearly level to very steep. Many streams and gullies cut the Badlands.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Missouri-White (1014), 47 percent; Niobrara (1015), 30 percent; North Platte (1018), 14 percent; and Cheyenne (1012), 9 percent. The headwaters of the White and Niobrara Rivers are in the part of this MLRA in northwestern Nebraska. The White River is the main drainage through the Badlands National Park. Tributaries to the White River carved the badlands in the northwest corner of the MLRA.

Geology

Tertiary continental sediments consisting of sandstone, siltstone, and claystone underlie most of this area. Locally, these units are called the Ogallala Group and the Arikaree Group. Many of the bedrock units in the southern third of the area are covered by loess. Sand, silt, and clay alluvium is under the valley floors of the major drainages. The Pine Ridge escarpment marks the northern extent of the Ogallala aquifer. This is the most extensive and heavily used aquifer on the high plains between the Rocky Mountains and the Mississippi River. The Badlands consist of stream-laid layers of silt, clay, and sand mixed with layers of volcanic ash. They are internationally famous for their Oligocene fossil assemblages and as a tourist destination.

Climate

The average annual precipitation in this area is 13 to 19 inches (330 to 485 millimeters). Most of the rainfall occurs as frontal storms in spring and early summer. Some high-intensity, convective thunderstorms occur in late summer. Precipitation in winter occurs as snow. Much of this area receives about 35 inches (90 centimeters) of snow annually, but the snow seldom covers the ground for more than a week at a time. The average annual temperature is 43 to 51 degrees F (6 to 10 degrees C). The freeze-free period averages about 150 days and ranges from 125 to 180 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 5.0%; ground water, 17.1%
Irrigation—surface water, 19.1%; ground water, 25.5%
Other—surface water, 11.2%; ground water, 22.1%

The total withdrawals average 39 million gallons per day (1,985 million liters per day). About 65 percent is from ground water sources, and 35 percent is from surface water sources. Most of the area depends on the rather low and erratic precipitation for water. Some surface water for irrigation is obtained from the Niobrara and White Rivers in Nebraska. This water is of good quality. It contains less total dissolved solids than the local ground water. It is a sodium bicarbonate type and is hard or very hard.

Ground water is scarce and of poor quality in most of the area. Locally, mainly south of Pine Ridge and in Nebraska, underground sand and gravel in the Ogallala and Arikaree Formations yield moderate to large quantities of good-quality water. The level of total dissolved solids is typically less than 400 parts per million (milligrams per liter) in South Dakota, but the sodium levels are high. This water is the least mineralized ground water in South Dakota but is still hard or very hard. Selenium concentrations from the underlying Pierre Shale can exceed the standards for drinking water. Water for all uses is pumped from the Arikaree Formation in Nebraska. This water is less mineralized than that in South Dakota and is not so hard. It is a sodium bicarbonate type and does not contain selenium.

Soils

The dominant soil orders in this MLRA are Entisols, Inceptisols, and Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic or aridic soil moisture regime, and mixed mineralogy. They are shallow to very deep, generally well drained or somewhat excessively drained, and loamy or sandy. Ustorthents (Fairburn and Mittenbutte series) formed in residuum on uplands. Ustipsamments (Dankworth series) formed in sandy eolian sediments on dunes. Argiustolls (Alliance, Hemingford, and Rosebud series) formed in loess and residuum on uplands. Haplustolls formed in residuum on uplands (Busher, Oglala, and Ponderosa series) and in alluvium and eolian deposits on alluvial fans, stream terraces, and hills (Jayem and Vetal series). Ustifluvents (Interior series) and Haplustepts (Cedarpass series) formed in sodium-rich alluvial deposits and residuum in the Badlands.

Biological Resources

This area supports a mixture of short, mid, and tall grasses. Blue grama, western wheatgrass, threadleaf sedge, sideoats grama, little bluestem, prairie sandreed, switchgrass, sand bluestem, and needleandthread are the major species. On Pine Ridge, these plants grow in association with ponderosa pine, eastern redcedar, western snowberry, skunkbush sumac, common chokecherry, and rose. Numerous woody draws occur in this area and support such species as green ash, boxelder, hackberry, chokecherry, bur oak, buffaloberry, and green muhly. The eroded walls and escarpments of the Badlands are devoid of vegetation.

Some of the major wildlife species in this area are mule deer, white-tailed deer, pronghorn antelope, coyote, beaver, raccoon, skunk, turkey, opossum, muskrat, mink, jackrabbit, cottontail, weasel, prairie dog, prairie grouse, mourning dove, meadowlark, and lark bunting.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 22%
Grassland—private, 60%; Federal, 11%
Forest—private, 4%
Urban development—private, 1%
Other—private, 2%

Most of this area is in ranches or farms. More than three-fifths of the area is rangeland that is grazed primarily by livestock. Scenic Pine Ridge has grassed areas and pine trees of commercial value. About 20 percent of the area is cropland. South of Pine Ridge, the major enterprise is cash-grain farming and winter wheat is the main crop. In other parts of the area, the crops are grown mainly as feed and forage for livestock. Irrigated corn and sugar beets are grown in areas where the supply of water is adequate and the soils are suitable. The Badlands National Park is a major tourist attraction in the northern part of this MLRA.

The main resource concerns are wind erosion, water erosion, and the quality of surface water. Wind erosion and water erosion are hazards on cropland and hayland and in areas of pasture and rangeland where the plant cover is depleted by overgrazing. Additional soil resource concerns are maintenance of the content of organic matter and tilth of the soils and soil moisture management.

The important conservation practices on cropland are cropping systems that include high-residue crops, systems of crop residue management (such as no-till and mulch-till systems), level terraces, contour farming, contour stripcropping, irrigation water management, and nutrient management. The most important conservation practice on rangeland is prescribed grazing. Generally, cultural treatments are not used to increase forage production on the rangeland in this area. Cool-season, tame pastures are established to supplement forage production. Haying commonly provides supplemental feed during winter. Forest stand improvement and firebreaks reduce the hazard of wildfires on forestland and improve forest growth, quality, health, and productivity. ■

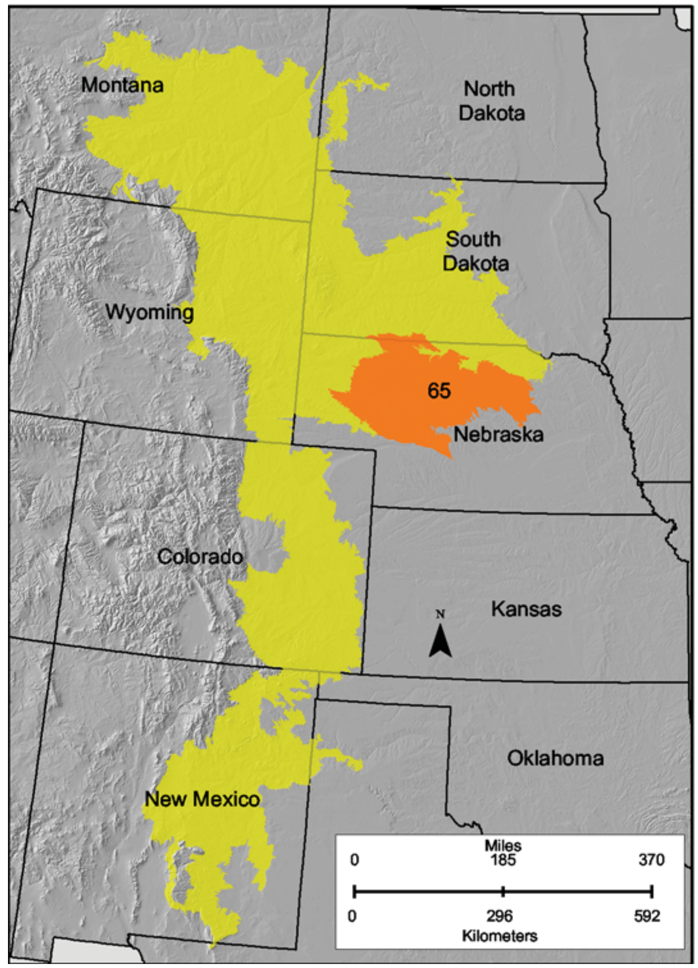

Figure 65-1: Location of MLRA 65 in Land Resource Region G.

65—Nebraska Sand Hills

This area (shown in fig. 65-1) is in Nebraska (98 percent) and South Dakota (2 percent). It makes up about 20,545 square miles (53,235 square kilometers). It has no major cities. The towns of Ainsworth, Mullen, and Valentine, Nebraska, are in this area. Several national wildlife refuges occur in this area, including Lacreek, Fort Niobrara, Valentine, and Crescent Lake National Wildlife Refuges. The Samuel R. McKelvie and Nebraska National Forests are in the area. This MLRA is the largest sand-dune area in the Western Hemisphere and is one of the largest grass-stabilized dune regions in the world.

Physiography

This area is in the High Plains Section of the Great Plains Province of the Interior Plains. Elevation ranges from 1,970 to 3,940 feet (600 to 1,200 meters), increasing gradually from east to west. Most of the area occurs as rolling to steep, irregular sand dunes stabilized by grasses and as narrow, elongated, nearly level to gently sloping valleys between the sand dunes. The height of the dunes ranges from 10 to 400 feet (3 to 120 meters). The dunes and narrow valleys commonly extend for several miles in a northwest-southeast direction. Many small depressions are in scattered areas. The area has few streams but has many small permanent and intermittent lakes.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Loup (1021), 45 percent; Niobrara (1015), 24 percent; North Platte (1018), 16 percent; Elkhorn (1022), 9 percent; Platte (1020), 4 percent; and Missouri-White (1014), 2 percent. The Niobrara River is near the northern boundary of the area. It provides opportunities for river rafting. The North Platte River runs along the southwest edge of the MLRA. The North and Middle Loup Rivers and the Calamus, Snake, and Dismal Rivers are in the central and eastern parts of the MLRA.

Geology

This area consists of Quaternary sand dunes. The sands are derived from the underlying Tertiary Ogallala and Arikaree Groups. These units formed when rivers deposited sediments that originated as erosional detritus following the uplift of the Rocky Mountains to the west. The Ogallala aquifer underlies this area. It is the most extensive and heavily used aquifer on the high plains between the Rocky Mountains and the Mississippi River. The major recharge area for this aquifer is the Sand Hills.

Climate

The average annual precipitation in this area is 15 to 26 inches (380 to 660 millimeters). About three-fourths of the precipitation falls from the middle of spring to the middle of autumn. The rainfall occurs as frontal storms in spring and early summer and high-intensity, convective thunderstorms in late summer. Precipitation in winter occurs as snow. The average annual temperature is 46 to 50 degrees F (8 to 10 degrees C). The freeze-free period averages 155 days and ranges from 140 to 175 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 2.2%; ground water, 8.0%
Irrigation—surface water, 19.6%; ground water, 63.8%
Other—surface water, 4%; ground water, 2.4%

The total withdrawals average 840 million gallons per day (3,180 million liters per day). About 74 percent is from ground water sources, and 26 percent is from surface water sources. Precipitation is the source of water for range vegetation. The many small lakes and ponds and a few streams provide water for livestock, some irrigation, and domestic use. The surface water is of excellent quality and is suitable for all uses.

The Sand Hills is a primary recharge area for the Ogallala aquifer. Ground water from the Ogallala aquifer is abundant and of good quality. It is a calcium bicarbonate type and is very hard. It is very low in total dissolved solids (less than 200 parts per million or milligrams per liter) in this area. Because of the abundance of surface water for livestock and domestic use, the ground water is used primarily for irrigation in the flatter areas of the MLRA.

Soils

The dominant soil orders in this MLRA are Entisols and Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic or aridic soil moisture regime, and mixed mineralogy. They generally are very deep, excessively drained to somewhat poorly drained, and sandy. Ustipsamments formed in sandy eolian material on dunes (Valentine series) and a mixture of sandy eolian material and sandy alluvial material on hummocks and terraces (Ipage series) and in swales (Els series). Haplustolls formed in sandy eolian material in areas between dunes and on stream terraces (Dailey and Dunday series) and in a mixture of sandy eolian material and sandy alluvial material in swales and on stream terraces (Elsmere series).

Biological Resources

This area supports mid and tall grasses. Little bluestem, sand bluestem, prairie sandreed, switchgrass, Indiangrass, sand lovegrass, and needleandthread are the major species on uplands. Big bluestem, switchgrass, Indiangrass, prairie cordgrass, and various sedges and rushes grow on soils having a high water table.

Some of the major wildlife species in this area are white-tailed deer, mule deer, pronghorn antelope, black-tailed jackrabbit, coyote, upland sandpiper, western meadowlark, sharp-tailed grouse, and greater prairie chicken. The species of fish in the area include sunfish, drum, minnow, catfish, perch, bluegill, and carp.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 5%
Grassland—private, 89%; Federal, 3%
Urban development—private, 1%
Water—private, 1%
Other—private, 1%

More than nine-tenths of this area is in large ranches, most of which support native grasses grazed by livestock. Tracts along streams and in subirrigated valleys are used mainly for hay. The rolling hills and dry valleys are grazed. Use of sprinkler irrigation has increased in recent years. Corn is the principal irrigated crop.

The major soil resource concern on rangeland is wind erosion in areas where the plant cover has been depleted by overgrazing. The major soil resource concerns on cropland are wind erosion, maintenance of the content of organic matter and tilth of the soils, and soil moisture management.

Conservation practices on rangeland generally include proper range management and improvement practices, such as proper grazing use, deferment or rest periods, planned grazing systems, range seeding or interseeding, and weed control. The important conservation practices on cropland are cropping systems that include high-residue crops, systems of crop residue management (such as no-till and mulch-till systems), irrigation water management, and nutrient management. ■

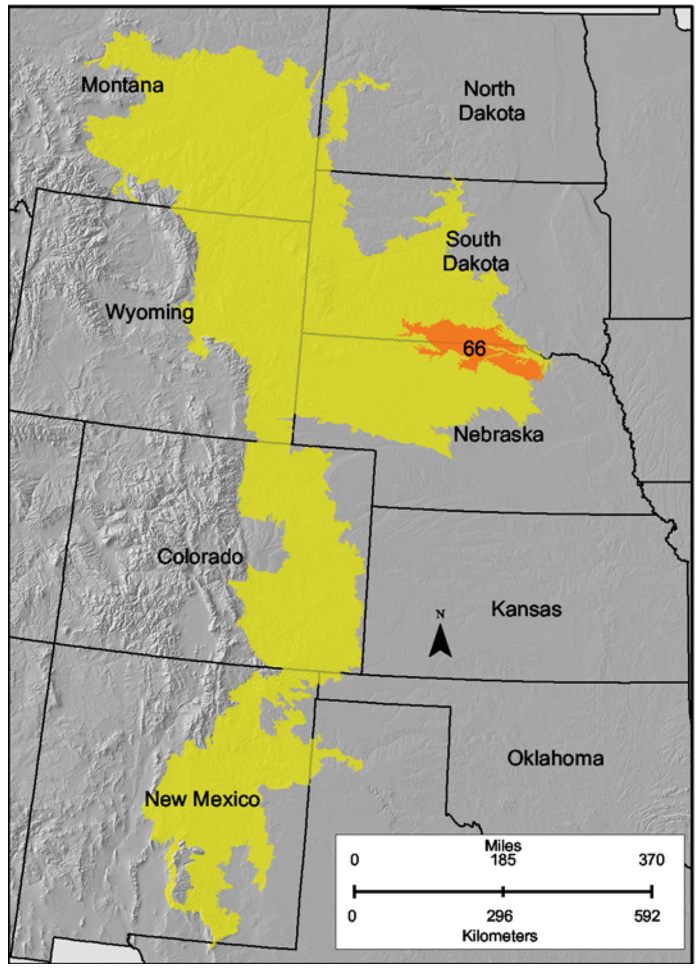

Figure 66-1: Location of MLRA 66 in Land Resource Region G.

66—Dakota-Nebraska Eroded Tableland

This area (shown in fig. 66-1) is in Nebraska (56 percent) and South Dakota (44 percent). It makes up about 5,660 square miles (14,665 square kilometers). The town of Springview, Nebraska, is in the central part of the area, and O'Neill, Nebraska, is in the southeastern part. The town of Winner, South Dakota, is just north of the MLRA, and the town of Valentine, Nebraska, is just outside the southwest corner. U.S. Highways 18, 20, 83, and 183 cross the area. A portion of the Rosebud Indian Reservation is in the northwestern part of the MLRA.

Physiography

The northern half of this MLRA is in the Missouri Plateau, Unglaciated, Section of the Great Plains Province of the Interior Plains. The southern half is in the High Plains Section of the same division and province. This MLRA is part of the fluvial plain that built up to the east as the Rocky Mountains eroded. Broad intervalley remnants of that smooth fluvial plain dominate the area. Some terraces and river breaks and local badlands are along the major drainages. Elevation ranges from 1,970 to 2,950 feet (600 to 900 meters). The higher parts of the tableland are nearly level to moderately sloping. Steeper areas are on the sides of ridges and drainages. Stream valleys are well defined, except in some undulating areas where sandy eolian sandy material mantles the bedrock.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Niobrara (1015), 82 percent; Missouri-White (1014), 16 percent; and Elkhorn (1022), 2 percent. The Keya Paha, Elkhorn, and Niobrara Rivers flow through this area. The Niobrara is a National Scenic River.

Geology

The Cretaceous Niobrara Formation underlies most of this area. It is made up of layers of marine sediments, mostly shaly chalk and limestone. Some eolian deposits are on the surface in the western and southern parts of the area. Alluvial sand and gravel underlie the valley floors along the major streams.

Climate

The average annual precipitation in this area is 18 to 25 inches (455 to 635 millimeters). Most of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. Precipitation in winter occurs mainly as snow. The annual snowfall ranges from about 24 to 40 inches (610 to 1,015 millimeters). Summers are hot, and winters are cold. The average annual temperature is 46 to 49 degrees F (8 to 9 degrees C). The freeze-free period averages 160 days and ranges from 145 to 175 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 0.3%; ground water, 0.7%
Irrigation—surface water, 26.0%; ground water, 63.1%
Other—surface water, 8.9%; ground water, 1.1%

The total withdrawals average 220 million gallons per day (833 million liters per day). About 65 percent is from ground water sources, and 35 percent is from surface water sources. Because of the limited amount of precipitation, farming is risky and maximum crop production is not expected in most years. Most of the soils are deficient in moisture during much of the latter part of the growing season. The surface water is of good quality. It is a calcium, magnesium, and bicarbonate type and is very hard. The level of total dissolved solids averages about 390 parts per million (milligrams per liter). The Niobrara River, the only perennial stream in the area, provides water for irrigation, livestock, domestic uses, and public supply.

Throughout most of the area, shallow water is available in quantities sufficient for livestock and domestic uses. Most of the shallow water is from sand and gravel deposits in drainages. The Niobrara Formation supplies ground water for irrigation, livestock, and domestic uses. This unit typically is considered an aquifer only where solution channels and fractures have opened the rock. The ground water is a calcium bicarbonate type and is very hard. The level of total dissolved solids averages about 490 parts per million (milligrams per liter).

Soils

The dominant soil orders in this MLRA are Entisols and Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic or aridic soil moisture regime, and mixed mineralogy. They generally are very deep, well drained to excessively drained, and loamy or sandy. Haplustolls formed in eolian sediments (Anselmo and Dunday series) and loamy over sandy sediments (Meadin, O'Neill, and Pivot series) on stream terraces and uplands and in valleys. Argiustolls (Jansen series) formed in loamy sediments over alluvium on uplands. Ustipsamments (Valentine series) formed in sandy eolian material on dunes.

Biological Resources

This area supports mixed prairie vegetation. Little bluestem, prairie sandreed, green needlegrass, and needleandthread are the dominant species. Sideoats grama and plains muhly are important species on shallow soils. Leadplant and prairie rose grow on the sides of draws. Hackberry and green ash grow in the draws in some areas.

Some of the major wildlife species in this area are mule deer, white-tailed deer, coyote, beaver, raccoon, opossum, muskrat, mink, tree squirrel, prairie dog, turkey, pheasant, prairie grouse, meadowlark, lark bunting, bobwhite quail, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 27%
Grassland—private, 65%; Federal, 1%
Forest—private, 3%
Urban development—private, 2%
Other—private, 2%

Most of this area supports native grasses and is grazed by cattle. Some of the smoother areas are used for crops, mainly corn, forage and grain sorghum, and alfalfa for livestock feed. Winter wheat is grown as a cash crop in a few areas.

The major resource concerns are erosion and the quality of surface water. The major soil resource concerns on cropland and hayland are wind erosion, water erosion, maintenance of the content of organic matter and tilth of the soils, and soil moisture management. The major soil resource concerns on pasture and rangeland are wind erosion and water erosion in areas where the plant cover has been depleted by overgrazing.

The most important conservation practice on rangeland is prescribed grazing. Generally, cultural treatments are not used to increase forage production on the rangeland in this area. Cool-season, tame pastures are established to supplement forage production. The most important conservation practices on cropland are cropping systems that include high-residue crops, systems of crop residue management (such as no-till and mulch-till systems), level terraces, contour farming, contour stripcropping, irrigation water management, and nutrient management. ■

67A—Central High Plains, Northern Part

This area (shown in fig. 67A-1) is in Wyoming (68 percent), Nebraska (29 percent), and Colorado (3 percent). It makes up about 8,165 square miles (21,150 square kilometers). The cities

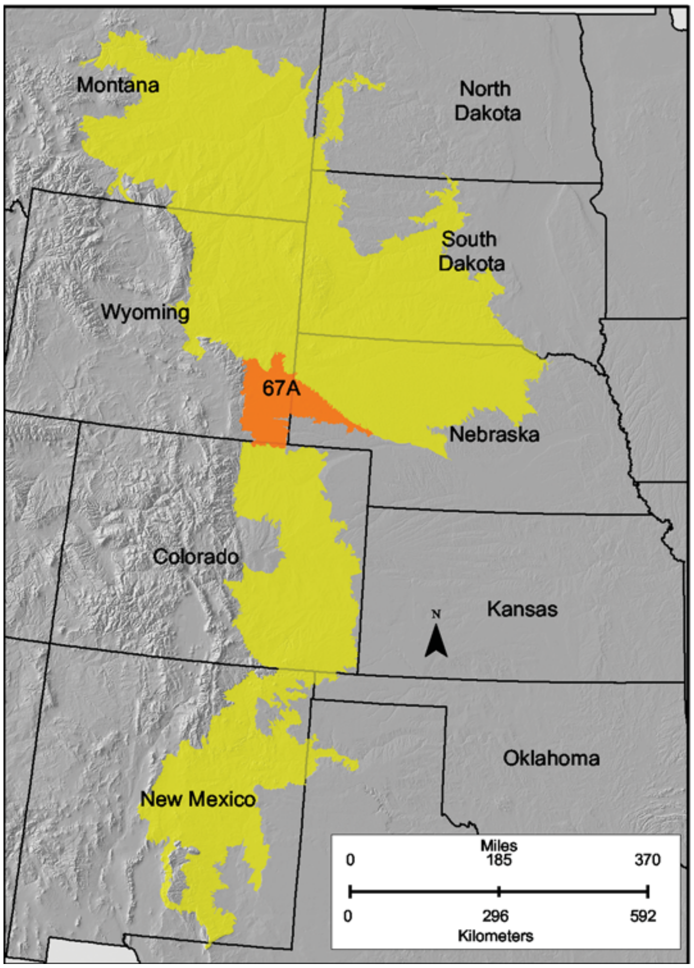

Figure 67A-1: Location of MLRA 67A in Land Resource Region G.

of Cheyenne and Wheatland, Wyoming, are in this MLRA. Interstate 80 skirts the southern edge of the MLRA.

Physiography

This area occurs primarily in the High Plains Section of the Great Plains Province of the Interior Plains. The higher parts of the tableland are nearly level to moderately sloping, but steeper areas are on the sides of ridges and drainageways. Drainages are well defined, except in some undulating areas where sandy eolian material mantles the bedrock. In most of the MLRA, elevation ranges from 3,200 to 5,500 feet (975 to 1,675 meters). In some areas, however, it is as high as 7,400 feet (2,255 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: North Platte (1018), 80 percent, and South Platte (1019), 20 percent. Parts of the North Platte and Laramie Rivers occur in this MLRA.

Geology

This MLRA is dominated by residual geologic materials. Large areas of eolian and alluvial deposits, however, occur in parts of the MLRA. Sandstone and conglomerate are the dominant rock types. The Tertiary White River, Upper Miocene Rock, and Lower Miocene Rock Formations are dominant in the MLRA. The Cretaceous Lance Formation occurs as small areas in the western part the MLRA. Quaternary alluvial and eolian deposits and gravel pediments occur in some areas.

Climate

The average annual precipitation in this area ranges from 12 to 19 inches (305 to 485 millimeters). Much of the precipitation occurs as rain in the period April through July. The rain falls during convective thunderstorms. The driest period is usually November through February. The average annual temperature ranges from 43 to 50 degrees F (6 to 10 degrees C). The freeze-free period averages 145 days and ranges from 130 to 165 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.8%; ground water, 1.2%
Livestock—surface water, 0.2%; ground water, 0.3%
Irrigation—surface water, 62.3%; ground water, 19.5%
Other—surface water, 14.6%; ground water, 1.1%

The total withdrawals average 1,795 million gallons per day (6,795 million liters per day). About 22 percent is from ground water sources, and 78 percent is from surface water sources. Water for range vegetation and dryfarming is provided by the low and erratic precipitation. Irrigation water is obtained mostly from reservoirs on the North Platte River and its tributaries. The surface water is of good quality and has few limitations affecting its use.

All four of the principal aquifer types in Wyoming occur in this area. Most of the ground water is pumped from the alluvial aquifer along the North Platte River and its tributaries and from the High Plains (Ogallala) aquifer. These unconsolidated and consolidated sand and gravel aquifers yield adequate quantities of ground water for livestock and domestic use, some irrigation, and some other uses. Water from the alluvial aquifer is the hardest water in the State of Wyoming but has a median concentration of total dissolved solids of less than 500 parts per million (milligrams per liter). Wells in the High Plains aquifer provide high yields of water that has the lowest median concentration of total dissolved solids in the State (260 parts per million or milligrams per liter). The water from both aquifers is hard. In areas where shale bedrock is near the surface, ground water is scarce and commonly of poor quality. The Structural Basin and sandstone and carbonate bedrock aquifers also occur in this area but are not utilized because of the readily available water in the shallow aquifers.

Soils

The dominant soil orders in this MLRA are Mollisols and Entisols. The dominant soil temperature regime is mesic, and the dominant soil moisture regime is ustic. The soils receiving less than 14 inches (355 millimeters) of precipitation annually have an aridic soil moisture regime that borders on ustic. Some soils with a frigid soil temperature regime occur in the far western part of the MLRA, above an elevation of about 6,100 feet (1,860 meters). Soils with mixed mineralogy are dominant. Most of the soils in the MLRA are sandy or loamy. The MLRA has many areas of soils that are shallow or moderately deep to sandstone or very gravelly layers. Deep soils that formed in slope, alluvial, or eolian deposits are common. Soils near major drainageways formed in stream- or river-deposited alluvium. Most of the soils are well drained, but poorly drained or somewhat poorly drained soils occur on the flood plains along the major rivers. Most of the soils are calcareous.

Some of the most extensive and representative great groups are Torriorthents, Haplustolls, Argiustolls, Calciustolls, and Haplargids. Some of the most extensive and representative series are Altvan, Ascalon, Vetal, Mitchell, Dwyer, Keeline, Jayem, Tassel, Turnercrest, Treon, Manter, and Dunday series.

Biological Resources

This area supports cool- and warm-season grassland vegetation. Rhizomatous wheatgrasses, needleandthread, and blue grama are the dominant species on deep soils. Rhizomatous wheatgrasses, little bluestem, bluebunch wheatgrass, Indian ricegrass, and needleandthread are the major species on shallow soils on hills and ridges. Sandy soils have a plant community that includes prairie sandreed, sand bluestem, and sagebrush. A few areas of shallow soils on steep escarpments have a plant community that includes Rocky Mountain juniper and/or ponderosa pine. Basin wildrye, green needlegrass, big bluestem, rhizomatous wheatgrasses, and shrubs are dominant on the bottom land along streams and rivers.

Some of the major wildlife species in this area are deer, antelope, coyote, beaver, muskrat, jackrabbit, cottontail rabbit, geese, ducks, and turkeys. The species of fish in the area include walleye, bass, catfish, and rainbow trout.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 30%
Grassland—private, 65%; Federal, 3%
Urban development—private, 1%
Other—private, 1%

Most of this area is grazed by cattle. The rangeland is primarily warm- and cool-season prairie, but areas of shallow or sandy soils support shrubs. About 30 percent of the area is cropland. The main irrigated crops are corn, alfalfa, beans, and sugar beets. The main nonirrigated crop is winter wheat. The irrigated crops are grown where irrigation water is available from rivers or ground water sources. Nonirrigated small grain crops are grown in areas with level to moderately sloping soils that can store an adequate amount of soil moisture and that receive an adequate amount of precipitation.

The major resource concerns are wind erosion and the quality of water in streams, rivers, and aquifers. The quantity of water for irrigating crops is a concern in some areas.

The important conservation practices on cropland are those that reduce the hazard of wind erosion, improve the efficiency of irrigation water use, and protect ground water from contamination by leached nutrients and pesticides. The important conservation practices on rangeland are those that improve the health of the soil and plant communities and improve the distribution of livestock. ■

67B—Central High Plains, Southern Part

This area is entirely in Colorado (fig. 67B-1). It makes up about 19,855 square miles (51,445 square kilometers). Denver, Fort Collins, Greeley, Fort Morgan, Limon, and Springfield are in this MLRA. Interstates 25, 76, and 70 bisect the northern part of the area. The Pawnee and Comanche National Grasslands occur in the area. Gas and oil fields are in scattered areas throughout the MLRA. The greatest concentration of these fields is in the Denver Basin area.

Physiography

Most of this area is in the Colorado Piedmont Section of the Great Plains Province of the Interior Plains. The rest is in the Raton Section of the same province and division. This MLRA is on an elevated, smooth to slightly irregular plain consisting of sediments deposited by rivers that drained the young and actively eroding Rocky Mountains. This old plain is now a dissected peneplain with a few dissected, lava-capped plateaus and buttes. Elevation ranges from 3,000 to 7,800 feet (915 to 2,380 meters), increasing gradually from east to west. In many areas the undulating to rolling shale plain is mantled by loess or windblown sand, alluvium, and outwash. Wide bands of steep slopes border several of the larger tributaries of the South

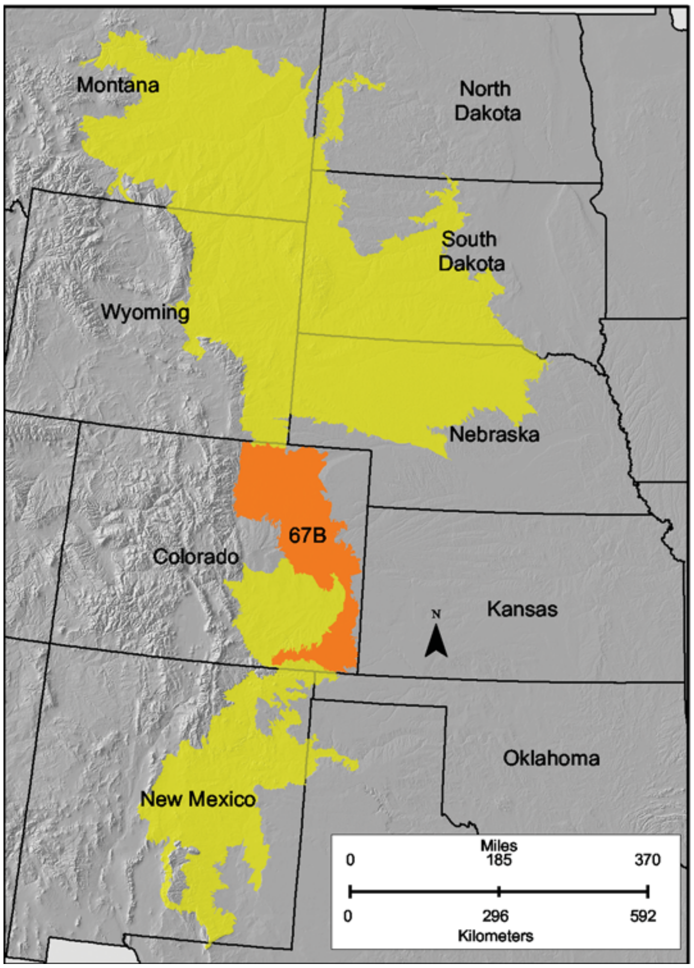

Figure 67B-1: Location of MLRA 67B in Land Resource Region G.

Platte and Arkansas Rivers. Local relief is mostly less than 80 feet (25 meters) but is as much as 165 feet (50 meters) in some of the rough, broken areas.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: South Platte (1019), 49 percent; Upper Arkansas (1102), 23 percent; Republican (1025), 15 percent; Upper Cimarron (1104), 11 percent; and Smoky Hill (1026), 2 percent. The South Platte and Arkansas Rivers bisect this MLRA as they flow east into Nebraska and Kansas.

Geology

Cretaceous and Quaternary sediments cover approximately equal areas of the surface of this MLRA. Rolling sandy plains and dune areas are throughout the MLRA. Eolian and alluvial deposits cover large areas of the South Platte River drainage. Cretaceous Pierre Shale is at the surface in much of the area north of the Arkansas River. The older Niobrara Chalk is exposed closer to the river, and the even older Dakota Sandstone is exposed south of the river. Some scattered outcrops of Jurassic and Triassic sandstone, shale, and siltstone also are south of the Arkansas River. These units are commonly reddish. About half of the area is covered by river-laid continental sediments consisting of loose to well cemented sand and gravel with some silts and clays. Much of the Quaternary alluvium has been reworked into dunes and loess caps by the wind. The Tertiary Ogallala Formation occurs at the far eastern edges of this MLRA. Quaternary and more recent sand and gravel deposits cover the shale and chalk in the river valleys.

Climate

The average annual precipitation in this area is 12 to 18 inches (305 to 455 millimeters), increasing from west to east. The amount of precipitation fluctuates widely from year to year. Rainfall occurs as frontal storms in spring and early summer and high-intensity, convective thunderstorms in late summer. The maximum precipitation occurs from the middle of spring through late autumn. Precipitation in winter occurs as snow. The average annual temperature is 45 to 55 degrees F (7 to 13 degrees C). The freeze-free period averages 160 days and ranges from 135 to 190 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 5.5%; ground water, 1.2%
Livestock—surface water, 1.5%; ground water, 0.2%
Irrigation—surface water, 61.1%; ground water, 26.6%
Other—surface water, 2.5%; ground water, 1.3%

The total withdrawals average 4,135 million gallons per day (15,650 million liters per day). About 29 percent is from ground water sources, and 71 percent is from surface water sources. Water for range vegetation and dryfarming is provided by the low and erratic precipitation. Irrigation water is obtained mostly from reservoirs on the South Platte River and its tributaries in the northern part of the MLRA and from the Arkansas River and its tributaries in the southern part. In the western part of the MLRA, the surface water is of good quality and has few limitations affecting its use. As more agricultural drainage is returned to the rivers, the level of total dissolved solids and sediment causes some water-quality problems in the eastern part of the area.

The ground water used in the northern part of this area is pumped from the alluvial aquifer along the South Platte River and its tributaries. This unconsolidated and consolidated sand and gravel aquifer yields large quantities of ground water for irrigation, for some public supply, and for livestock and domestic use. Water from the alluvial aquifer is a calcium sulfate type and is very hard. Its level of total dissolved solids generally exceeds 1,000 parts per million (milligrams per liter). Water quality is best along the edges of valleys where recharge from adjacent aquifers occurs. The water degrades downstream because of the addition of salts from irrigation return flows and seepage from leaky ditches, reservoirs, and the river itself.

In the southern part of this area, a 1-to-5-mile-wide band of alluvial deposits along the Arkansas River provides water for livestock, public supply, and domestic uses and for local irrigation. The median level of total dissolved solids in this aquifer is 2,900 parts per million (milligrams per liter). The salt content increases downstream to the point that the water can be used only to irrigate salt-tolerant crops. The high amounts of dissolved solids, especially sulfate, limit use of the water for drinking. This water is very hard.

The deeper consolidated sand and gravel deposits in the Denver Basin aquifer provide water for livestock, for some domestic use, and for limited local irrigation. This aquifer underlies the northwestern part of the area. The water generally has more than 1,000 parts per million (milligrams per liter) total dissolved solids. It is soft and generally contains sodium bicarbonate and sulfate ions.

The High Plains aquifer occurs in the eastern part of this MLRA. It provides water for irrigation, livestock, public supply, and domestic uses. Wells provide water that is very low in total dissolved solids, a median concentration of 230 parts per million (milligrams per liter), north of the Arkansas River. The water is a calcium bicarbonate type that is moderately hard or hard. South of the Arkansas River, the median level of total dissolved solids doubles and the water becomes more of a sodium sulfate type. Naturally occurring levels of fluoride, sulfate, and total dissolved solids in this part of the High Plains aquifer commonly exceed the national standards for drinking water. In areas where shale bedrock is near the surface, ground water is scarce and commonly of poor quality.

Soils

The dominant soil orders in this MLRA are Mollisols, Alfisols, Aridisols, and Entisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic or aridic soil moisture regime, and mixed, carbonatic, or smectitic mineralogy. They are very shallow to very deep, generally well drained, and loamy or clayey. Argiustolls (Ascalon, Altvan, and Nunn series) formed in alluvium along the major rivers. Haplustalfs formed in loamy sediments (Baca series) and eolian sediments (Vona and Wiley series) on hills and plains. Haplargids (Olney series) formed in eolian sediments on hills and plains. Ustorthents (Colby and Otero series) formed in loess on hills and plains. Torriorthents formed in alluvium and/or eolian sediments on alluvial fans, flood plains, and footslopes (Thedalund and Rocky Ford series) and in residuum and/or eolian sediments on hills, cuestas, and mesas (Minnequa, Penrose, and Travessilla series).

Biological Resources

Most of this area supports short prairie grasses. Needleandthread, prairie junegrass, blue grama, galleta, cholla, threeawn, ring muhly, and alkali sacaton are the major species. Cottonwood is common along the major streams. Stony and rocky soils support a mixed stand of pinyon and juniper with understory species similar to those in nearby openings and grasslands. Sand sage is the potential natural vegetation on rolling plains with grass-stabilized sand dunes and sheets.

Some of the major wildlife species in this area are mule deer, antelope, jackrabbit, cottontail, turkey, pheasant, Canada goose, scaled quail, bobwhite quail, and mourning dove. The species of fish in the area include walleye, catfish, and crappie.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 28%
Grassland—private, 65%; Federal, 3%
Urban development—private, 1%
Other—private, 3%

Nearly all of this area is in farms or ranches. About two-thirds of the area supports native short grasses used for grazing. Flood plains and terraces along the Platte and Arkansas Rivers, making up about one-fifth of the area, are irrigated. Alfalfa, sugar beets, grain sorghum, melons, seed crops, corn, small grains, onions, and other vegetables are the chief crops. Soils that are frequently flooded and soils that are strongly affected by salts generally are used for grazing. About one-tenth of the area is dry-farmed. Winter wheat, dry beans, and grain sorghum are the main crops.

A major soil resource concern is the loss of prime farmland and cropland of statewide importance through conversion to urban use. Additional concerns are wind erosion, water erosion, surface compaction caused by tillage practices, increased salinization of cropland caused by irrigation water management practices, and overall degradation of soil quality.

Conservation practices on cropland generally include irrigation water management, conservation tillage, crop rotations, crop residue management, pest management, and nutrient management. The most important conservation practice on rangeland is prescribed grazing. ■

69—Upper Arkansas Valley Rolling Plains

This area is entirely in Colorado (fig. 69-1). It makes up about 11,920 square miles (30,885 square kilometers). The city of Pueblo and the towns of Rocky Ford, La Junta, and Lamar

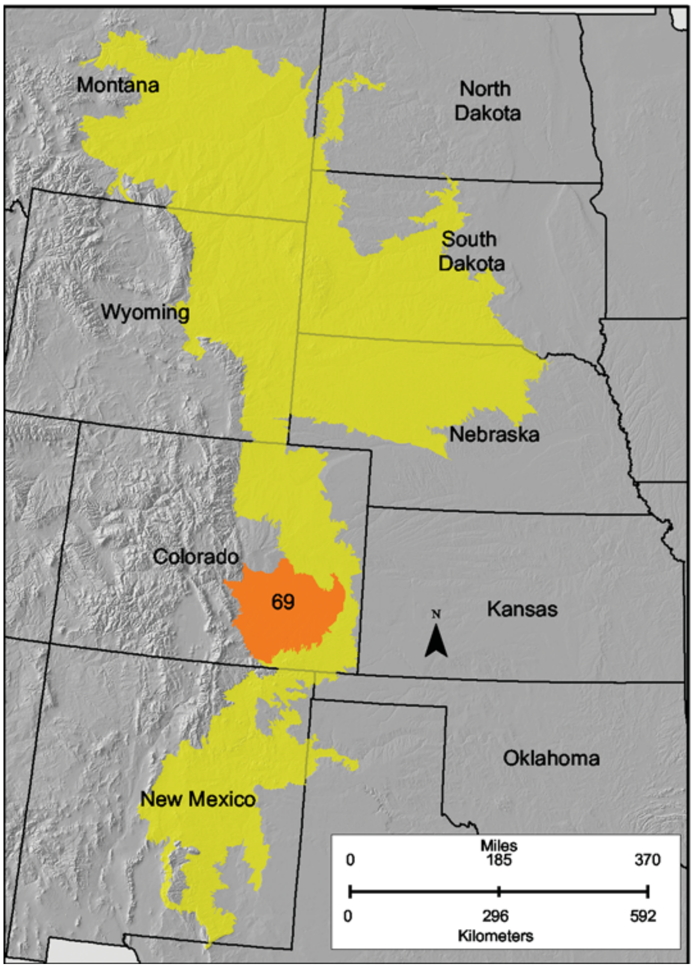

Figure 69-1: Location of MLRA 69 in Land Resource Region G.

are in this MLRA. Interstate 25 crosses the northwest corner of the area. The Comanche National Grasslands occur in the area. Many military installations are in this MLRA, including Fort Carson, the High Speed Ground Testing Center, and the Pueblo Ordinance Depot.

Physiography

The northern two-thirds of this area is in the Colorado Piedmont Section of the Great Plains Province of the Interior Plains. The rest is in the Raton Section of the same province and division. This MLRA is an elevated plain consisting of sediments deposited by rivers that drained the young and actively eroding Rocky Mountains. This old plain is now a dissected peneplain with a few dissected, lava-capped plateaus and buttes. Elevation ranges from 3,600 to 6,230 feet (1,100 to 1,900 meters), increasing gradually from east to west. In many areas the undulating to rolling shale plain is mantled by loess or windblown sand, alluvium, and outwash. Wide bands of steep slopes border several of the larger tributaries of the Arkansas River. Local relief is mostly less than 80 feet (25 meters) but is as much as 165 feet (50 meters) in some of the rough, broken areas.

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is Upper Arkansas (1102). The Arkansas River bisects this MLRA as it flows east into Kansas.

Geology

Cretaceous and Quaternary sediments cover approximately equal areas of the surface of this MLRA. The Cretaceous Pierre Shale is at the surface in much of the area north of the Arkansas River. The older Niobrara Chalk is exposed closer to the river, and the even older Dakota Sandstone is exposed south of the river. Some scattered outcrops of Jurassic and Triassic sandstone, shale, and siltstone also are south of the Arkansas River. These units commonly are reddish. About half of this area is covered by river-laid continental sediments consisting of loose to well cemented sand and gravel with some silts and clays. Much of the Quaternary alluvium has been reworked into dunes and loess caps by the wind. The Tertiary Ogallala Formation occurs at the far eastern edges of this MLRA. Quaternary and more recent sand and gravel deposits cover the shale and chalk in the river valleys.

Climate

The average annual precipitation in this area is 10 to 19 inches (255 to 485 millimeters), increasing from west to east. The amount of precipitation fluctuates widely from year to year. Rainfall occurs as frontal storms in spring and early summer and high-intensity, convective thunderstorms in late summer. The maximum precipitation occurs from the middle of spring through late autumn. Precipitation in winter occurs as snow. The average annual temperature is 47 to 54 degrees F (8 to 12 degrees C). The freeze-free period averages 170 days and ranges from 145 to 200 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.8%; ground water, 0.3%
Livestock—surface water, 2.0%; ground water, 0.3%
Irrigation—surface water, 68.7%; ground water, 26.1%
Other—surface water, 1.2%; ground water, 0.6%

The total withdrawals average 1,820 million gallons per day (6,890 million liters per day). About 27 percent is from ground water sources, and 73 percent is from surface water sources. The low and erratic precipitation is the source of water for range vegetation. Surface water quality in Colorado is typically excellent. The Arkansas River and its larger tributaries provide water for irrigation and public supply along their valleys. A number of reservoirs on tributaries to the Arkansas River provide water for irrigation, public supply, livestock, and domestic use.

In the northwest corner of this area, the deeper, consolidated sand and gravel deposits (the Denver Basin aquifer) provide water for livestock and some domestic use and for some limited local irrigation. Water in the Denver Basin generally has more than 1,000 parts per million (milligrams per liter) total dissolved solids. It is soft and generally contains sodium bicarbonate and sulfate ions. A 1-to-5-mile-wide band of alluvial deposits along the Arkansas River provides water for livestock, public supply, and domestic uses and for local irrigation. North of the river, this ground water is a calcium bicarbonate type and is very low in total dissolved solids (230 parts per million or milligrams per liter). South of the river, the ground water changes to a sodium sulfate type and has twice the total dissolved solids that occur north of the river. Another alluvial aquifer, the High Plains aquifer, is in the far eastern part of the MLRA. The water in this aquifer is normally not suitable for drinking because it has high levels of naturally occurring fluoride, sulfate, and total dissolved solids (more than 2,000 parts per million or milligrams per liter). Ground water is scarce in most areas where shale is near the surface.

Soils

The dominant soil orders in this MLRA are Alfisols, Aridisols, and Entisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic or aridic soil moisture regime, and mixed, carbonatic, or smectitic mineralogy. They are very shallow to very deep, generally well drained, and loamy or clayey. Haplustalfs formed in loamy sediments (Baca series) and eolian sediments (Vona and Wiley series) on hills and plains. Haplargids (Olney series) formed in eolian sediments on hills and plains. Ustorthents (Colby series) formed in loess on hills and plains. Torriorthents formed in alluvium and/or eolian sediments on alluvial fans, flood plains, and footslopes (Limon, Manvel, and Rocky Ford series) and in residuum and/or eolian sediments on hills, cuestas, and mesas (Minnequa, Penrose, and Travessilla series).

Biological Resources

This area supports short prairie grasses. Blue grama, galleta, cholla, threeawn, ring muhly, and alkali sacaton are the major species. Cottonwood is common along the major streams. Stony and rocky soils support a mixed stand of pinyon and juniper with understory species similar to those in nearby openings and grasslands.

Some of the major wildlife species in this area are mule deer, antelope, jackrabbit, cottontail, turkey, pheasant, scaled quail, bobwhite quail, and mourning dove. The species of fish in the area include walleye, catfish, and crappie.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 11%
Grassland—private, 78%; Federal, 7%
Urban development—private, 2%
Water—private, 1%
Other—private, 1%

Nearly all of this area is in farms or ranches. More than three-fourths of the area supports native short grasses and is used for grazing. Flood plains and terraces along the Arkansas River, making up about one-tenth of the area, are irrigated. Alfalfa, sugar beets, grain sorghum, melons, seed crops, corn, small grains, onions, and other vegetables are the chief crops. Soils that are frequently flooded and soils that are strongly affected by salts are used for grazing. Winter wheat, dry beans, and grain sorghum are the main dry-farmed crops.

The major soil resource concerns are wind erosion, water erosion, increased salinization of cropland because of inefficient water management practices, surface compaction resulting from tillage practices, and overall degradation of soil quality.

Conservation practices on cropland generally include irrigation water management, conservation tillage, crop rotations, crop residue management, pest management, and nutrient management. The most important conservation practice on rangeland is prescribed grazing. ■

70A—Canadian River Plains and Valleys

This area (shown in fig. 70A-1) is in northeastern New Mexico (90 percent), southeastern Colorado (6 percent), the Oklahoma Panhandle (3 percent), and northern Texas (1 percent). It makes up about 10,770 square miles (27,910 square kilometers). The towns of Las Vegas, Springer, and Raton, New Mexico, are in this MLRA. Interstate 25 crosses the northwest part of the area, and Interstate 40 crosses the southern tip. The Capulin Volcano National Monument and some of the Comanche National Grasslands are in the northeastern part of this area.

Physiography

Most of this area is in the Raton Section of the Great Plains Province of the Interior Plains. The area is characterized by broad, gently undulating to rolling piedmont plains with extensive basalt flows and varying degrees of dissection. These plains are interspersed with relatively smooth valleys and basins. About 25 percent of the area is on steep or very steep dissected slopes. These slopes are below the Canadian escarpment and on the breaks along the Cimarron River in the northern part of the area. Elevation ranges from 5,000 to 7,000

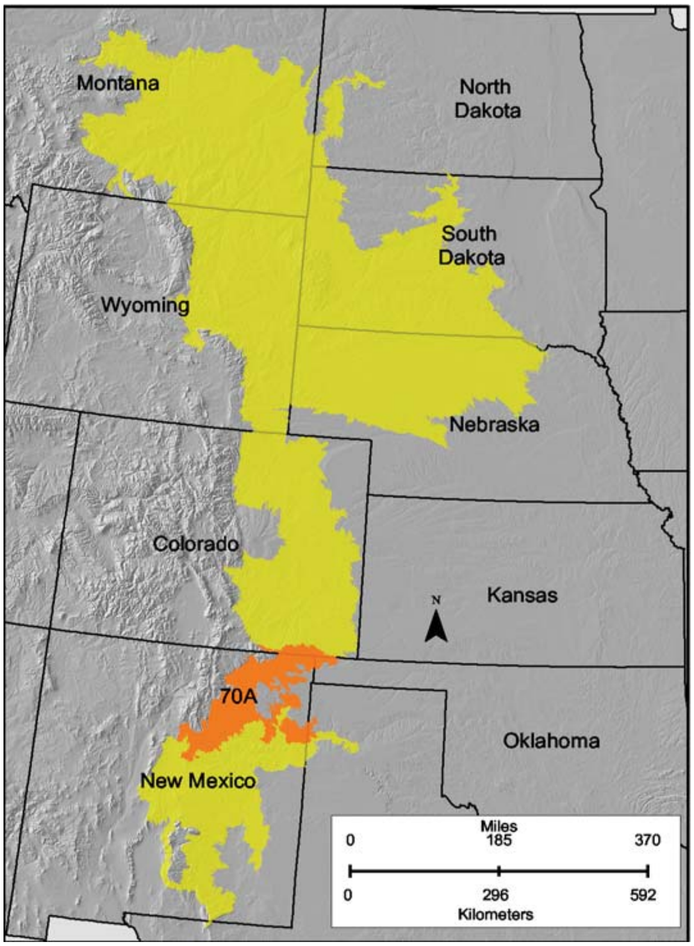

Figure 70A-1: Location of MLRA 70A in Land Resource Region G.

feet (1,525 to 2,135 meters). A few isolated mountains and mesas occur in the area. This MLRA includes the highest point in Oklahoma, Black Mesa, which is at an elevation of 4,973 feet (1,516 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Canadian (1108), 51 percent; Upper Cimarron (1104), 16 percent; Upper Pecos (1306), 15 percent; Lower Canadian (1109), 11 percent; North Canadian (1110), 5 percent; and Rio Grande-Elephant Butte (1302), 2 percent. The headwaters of the Cimarron, Canadian, and Pecos Rivers cross this area.

Geology

The southwestern and western parts of this area are underlain by Cretaceous shales of the Dakota, Graneros, and Pierre Formations and, to a lesser extent, by Cretaceous limestones of the Greenhorn Formation. The northern and eastern parts of the area are underlain by Tertiary basalts and other volcanic rocks. The northeastern part also is underlain by Cretaceous shales and limestones of the Dakota, Graneros, and Pierre Formations.

Climate

The average annual precipitation in this area is 10 to 21 inches (255 to 535 millimeters), fluctuating widely from year to year. Most of the rainfall occurs in spring and fall. The average annual temperature is 46 to 58 degrees F (8 to 14 degrees C). The freeze-free period averages 175 days and ranges from 130 to 215 days, increasing in length from northwest to southeast.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.7%; ground water, 0.8%
Livestock—surface water, 1.0%; ground water, 0.7%
Irrigation—surface water, 75.8%; ground water, 20.7%
Other—surface water, 0.1%; ground water, 0.1%

The total withdrawals average 70 million gallons per day (265 million liters per day). About 22 percent is from ground water sources, and 78 percent is from surface water sources. Water is scarce throughout the area because of the low and erratic precipitation and the few perennial streams. Most of the surface water used in this area is from the Canadian and Pecos Rivers and their headwater streams. The surface water is of good quality because only a small amount of agricultural return flows reaches the rivers.

The only major aquifer in this MLRA is the Eastern New Mexico Basin Fill aquifer, in a small separate section of the area where the Canadian River crosses the State border into Texas. This aquifer is part of the High Plains (Ogallala) aquifer, which is not actually a basin fill deposit but has water so similar in quality to that of other basin fill aquifers that it is lumped with them. Because of low levels of total dissolved solids, sodium, and hardness, the ground water in this aquifer is very well suited to agricultural use. Most of the ground water is pumped from the alluvial deposits in valleys along the larger streams in the area. The ground water is of good enough quality to be used for domestic and livestock supplies and for some limited irrigation. Small amounts of ground water are in fractures and joints in the shale and sandstone bedrock on uplands.

Soils

The dominant soil orders in this MLRA are Mollisols, Alfisols, and Entisols. Most of the soils are Ustolls, Orthents, or Ustalfs. They are wel1 drained and moderately fine textured or fine textured. They have a mesic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy. Deep Argiustolls (Swastika, Partri, and Charette series) and Haplustol1s (Colmor series) and moderately deep Argiustolls (Carnero series) are on uplands. Deep Calciustol1s (Ayon series) are on mesas and side slopes. Deep Torriorthents (Vermejo series) and Haplustolls (Manzano series) are in drainageways and on valley floors. Shallow Haplustolls (Apache series) are on basalt mesas, the upper side slopes, and ridges. Shallow Haplustalfs (Sombordoro series) and Torriorthents (Travessilla and Mion series) are on moderately rolling to steep hills, ridges, and the side slopes of canyons.

Biological Resources

The native vegetation in this area consists of short or mid prairie grasses in the lowlands and pinyon and juniper at the higher elevations and on breaks. Fine textured soils support vegetation characterized by western wheatgrass, blue grama, sideoats grama, and galleta. Alkali sacaton and western wheatgrass dominate drainageways. Soils along natural escarpments and shallow soils support little b1uestem, sideoats grama, and blue grama and species of oak, juniper, pinyon, mountain mahogany, sumac, and Apache plume.

Some of the major wildlife species in this area are mule deer, antelope, jackrabbit, cottontail, pheasant, bobwhite quail, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 1%
Grassland—private, 76%; Federal, 3%
Forest—private, 13%
Urban development—private, 1%
Other—private, 6%

Farms or ranches make up nearly all of this area. The principal enterprise is cattle grazing. About 1 percent of the area is cropland. Small grains and grain sorghum are the principal crops. Irrigated hay, pasture, and small grains are grown in small tracts where irrigation water is provided by wells and reservoirs.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter in the soils, and management of soil moisture. Conservation practices on rangeland generally include reasonable stocking rates and pasture rotation. ■

70B—Upper Pecos River Valley

This area (shown in fig. 70B-1) is in east-central New Mexico (90 percent) and western Texas (10 percent). It makes up about 9,900 square miles (25,660 square kilometers). The towns of Tucumcari, Santa Rosa, and Fort Sumner, New Mexico, are in this MLRA. Interstate 40 connects Tucumcari and Santa Rosa, and numerous U.S. highways cross the area.

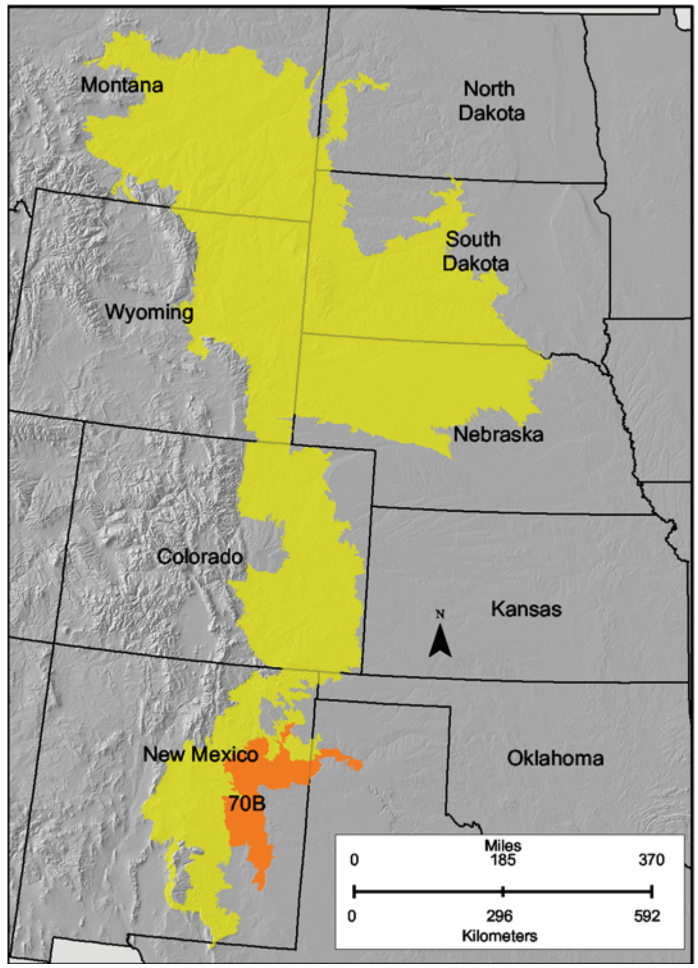

Figure 70B-1: Location of MLRA 70B in Land Resource Region G.

Physiography

Most of this area is in the Pecos Valley Section of the Great Plains Province of the Interior Plains. The area is characterized by piedmont plains and tablelands formed by sedimentary rocks. It is dissected by terraced valleys along the Pecos and Canadian Rivers. Gently undulating to rolling plains and sandhills are interspersed with relatively smooth valleys and basins. A few small mesas and buttes occur throughout the MLRA. Elevation ranges from 3,700 to 5,300 feet (1,130 to 1,615 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Pecos (1306), 50 percent; Upper Canadian (1108), 37 percent; and Lower Canadian (1109), 13 percent. The Pecos and Canadian Rivers and many of their tributaries occur in this area.

Geology

This area is underlain primarily by sandstones and shales in the Santa Rosa and Chinle Formations of Triassic age. The southern part of the area has Quaternary alluvium, dunes, terraces, and pediments in combination with shales and sandstones of the Artesia Group of Permian age.

Climate

The average annual precipitation in most of this area is 13 to 15 inches (330 to 380 millimeters), f1uctuating widely from year to year. It is 19 inches (485 millimeters) in the eastern one-fourth of the area. Most of the precipitation occurs during summer and fall. The average annual temperature is 54 to about 60 degrees F (12 to 16 degrees C). The freeze-free period averages 205 days and ranges from 185 to 225 days, increasing in length from north to south.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 0.3%; ground water, 0.6%
Irrigation—surface water, 93.9%; ground water, 4.7%
Other—surface water, 0.5%; ground water, 0.0%

The total withdrawals average 105 million gallons per day (400 million liters per day). About 5 percent is from ground water sources, and 95 percent is from surface water sources. Water is scarce throughout the area because of the low and erratic precipitation and the few perennial streams. Most of the surface water used in the area is from reservoirs on the Canadian and Pecos Rivers and their tributaries. The surface water is of better quality in the northern part of the area than in the southern part. The Pecos and Canadian Rivers become saltier as more agricultural return flows, wastewater from oil and gas development and potash mining operations, and saline seeps discharge into the rivers and their tributaries.

A small part of the Pecos River Basin Limestone aquifer underlies this area. The water from this aquifer is not of very good quality. It is high in sulfate because it dissolves gypsum within the aquifer. This sodium sulfate type of water is very hard, and its median level of total dissolved solids exceeds 1,000 parts per million (milligrams per liter). Another source of ground water is the alluvial deposits in the valleys along the larger streams. This ground water is of good enough quality to be used for domestic and livestock supplies and for some limited irrigation. Small amounts of ground water are in fractures and joints in the bedrock on uplands.

Soils

The dominant soil orders in this MLRA are Aridisols and Entisols. Most of the soils are Argids, Calcids, Cambids, or Orthents. They are well drained and coarse textured to fine textured. They have a thermic soil temperature regime, an aridic soil moisture regime, and gypsic, carbonatic, or mixed mineralogy. Deep Calciargids and Haplargids (Redona, Tucumcari, Faskin, and Berwolf series) formed on alluvial fan terraces, plains, and uplands. Deep Haplocambids (Ima and La Lande series) formed on fan terraces and piedmont slopes. Deep Haplocalcids (Quay, Ratliff, Chispa, and Poquita series) formed on fan terraces and uplands. Moderately deep Haplocalcids (San Jon and Conchas series) and very deep Torriorthents (Holloman series) formed on uplands. Deep Torrerts (Montoya series) formed on flood plains. Deep Torriorthents (Lacita series) formed on alluvial fans. Shallow Torriorthents (Lacoca series) formed on ridges. Very deep Calcigypsids (Reeves series) have gypsic mineralogy and formed mainly in nearly level to gently sloping areas. Deep Torripsamments (Roswell series) formed on dunes on terraces. Shallow and moderately deep Petrocalcids (Kolar, Neso, and Pojo series) formed on mesas.

Biological Resources

The native vegetation in this area consists of short or mid prairie grasses in the lowlands and pinyon and juniper at the higher elevations and on the steeper north-facing slopes. Upland sites are characterized by gramas, dropseeds, bluestems, bristlegrass, and small soapweed. Depressional areas are characterized by alkali sacaton, vine-mesquite, and galleta in the northern part of the MLRA and tobosa in the southern part. Bluestems, Indiangrass, and soapweed characterize the sandhills, which also support sand sage in the northern part of the MLRA and shinnery oak in the southern part.

Some of the major wildlife species in this area are mule deer, antelope, coyote, kit fox, bobcat, badger, beaver, skunk, muskrat, jackrabbit, cottontail, rock squirrel, pack rat, sandhill crane, pheasant, raven, bobwhite quail, scaled quail, and box turtle.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 2%
Grassland—private, 85%; Federal, 5%
Forest—private, 1%
Urban development—private, 1%
Water—private, 1%
Other—private, 5%

Farms or ranches make up nearly all of this area. Cattle and sheep grazing is the principal enterprise. About 2 percent of the area is in irrigated cropland. Canals from reservoirs provide irrigation water. The main irrigated crops are alfalfa, grain sorghum, and wheat.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter in the soils, and management of soil moisture. Conservation practices on cropland generally include conservation tillage, crop residue management, and irrigation water management. Conservation practices on rangeland generally include prescribed grazing, fencing, brush management, and development of watering facilities. ■

70C—Central New Mexico Highlands

This area (shown in fig. 70C-1) is in central New Mexico (95 percent) and in Texas (5 percent). It makes up about 12,495 square miles (32,375 square kilometers). The towns of Moriarty, Corona, and Carrizozo, New Mexico, and Pine Springs, Texas, are in this MLRA. Interstate 40 crosses the northern end of the MLRA. Areas of the Lincoln National Forest are in the south-central and southwestern parts of this MLRA and in the Guadalupe Mountains, which is in a separate part of the MLRA, southeast of the main part. Outliers of the Cibola National Forest are in the south-central and northwest parts of the area. The Guadalupe Mountains National Park is in the part of this area in Texas, and the western portion of the Carlsbad Caverns National Park is in the separate, southwest part of the MLRA, in New Mexico. The eastern one-fourth of the Mescalero Indian Reservation is in the southern part of the area. Areas of the Fort Bliss Military Reservation and the White Sands Missile Range are in the far western part of the MLRA.

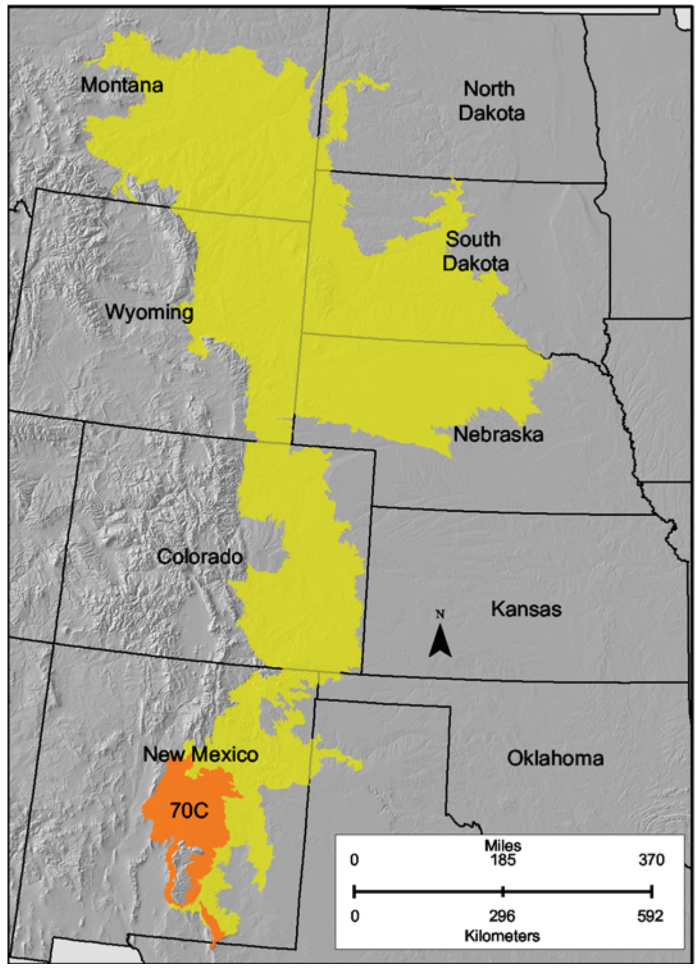

Figure 70C-1: Location of MLRA 70C in Land Resource Region G.

Physiography

This area is in the Sacramento Section of the Basin and Range Province of the Intermontane Plateaus. It is characterized by block-faulted ranges separated by intermountain basins. Tablelands and mesas are capped by sedimentary rocks. Many local terraces are near small streams. Steep escarpments and breaks are common. Elevation generally ranges from 5,000 to 7,400 feet (1,525 to 2,255 meters). In some mountainous areas, however, it is more than 8,500 feet (2,590 meters). It is 8,749 feet (2,667 meters) on Guadalupe Peak, the highest point in Texas. This peak is in the part of this MLRA in the Guadalupe Mountains National Park.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Pecos (1306), 54 percent; Rio Grande Closed Basins (1305), 38 percent; and Rio Grande-Elephant Butte (1302), 8 percent. Some western tributaries to the Pecos River cross this area.

Geology

The northern one-third of this area is underlain by Quaternary alluvium and sand dunes of Quaternary age with minor exposures of basalt. The southern two-thirds is underlain by sandstones, shales, and dolomites in the Permian-age Glorieta and San Andres Formations.

Climate

The average annual precipitation in most of this area is 11 to 15 inches (280 to 380 millimeters), occurring mostly in summer. It is as high as 26 inches (660 millimeters) in the mountains. The average annual temperature is 46 to 60 degrees F (8 to 16 degrees C). The freeze-free period averages 190 days and ranges from 135 to 250 days, decreasing in length with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 0.0%; ground water, 0.7%
Irrigation—surface water, 33.5%; ground water, 65.5%
Other—surface water, 0.4%; ground water, 0.0%

The total withdrawals average 135 million gallons per day (510 million liters per day). About 66 percent is from ground water sources, and 34 percent is from surface water sources. Water is scarce throughout the area because of the low and erratic precipitation and the few perennial streams. Most of the surface water used in this area is from the western tributaries of the Pecos River. The surface water is generally of good quality because it has not been contaminated by agricultural return flows. Some local water-quality problems occur in areas where wastewater from oil and gas development or potash mining is discharged into the surface water.

A small part of the Pecos River Basin Limestone aquifer underlies the northeastern and southeastern parts of this MLRA. Most of the water from this aquifer is not of very good quality. It is high in sulfate because it dissolves gypsum within the aquifer. This sodium sulfate type of water is very hard, and its median level of total dissolved solids exceeds 1,000 parts per million (milligrams per liter). The Eastern New Mexico Basin Fill aquifer is a source of ground water on the western edge of the area. Because of low levels of total dissolved solids, sodium, and hardness, this water is very well suited to most uses. Another source of ground water is the alluvial deposits in the valleys along the few large streams. The water from these deposits is of good enough quality to be used for domestic and livestock supplies and for some limited irrigation. Small amounts of ground water are in fractures and joints in the bedrock on uplands.

Soils

The dominant soil orders in this MLRA are Aridisols, Entisols, and Mollisols. Most of the soils are Argids, Calcids, Ustolls, or Orthents. They are well drained and are moderately coarse textured to moderately fine textured. They have a mesic soil temperature regime, an ustic or aridic soil moisture regime, and carbonatic or mixed mineralogy. Generally, the moisture regime is aridic bordering on ustic, but areas of pinyon-juniper woodland and savanna at the higher elevations have an ustic regime bordering on aridic.

Very deep Calciargids (Tapia, Clovis, and Witt series) and very deep Haplargids (Penistaja series) formed on uplands. Very deep Haplocalcids (Dean and Harvey series) formed on alluvial fan terraces and mesas. Very deep, saline Haplocalcids (Willard series) formed in lacustrine deposits on lake terraces. Very shallow and shallow Calciustolls (Deama series) and Haplustolls (Tortugas and Laporte series) formed on mesas and hills underlain by limestone bedrock. Shallow Torriorthents (Travessilla series) formed in sandy eolian deposits over sandstone bedrock on hills. Very deep Torriorthents (Otero series) formed in sandy alluvium locally reworked by the wind. Shallow Petrocalcids (Pastura series) formed on mesas. Deep Argiustolls (Romine series) formed in gravelly and cobbly sediments on alluvial fan terraces. Deep Argiustolls (Rednun series) formed in fine textured sediments on alluvial plains.

Biological Resources

The soils at the higher elevations are in areas of juniper-pinyon savanna and pinyon-juniper woodland. They have a diverse understory dominated by sideoats grama, little bluestem, blue grama, bottlebrush squirreltail, western wheatgrass, pinyon ricegrass, Bigelow sagebrush, and winterfat. The soils at the lower elevations are characterized by a mixed grassland prairie of little bluestem, grama grasses, western wheatgrass, galleta, and New Mexico feathergrass. They also support sand sagebrush and sumac. Alkaline soils support fourwing saltbush, winterfat, and alkali sacaton. The drainageways at the higher elevations are dominated by giant sacaton, and those at the lower elevations are dominated by western wheatgrass. Fourwing saltbush, winterfat, and alkali sacaton also are prevalent in the drainageways.

Some of the major wildlife species in this area are badger, porcupine, skunk, jackrabbit, cottontail, prairie dog, kangaroo rat, pocket gopher, pocket mouse, sparrow hawk, red-tailed hawk, Cooper's hawk, marsh hawk, prairie falcon, scaled quail, raven, western kingbird, horned lark, warbler, mourning dove, and rattlesnake.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 1%
Grassland—private, 72%; Federal, 17%
Forest—private, 6%; Federal, 2%
Urban development—private, 1%
Other—private, 1%

Ranches make up most of this area. Cattle and sheep grazing is the primary land use. Land ownership is about four-fifths private and one-fifth Federal or State. Most of the area is a rolling grassland prairie. Large areas adjacent to the mountains are in pinyon-juniper savanna or pinyon-juniper woodland. A small percentage of the area is irrigated cropland. Most of this cropland is in the Estancia Basin.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter in the soils, and management of soil moisture. Conservation practices on cropland generally include conservation tillage, crop residue management, and irrigation water management. Conservation practices on rangeland generally include prescribed grazing, fencing, brush management, and development of watering facilities. ■

70D—Southern Desert Foothills

This area is entirely in south-central New Mexico (fig. 70D-1). It makes up about 3,000 square miles (7,775 square kilometers). The towns of Carlsbad and Roswell are just outside this area to the east. U.S. Highways 62 and 100 cross the southern end of this area, and U.S. Highways 70 and 380 cross the northern end. The eastern part of the Carlsbad Caverns National Park is in the southeast corner of the area. A small part of Fort Bliss Military Reservation is in the western tip of the area.

Physiography

This area is in the southern part of the Sacramento Section of the Basin and Range Province of the Intermontane Plateaus. It is characterized by nearly level to rolling or steep limestone hills with intermittent drainageways. Small areas of nearly level valley bottom land occur in the larger drainageways. Elevation generally is 4,000 to 6,000 feet (1,220 to 1,830 meters) but is 8,000 feet (2,440 meters) in some areas.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Pecos (1306), 75 percent; Rio Grande Closed Basins (1305), 21 percent; and Lower Pecos (1307), 4 percent. Some western tributaries to the Pecos River cross this area.

Geology

This area is underlain by limestones, sandstones, shales, and dolomites in the Glorieta and San Andres Formations of Permian age.

Climate

The average annual precipitation in this area is 12 to 22 inches (305 to 560 millimeters). The higher amount of precipitation occurs along the eastern edge of the area. The precipitation fluctuates widely from year to year. Most of the precipitation is received from early summer to early autumn. The average annual temperature is 51 to 63 degrees F (11 to 17 degrees C). The freeze-free period averages 215 days and ranges from 180 to 255 days, increasing in length from west to east.

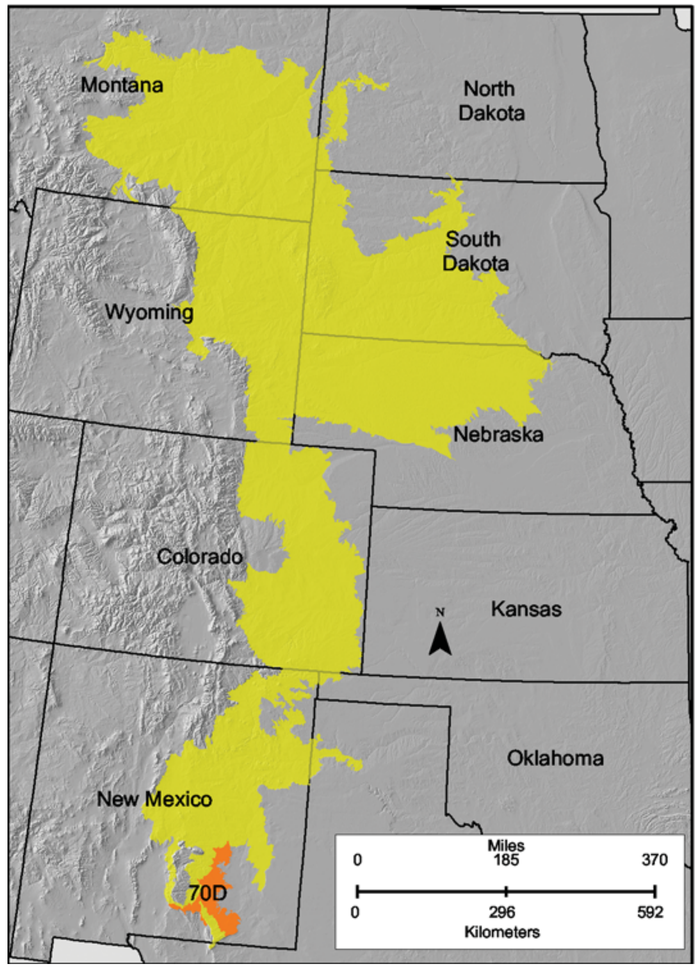

Figure 70D-1: Location of MLRA 70D in Land Resource Region G.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 0.1%; ground water, 1.0%
Irrigation—surface water, 91.9%; ground water, 7.1%

Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average 70 million gallons per day (265 million liters per day). About 8 percent is from ground water sources, and 92 percent is from surface water sources. Most of the surface water used in this area is from the western tributaries of the Pecos River. The surface water generally is of good quality because it has not been contaminated by agricultural return flows. Some local water-quality problems occur in areas where wastewater from oil and gas development or potash mining is discharged into the surface water.

Part of the Pecos River Basin Limestone aquifer underlies the eastern portion of this MLRA. Most of the water from this aquifer is not of very good quality. It is high in sulfate because it dissolves gypsum within the aquifer. This sodium sulfate type of water is very hard, and its median level of total dissolved solids exceeds 1,000 parts per million (milligrams per liter). Another source of ground water is the alluvial deposits in the valleys along the few large streams. This water is of good enough quality to be used for domestic and livestock supplies and for some limited irrigation. Small amounts of ground water are in fractures and joints in the bedrock on uplands.

Soils

The dominant soil orders in this MLRA are Aridisols and Mollisols. Most of the soils are Calcids, Cambids, or Ustolls. They are well drained and mostly shallow and loamy-skeletal. They have a thermic soil temperature regime, an aridic soil moisture regime, and carbonatic or mixed mineralogy. Rock outcrop makes up a significant portion of the area. Shallow or very shallow Calciustolls (Ector series) and Haplocalcids (Lozier series) are underlain by limestone and are on hills. Shallow Petrocalcids (Philder series) have a petrocalcic horizon and formed on fan remnants. Very deep Haplocalcids (Armesa series) formed in loamy fan alluvium on pediments and fan piedmonts. Very deep Haplocambids (Reyab series) formed in silty alluvium in drainageways and on terraces and alluvial fans.

Biological Resources

This area supports natural prairie vegetation characterized by sideoats grama, black grama, blue grama, green sprangletop, tridens, Metcalfe muhly, and a diversity of shrubs, such as mariola, sumacs, catclaw, sotol, agave, and fourwing saltbush. Drainageways are dominated by Apache plume, New Mexico walnut, desertwillow, brickellbush, littleleaf sumac, hackberry, and a few cottonwoods.

Some of the major wildlife species in this area are antelope, badger, jackrabbit, cottontail, prairie dog, ground squirrel, pocket gopher, kangaroo rat, golden eagle, Swainson’s hawk, sparrow hawk, prairie falcon, scaled quail, burrowing owl, meadowlark, horned lark, loggerhead shrike, mourning dove, box turtle, prairie rattlesnake, western coachwhip snake, Texas horned lizard, and plains spadefoot toad.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—private, 47%; Federal, 49%
Forest—Federal, 3%
Urban development—private, 1%

Most of this area is Federal land. The extreme western part is dominantly in military use and ownership. The rest is used primarily as rangeland grazed by cattle and sheep. Small tracts in some of the stream valleys are irrigated.

The major soil resource concerns are the erosion caused by overgrazing, maintenance of the content of organic matter in the soils, and management of soil moisture. Conservation practices on rangeland generally include reasonable stocking rates and pasture rotation. ■

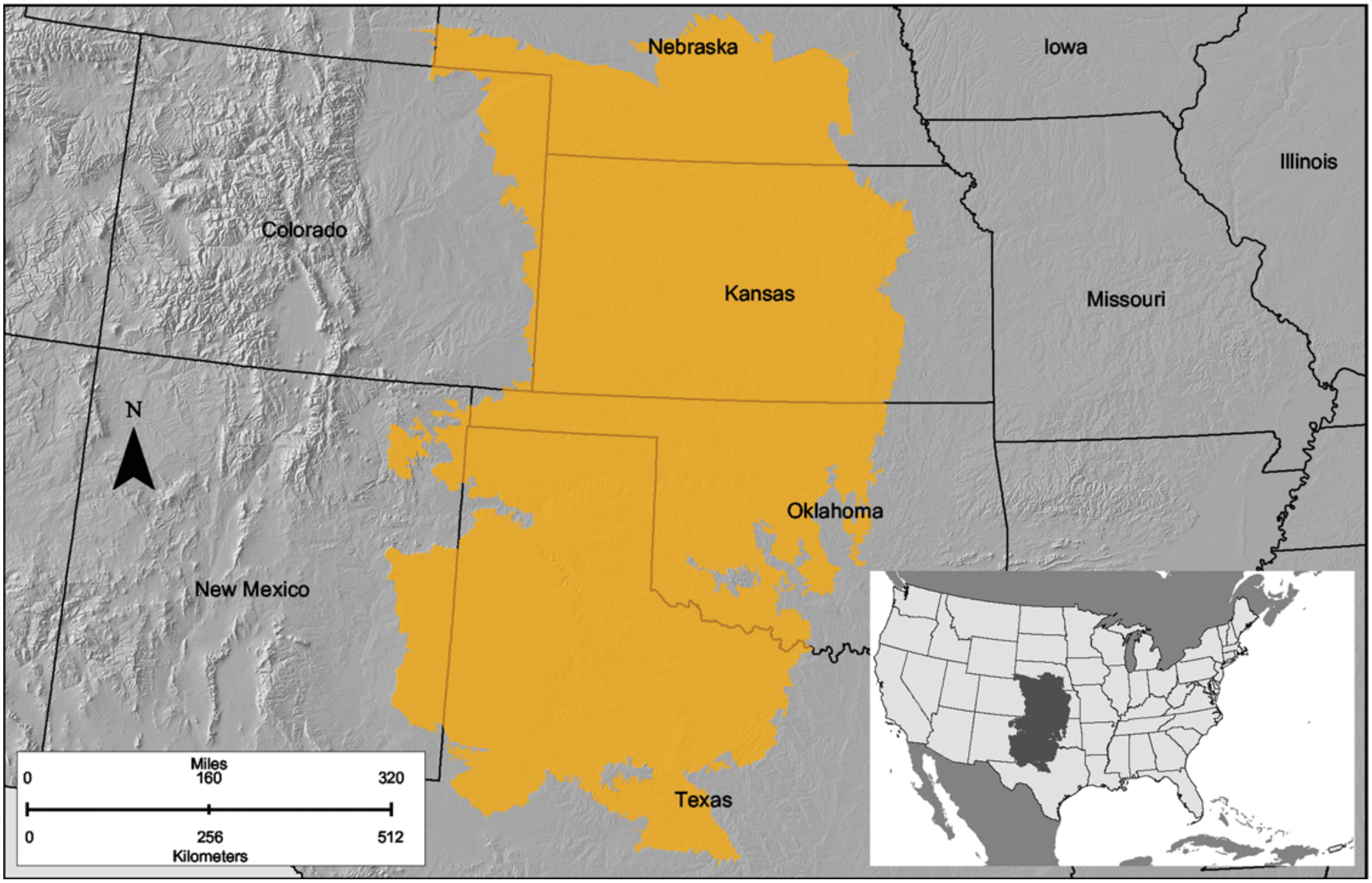

Figure H-1: Location of Land Resource Region H.

H—Central Great Plains Winter Wheat and Range Region

This region (shown in fig. H-1) is in Texas (35 percent), Kansas (29 percent), Oklahoma (16 percent), Nebraska (13 percent), New Mexico (4 percent), and Colorado (3 percent). Also, a very small part of the region is in Wyoming. This region makes up 219,740 square miles (569,420 square kilometers).

This region is in the south-central part of the Great Plains. It is a nearly level to gently rolling fluvial plain in the northern part and more of an eroded plateau with entrenched streams in the southern part. The average annual precipitation ranges from 20 to 29 inches (510 to 735 millimeters) in most of the region. Most of the precipitation falls during spring and fall thunderstorms. Snowfall provides only a small portion of the annual precipitation. The average annual temperature ranges from 54 to 60 degrees F (12 to 16 degrees C) in most of this region. The freeze-free period ranges from 190 to 235 days, increasing in length from north to south.

The total withdrawals of freshwater in this region average about 17,560 million gallons per day (52,345 million liters per day). About 73 percent is from ground water sources, and 27 percent is from surface water sources. About 91 percent of the water is used for irrigation.

The soils in this region are dominantly Mollisols, but significant acreages of Alfisols, Entisols, and Inceptisols also occur. The dominant soil suborder is Argiustolls. Other notable suborders include Haplustolls, Ustipsamments, Calciustolls, Paleustolls, and Paleustalfs. Most of the soils in the region have a mesic or thermic soil temperature regime and an ustic soil moisture regime. Mineralogy is dominantly mixed but is smectitic or carbonatic in some soils.

About 99 percent of the land in this region is privately owned. The native vegetation consists mainly of mid and tall prairie grasses, but some areas support short prairie grasses or a mixture of these and other prairie grasses. Small areas of oak-savanna occur in the MLRAs in the southern part of the region. The region has almost as much cropland as it has grassland. The production of beef cattle is the dominant agricultural

Figure H-2: Wheat in an area of Land Resource Region H.

enterprise. Dry-farmed winter wheat (fig. H-2) and other small grains are grown for either cash or feed. Irrigated crops, mainly corn, alfalfa, and forage crops, are grown along many of the major streams.

The major resource concerns on the grassland in this region are overgrazing and the spread of invasive plants and noxious weeds. The major resource concerns on cropland are wind erosion, water erosion, maintenance of the content of organic matter in the soils, and soil moisture management. The quality of surface water also is a concern. Sediment, nutrients, pesticides, and salinity are the major nonpoint sources of surface- and ground-water pollution. Control of saline seeps on rangeland and salt management on irrigated land are concerns in some areas of the region. ■

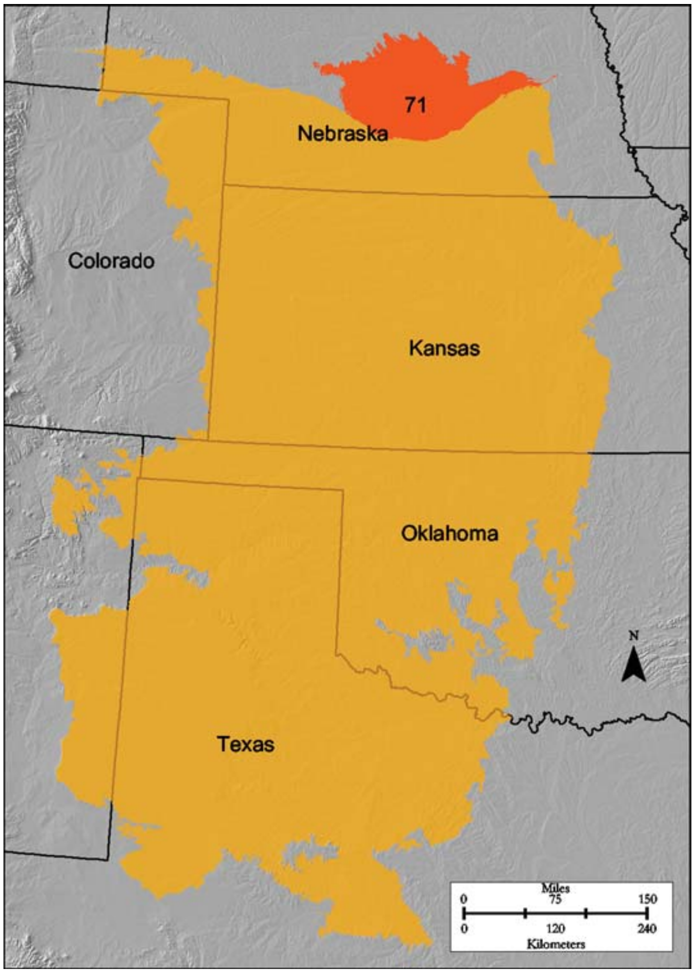

Figure 71-1: Location of MLRA 71 in Land Resource Region H.

71—Central Nebraska Loess Hills

This area is entirely in Nebraska (fig. 71-1). It makes up about 8,165 square miles (21,160 square kilometers). The cities of Kearney, Lexington, and Grand Island and the towns of Broken Bow, Ord, Loup City, St. Paul, and Central City are in this MLRA. Interstate 80 skirts the southern edge of this area.

Physiography

This MLRA is in the High Plains Section of the Great Plains Province of the Interior Plains. This area is the eastern extent of the fluvial plain created by the ancient rivers that drained the rapidly eroding Rocky Mountains after the mountains were uplifted. This smooth plain has been dissected by present-day rivers, and thick deposits of loess derived from the fluvial plain occur on ridges between the broad stream valleys. Elevation ranges from 1,640 to 2,620 feet (500 to 800 meters), increasing from east to west. Nearly level to gently sloping, loess-mantled, narrow ridgetops are separated by steep slopes bordering drainages. Some stream valleys have nearly level flood plains and large stream terraces. Nearly level soils occur on high stream terraces in the southern part of the area, in the Platte River Valley. Local relief is 20 to 100 feet (5 to 30 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Loup (1021), 60 percent, and Platte (1020), 40 percent. The Platte River runs along the southern edge of this MLRA, and the North, Middle, and South branches of the Loup River join to form the Loup River in this area.

Geology

Most of the uplands in this area are covered with thick deposits of loess. Extensive terraces are in the valleys along the Loup and Platte Rivers. These terraces contain silt, sand, and gravel, and the river valleys are filled with Quaternary and younger deposits of sand and gravel. The eastern extent of the Tertiary Ogallala Formation underlies most of this MLRA. Pierre Shale and Niobrara Chalk, Cretaceous marine sediments, underlie the eastern edge of the area.

Climate

The average annual precipitation in this area is 21 to 29 inches (535 to 735 millimeters). Most of the precipitation falls from spring through autumn, but the maximum occurs from late spring to early summer. The rainfall occurs as frontal storms in spring and early summer and high-intensity, convective thunderstorms in late summer and early autumn. Precipitation in winter typically occurs as snow. The average annual temperature is 47 to 51 degrees F (8 to 11 degrees C). The freeze-free period averages 165 days and ranges from 140 to 190 days, increasing in length from west to east.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 2.0%
Livestock—surface water, 0.2%; ground water, 0.7%
Irrigation—surface water, 25.1%; ground water, 55.9%
Other—surface water, 15.7%; ground water, 0.5%

The total withdrawals average 1,295 million gallons per day (4,900 million liters per day). About 59 percent is from ground water sources, and 41 percent is from surface water sources. The low, erratic precipitation is the source of water for crops and native grasses in most of the area. The Loup and Platte Rivers provide water for irrigation along their valleys. This water is of good quality and is suitable for all uses.

In much of the area, an abundant supply of good-quality ground water is used for domestic purposes and livestock and locally for irrigation. Ground water from Quaternary sand and gravel in valley fill aquifers and from eolian deposits of silt and fine sand is similar in quality to the ground water from the Tertiary Ogallala aquifer. It has less than 500 parts per million (milligrams per liter) total dissolved solids. It is a calcium bicarbonate type of water and is very hard. Gravity-irrigated farmland is concentrated on the terraces and river valleys, especially along the Platte River.

Soils

The dominant soil orders in this MLRA are Entisols and Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy. They are generally very deep, well drained to excessively drained, and loamy or sandy. Ustorthents (Coly series) formed in loess on uplands. Ustifluvents (Hobbs series) formed in alluvium on flood plains and alluvial fans. Ustipsamments (Valentine series) formed in sandy eolian material on dunes. Haplustolls (Cozad, Hord, and Uly series) formed in alluvium and/or loess on stream terraces and uplands. Argiustolls formed in loess over alluvium on stream terraces (Hall series) and in loess on uplands (Holdrege series).

Biological Resources

The uplands in this area support short, mid, and tall grasses. Big bluestem, little bluestem, switchgrass, Indiangrass, sideoats grama, blue grama, and western wheatgrass are the major species on silty soils. Needleandthread, prairie sandreed, sand bluestem, little bluestem, and blue grama are the major species on sandy soils.

Some of the major wildlife species in this area are white-tailed deer, coyote, raccoon, opossum, cottontail, muskrat, squirrel, mink, pheasant, prairie chicken, bobwhite quail, and mourning dove. The species of fish in the area include bass, bluegill, and channel catfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 44%
Grassland—private, 48%; Federal, 1%
Forest—private, 1%
Urban development—private, 3%
Water—private, 1%
Other—private, 2%

Nearly all of this area is in farms and ranches, and almost two-fifths is dry-farmed. About one-half of the area supports native grasses used for grazing. Winter wheat, grain sorghum, and alfalfa are the major dry-farmed cash crops. Between 5 and 10 percent of the area, consisting of flood plains and terraces along the Platte River and its larger tributaries, is irrigated. Corn, soybeans, alfalfa, and seed crops are the principal irrigated crops. Alfalfa is commercially grown in the Platte River Valley.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and tilth of the soils, and soil moisture management. The resource concerns on rangeland are wind erosion and water erosion; plant productivity, health, and vigor; and the spread of noxious and invasive plant species.

Conservation practices on cropland generally include high-residue crops in the cropping system; systems of crop residue management, such as no-till and mulch-till systems; level terraces; contour farming; contour stripcropping; irrigation water management; and nutrient management. Conservation practices on rangeland generally include prescribed grazing, brush management, proper distribution of watering facilities, and control of noxious and invasive plant species. ■

72—Central High Tableland

This area (shown in fig. 72-1) is in Kansas (54 percent), Nebraska (25 percent), and Colorado (21 percent). A very small part of the area is in Wyoming. The area makes up about 34,550 square miles (89,535 square kilometers). It includes the towns of Garden City, Goodland, and Colby, Kansas; Imperial, North Platte, Ogallala, and Sidney, Nebraska; and Holyoke and Wray, Colorado. Interstate 70 bisects the area, and Interstates 76 and 80 follow the south side of the South and North Platte Rivers, respectively. The Cimarron National Grasslands occur in the southeast corner of the MLRA.

Physiography

Almost all of this area is in the High Plains Section of the Great Plains Province of the Interior Plains. A small part of the area, where the South Platte River enters Nebraska, is in the Colorado Piedmont Section of the same province and division. This MLRA consists of broad intervalley remnants of a smooth, fluvial plain. Elevation ranges from 2,600 to 3,900 feet (795 to 1,190 meters), increasing from east to west. Slopes generally are nearly level to gently rolling on this smooth tableland, but steep slopes border the major valleys. Broad, level flood plains and terraces are along the Arkansas and Platte Rivers and a few of their larger tributaries. Local relief on uplands is in meters, but valleys are tens of meters below the general level of the uplands.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Republican (1025), 38 percent; Middle Arkansas (1103), 20 percent; Smoky Hill (1026), 15 percent; South Platte (1019), 13 percent; Upper Cimarron (1104), 11 percent; North Platte (1018), 2 percent; and Upper Arkansas (1102), 1 percent. The

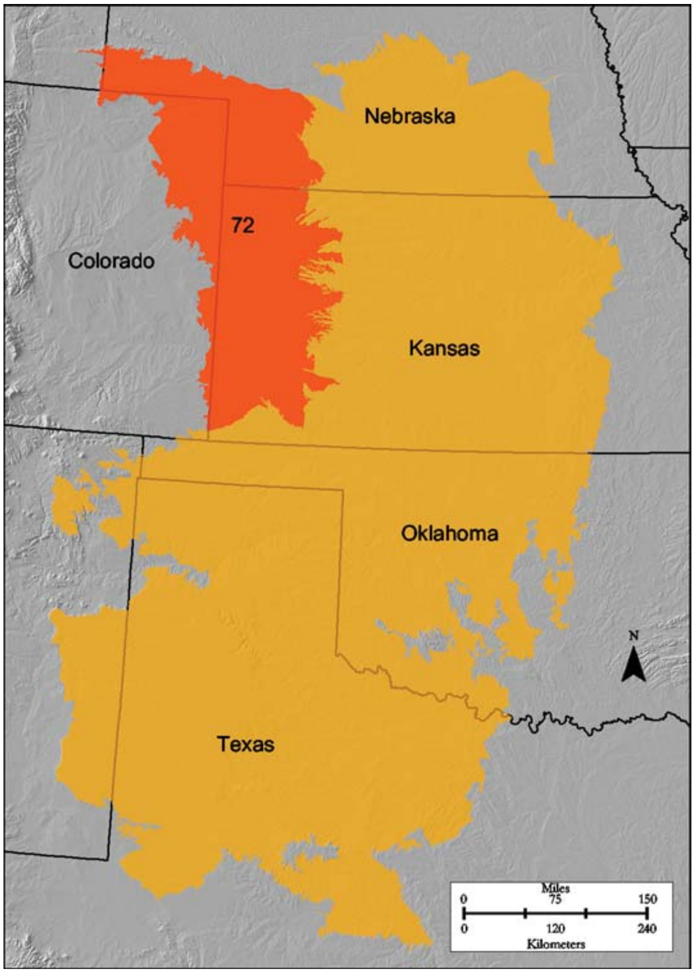

Figure 72-1: Location of MLRA 72 in Land Resource Region H.

North Platte River forms the northern boundary of this MLRA. The South Platte River joins the North Platte River at the town of North Platte, Nebraska. The Arkansas River bisects the southern part of the MLRA. Other large rivers between the North Platte and Arkansas Rivers in the area include the Republican, Sappa, Prairie Dog, Solomon, Saline, and Smoky Hill Rivers. The Cimarron River is in the southeast corner of the area.

Geology

The smooth tableland lying between the major river valleys in this MLRA has river-laid sediments washed out onto the plains following uplift of the Rocky Mountains in Colorado. In many areas the wind reworked these sediments, forming a hummocky, dune surface of eolian sand. A loess mantle occurs in other parts of the area. The Tertiary-age Ogallala and White River Formations cover Cretaceous Pierre Shale. The Ogallala Formation consists of loose to well cemented sand and gravel, and the White River Formation consists of ashy claystone and sandstone. The Pierre Shale can be near the surface in the river valleys cut into the Tertiary sediments. Quaternary and more recent sand and gravel cover the shale in the river valleys.

Climate

The average annual precipitation in this area is 14 to 25 inches (355 to 635 millimeters). It fluctuates widely from year to year. Most of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. The maximum precipitation occurs from late spring through early autumn. Precipitation in winter occurs as snow. The annual snowfall ranges from about 16 inches (40 centimeters) in the southern part of the area to 35 inches (90 centimeters) in the northern part. The average annual temperature is 46 to 57 degrees F (8 to 14 degrees C). The freeze-free period averages 175 days and ranges from 135 to 210 days, increasing in length from northwest to southeast.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.8%
Livestock—surface water, 0.3%; ground water, 0.6%
Irrigation—surface water, 23.2%; ground water, 73.5%
Other—surface water, 0.9%; ground water, 0.7%

The total withdrawals average 4,225 million gallons per day (15,990 million liters per day). About 76 percent is from ground water sources, and 24 percent is from surface water sources. The low, erratic precipitation is the source of water for dry-farmed crops and pastures on uplands. Water from the Arkansas, Republican, and North and South Platte Rivers is used for irrigation in the valleys of these rivers. The surface water is generally of good quality. It is suitable for all in-stream uses and for irrigation. In this MLRA, the quantity of the water is a much greater problem than the quality. Water from the South Platte River is highly mineralized because of irrigation use and reuse in Colorado.

In most of this area, good-quality ground water is adequate for domestic and livestock needs and is used locally for irrigation. Ground water is scarce in areas where shale is near the surface. Almost all of the ground water used for irrigation in the uplands comes from Quaternary sand and gravel deposits near the surface, the Ogallala Formation, and the Brule Formation, all of which are part of the High Plains aquifer. This water is typically low in total dissolved solids but is hard or very hard. Some ground water is obtained from alluvium in the principal river valleys. The water from the alluvial aquifers is very hard. Shallow ground water can be contaminated by nitrate and atrazine from agricultural lands.

Soils

The dominant soil orders in this MLRA are Entisols and Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic or aridic soil moisture regime, and mixed or smectitic mineralogy. They generally are very deep and moderately well drained to excessively drained. The texture of the soils varies. Ustorthents (Colby and Sulco series) and Haplustolls (Ulysses series) formed in loess on hills and plains. Torripsamments (Valent series) formed in sandy eolian material on dunes. Argiustolls formed in loess (Keith, Kuma, and Richfield series) and loamy eolian and/or outwash sediments (Manter and Satanta series) on hills, plains, and stream terraces and in mixed loess and local alluvium on plains and in drainageways and depressions (Rago series). Paleustolls (Platner series) formed in pedisediments on plains and tablelands.

Biological Resources

This area supports short prairie grasses. Blue grama and buffalograss are the dominant species. Sideoats grama, blue grama, hairy grama, and little bluestem grow on the steeper valley walls along the major rivers.

Some of the major wildlife species in this area are white-tailed deer, antelope, coyote, badger, raccoon, skunk, rabbit, prairie dog, pheasant, prairie chicken, quail, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 67%
Grassland—private, 30%
Urban development—private, 2%
Other—private, 1%

Nearly all of this area is in farms or ranches dominated by cash-grain farming and livestock production. More than two-thirds of the area is cropland used for dry-farmed crops. Winter wheat, typically grown in a winter wheat-fallow rotation, is the primary crop. Other small grains, grain sorghum, alfalfa, and grass hay crops also are widely grown, especially in the narrow irrigated areas along the Platte, Republican, and Arkansas Rivers. Corn, grain sorghum, and sugar beets are grown extensively on the nearly level uplands where ground water is used for irrigation. Pinto beans are grown on some broad, flat plains. Nearly one-third of the area, consisting of hilly and steep slopes bordering the drainageways, supports native grasses and shrubs used for grazing.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and tilth of the soils, and soil moisture management. The resource concerns on rangeland are wind erosion; plant productivity, health, and vigor; the spread of noxious and invasive species; and inadequate wildlife habitat.

Conservation practices on cropland generally include high-residue crops in the cropping system; systems of crop residue management, such as no-till and mulch-till systems; level terraces; contour farming; contour stripcropping; conservation crop rotations; irrigation water management; and pest and nutrient management. Conservation practices on rangeland generally include prescribed grazing, brush management, management of upland wildlife habitat, proper distribution of watering facilities, and control of noxious and invasive plant species. ■

73—Rolling Plains and Breaks

This area (shown in fig. 73-1) is in Kansas (78 percent) and Nebraska (22 percent). It makes up about 21,485 square miles (55,670 square kilometers). The towns of Hays, Great Bend, and Dodge City, Kansas, and Alma, Curtis, Holdrege, and McCook, Nebraska, are in this MLRA. The MLRA is bisected by Interstate 70. The Platte River is at the northern edge of the area, and the Arkansas River is at the southern edge.

Physiography

Almost all of this area is in the Plains Border Section of the Great Plains Province of the Interior Plains. The northwest and southwest corners of the area are in the High Plains Section of the same province and division. The surface of the area is a sub-maturely or maturely dissected plateau. Elevation ranges from 1,650 to 3,000 feet (505 to 915 meters), increasing from east to west. The dissected plains in this area have broad, undulating to rolling ridgetops and hilly to steep valley sides. The valleys are generally narrow, but broad flood plains and terraces are along the Republican River and its larger tributaries. Local relief is in meters to tens of meters.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Smoky Hill (1026), 48 percent; Republican (1025), 30 percent; Middle Arkansas (1103), 19 percent; and Platte (1020), 3 percent. The North Platte River forms the northern boundary of the MLRA, and the Republican River parallels the Nebraska-Kansas border. The Arkansas River bisects the southern part of the area. Other large rivers between the Republican and Arkansas Rivers in this area include the Sappa, Prairie Dog, Solomon, Saline, and Smoky Hill Rivers. Medicine Creek is in the northwestern part of the area.

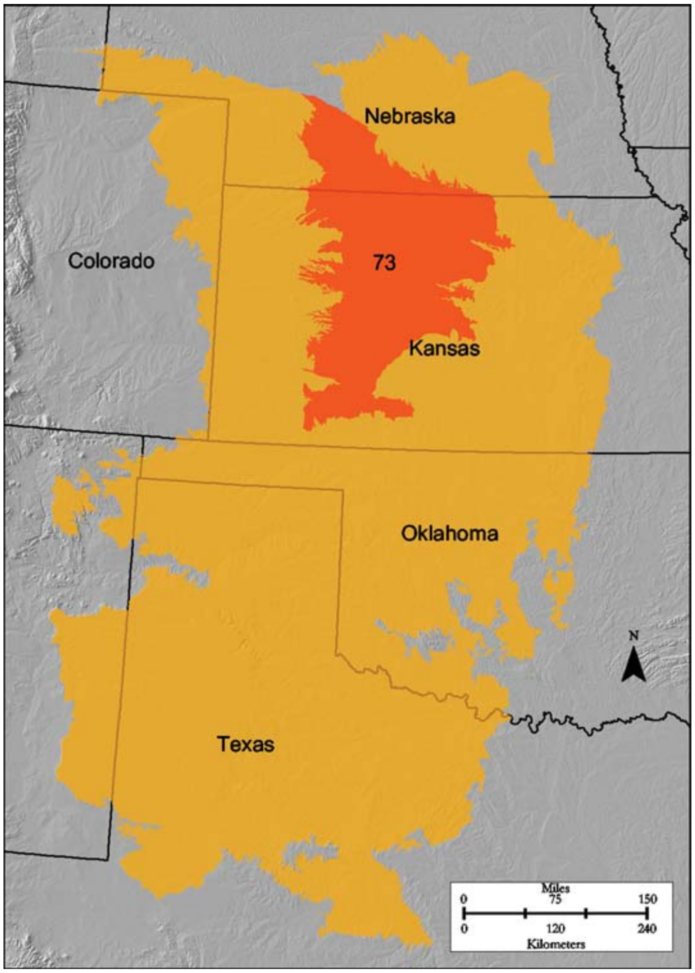

Figure 73-1: Location of MLRA 73 in Land Resource Region H.

Geology

The western half of this MLRA and areas along the Arkansas River have remnants of the Tertiary river-laid sediments washed out onto the plains from erosion of the prehistoric Rocky Mountains in Colorado. In the valley of the Arkansas River, the wind reworked these sediments, forming a hummocky dune surface of eolian sand. A loess mantle occurs on the higher ground in the western half of the area. The Tertiary-age Ogallala and White River Formations cover Cretaceous Pierre Shale in the northern part of the area. The Ogallala Formation consists of loose to well cemented sand and gravel, and the White River Formation consists of ashy claystone and sandstone. Pierre Shale and Niobrara Chalk are at the surface in the valleys of the Republican, Smoky Hill, and Saline Rivers. Fort Hays limestone and Blue Hill shale of the Niobrara Formation are at the surface in the valleys of the Saline and Smoky Hill Rivers. Shale is exposed in most of the eastern half of this MLRA, in Kansas. Quaternary and more recent sand and gravel partially cover the shale in the river valleys.

Climate

The average annual precipitation in this area is 19 to 30 inches (485 to 760 millimeters). Most of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. The maximum precipitation occurs from the middle of spring to early autumn. Precipitation in winter occurs as snow. The annual snowfall ranges from about 17 inches (45 centimeters) in the southern part of the area to 24 inches (60 centimeters) in the northern part. The average annual temperature is 48 to 56 degrees F (9 to 14 degrees C). The freeze-free period averages 180 days and ranges from 145 to 210 days, increasing in length from northwest to southeast.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.1%; ground water, 0.9%
Livestock—surface water, 0.2%; ground water, 1.4%
Irrigation—surface water, 12.2%; ground water, 77.9%
Other—surface water, 7.0%; ground water, 0.4%

The total withdrawals average 1,400 million gallons per day (5,300 million liters per day). About 81 percent is from ground water sources, and 19 percent is from surface water sources. The moderate, erratic precipitation is the source of water for crops and pasture in much of the area. The amount of surface water is limited throughout the area. The Republican and Platte Rivers and their larger tributaries provide surface water for irrigation along their valleys. The surface water is generally of good quality. It is suitable for all in-stream uses and for irrigation. Because of low flows, the rivers in Kansas are limited as sources of irrigation water.

Abundant supplies of ground water for irrigation and other uses are obtained from wells, primarily in the northern part of this MLRA. Alluvium in the valleys along the major rivers and their larger tributaries is one source of ground water, and Quaternary sand and gravel and the Ogallala Formation within the High Plains aquifer are other sources. The water from the Ogallala Formation is typically low in total dissolved solids but is hard or very hard. The water from the alluvial aquifers is very hard. Shallow ground water can be contaminated by nitrate and atrazine from agricultural lands. Some deeper wells have been drilled to obtain more saline water from the Dakota Formation. Ground water becomes scarce in the eastern half of the MLRA, where the High Plains aquifer has been eroded away and Cretaceous Pierre Shale and Niobrara Chalk are at, or close to, the surface.

Soils

The dominant soil order in this MLRA is Mollisols. Entisols are of lesser extent. The soils in the area dominantly have a mesic soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep, moderately well drained to somewhat excessively drained, and loamy or clayey. Haplustolls formed in mixed loess, alluvium, and residuum on footslopes (Armo series), in mixed loess and alluvium on stream terraces (Hord and Eltree series), in alluvium on flood plains and alluvial fans (Bridgeport and Roxbury series), in loess on uplands (Uly series), and in residuum on hills and plains (Nibson and Wakeen series). Calciustolls (Penden series) formed in loamy sediments on uplands in the western part of the area. Argiustolls (Harney, Holdrege, and Spearville series) and Ustorthents (Coly series) formed in loess on uplands.

Biological Resources

This area supports natural prairie vegetation. Little bluestem, big bluestem, switchgrass, western wheatgrass, and sideoats grama characterize the vegetation on loamy soils. Blue grama, buffalograss, and western wheatgrass characterize the vegetation on clayey soils on uplands.

Some of the major wildlife species in this area are mule deer, white-tailed deer, coyote, raccoon, pheasant, bobwhite quail, mourning dove, and meadowlark. The species of fish in the area include bass, bluegill, catfish, and bullhead.

Land Use

Following are the various kinds of land use in this MLRA:

- Cropland—private, 55%
- Grassland—private, 39%; Federal, 1%
- Forest—private, 1%
- Urban development—private, 2%
- Water—private, 1%
- Other—private, 1%

Nearly all of this area is in farms or ranches. More than half of the area is cropland used for dry-farmed crops. Winter wheat and grain sorghum are the major crops in much of the area. Corn is the main crop in the northern part of the area. Feed grains and hay crops also are widely grown. About 2 percent of the area, especially on the terraces and narrow bottom land along the Platte and Republican Rivers, is irrigated. Corn, alfalfa, small grains, and grass for hay are grown extensively on the irrigated land. About 40 percent of the area, consisting of hilly and steep slopes bordering the drainageways, supports native grasses and shrubs used for grazing.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter in the soils, and surface compaction. Also, soil moisture management is important in the western part of the area. The resource concerns on rangeland are plant productivity, health, and vigor; the spread of noxious and invasive plants; and inadequate wildlife habitat.

Conservation practices on cropland generally include high-residue crops in the cropping system; systems of crop residue management, such as no-till, strip-till, and mulch-till; level terraces in the western part of the area and gradient terraces and grassed waterways in the eastern part; contour farming; conservation crop rotations; irrigation water management; and nutrient and pest management. Conservation practices on rangeland generally include prescribed grazing, brush management, management of upland wildlife habitat, proper distribution of watering facilities, and control of noxious and invasive plant species. ■

74—Central Kansas Sandstone Hills

This area is entirely in Kansas (fig. 74-1). It makes up about 8,365 square miles (21,675 square kilometers). The city of Salina and the towns of Concordia, Junction City, McPherson, and Newton are in this MLRA. Interstate Highways 70 and 135 meet in Salina, and Interstate 35 crosses the southern part of this area. Wilson and Kanopolis State Parks are in this area. McConnell Air Force Base is in the southern part of the area.

Physiography

The northwest half of this area is in the Plains Border Section of the Great Plains Province of the Interior Plains. The northeast corner is in the Dissected Till Plains Section of the Central Lowland Province of the Interior Plains, and the rest of the area is in the Osage Plains Section of the same province and division. This area is an undulating to hilly, dissected plain. Wide flood plains and terraces are along the larger rivers, and narrow bottom land is along the small streams. Elevation is generally 1,310 to 1,640 feet (400 to 500 meters), increasing from east to west. Local relief is typically 65 to 130 feet (20 to 40 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Smoky Hill (1026), 47 percent; Middle Arkansas (1103), 22 percent; Kansas (1027), 11 percent; Republican (1025), 10 percent; and Neosho-Verdigris (1107), 10 percent. The Little Arkansas River forms the southwestern border of this area. From north to south, other rivers that cross the area include the Little Blue, Big Blue, Republican, Solomon, Salt, Saline, Cottonwood, Walnut, and Arkansas Rivers. The Solomon and Saline Rivers join the Smoky Hill River just south of Salina.

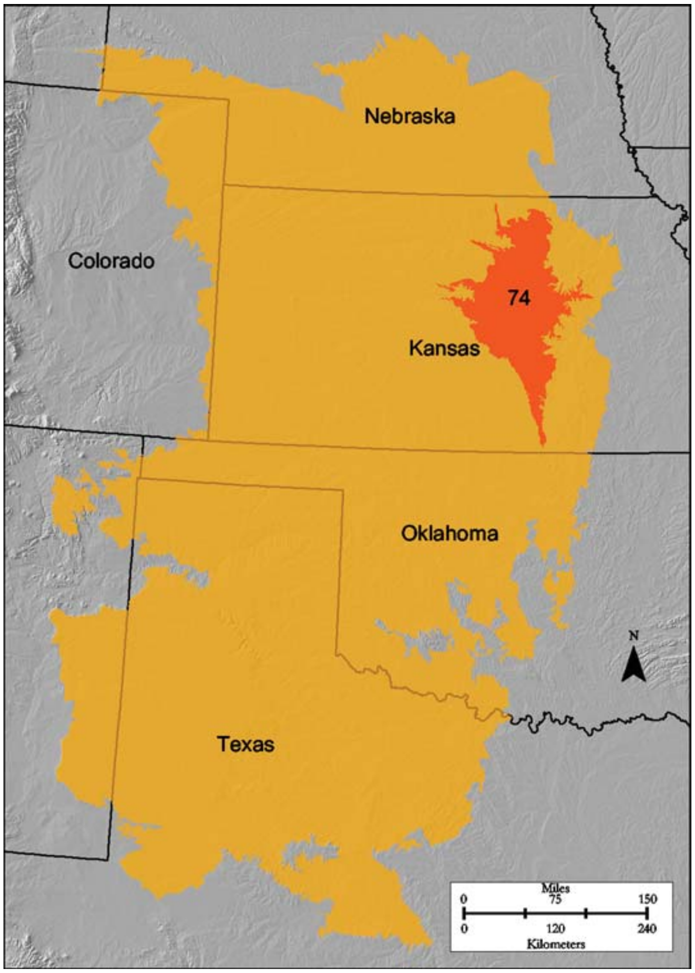

Figure 74-1: Location of MLRA 74 in Land Resource Region H.

Geology

This area is underlain by Cretaceous sandstone bedrock that dips gently to the east. The bedrock is exposed in a number of areas. Shale occurs in a few places. Loess deposits mantle the uplands, and deposits of unconsolidated sand and some gravel occur in the major stream and river valleys. The area south of central Kansas is underlain by unconsolidated sediments and Cretaceous-age soft sandstone and shale. The eastern edge of the area is underlain by Permian limestone deposits that form the Flint Hills region to the east.

Climate

The average annual precipitation in this area is 26 to 33 inches (660 to 840 millimeters). Most of the precipitation falls from spring through autumn, but the maximum is in midsummer. The rainfall typically occurs as high-intensity, convective thunderstorms. The annual snowfall averages almost 20 inches (50 centimeters). The average annual temperature is 52 to 56 degrees F (11 to 13 degrees C). The freeze-free period averages 200 days and ranges from 190 to 210 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 6.6%; ground water, 5.7%
Livestock—surface water, 0.3%; ground water, 4.2%
Irrigation—surface water, 70.8%; ground water, 0.5%
Other—surface water, 12.0%; ground water, 0.0%

The total withdrawals average 210 million gallons per day (795 million liters per day). About 10 percent is from ground water sources, and 90 percent is from surface water sources. If moisture is carefully conserved, the moderate precipitation generally is adequate for crops and pasture. The surface water is generally suitable for most uses with appropriate treatment. Water is stored in reservoirs outside this area for public supply, industry, and irrigation within this area. Some in-stream diversions also are used.

Ground water is adequate to meet domestic and livestock needs in most of the area and is used locally for irrigation, industry, and public supply. Most of the ground water used in this area is from the unconsolidated sediments in the valleys along the three large rivers that cross the area. The level of total dissolved solids is generally more than 500 and less than 1,000 parts per million (milligrams per liter). The water is very hard and requires softening when used to meet industry and domestic needs. As freshwater is removed, brine moving up into this aquifer from deeper marine sediments can increase the salinity of the water in the alluvial aquifer. The water can be contaminated mainly because of agricultural chemicals, irrigation return flows, and the production of oil and gas in the area. Municipal waste discharges and seepage and runoff from landfills are concerns around Salina.

Sandstone in the Great Plains aquifer is another source of rural and domestic water. Where it is close to the surface, the water in this aquifer is low in total dissolved solids. At depth, the levels of sulfate and chloride increase and the water becomes more saline and unsuitable for most uses. This water is very hard.

Ground water from the Chase and Council Grove aquifer is used for rural and domestic supply and some public supply. This water is very hard but is suitable for most uses. In some areas the levels of total dissolved solids and sulfate are high but do not limit use of the water. The water is briny on the western edge of the area. Ground water is scarce in areas where shale and clay are near the surface.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep, moderately well drained to somewhat excessively drained, and loamy or clayey. Haplustolls formed in residuum on uplands (Hedville series) and in alluvium on flood plains and stream terraces (Hord and Tobin series). Argiustolls formed in residuum on uplands (Edalgo, Lancaster, and Wells series) and in loess on uplands and stream terraces (Crete, Geary, Hastings, and Longford series).

Biological Resources

This area supports mid and tall grasses. Little bluestem, big bluestem, switchgrass, sideoats grama, and western wheatgrass are the major species.

Some of the major wildlife species in this area are white-tailed deer, cottontail, pheasant, prairie chicken, bobwhite quail, and mourning dove. The species of fish in the area include largemouth bass, bluegill, crappie, carp, channel catfish, flathead catfish, walleye, northern pike, white bass, and striped bass.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 52%
Grassland—private, 38%; Federal, 2%
Forest—private, 3%
Urban development—private, 3%
Water—private, 1%
Other—private, 1%

Most of this area is in farms. More than one-half of the area is cropland. Winter wheat is the principal crop. Other small grains, grain sorghum, hay, and corn also are important crops. Some areas along the large rivers are irrigated. The crops grown in nonirrigated areas also are grown in irrigated areas, but more corn and less wheat are grown in the irrigated areas. More than one-third of the area supports native grasses grazed by cattle.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and tilth of the soils, and soil moisture management. The resource concerns on pasture and rangeland are the productivity, health, and vigor of plants and the spread of noxious and invasive species.

Conservation practices on cropland generally include high-residue crops in the cropping system; systems of crop residue management, such as no-till and mulch-till; a combination of terraces and grassed waterways; contour farming; contour stripcropping; conservation crop rotations; and nutrient management. Conservation practices on rangeland generally include prescribed grazing, brush management, management of upland wildlife habitat, proper distribution of watering facilities, and control of noxious and invasive plant species. ■

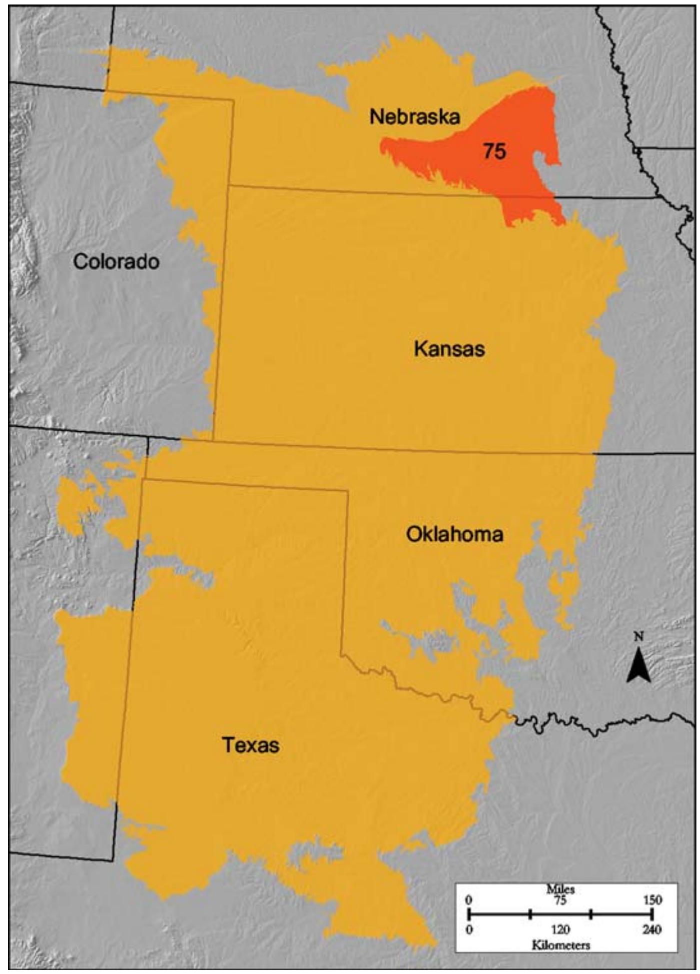

Figure 75-1: Location of MLRA 75 in Land Resource Region H.

75—Central Loess Plains

This area (shown in fig. 75-1) is in Nebraska (90 percent) and Kansas (10 percent). It makes up about 8,055 square miles (20,870 square kilometers). It includes the towns of Holdrege, Minden, Hastings, York, Seward, David City, Crete, and Fairbury, Nebraska, and Belleville, Kansas. Interstate 80 crosses the northeastern part of this area. Locally, much of the area south of the Platte River in Nebraska is called the “Rainwater Basin.”

Physiography

This area is in the Great Plains Province of the Interior Plains. The northern part, in Nebraska, is mostly in the High Plains Section of the province, and the part of the area along the Nebraska-Kansas border and in Kansas is in the Plains Border Section. This MLRA is an area of nearly level to gently rolling plains. Most of the stream valleys are narrow and are not deeply incised. The major river valleys are broader, and terraces are common. Elevation ranges from 1,650 to 1,970 feet (505 to 600 meters), increasing from east to west. Local relief is generally 10 to 25 feet (3 to 8 meters), but it can be 100 to 165 feet (30 to 50 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Kansas (1027), 77 percent; Republican (1025), 17 percent; and Platte (1020), 6 percent. The Platte River runs along the northern edge of this MLRA, in Nebraska. The Little Blue River crosses from Nebraska into the small part of this area in Kansas.

Geology

Most of this area is mantled by loess. The present drainage pattern cuts into the upper loess mantle and exposes the older Loveland loess in places. Quaternary sand and gravel deposits lie beneath the loess in Nebraska. Unconsolidated sediments lie beneath the loess in northern Kansas. Unconsolidated sand deposits are in the valleys along the major rivers and on the terraces along these rivers.

Climate

The average annual precipitation in this area is 23 to 36 inches (585 to 915 millimeters). The maximum precipitation occurs from the middle of spring to the middle of autumn. Most of the rainfall occurs as high-intensity, convective thunderstorms. The low winter precipitation occurs as snow. The average annual temperature is 50 to 58 degrees F (10 to 15 degrees C), increasing from north to south. The freeze-free period averages 195 days and ranges from 170 to 220 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 1.0%
Livestock—surface water, 0.1%; ground water, 0.4%
Irrigation—surface water, 25.4%; ground water, 66.5%
Other—surface water, 6.5%; ground water, 0.1%

The total withdrawals average 1,580 million gallons per day (5,980 million liters per day). About 68 percent is from ground water sources, and 32 percent is from surface water sources. The moderate, somewhat erratic precipitation is the source of water for grain crops, native grasses, and pasture. In the northwestern part of the area, the Platte River provides some water for irrigation. Reservoirs and in-stream diversions provide most of the water used in the part of this area in Kansas. The surface water is generally of good quality and requires minimal treatment for most uses.

Ground water that is hard but otherwise of good quality is abundant in the Quaternary sand and gravel in the High Plains aquifer underlying the part of this area in Nebraska. This is one of the most heavily used aquifers for irrigation water in Nebraska. The median level of total dissolved solids is 350 parts per million (milligrams per liter). Much of the recharge in this aquifer occurs from seepage beneath irrigated fields and directly from the Platte River. About 10 percent of the wells sampled in this aquifer exceeded the 10 parts per million (milligrams per liter) national drinking water standard for nitrate nitrogen. The median level of nitrogen in this aquifer is 2.4 parts per million (milligrams per liter). Ground water is scarce in areas where shale and clay are near the surface.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They generally are moderately deep to very deep, moderately well drained to somewhat poorly drained, and loamy or clayey. Haplustolls formed in residuum on uplands (Clime series), in loess on uplands (Kenesaw series), and in alluvium on stream terraces (Muir series). Argiustolls formed in loess (Crete, Geary, Holder, Holdrege, and Smolan series) and clayey sediments (Irwin and Ladysmith series) on uplands. Argiaquolls (Butler series) formed in mixed loess and alluvium on uplands and stream terraces. Ustifluvents (Hobbs series) formed in alluvium on flood plains.

Biological Resources

This area supports mid and tall grasses. Big bluestem, little bluestem, switchgrass, Indiangrass, and sideoats grama characterize the vegetation on silty soils in the uplands. These grasses and western wheatgrass are on bottom land and in upland basins.

Some of the major wildlife species in this area are white-tailed deer, badger, skunk, cottontail, tree squirrel, ground squirrel, pocket gopher, pheasant, and bobwhite quail.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 72%
Grassland—private, 18%; Federal, 1%
Forest—private, 2%
Urban development—private, 4%
Water—private, 1%
Other—private, 2%

Nearly all of this area is in farms. Almost three-fourths of the area is cropland. Hard winter wheat and grain sorghum are the main cash crops, but large acreages are planted to other small grains or to hay. Corn is a major cash crop in the northern part of the area. Most of the corn is irrigated by water from wells or canals. About one-fifth of the area is rangeland or pasture grazed by beef cattle.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and tilth of the soils, surface compaction, and soil moisture management. The resource concerns on pasture and rangeland are the productivity, health, and vigor of plants and the spread of noxious and invasive plant species.

Conservation practices on cropland generally include high-residue crops in the cropping system; systems of crop residue management, such as no-till and mulch-till; a combination of gradient terraces and grassed waterways; contour farming; contour stripcropping; and nutrient management. Conservation practices on rangeland generally include prescribed grazing, brush management, management of upland wildlife habitat, proper distribution of watering facilities, and control of noxious and invasive plant species. ■

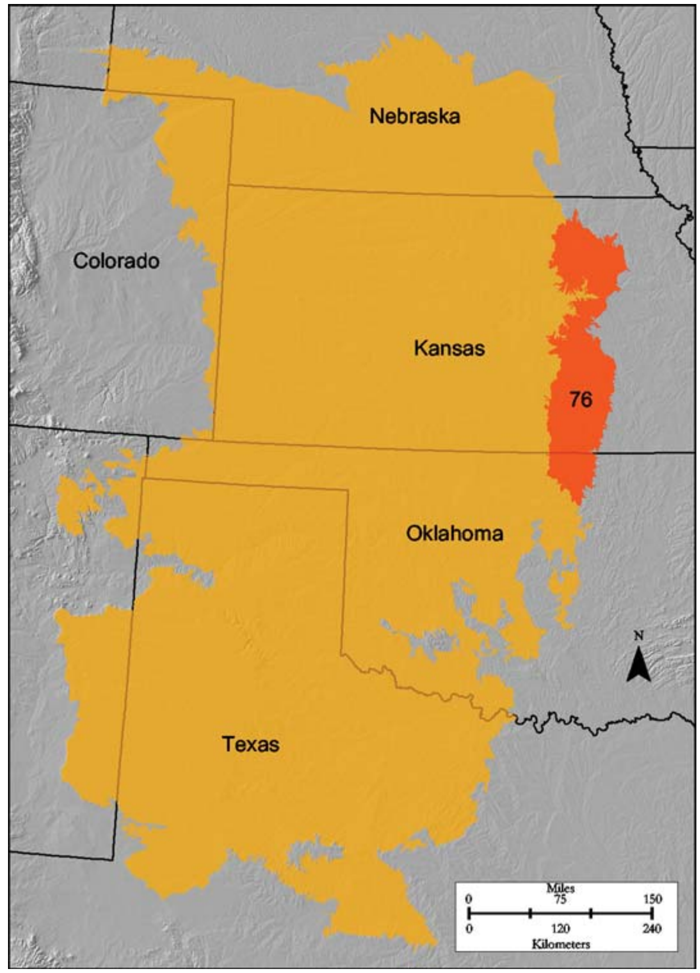

Figure 76-1: Location of MLRA 76 in Land Resource Region H.

76—Bluestem Hills

This area (shown in fig. 76-1) is in Kansas (84 percent) and Oklahoma (16 percent). It makes up about 7,555 square miles (19,585 square kilometers). The towns of Manhattan and El Dorado, Kansas, and Pawhuska, Oklahoma, are in this MLRA. The part of this area in Oklahoma lies between the towns of Ponca City and Bartlesville. Interstates 35 and 70 cross the part of the area in Kansas. The western edge of the Potawatomi Indian Reservation and the Fort Riley Military Base are in the part of the area in Kansas. Most of the Osage Indian Reservation in Oklahoma is in this area. The area is known as the “Flint Hills” in Kansas and the “Osage Hills” in Oklahoma.

Physiography

Most of this area is in the Osage Plains Section of the Central Lowland Province of the Interior Plains. The northern end of the area is in the Dissected Till Plains Section of the same province and division. The landscape consists of rolling hills and cuestas formed in dissected uplands that typically have narrow divides and narrow, steep-sided valleys where Pennsylvanian limestone bedrock is dominant. Stream valleys are less box-like (broader) where the dominant bedrock is shale. Significant flood plains occur only along a few large streams. Elevation ranges from 980 to 1,650 feet (300 to 505 meters). Local relief is generally 10 to 25 feet (3 to 8 meters), but it can be 100 to 165 feet (30 to 50 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Neosho-Verdigris (1107), 33 percent; Kansas (1027), 29 percent; Middle Arkansas (1103), 18 percent; Arkansas-Keystone (1106), 18 percent; and Republican (1025), 2 percent. The area has two large rivers. The Kansas River crosses the northern part of the area, and the Arkansas River runs along the southwestern edge. The smaller rivers that cross the area include the Vermillion, Mill, Neosho, Cottonwood, Fall, Verdigris, Grouse, Elk, Caney, and Bird Rivers.

Geology

The bedrock beneath this area is primarily Pennsylvanian and Permian shale and limestone. Chert (flint) in the limestone beds gives rise to the local name for this area in Kansas, the “Flint Hills.” The chert is much less erodible than the limestone, so the soils in the area become stony as the limestone erodes away, leaving the flint fragments. Mainly because of the stoniness, the prairie in this area generally has never been converted to cropland. The limestone beds beneath part of this area in Oklahoma are of Pennsylvanian age. Unconsolidated sand and gravel occur in river valleys and on terraces.

Climate

The average annual precipitation in this area is 31 to 38 inches (785 to 965 millimeters). The maximum precipitation occurs from the middle of spring through early autumn. Most of the rainfall occurs as high-intensity, convective thunderstorms. The annual snowfall averages 14 to 20 inches (35 to 50 centimeters). The average annual temperature is 52 to 60 degrees F (11 to 15 degrees C). The freeze-free period averages 210 days and ranges from 190 to 225 days, increasing in length to the south.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 12.9%; ground water, 10.2%
Livestock—surface water, 15.8%; ground water, 4.5%
Irrigation—surface water, 53.9%; ground water, 2.7%
Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average 35 million gallons per day (130 million liters per day). About 17 percent is from ground water sources, and 83 percent is from surface water sources. The moderate precipitation provides water for pastures and crops. Much of the water for livestock is stored in small reservoirs and ponds. A small area is irrigated with water from the Arkansas River in Oklahoma. The surface water is generally of good quality and is suitable for most uses.

Ground water is used for rural and domestic supplies and as livestock water. In the areas of limestone, shallow wells yield moderate quantities of good-quality water, but very little water is available in the areas underlain by shale. Water from deep wells is highly mineralized. Ground water from the Chase and Council Grove aquifer along the west side of this area, in Kansas, is very hard but is suitable for most uses. The levels of total dissolved solids and sulfate are high in some areas but do not limit use of the water.

Ground water is available in the unconsolidated sediments in the valleys along the Kansas and Arkansas Rivers in the area. The level of total dissolved solids generally is about 500 parts per million (milligrams per liter) in the valley along the Arkansas River and 500 to 1,000 parts per million (milligrams per liter) in the valley along the Kansas River. The water is very hard and requires softening if it is used for industry or domestic purposes. As freshwater is removed, brine moving up into this aquifer from deeper marine sediments can increase the salinity (the level of chlorides and sulfates) of the water in the alluvial aquifer. The water in the aquifer can be contaminated mainly because of agricultural chemicals, irrigation return flows, and the production of oil and gas in the area.

The Vamoosa-Ada aquifer occurs in the part of this area in Oklahoma. It has good-quality water that is suitable for drinking but is little used. Some parts of this aquifer have been contaminated because of past oil and gas exploration and production activities.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a mesic or thermic soil temperature regime, an ustic or udic soil moisture regime, and mixed or smectitic mineralogy. They are very shallow to very deep, moderately well drained to somewhat excessively drained, and generally loamy or clayey. Haplustolls (Clime, Shidler, and Sogn series) formed in residuum on uplands. Natrustolls (Dwight series) formed in clayey sediments on uplands. Argiustolls formed in residuum (Benfield, Foraker, Florence, and Labette series) and mixed colluvium and alluvium (Tully series) on uplands. Hapludolls (Ivan and Verdigris series) formed in alluvium on flood plains. Argiudolls (Martin and Summit series) formed in colluvium and/or residuum. Hapluderts (Apperson series) formed in shale residuum.

Biological Resources

This area supports tall prairie grasses. Big bluestem, Indiangrass, switchgrass, and little bluestem are the dominant species. Little bluestem and big bluestem grow on shallow soils. Very little of this area has been cultivated because of the abundance of cherty limestone near and on the surface. Thus, the MLRA has the last large intact areas of the tall grass ecosystem in the United States. It is a focal area for the preservation of this ecosystem.

Some of the major wildlife species in this area are white-tailed deer, coyote, fox, badger, beaver, raccoon, skunk, civet, opossum, muskrat, mink, great blue heron, prairie chicken, and bobwhite quail. The species of fish in the area include bass, walleye, catfish, bullhead, and carp.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 18%
Grassland—private, 69%; Federal, 3%
Forest—private, 4%
Urban development—private, 3%
Water—private, 2%
Other—private, 1%

Nearly all of this area is in farms or ranches. Nearly three-fourths of the area supports native grasses grazed by beef cattle. Nearly one-fifth of the area, consisting mainly of the deeper soils in valleys and on some of the uplands, is cropland. Some winter wheat is grown as a cash crop. Other small grains, grain sorghum, alfalfa, and other kinds of hay are the major crops. These crops are also grown in small irrigated areas along the Arkansas River.

The major soil resource concerns are water erosion, surface compaction, moisture conservation, and maintenance of the content of organic matter in the soils. Maintenance of plant health and vigor and control of noxious and invading plants are the major management concerns on grassland.

Conservation practices on cropland generally include terraces, grassed waterways, grade-control structures, conservation tillage, and nutrient and pest management. Conservation practices on rangeland generally include brush management, control of noxious weeds, nutrient management, and proper grazing management. ■

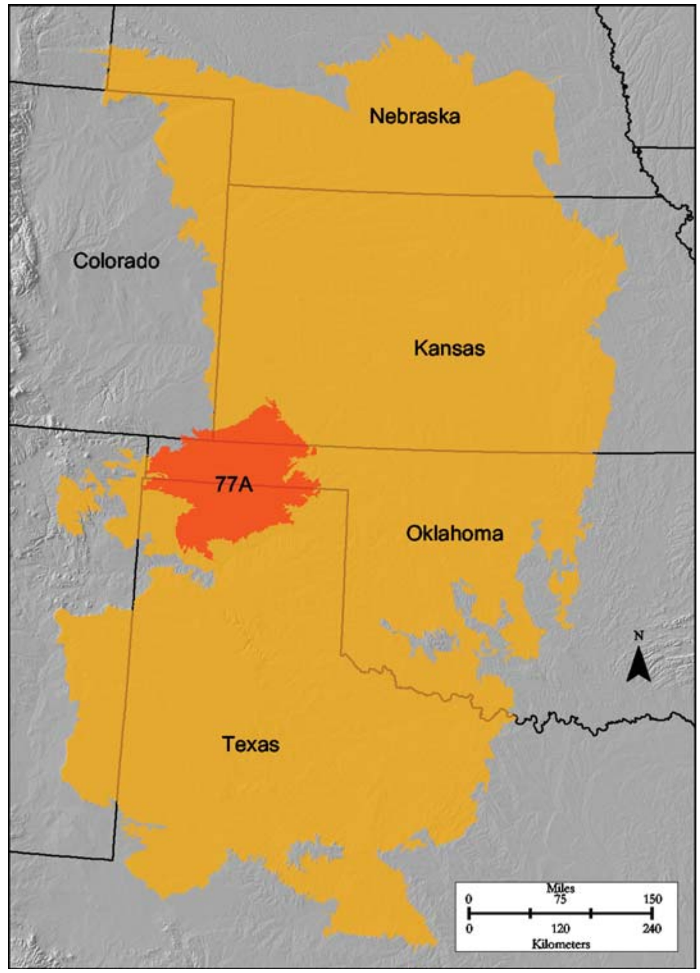

Figure 77A-1: Location of MLRA 77A in Land Resource Region H.

77A—Southern High Plains, Northern Part

This area (shown in fig. 77A-1) is in northwestern Texas (44 percent), the Oklahoma Panhandle (41 percent), southwestern Kansas (14 percent), and southeastern Colorado (1 percent). It makes up about 10,005 square miles (25,930 square kilometers). The towns of Dumas, Dalhart, Spearman, and Perryton, Texas, are in the southern part of this area. The towns of Elkhart, Hugoton, and Liberal, Kansas, are in the northern part. The towns of Boise City, Guymon, and Hooker, Oklahoma, are in the central part. The area has numerous U.S. highways but no interstate highways. Most of the Rita Blanca National Grassland is in the western part of this area, and more than half of the Cimarron National Grassland is in the northern part, in Kansas.

Physiography

This area is in the High Plains Section of the Great Plains Province of the Interior Plains. It is characterized by extensive areas of open plains on an elevated plateau. Numerous draws with moderate to very steep slopes and narrow flood plains are incised into the plateau and generally trend from southwest to northeast. The area has a number of interspersed playa basins ranging from 5 to more than 100 acres (2 to 40 hectares) in size. Elevation is 4,500 feet (1,370 meters) in the western part of the area and gradually decreases to 2,900 feet (885 meters) in the east-northeast part. The topographical relief is dominated by nearly level and very gentle slopes.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: North Canadian (1110), 74 percent; Upper Cimarron (1104), 22 percent; and Lower Canadian (1109), 4 percent. The area is bounded by the Cimarron River to the north, the Canadian Breaks to the south and east, and Rita Blanca Creek to the west.

Geology

The surface of this area is covered primarily by eolian loess and sand deposits of Holocene age. These deposits are underlain by sand and gravel of the Ogallala Formation of Miocene-Pliocene age. Unconsolidated sand and gravel deposits occur in the larger river valleys.

Climate

The average annual precipitation in this area is 15 to 22 inches (380 to 560 millimeters), fluctuating widely from year to year. Most of the rainfall occurs as high-intensity, convective thunderstorms during spring and fall. Most of the winter precipitation occurs as snow. The average annual temperature is 54 to 58 degrees F (12 to 14 degrees C). The freeze-free period averages 200 days and ranges from 185 to 215 days, increasing in length from north to south.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.3%; ground water, 1.0%
Livestock—surface water, 0.1%; ground water, 0.5%
Irrigation—surface water, 8.0%; ground water, 89.8%
Other—surface water, 0.0%; ground water, 0.3%

The total withdrawals average 1,445 million gallons per day (5,470 million liters per day). About 92 percent is from ground water sources, and 8 percent is from surface water sources. The moderately low, erratic precipitation is the source of water for dry-farmed crops and for range. The flow of the Canadian River and its tributaries fluctuates widely from year to year, and the water in these rivers is little used for irrigation. The water is slightly saline because of natural sources of salts and because of irrigation return flows from cropland irrigated with ground water.

Sand and gravel in the High Plains or Ogallala aquifer yield an abundance of ground water for irrigation and public supply. The water is very hard and has a median level of total dissolved solids that increases from 340 to 419 parts per million (milligrams per liter) from Kansas to Texas. The water table has dropped from historic levels because of the number of high-yield wells tapping this aquifer. In some areas the declining water table and rising energy costs have resulted in conversion from previously irrigated cropland to dry-farmed cropland. Alluvial and terrace deposits provide water for irrigation and domestic use in the part of this area in Oklahoma. This water is very similar in quality to the water in the High Plains aquifer, but it has a slightly higher median level of total dissolved solids.

Soils

The dominant soil orders in this area are Alfisols and Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy. They generally are very deep, well drained, and loamy. Paleustolls (Dumas, Gruver, and Sherm series) and Argiustolls (Belfon, Darrouzett, Hugoton, and Zella series) formed in loess on plains. Paleustolls formed in loamy material (Sunray and Texline series) and loess (Dallam and Dalhart series) on plains and in sandy eolian material on sandhills (Eva series). Haplustalfs (Bigbow and Canina series) formed in loess on plains. Calciustolls (Conlen series) formed in loess on ridges and side slopes adjacent to drainageways. Very shallow and shallow Calciustolls (Plack series) have a petrocalcic horizon and formed in loamy material in sloping areas. Haplusterts (Hansford and Lautz series) formed in lacustrine deposits on playa floors.

Biological Resources

This area dominantly supports short or mid prairie grasses. Nearly level plains dominated by fine textured soils are characterized by a plant community of short grasses with a few mid grasses. Blue grama and buffalograss are common; blue grama is the dominant species. On very gently sloping and gently sloping plains dominated by moderately fine textured soils, the plant community is characterized by short and mid grasses and sideoats grama is the dominant species. In areas of sandy soils on gently to moderately sloping plains and sandhills, the plant community is characterized by tall grasses. Little bluestem and sand bluestem make up nearly half of these tall grasses. The woody shrubs on sandy soils include sand sage and shin oak.

Some of the major wildlife species in this area are mule deer, white-tailed deer, coyote, badger, raccoon, skunk, jackrabbit, cottontail, turkey, pheasant, Canada goose, scaled quail, bobwhite quail, and mourning dove. The species of fish in the area include bass, bluegill, catfish, and bullhead.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 60%
Grassland—private, 32%; Federal, 5%
Urban development—private, 2%
Other—private, 1%

Farms and ranches make up nearly all of this area. About three-fifths of the area is cropland, which is used mainly for wheat, grain sorghum, corn, and soybeans. Almost two-fifths of the area is range or improved pasture. Confined animal-feeding operations, primarily for beef cattle and swine, are economically important in the area. In some areas beef cattle graze small grain pastures throughout the winter.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems that reduce the need for tillage), cover crops, windbreaks, vegetative wind barriers, wind stripcropping, and nutrient management. The dominant conservation practice on rangeland is prescribed grazing. Generally, cultural treatments are not used to increase forage production on the rangeland in this area. Haying commonly provides supplemental feed during the long winters. ■

77B—Southern High Plains, Northwestern Part

This area (shown in fig. 77B-1) is in northeastern New Mexico (64 percent), northwestern Texas (35 percent), and the Oklahoma Panhandle (1 percent). It makes up about 3,930 square miles (10,185 square kilometers). The towns of Perico, Corlena, Middle Water, and Ware, Texas, and Amistad, Clayton, Seneca, and Stead, New Mexico, are in this MLRA. U.S. Highways 56, 64, and 87 cross this area. The Kiowa and Rita Blanca National Grasslands are in the area.

Physiography

The eastern half of this area is in the High Plains Section of the Great Plains Province of the Interior Plains. The western half is in the Raton Section of the same province and division. This MLRA is characterized by extensive areas of open plains on an elevated plateau. Moderately steep escarpments border the plateau to the west. A few draws with moderate to steep slopes and narrow flood plains are incised into the plateau and generally trend from northwest to southeast. Elevation is 5,200 feet (1,585 meters) in the northwestern part of the area and gradually decreases to 3,800 feet (1,160 meters) in the southeastern part. The topographical relief is characterized by nearly level to gently sloping plains and gently sloping to strongly sloping sandhills.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Canadian (1109), 60 percent; Upper Canadian (1108), 26 percent; North Canadian (1110), 12 percent; and Upper Cimarron (1104), 2 percent. The area is bounded by Rita Blanca Creek to the north and east and the Canadian Breaks to the south.

Geology

The surface of this area is covered primarily by eolian sediments of the Blackwater Draw Formation and sandy eolian deposits of Holocene age. These deposits are underlain by sand and gravel of the Ogallala Formation of Miocene-Pliocene age. Unconsolidated sand and gravel deposits occur in the larger river valleys.

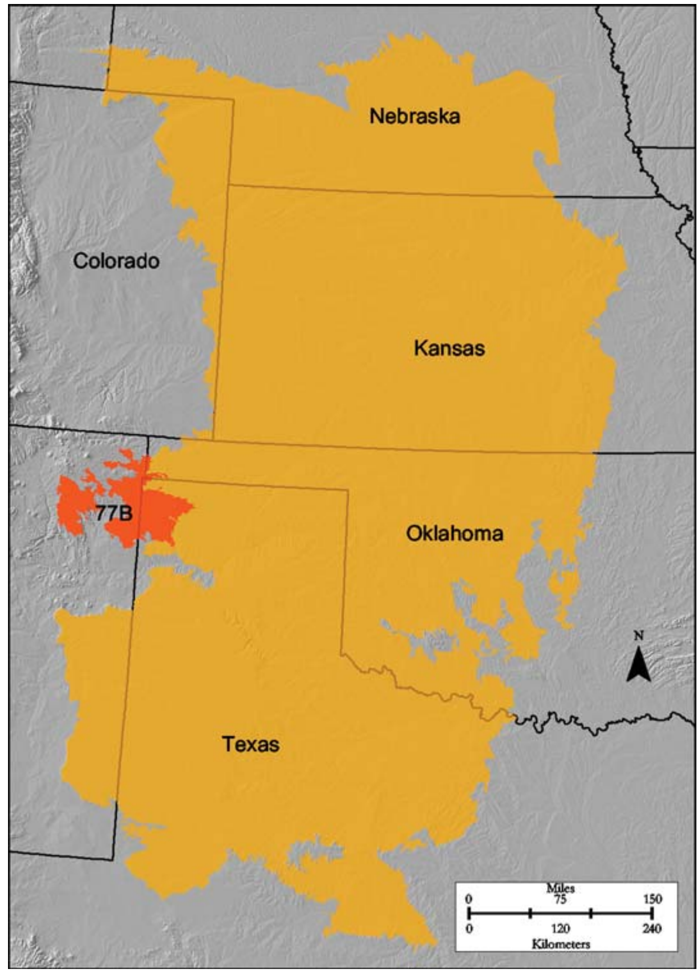

Figure 77B-1: Location of MLRA 77B in Land Resource Region H.

Climate

The average annual precipitation in this area is 14 to 18 inches (355 to 455 millimeters), fluctuating widely from year to year. Most of the rainfall occurs as high-intensity, convective thunderstorms during spring and fall. Most of the winter precipitation occurs as snow. The average annual temperature is 49 to 56 degrees F (10 to 14 degrees C). The freeze-free period averages 185 days and ranges from 165 to 205 days, increasing in length from north to south.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 0.1%; ground water, 0.1%
Irrigation—surface water, 31.7%; ground water, 68.1%
Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average 360 million gallons per day (1,360 million liters per day). About 68 percent is from ground water sources, and 32 percent is from surface water sources. The moderately low, erratic precipitation is the source of water for dry-farmed crops and for range. The flow in the tributaries of the Canadian River fluctuates widely from year to year, and the water in these tributaries is little used for irrigation. Reservoirs provide some surface water for irrigation. Most of the surface water in the area is slightly saline because of natural sources of salts and because of irrigation return flows from cropland irrigated with ground water.

Sand and gravel in the High Plains or Ogallala aquifer yield an abundance of ground water for irrigation, but the water table generally is gradually declining. This aquifer is called the Eastern New Mexico Basin Fill aquifer in the part of this area in New Mexico. The High Plains aquifer is not actually a basin fill deposit, but its water is so similar in quality to the water in other basin fill aquifers in New Mexico that it is lumped with them. The water is very hard and has a median level of total dissolved solids of 400 to 500 parts per million (milligrams per liter).

Soils

The dominant soil order in this area is Alfisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy. They generally are very deep, well drained, and loamy or sandy. Paleustalfs formed in loamy sediments on plains (Dallam, Perico, Rickmore, and Spurlock series) and in sandy eolian material on dunes and hummocks (Vingo series). Torripsamments (Valent series) formed on steep dunes.

Biological Resources

This area dominantly supports mid and tall prairie grasses. Nearly level to sloping plains and sandhills dominated by moderately fine textured to moderately coarse textured soils are characterized by a mixture of mid and tall grasses and a lesser amount of short grasses. On loamy soils, mid grasses are dominant and sideoats grama is the dominant species. Woody shrubs, particularly yucca, catclaw, and sand sage, make up 5 percent or less of the plant community. On sandy soils, nearly half of the grasses in the plant community are tall grasses, such as little bluestem and sand bluestem. Woody shrubs, specifically sand sage, shin oak, and skunkbush, make up 20 to 30 percent of the plant community.

Some of the major wildlife species in this area are mule deer, white-tailed deer, coyote, badger, raccoon, skunk, jackrabbit, cottontail, turkey, pheasant, Canada goose, scaled quail, bobwhite quail, and mourning dove. The species of fish in the area include bass, bluegill, catfish, and bullhead.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 30%
Grassland—private, 63%; Federal, 5%
Urban development—private, 1%
Other—private, 1%

Rangeland and cropland make up nearly all of this MLRA. About two-thirds of the area is used for grazing, and the beef cattle industry is economically important in the area. In some areas beef cattle graze small grain pastures throughout the winter. Almost one-third of the area is cropland. Most of the crops are irrigated. Corn is the principal irrigated crop. Wheat and grain sorghum also are grown in irrigated areas.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems that reduce the need for tillage), cover crops, windbreaks, vegetative wind barriers, wind stripcropping, and nutrient management. The most important conservation practice on rangeland is prescribed grazing. Generally, cultural treatments are not used to increase forage production on the rangeland in this area. Haying commonly provides supplemental feed during the long winters. ■

77C—Southern High Plains, Southern Part

This area (shown in fig. 77C-1) is in western Texas (90 percent) and eastern New Mexico (10 percent). It makes up about 20,955 square miles (54,300 square kilometers). The cities of Amarillo and Lubbock, Texas, and the towns of Brownfield, Floydada, Hereford, Lamesa, Levelland, Littlefield, Muleshoe, and Plainview, Texas, and Clovis, Grady, and Portales, New Mexico, are in this MLRA. Interstate 40 crosses the northern end of this area, and Interstate 27 connects Amarillo and Lubbock, Texas. The Cannon Air Force Base is in the part of the area in New Mexico, and the Reese and Webb Air Force Bases are in the part in Texas. The area has a number of national wildlife refuges.

Physiography

This area is in the High Plains Section of the Great Plains Province of the Interior Plains. It is characterized by extensive areas of open plains on a distinct elevated plateau. The area is

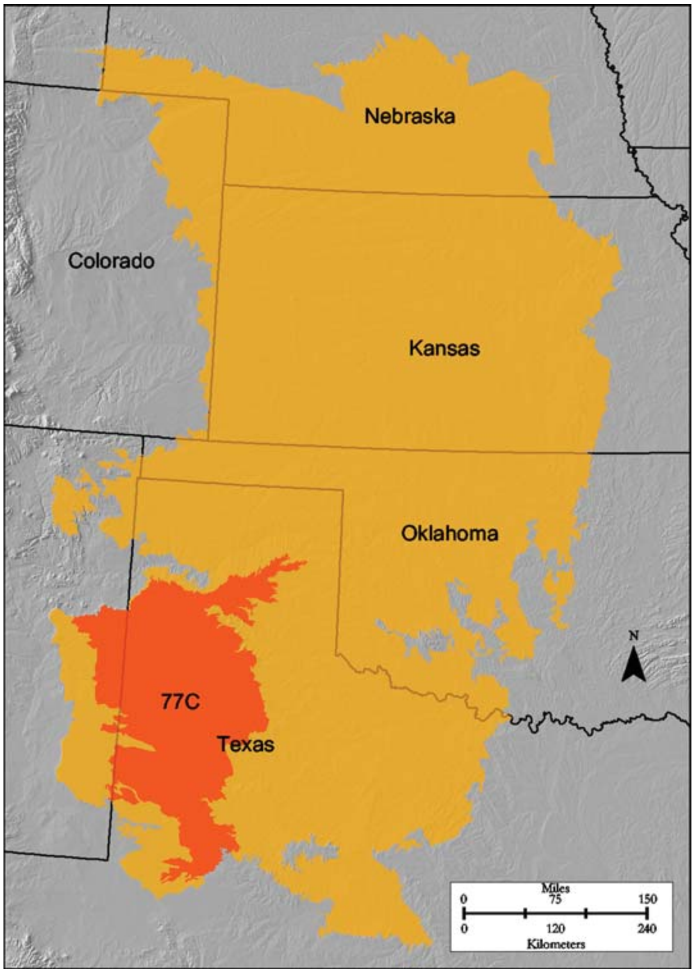

Figure 77C-1: Location of MLRA 77C in Land Resource Region H.

bounded by the Canadian Breaks to the north, steep escarpments overlooking the Rolling Red Plains to the east, and the Edwards Plateau to the south. To the west, the plains grade indiscernibly into the Southern High Plains, Southwestern Part (MLRA 77D). A few draws with moderate to steep slopes and very narrow flood plains are incised into the plateau and trend generally from northwest to southeast. Numerous playa basins ranging from 5 to 160 acres (2 to 65 hectares) in size dot the landscape. Elevation is 4,600 feet (1,400 meters) in the northwestern part of the area and gradually decreases to 2,600 feet (795 meters) in the southeastern part. The topographical relief is dominated by nearly level and very gentle slopes.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Brazos Headwaters (1205), 44 percent; Red Headwaters (1112), 28 percent; Upper Colorado (1208), 22 percent; Red-Washita (1113), 4 percent; and Lower Canadian (1109), 2 percent. A few streams in the northern part of this area drain to the north into the Canadian River, which is outside this area. Many headwater streams of the Red River are in this area, and some of the headwaters of the Brazos and Colorado Rivers are in the southern part of the area.

Geology

The surface of this area is covered primarily by eolian deposits in the Blackwater Draw Formation of Pleistocene age. Lacustrine deposits of dolomite with interbedded clastic sediments are both laterally extensive where they are of Pliocene age (Blanco Formation) and more local where they are of Pleistocene age (Tule, Double Lakes, and Tahoka Formations). Locally, draws inset alluvial deposits in the Ogallala Formation of Miocene-Pliocene age.

Climate

The average annual precipitation in this area is 16 to 22 inches (405 to 560 millimeters), fluctuating widely from year to year. Most of the rainfall occurs as high-intensity, convective thunderstorms during late spring and early fall. The average annual temperature is 55 to 63 degrees F (13 to 17 degrees C). The freeze-free period averages 225 days and ranges from 195 to 255 days, increasing in length from north to south.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 1.1%; ground water, 1.2%
Livestock—surface water, 0.1%; ground water, 0.2%
Irrigation—surface water, 20.4%; ground water, 76.1%
Other—surface water, 0.7%; ground water, 0.3%

The total withdrawals average 3,800 million gallons per day (14,385 million liters per day). About 78 percent is from ground water sources, and 22 percent is from surface water sources. The moderately low, erratic precipitation is the source of water for dry-farmed crops and for range. Few perennial streams are in the area. Their flow fluctuates widely from year to year, and their water is little used for irrigation. The headwaters of both the Brazos and Colorado Rivers receive high salt loads from natural sources downstream from this area.

Irrigation water is obtained from wells in the High Plains or Ogallala aquifer, but withdrawals exceed recharge and the water table is gradually declining. In some areas the declining water table and increasing energy costs have resulted in the conversion of previously irrigated cropland to dry-farmed cropland. The High Plains aquifer is called the Eastern New Mexico Basin Fill aquifer in the part of this area in New Mexico. The High Plains aquifer is not actually a basin fill deposit, but its water is so similar in quality to that of other basin fill aquifers in New Mexico that it is lumped with them. The ground water in this area is very hard and has a median level of total dissolved solids of 400 to 500 parts per million (milligrams per liter).

Soils

The dominant soil orders in this MLRA are Alfisols, Inceptisols, Mollisols, and Vertisols. The soils in the area dominantly have a thermic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy. They generally are moderately deep to very deep, well drained, and clayey, loamy, or sandy.

Paleustalfs (Amarillo and Arvana series) formed in loamy eolian sediments (Amarillo series) and sandy eolian sediments (Brownfield, Patricia, and Plains series) on nearly level to gently sloping plains. They also formed in loamy eolian sediments on nearly level to very gently sloping plains and the side slopes of drainageways and playa basins (Posey series). Haplustalfs formed in loamy eolian sediments (Tokio series) and sandy eolian sediments (Yoakran series) on nearly level to gently sloping plains. Calciustepts formed in loamy eolian sediments on nearly level to gently sloping plains or playa steps within playa basins (Arch and Gomez series), on dunes on the margins of playa basins (Drake series), and on plains and the side slopes of drainageways and playa basins (Midessa series). Ustipsamments (Nutivoli series) formed in sandy eolian sediments on dunes. Haplusterts (Chapel, Lazbuddie, Lockney, McLean, Ranco, Randall, and Sparenberg series) formed in clayey lacustrine deposits on playa floors within playa basins.

Paleustolls (Acuff, Friona, Olton, Pantex, and Pullman series) formed in loamy and clayey eolian sediments on plains. They also formed in mixed alluvium and eolian sediments (Estacado series) and in loamy eolian sediments (Mansker series) on plains and shoulder slopes along drainageways and in playa basins. Calciustolls formed in loamy eolian sediments (Pep series) and in lacustrine deposits (Portales series) on plains and the side slopes of drainageways and playa basins.

Biological Resources

The northeastern part of this area supports dominantly short and mid prairie grasses and sparse trees and shrubs. Fine textured soils on broad, nearly level plains support a plant community of short grasses and a few mid grasses. The most common species are blue grama and buffalograss; blue grama is dominant. In areas of moderately fine textured soils on very gently to moderately sloping plains, the plant community consists of mixed short and mid grasses and sideoats grama is the dominant species.

The southwestern part of this area primarily supports mixed prairie grasses and sparse trees and shrubs. Moderately fine textured and moderately coarse textured soils on nearly level to gently sloping plains and gently to strongly sloping sandhills are characterized by a mixture of tall and mid grasses and lesser amounts of short grasses. On loamy soils, mid grasses tend to dominate and sideoats grama is the dominant species. Woody shrubs, particularly yucca, catclaw, and sand sage, make up 5 percent or less of the plant community. On sandy soils, nearly half of the grasses in the plant community are tall grasses, such as little bluestem and sand bluestem. Woody shrubs, specifically sand sage, shin oak, and skunkbush, make up 20 to 30 percent of the plant community on the sandy soils.

Some of the major wildlife species in this area are mule deer, white-tailed deer, coyote, badger, raccoon, skunk, jackrabbit, cottontail, turkey, pheasant, Canada goose, scaled quail, bobwhite quail, and mourning dove. The species of fish in the area include bass, bluegill, catfish, and bullhead.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 73%
Grassland—private, 23%
Urban development—private, 3%
Other—private, 1%

Farmland makes up nearly all of this area. It is mainly cropland. A lesser percentage of the farmland consists of rangeland, improved pasture, and wildlife habitat, primarily in the southern and western parts of the area. The principal crops are wheat, grain sorghum, and corn in the northern part of the area and cotton, grain sorghum, and peanuts in the southern part. Minor crops include soybeans, sunflowers, alfalfa hay, and forage sorghum. Confined animal-feeding operations, primarily for beef cattle, are economically important in the area. In some areas beef cattle graze small grain pastures throughout the winter.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems that reduce the need for tillage), cover crops, windbreaks, vegetative wind barriers, wind stripcropping, and nutrient management. The most important conservation practice on rangeland is prescribed grazing. Generally, cultural treatments are not used to increase forage production on the rangeland in this area. Haying commonly provides supplemental feed during the long winters. ■

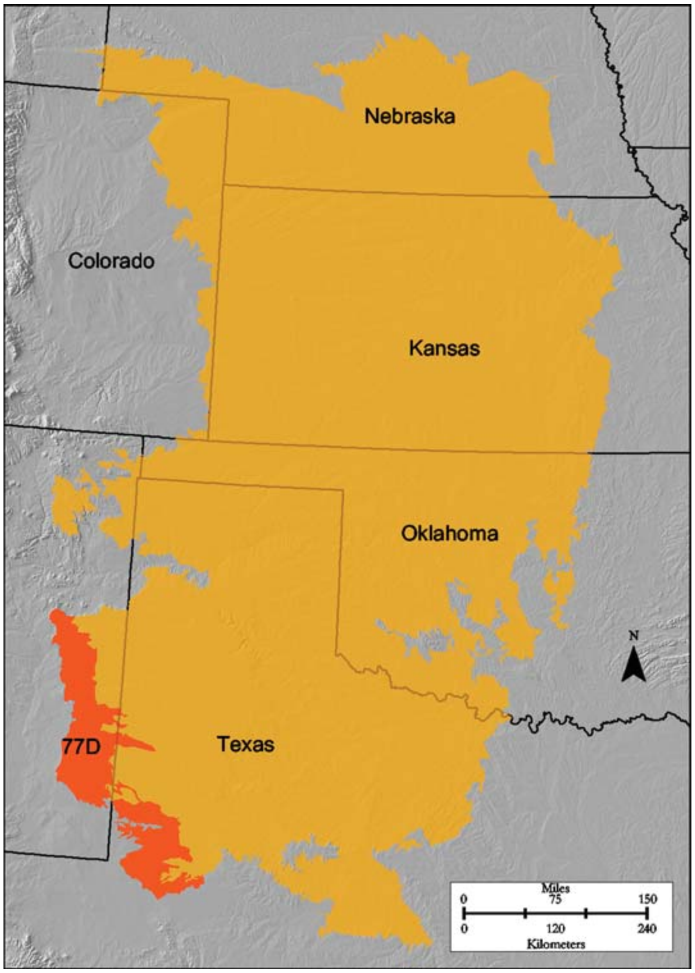

Figure 77D-1: Location of MLRA 77D in Land Resource Region H.

77D—Southern High Plains, Southwestern Part

This area (shown in fig. 77D-1) is in southeastern New Mexico (52 percent) and western Texas (48 percent). It makes up about 9,905 square miles (25,665 square kilometers). The towns of Crossroads, House, Lovington, McAlister, Melrose, and Tatum, New Mexico, and the cities or towns of Midland, Odessa, Andrews, and Gardendale, Texas, are in this MLRA. Interstate 20 crosses the southern tip of this area, in Texas. The Melrose Bombing Range Military Reservation is in the north end of this area, in New Mexico.

Physiography

This area is in the High Plains Section of the Great Plains Province of the Interior Plains. It is characterized by large areas of open plains on an elevated plateau. The area is bounded by steep escarpments to the west and by the Canadian Breaks to the north. The Pecos Valley lies below the escarpments. A small number of draws with moderate to steep slopes and very narrow flood plains are incised into the plateau and trend generally from northwest to southeast. The area has some interspersed playa basins ranging from 5 to more than 100 acres (2 to 40 hectares) in size. Elevation is 5,200 feet (1,585 meters) in the northwestern part of the area and gradually decreases to 2,800 feet (855 meters) in the southeastern part. The topographical relief is characterized by nearly level to gently sloping plains and gently sloping to strongly sloping sandhills.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Colorado (1208), 72 percent; Brazos Headwaters (1205), 13 percent; Upper Pecos (1306), 10 percent; and Lower Pecos (1307), 5 percent. Some headwater streams of the Colorado and Concho Rivers cross the part of this area in Texas. No large rivers are in the part in New Mexico. A few headwater tributaries of the Brazos River occur in the northern end of the area.

Geology

The surface of this area is covered primarily by eolian sediments in the Blackwater Draw Formation of Pleistocene age and sand sheets and dunes of Quaternary age. It is underlain by sand and gravel of the Miocene-Pliocene Ogallala Formation. Thin alluvial deposits are in the few large river valleys in the area.

Climate

The average annual precipitation in this area is 13 to 19 inches (330 to 485 millimeters), fluctuating widely from year to year. Most of the rainfall occurs as high-intensity, convective thunderstorms during spring and fall. For the most part, winter precipitation occurs as light snow and rainfall. The average annual temperature is 55 to 64 degrees F (13 to 18 degrees C). The freeze-free period averages 220 days and ranges from 190 to 250 days, increasing in length from north to south.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 2.2%; ground water, 3.0%
Livestock—surface water, 0.1%; ground water, 0.3%
Irrigation—surface water, 25.7%; ground water, 52.2%
Other—surface water, 11.0%; ground water, 5.5%

The total withdrawals average 1,090 million gallons per day (4,125 million liters per day). About 61 percent is from ground water sources, and 39 percent is from surface water sources. The headwaters of the Colorado and Concho Rivers receive high salt loads from natural sources in this area. These rivers flow into reservoirs to the east of this area, where the salinity levels are diluted by fresher runoff, which makes the water usable.

Irrigation water is obtained from wells in the High Plains or Ogallala aquifer, but withdrawals exceed recharge and the water table is gradually declining. Some areas that formerly were irrigated are now dry-farmed. The High Plains aquifer is called the Eastern New Mexico Basin Fill aquifer in the part of this area in New Mexico. The High Plains aquifer is not actually a basin fill deposit, but its water is so similar in quality to the water in other basin fill aquifers in New Mexico that it is lumped with them. The ground water in this area is very hard and has a median level of total dissolved solids of 400 to 500 parts per million (milligrams per liter).

Soils

The dominant soil orders in this MLRA are Aridisols and Entisols. The soils in the area dominantly have a thermic soil temperature regime, an aridic soil moisture regime, and mixed or siliceous mineralogy. They are very shallow to very deep, well drained, and generally loamy or sandy. Paleargids (Arizer and Sparks series) formed in alluvium on plains. Haplargids (Spantara and Triomas series) formed in sandy eolian and alluvial deposits on plains. Calciargids (Amarose series) formed in loamy eolian material on plains. Petrocalcids (Blakeney, Conger, Douro, and Kimbrough series) formed in loamy material on plains, divides, and ridges. Torripsamments (Penwell series) and Ustipsamments (Milsand series) formed in sandy eolian deposits on plains and dunes. Endoaquepts (Grier series) formed in alluvium on playa steps within playa basins.

Biological Resources

The northeastern part of this area dominantly supports short and mid prairie grasses. Broad, nearly level plains dominated by fine textured soils are characterized by a plant community of short grasses with a few mid grasses. The most common species are blue grama and buffalograss; blue grama is dominant. In areas of moderately fine textured soils on very gently sloping to moderately sloping plains, the plant community is characterized by a mixture of short and mid grasses and sideoats grama is the dominant species.

The southwestern part of this area dominantly supports mixed prairie grasses. This part of the area is on nearly level to gently sloping plains and gently sloping to strongly sloping sandhills. The moderately fine textured and moderately coarse textured soils are characterized by a mixture of mid and tall grasses and lesser amounts of short grasses. On loamy soils, mid grasses tend to dominate and sideoats grama is the dominant species.

Woody shrubs, particularly yucca, catclaw, and sand sage, make up 5 percent or less of the plant community. On sandy soils, nearly half of the grasses in the plant community are tall grasses, such as little bluestem and sand bluestem. Woody shrubs, specifically sand sage, shin oak, and skunkbush, make up 20 to 30 percent of the plant community on the sandy soils.

Some of the major wildlife species in this area are mule deer, white-tailed deer, coyote, badger, raccoon, skunk, jackrabbit, cottontail, turkey, pheasant, Canada goose, scaled quail, bobwhite quail, and mourning dove. The species of fish in the area include bass, bluegill, catfish, and bullhead.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 22%
Grassland—private, 72%; Federal, 1%
Urban development—private, 4%
Other—private, 1%

Farms and ranches make up nearly all of this area. Almost three-fourths of the area is rangeland. The beef cattle industry is economically important in the area. In some areas beef cattle graze small grain pastures throughout the winter. Almost one-fourth of the area is cropland. Nearly two-thirds of the cropland is irrigated. Cotton, wheat, grain sorghum, and alfalfa hay are the principal crops.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems that reduce the need for tillage), cover crops, windbreaks, vegetative wind barriers, wind stripcropping, and nutrient management. The most important conservation practice on rangeland is prescribed grazing. Generally, cultural treatments are not used to increase forage production on the rangeland in this area. Haying commonly provides supplemental feed during the long winters. ■

77E—Southern High Plains, Breaks

This area (shown in fig. 77E-1) is in western Texas (69 percent), northwestern Oklahoma (21 percent), and southwestern Kansas (10 percent). It makes up 10,320 square miles (26,735 square kilometers). It includes the towns of Borger, Channing, Follett, Fritch, and Stinnett, Texas; Fargo, Beaver, Laverne, Shattuck, and Slapout, Oklahoma; and Meade, Kansas. Numerous U.S. highways cross this area. The McClellan Creek National Grassland, Alibates Flint Quarries National Monument, and Lake Meredith National Recreational Area are in this MLRA.

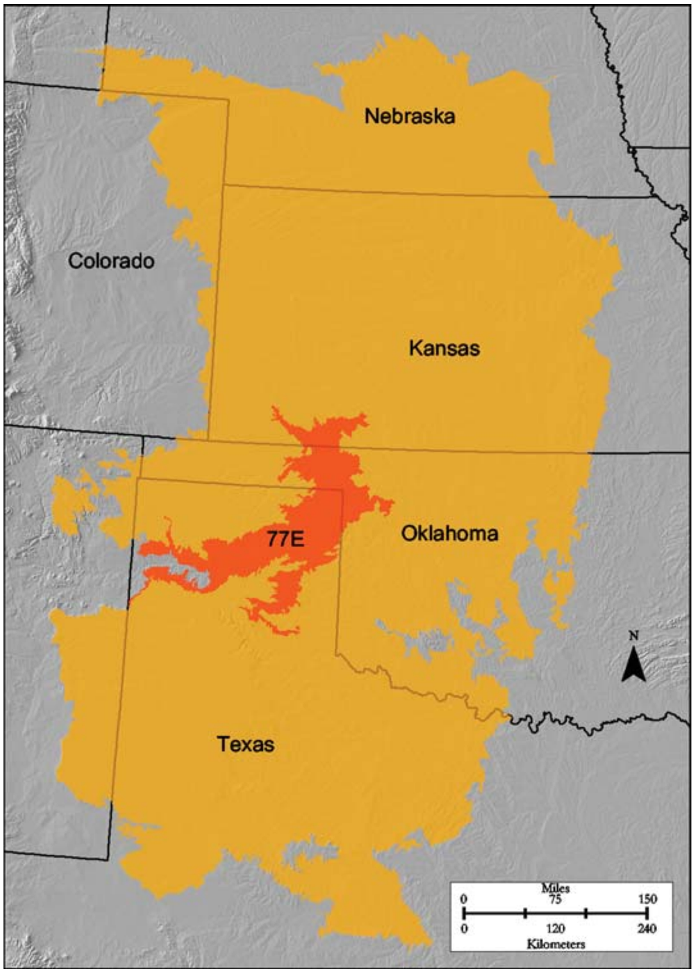

Figure 77E-1: Location of MLRA 77E in Land Resource Region H.

Physiography

Most of this area is in the High Plains Section of the Great Plains Province of the Interior Plains. The northeast quarter of the area is in the Plains Border Section of the same province and division. This MLRA is characterized by very steep escarpments, very gently sloping to moderately sloping plains, strongly sloping hills and ridges, and integrated drainage networks along the Canadian and Beaver Rivers. The area has undulating to hilly topography and well developed, dendritic drainage systems. Elevation ranges from 2,200 feet (670 meters) in the southeastern part of the area to 4,800 feet (1,465 meters) in the northwestern part.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Canadian (1109), 43 percent; North Canadian (1110), 28 percent; Upper Cimarron (1104), 13 percent; Red Headwaters (1112), 12 percent; and Red-Washita (1113), 4 percent. The Canadian, Beaver, and Cimarron Rivers drain this area.

Geology

The surface of this area is covered primarily by loamy and sandy sediments of the Ogallala Formation of Miocene-Pliocene age. Unconsolidated sand and gravel deposits occur in the larger river valleys.

Climate

The average annual precipitation in this area is 16 to 25 inches (405 to 635 millimeters), fluctuating widely from year to year. Most of the rainfall occurs as high-intensity, convective thunderstorms during spring and fall. Winter precipitation occurs mainly as snow. The average annual temperature is 55 to 60 degrees F (13 to 16 degrees C). The freeze-free period averages 215 days and ranges from 195 to 235 days, increasing in length from north to south.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 3.1%; ground water, 4.3%
Livestock—surface water, 0.7%; ground water, 1.6%
Irrigation—surface water, 20.2%; ground water, 67.7%
Other—surface water, 1.2%; ground water, 1.2%

The total withdrawals average 420 million gallons per day (1,590 million liters per day). About 75 percent is from ground water sources, and 25 percent is from surface water sources. The moderately low, erratic precipitation is the source of water for dry-farmed crops and for range. The flow in the Canadian River and its tributaries fluctuates widely from year to year, and the water in these rivers is little used for irrigation. Reservoirs provide some surface water for irrigation and for municipal and industrial uses. A large reservoir on the Canadian River, Lake Meredith, provides water for municipal and industrial uses in Amarillo. Also, it provides water to cities in MLRAs to the south via the Canadian River Aqueduct. Most of the surface water in the area is slightly saline because of natural sources of salts and because of irrigation return flows from cropland irrigated with ground water.

Sand and gravel in the High Plains or Ogallala aquifer yield an abundance of ground water for irrigation and public supply. The water is very hard and has a median level of total dissolved solids that increases from 340 to 419 parts per million (milligrams per liter) from Kansas to Texas. The water table has dropped from historic levels because of the number of high-yield wells tapping this aquifer. Alluvial and terrace deposits in Oklahoma provide water for irrigation and domestic use in this area. This water is very similar in quality to the water in the High Plains aquifer, but it has a slightly higher median level of total dissolved solids.

Soils

The dominant soil orders in this MLRA are Alfisols, Inceptisols, and Mollisols. The soils in the area dominantly have a thermic soil temperature regime, an ustic soil moisture regime, and mixed or carbonatic mineralogy. They are shallow to very deep, well drained, and generally loamy or sandy.

Argiustolls (Alibates series), Paleustolls (Manson series), Paleustalfs (Plemons series), and Haplustalfs (Ady series) formed in loamy sediments on plains. Argiustolls also formed in old alluvium on plains (Abbie and Irene series) and in loamy material on stream terraces (Texroy series). Haplustolls formed in alluvium on flood plains (Bippus and Sprone series) and in mixed alluvium and colluvium on backslopes and footslopes on escarpments and hillslopes (Paloduro series). Calciustolls formed in sandy and gravelly old alluvium on knobs and hillslopes (Tascosa series), in older loamy alluvium on hillslopes (Mansic and Oklark series), and in weathered caliche on plains (Laverne series). Haplustepts formed in alluvium on hillslopes (Berda and Mobeetie series) and in coarse-textured sediments on flood plains (Guadalupe series). Calciustepts (Veal series) formed in mixed alluvium and colluvium on backslopes and footslopes on escarpments and hillslopes. Haplocalcids (Potter series) formed in weathered caliche on hills, ridges, and escarpments. Ustipsamments (Jester and Likes series) formed in wind-reworked sandy alluvium on dunes.

Biological Resources

This area supports mixed prairie grasses and a lesser amount of woody species, including yucca, pricklypear, sand sagebrush, winterfat, and hackberry. Cottonwood and western soapberry are along major stream channels. On very gently to moderately sloping plains dominated by fine textured soils, the plant community consists of short grasses and a few mid grasses. The most common species are blue grama and buffalograss, and blue grama is the dominant species. Fine textured to coarse textured soils on strongly sloping hills, ridges, or scarp slopes support a mixture of tall and mid grasses and a lesser amount of short grasses. In strongly sloping areas of loamy, calcareous soils, mid grasses tend to dominate and sideoats grama is the dominant species. Woody shrubs, particularly yucca, catclaw, and sand sage, make up a minor percentage of the plant community. On sandy soils, nearly half of the grasses in the plant community are tall grasses, such as little bluestem and sand bluestem. Woody shrubs, specifically sand sage, shin oak, and skunkbush, make up about one-fourth of the plant community on the sandy soils.

Some of the major wildlife species in this area are mule deer, white-tailed deer, coyote, badger, raccoon, skunk, jackrabbit, cottontail, turkey, pheasant, Canada goose, scaled quail, bobwhite quail, and mourning dove. The species of fish in the area include bass, bluegill, catfish, and bullhead.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 14%
Grassland—private, 82%; Federal, 1%
Urban development—private, 2%
Water—private, 1%

Farms and ranches make up nearly all of this area. Most of the area is used for ranching, and the beef cattle industry is economically important in the area. In some areas beef cattle graze small grain pastures throughout the winter. The cropland in this MLRA is primarily in the northeastern part of the area. Wheat, grain sorghum, and hay are the principal crops. The crops are grown mainly on nonirrigated land, but a small percentage of the cropland is irrigated.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems that reduce the need for tillage), cover crops, windbreaks, vegetative wind barriers, wind stripcropping, and nutrient management. The most important conservation practice on rangeland is prescribed grazing. Generally, cultural treatments are not used to increase forage production on the rangeland in this area. Haying commonly provides supplemental feed during the long winters. ■

78A—Rolling Limestone Prairie

This area is in north-central Texas (fig. 78A-1). It makes up about 4,750 square miles (12,310 square kilometers). The towns of Throckmorton, Albany, Baird, Coleman, and Paint Rock are in this area. Interstate 20 cuts through the middle of the area.

Physiography

The northern part of this area is in the Osage Plains Section of the Central Lowland Province of the Interior Plains. The southern part is in the Central Texas Section of the Great Plains Province of the Interior Plains. This MLRA is on a moderately dissected, rolling plain with prominent ridges and valleys and stream terraces associated with incised river systems. The rolling landscape developed over interbedded limestones and shales. Limestone outcrops form escarpments and cuestas, and limestone surface fragments cover colluvium on the adjacent side slopes. Very deep, clayey soils are common in the valleys, most of which are underlain by shale. Elevation ranges from 2,280 feet (695 meters) in the southwestern part of the area to 1,220 feet (370 meters) in the northeastern part. Maximum local

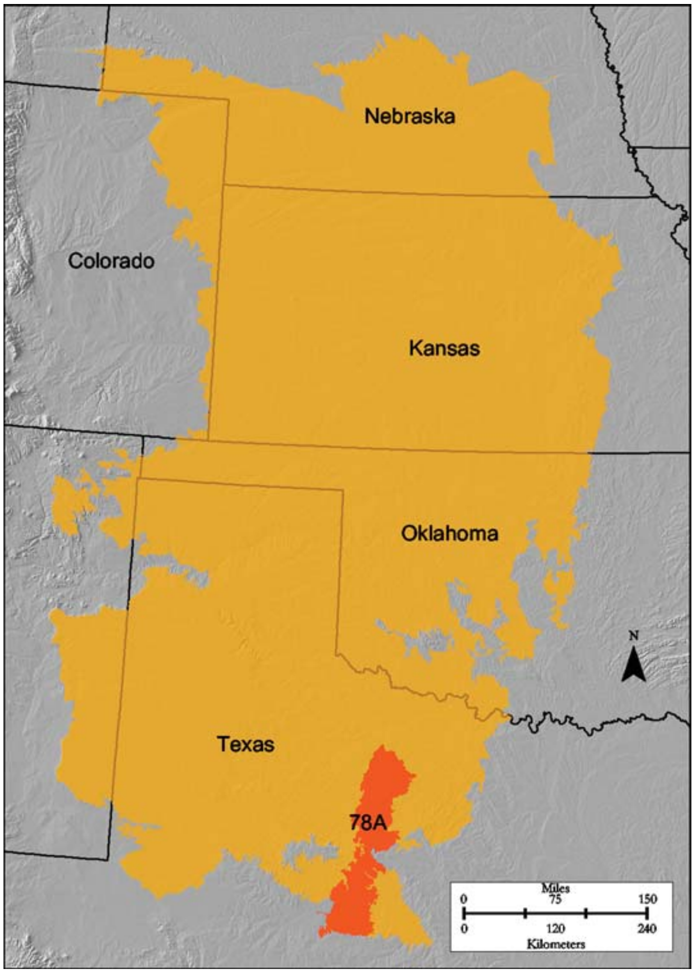

Figure 78A-1: Location of MLRA 78A in Land Resource Region H.

relief is about 165 feet (50 meters), and the average local relief is about 15 feet (5 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Middle Brazos (1206), 53 percent; Lower Colorado-San Bernard Coastal (1209), 46 percent; and Red-Washita (1113), 1 percent. Tributaries of the Brazos River are in the northern end of this area, and the Colorado River cuts across the southern end.

Geology

This area is underlain by interbedded light gray and white limestones and gray shales of Permian age. Geologic erosion has produced a subdued, terraced landscape. Prominent limestone scarps that are 15 to 85 feet (5 to 25 meters) high are common throughout the area. Stones and boulders are embedded in soils that formed on colluvial slopes below fractured limestone outcrops. Sandy and loamy stream terrace deposits are associated with streams that generally flow from northwest to southeast. Erosional remnants of older stream terraces are on uplands. Limestone and caliche quarries provide road material in this area. Oil and gas production is important in some areas.

Climate

The average annual precipitation in this area is 23 to 29 inches (585 to 735 millimeters). Most of the rainfall occurs as convective thunderstorms during the growing season. Precipitation in winter occurs as snow. The average annual snowfall is about 4 inches (10 centimeters). The average annual temperature is 63 to 66 degrees F (17 to 19 degrees C). The freeze-free period averages 250 days and ranges from 240 to 265 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 4.6%; ground water, 3.1%
Livestock—surface water, 2.8%; ground water, 0.7%
Irrigation—surface water, 67.8%; ground water, 18.5%
Other—surface water, 1.2%; ground water, 1.2%

The total withdrawals average 80 million gallons per day (300 million liters per day). About 24 percent is from ground water sources, and 76 percent is from surface water sources. The moderate, somewhat erratic precipitation provides water for range and crops. Small ponds on individual farms provide water for livestock. Some of the larger ponds on individual farms are used for flood control, recreation, irrigation water, or water for livestock. A few large ponds and reservoirs provide municipal water and irrigation water. The Colorado River and tributaries of the Brazos River are potential sources of water for irrigation. This river water is typically saline because of contamination by human activities and by natural sources of salts.

The Trinity Group aquifer (limestone) underlies part of the southern half of this MLRA. The median level of total dissolved solids in the water in this aquifer is 619 parts per million (milligrams per liter), and the water is very hard. Ground water levels are declining in this aquifer because of heavy pumping. Deep sand and gravel deposits beneath river valley floors yield some ground water. The quality of this water is comparable to that in the Trinity Group aquifer, but about 40 percent of all the samples from the alluvium had more than 10 parts per million (milligrams per liter) nitrate. Ground water is scarce in sloping areas where the underlying sandstone and shale are near the surface.

Soils

The dominant soil orders in this MLRA are Entisols, Inceptisols, Mollisols, and Vertisols. The soils in the area dominantly have a thermic soil temperature regime, an ustic soil moisture regime, and smectitic, mixed, or carbonatic mineralogy. They are very shallow to very deep, well drained, and generally loamy or clayey. Some Argiustolls (Rowden and Swenson series) formed in clayey and loamy sediments over limestone bedrock. Other Argiustolls (Sagerton series) formed in clayey and loamy alluvium on alluvial plains. Calciustolls formed in residuum on ridges and plains (Lueders, Springcreek, and Talpa series), in old alluvium on hills and knobs (Pitzer series), and in loamy alluvium on stream terraces, alluvial fans, and plains (Nuvalde and Rowena series). Haplustolls (Clearfork, Gageby, and Nukrum series) formed in loamy and clayey alluvium on flood plains. Haplustepts (Owens and Throck series) and Ustorthents (Harpersville series) formed in residuum on escarpments and plains. Haplusterts (Leeray series) formed in clayey alluvium in valleys.

Biological Resources

This area is in the central part of the mixed grass prairie. Loamy and clayey soils on uplands favor mid and tall grasses. Big bluestem, little bluestem, Indiangrass, sideoats grama, Texas cupgrass, vine mesquite, buffalograss, and Texas wintergrass are the dominant species. Abundant forbs include catclaw sensitivebrier, heath aster, Engelmann's daisy, gaura, prairie clover, dalea, plains blackfoot, and verbena. Scattered motts of live oak, elm, bumelia, and hackberry are common. Mesquite has invaded throughout the MLRA, except for areas of shallow soils. Pricklypear cacti are invasive on some shallow soils. Soils on low stream terraces and flood plains favor the growth of bluestems, Indiangrass, switchgrass, grama grasses, Texas wintergrass, and western wheatgrass. Hackberry, pecan, elm, and cottonwood are common on the bottom land in the area.

The major wildlife species in this area are white-tailed deer, turkey, bobwhite quail, mourning dove, fox squirrel, ducks, geese, fox, ringtail cat, coyote, bobcat, rabbits, badgers, songbirds, and rattlesnakes. Rivers, constructed ponds, and reservoirs provide good opportunities for fishing.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 16%
Grassland—private, 80%
Urban development—private, 2%
Water—private, 1%
Other—private, 1%

Farms and ranches make up nearly all of this area. Most of the farmland is used for the production of cattle and, to a lesser extent, sheep and horses. The cropland in the area is limited to soils that formed on terraces and flood plains. It is commonly used for small grains or hay for livestock and wildlife. Forage sorghum and alfalfa are grown for livestock. Wheat, cotton, and sorghum are the principal crops grown in the area. Some cropland has been converted to pasture. The leasing of lands for hunting and other kinds of recreation is common in this area.

The major soil resource concerns are water erosion, maintenance of the content of organic matter in the soils, and conservation of soil moisture. The major management concerns on rangeland are proper stocking rates, a dependable water supply, brush management, and food and cover for wildlife.

Conservation practices on cropland generally include a combination of terraces and grassed waterways. They also include contour farming and crop residue management. Conservation practices on rangeland generally include proper grazing use, brush management, fencing, watering facilities, and measures that improve wildlife habitat. ■

78B—Central Rolling Red Plains, Western Part

This area (shown in fig. 78B-1) is in west-central Texas (92 percent) and southwestern Oklahoma (8 percent). It makes up about 18,610 square miles (48,220 square kilometers). The towns of Childress, Post, Snyder, and Big Spring, Texas, are in this area. Interstate 20 crosses the southern end of this area. Palo Duro Canyon, Caprock Canyon, and Copper Breaks State Parks are in this area.

Physiography

Most of this area is in the Osage Plains Section of the Central Lowland Province of the Interior Plains. The southern end is in the Central Texas Section of the Great Plains Province of the Interior Plains, and the western one-third is in the High Plains Section of the same province and division. This area is characterized by rolling plains with ancient stream terraces or terrace remnants associated with stream dissection. Gypsum interbedded with limestones and dolomites can form a karst landscape with steep escarpments. Low, stabilized dunes associated with wind-reworked sandy alluvium are in scattered areas throughout the MLRA. The erosional surface has stream channels entrenched in gently dipping bedrock. Elevation is 1,450 feet (440 meters) in the eastern part of the area and gradually increases to about 2,940 feet (895 meters) in the

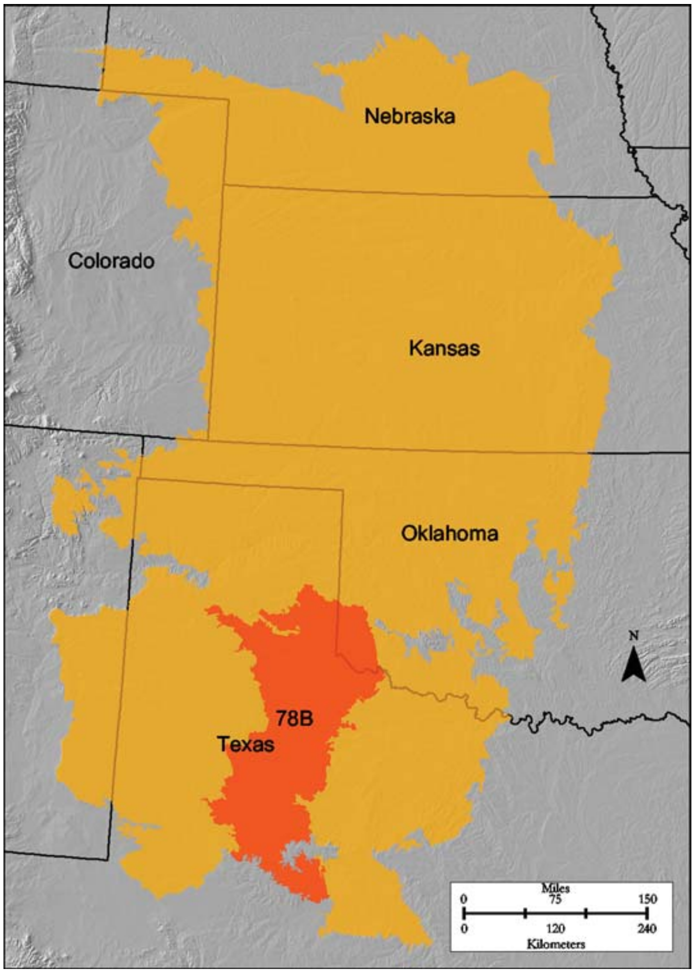

Figure 78B-1: Location of MLRA 78B in Land Resource Region H.

western part. Maximum local relief is about 180 feet (55 meters), but relief is considerably lower in most of the area.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Red-Washita (1113), 28 percent; Red Headwaters (1112), 24 percent; Brazos Headwaters (1205), 21 percent; Upper Colorado (1208), 18 percent; Middle Brazos (1206), 6 percent; and Lower Colorado-San Bernard Coastal (1209), 3 percent. The major rivers crossing this area from north to south include the Prairie Dog Town Fork of the Red River, the Pease and Wichita Rivers, the Salt Fork of the Brazos River, the Double Mountain Fork of the Brazos River, and the Colorado River.

Geology

This area is underlain by gently dipping Triassic and Permian deposits that are overlain by slope alluvium and stream terrace deposits of Quaternary age. Triassic sediments include calcareous sandstone, shale, clay, and conglomerate in the Dockum Group. Most of the area is characterized by red soils weathered from Permian red-bed sediments. Permian deposits include interbedded shale, sandstone, gypsum, and dolomite in the Whitehorse and Blaine Formations. Loamy, sandy, and clayey sediments of Quaternary age overlie Triassic and Permian deposits on fan remnants and stream terraces. A surface veneer of siliceous gravel can indicate thin, ancient terrace deposits. Mining operations for gypsum and gravel are in scattered areas throughout the MLRA. Oil and gas production is important in some areas.

Climate

The average annual precipitation in this area is 19 to 26 inches (485 to 660 millimeters), increasing from west to east across the area. Most of the rainfall occurs as convective thunderstorms during late spring and early fall. The precipitation occurring as snow during the winter averages about 3 inches (8 centimeters). The average annual temperature is 57 to 65 degrees F (14 to 18 degrees C). The freeze-free period averages 235 days and ranges from 215 to 260 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 1.8%; ground water, 1.7%
Livestock—surface water, 1.7%; ground water, 0.7%
Irrigation—surface water, 70.2%; ground water, 23.0%
Other—surface water, 0.4%; ground water, 0.4%

The total withdrawals average 510 million gallons per day (1,930 million liters per day). About 26 percent is from ground water sources, and 74 percent is from surface water sources. The moderate, somewhat erratic precipitation provides water for range and crops. Small ponds on individual farms provide water for livestock. Some larger ponds on individual farms are used for flood control, recreation, irrigation water, or water for livestock. A few large ponds and reservoirs are sources of municipal water and irrigation water. In the southern part of the area, the Colorado River and tributaries of the Brazos River are potential sources of water for irrigation. This river water is saline because of contamination from human activities and from natural sources of salts. The salinity levels in reservoirs are diluted by fresher water inflows from other areas.

Most of the ground water in this area comes from the alluvial and bolson deposits in Texas. The median level of total dissolved solids is 771 parts per million (milligrams per liter), and the ground water is very hard. About 40 percent of all the samples from the alluvial and bolson deposits had more than 10 parts per million (milligrams per liter) nitrate. Ground water is scarce in sloping areas where the underlying sandstone and shale are near the surface.

The Dog Creek-Blaine aquifer in the extreme southwest corner of Oklahoma occurs in this MLRA. Water from this aquifer is somewhat saline and is used for irrigation. It is unsuitable for public supply. The median level of total dissolved solids is 3,070 parts per million (milligrams per liter), and the water is very hard. The water has the highest median levels of total dissolved solids, hardness, and sulfate of all the water from aquifers in Oklahoma.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Inceptisols, and Mollisols. The soils in the area dominantly have a thermic soil temperature regime, an ustic soil moisture regime, and mixed or carbonatic mineralogy. They are very shallow to very deep, are well drained, and generally are sandy, loamy, or clayey. Argiustolls (Frankirk, Sagerton, and Westill series) formed in clayey and loamy alluvium on stream terraces and alluvial plains. Calciustolls (Talpa series) and Haplustepts (Obaro, Spade, and Tilvern series) formed in residuum on hills and ridges. Calciustepts (Aspermont and Veal series) formed in loamy, calcareous colluvium and slope alluvium on hillslopes and side slopes. Haplustalfs (Paducah series) formed in loamy residuum on plains. Paleustalfs (Delwin, Heatly, Miles, and Nobscot series) formed in sandy and loamy alluvium, commonly reworked by the wind, on stream terraces and plains. Ustorthents (Cottonwood and Knoco series) and Torriorthents (Latom series) formed in residuum on hills and ridges. Ustipsamments (Eda, Jester, and Tivoli series) formed in sandy eolian deposits on dunes adjacent to the major rivers. Ustifluvents (Colorado, Lincoln, Mangum, and Yomont series) formed in sandy, loamy, or clayey alluvium on flood plains.

Biological Resources

This area is in the central part of the mixed grass prairie. Loamy and clayey soils favor the growth of buffalograss, curlymesquite, sideoats grama, blue grama, vine mesquite, little bluestem, sand bluestem, Arizona cottontop, silver bluestem, Texas wintergrass, and tobosagrass. Mesquite, lotebush, and redberry juniper are common brushy invaders. Sandy soils favor bluestems, switchgrass, sand lovegrass, sand dropseed, and sand sagebrush. Some sandy areas support thick stands of shinnery oak. Saltcedar has invaded areas on flood plains where the water table is near the surface.

The common wildlife species in this area include white-tailed deer, desert mule deer, coyote, bobcat, black-tailed jackrabbit, cottontail rabbit, prairie dog, feral hogs, turkey, bobwhite quail, blue quail, mourning dove, ducks, and geese. Antelope and mountain lion inhabit a few areas.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 27%
Grassland—private, 70%
Urban development—private, 1%
Water—private, 1%
Other—private, 1%

Ranches and farms make up nearly all of this area. Soils that formed on Permian red beds, which make up almost three-fourths of the area, are used as rangeland. Soils that formed in Quaternary deposits on terraces or flood plains, which make up just under one-fourth of the area, are used as cropland. These nearly level and very gently sloping soils are commonly used for small grains for livestock and wildlife grazing during fall and winter. Cotton, wheat, and sorghums are the main crops. Cotton, alfalfa, and peanuts are irrigated in areas that have an adequate amount of good-quality water. Many of the farms and ranches are leased for hunting or other forms of recreation.

The major soil resource concerns include wind erosion, water erosion, maintenance of the content of organic matter in the soils, and management of soil moisture. The major management concerns on rangeland include proper stocking rates, the need for brush control, and the availability of stock water in periods of inadequate rainfall.

Conservation practices on cropland generally include a combination of terraces and grassed waterways. They also include contour farming and crop residue management. Conservation practices on rangeland generally include proper grazing use, brush control (which improves wildlife habitat and forage production), fencing, watering facilities, and measures that improve wildlife habitat. ■

78C—Central Rolling Red Plains, Eastern Part

This area (shown in fig. 78C-1) is in central Oklahoma (54 percent), north-central Texas (36 percent), and south-central Kansas (10 percent). It makes up about 19,565 square miles (50,705 square kilometers). The cities of Altus, Clinton, Elk City, and Woodward, Oklahoma, and Abilene, Texas, are in this area. The Black Kettle National Grasslands, the Washita National Wildlife Management Area, Altus Force Base (in Oklahoma), and Dyess Air Force Base (in Texas) also are in this MLRA.

Physiography

Most of this area is in the Osage Plains Section of the Central Lowland Province of the Interior Plains. The southwest tip is in the Central Texas Section of the Great Plains Province

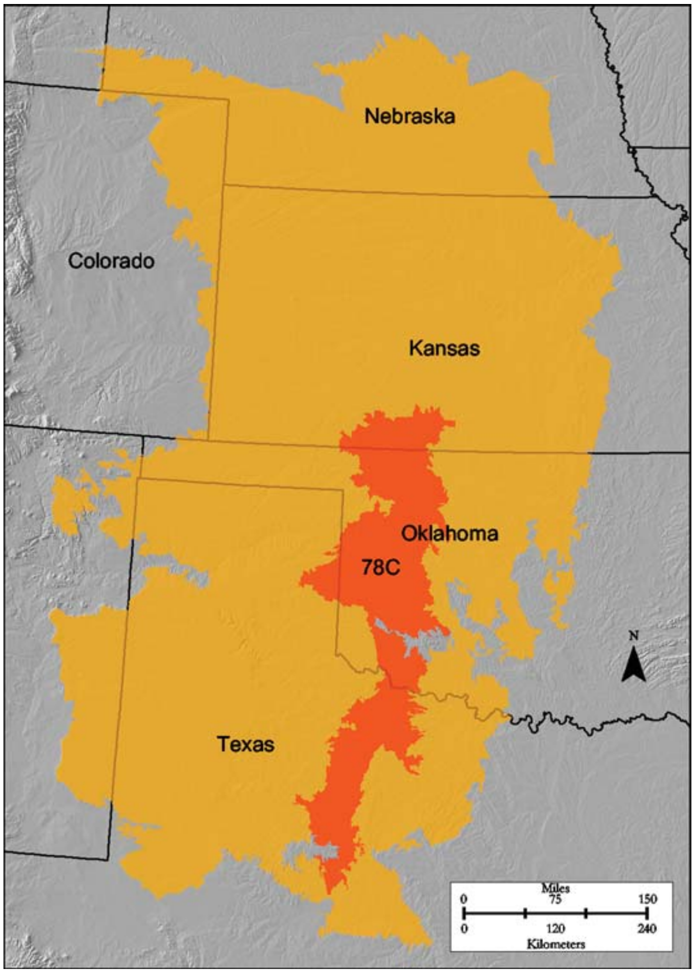

Figure 78C-1: Location of MLRA 78C in Land Resource Region H.

of the Interior Plains, and the northern tip is in the Plains Border Section of the same province and division. This area is characterized by smooth to rolling hills and valleys. It is on moderately dissected, rolling plains with prominent ridges and valleys, some local areas of badlands, and numerous stream terraces. Elevation ranges from about 1,000 feet (305 meters) along the Red River to 2,000 feet (610 meters) in Oklahoma. Maximum local relief is about 300 feet (90 meters), and the average local relief is about 100 feet (30 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Red-Washita (1113), 30 percent; Middle Brazos (1206), 17 percent; Red Headwaters (1112), 14 percent; Lower Cimarron (1105), 11 percent; Lower Canadian (1109), 7 percent; Arkansas-Keystone (1106), 7 percent; North Canadian (1110), 6 percent; Upper Cimarron (1104), 5 percent; Lower Colorado-San Bernard Coastal (1209), 2 percent; and Brazos Headwaters (1205), 1 percent. From north to south, some of the major rivers in this area include the Mule River and Salt Fork of the Arkansas River in Kansas; the Cimarron, North Canadian, Canadian, and Washita Rivers and North Fork of the Red River in Oklahoma; and the Pease, Wichita, and Brazos Rivers in Texas. The Red River forms the boundary between Texas and Oklahoma in this MLRA.

Geology

This area is underlain primarily by soft, calcareous sandstones, siltstones, and shales in red beds of the Wellington Formation, El Reno Group, Whitehorse Group, Cloud Chief Formation, and Quartermaster Formation of Permian age in Oklahoma and of the Wichita and Clear Fork Groups of Permian age in Texas. Characteristic red soils have formed in most of the area because of the underlying Permian red-bed sedimentary rocks.

Climate

The average annual precipitation in this area is 22 to 30 inches (560 to 760 millimeters). Most of the rainfall occurs as convective thunderstorms during the growing season. The precipitation occurring as snow during the winter averages about 6 inches (15 centimeters). The average annual temperature is 56 to 65 degrees F (13 to 18 degrees C). The freeze-free period averages 230 days and ranges from 200 to 260 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 7.2%; ground water, 15.4%
Livestock—surface water, 4.4%; ground water, 5.1%
Irrigation—surface water, 12.8%; ground water, 40.7%
Other—surface water, 4.8%; ground water, 9.6%

The total withdrawals average 250 million gallons per day (950 million liters per day). About 71 percent is from ground water sources, and 29 percent is from surface water sources. The moderate, somewhat erratic precipitation provides water for range and crops. Small ponds on individual farms provide water for livestock. Some larger ponds on individual farms are used for flood control, recreation, irrigation water, or livestock water. A few large ponds and reservoirs are sources of municipal water and irrigation water. Many of the major rivers that cross this area are potential sources of irrigation water. Much of this river water, however, is high in content of salts because of contamination from human activities and from natural sources of salts (brine seeps).

Most of the ground water in this area comes from alluvial and terrace aquifers and is used for irrigation and domestic supply. The median level of total dissolved solids in the water in these aquifers ranges from 485 to 585 parts per million (milligrams per liter) from Oklahoma to Kansas and increases to

771 parts per million (milligrams per liter) in Texas. The high amounts of total dissolved solids are the result of gypsum in the alluvium. This ground water is very hard. About 40 percent of all the samples from the alluvial and bolson deposits in Texas had more than 10 parts per million (milligrams per liter) nitrate. Ground water is scarce in sloping areas where the underlying sandstone and shale are near the surface.

Soils

The dominant soil orders in this MLRA are Alfisols, Inceptisols, and Mollisols. The soils in the area dominantly have a thermic soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They generally are moderately deep to very deep, are well drained and moderately well drained, and generally are loamy or clayey. Paleustolls (Tillman and Deandale series) and Haplustepts (Quinlan, Vernon, and Woodward series) formed in residuum on hills and ridges. Argiustolls (Abbie, Abilene, Carey, St. Paul, and Selman series) formed in loamy alluvium on stream terraces. Haplustepts (Burford, Deepwood, Hardeman, and Shrewder series) formed in mixed alluvium and colluvium on hills and stream terraces and in valleys. Ustifluvents (Beckman, Clairemont, Lincoln, and Westola series) formed in alluvium on flood plains. Ustipsamments (Tivoli and Jester series) formed in sandy eolian deposits on dunes adjacent to the major rivers.

Biological Resources

This area is in the central part of the mixed grass prairie. Most of the rangeland in the area supports buffalograss, vine mesquite, blue grama, tobosagrass, Arizona cottontop, silver bluestem, little bluestem, and sideoats grama. Also, it has several hackberry trees and scattered infestations of mesquite. Sandy and loamy soils on alluvial plains and stream terraces support little bluestem, silver bluestem, switchgrass, sideoats grama, blue grama, dropseeds, buffalograss, and vine mesquite. Bottom land supports blue grama, little bluestem, silver bluestem, switchgrass, Indiangrass, sedges, sideoats grama, Texas wintergrass, and vine mesquite. The woody vegetation on bottom land includes cottonwood and elm along with some encroaching saltcedar.

The major wildlife species in this area include white-tailed deer, mule deer, coyote, black-tailed jackrabbit, prairie dog, bobwhite quail, blue quail, ducks, and geese.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 38%
Grassland—private, 56%; Federal, 1%
Urban development—private, 3%
Water—private, 1%
Other—private, 1%

Farms and ranches make up nearly all of this area. They produce a combination of grain crops and livestock. Most of the area is used as rangeland. The more gently sloping areas are used for pasture or for dry-farmed crops. Small grains, cotton, and grain sorghum are the principal crops. A few small areas are irrigated. These areas have a reliable water supply.

Water erosion and conservation of soil moisture are the major management concerns on cultivated soils and on overgrazed rangeland. Conservation practices on cropland generally include contour farming and crop residue management. Conservation practices on rangeland generally include proper grazing use, fencing, and development of watering facilities. ■

79—Great Bend Sand Plains

This area is entirely in Kansas (fig. 79-1). It makes up about 7,405 square miles (19,185 square kilometers). Great Bend, Hutchinson, and Wichita are in this MLRA. U.S. Highways 50, 54, and 56 cross the area. The western part of McConnell Air Force Base and the Quivira National Wildlife Refuge are in this area.

Physiography

Most of this area is in the Plains Border Section of the Great Plains Province of the Interior Plains. The eastern third is in the Osage Plains Section of the Central Lowland Province of the Interior Plains. The undulating to rolling plains in this area generally have narrow valleys, but broad flood plains and terraces are along the Arkansas River and its larger tributaries. Elevation ranges from 1,650 to 2,600 feet (505 to 795 meters), increasing from east to west.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Middle Arkansas (1103), 82 percent, and Arkansas-Keystone (1106), 18 percent. The Arkansas River bisects the northern part of this MLRA, and the Ninnescah River crosses the southern part. In this MLRA, Rattlesnake Creek flows north and the Little Arkansas River flows south into the Arkansas River.

Geology

This area is covered by a thick mantle of windblown clays, silts, and sand and sandy outwash material of Holocene and late Pleistocene age. Alluvium consisting of silty and clayey material and coarse gravel is deposited along the Little Arkansas and Arkansas Rivers. Young, low-elevation dunes consisting of fine to medium quartz sand are adjacent to the alluvial areas.

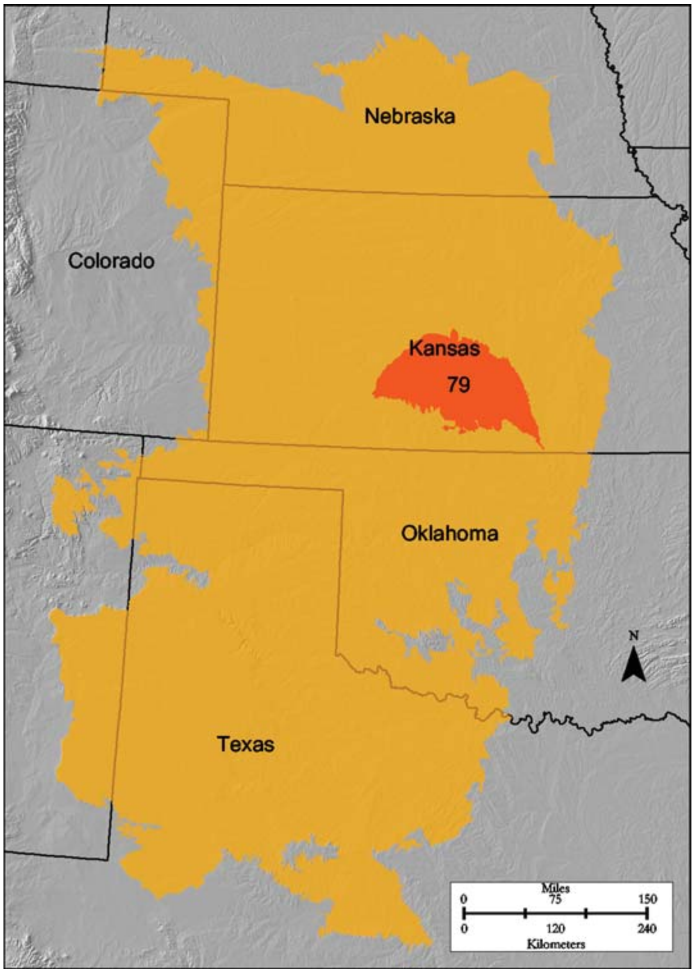

Figure 79-1: Location of MLRA 79 in Land Resource Region H.

Climate

The average annual precipitation in this area is 24 to 35 inches (610 to 890 millimeters). Most of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. The maximum precipitation occurs from the middle of spring to early in autumn. The annual snowfall ranges from about 14 inches (35 centimeters) in the southern part of the area to 20 inches (50 centimeters) in the northern part. The average annual temperature is 55 to 59 degrees F (13 to 15 degrees C). The freeze-free period averages 210 days and ranges from 195 to 225 days, increasing in length from northwest to southeast.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 6.8%; ground water, 4.0%
Livestock—surface water, 0.4%; ground water, 1.2%
Irrigation—surface water, 0.7%; ground water, 80.6%
Other—surface water, 2.0%; ground water, 4.3%

The total withdrawals average 740 million gallons per day (2,800 million liters per day). About 90 percent is from ground water sources, and 10 percent is from surface water sources. The source of water for crops and pasture is the moderate, somewhat erratic precipitation. In the northern part of the area, the Arkansas River is a potential source of irrigation water, but it currently is little used for this purpose. The Ninnescah River is another potential source of surface water in the area.

Deep sand in the High Plains or Ogallala aquifer yields an abundance of good-quality ground water. This aquifer provides water primarily for irrigation but also for domestic supply and livestock in rural areas and for industry and public supply in Wichita and in other towns or cities in the MLRA. The ground water in this aquifer has the lowest levels of total dissolved solids of any aquifer in Kansas, 340 parts per million (milligrams per liter).

Soils

The dominant soil orders in this MLRA are Mollisols, Alfisols, and Entisols. Most of the soils in the area have a mesic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy. They are moderately deep to very deep, poorly drained to excessively drained, and loamy or sandy. Nearly level and gently undulating Argiustolls formed in loamy alluvium on paleoterraces in river valleys (Naron and Farnum series). Haplustalfs formed in loamy alluvium on terraces (Nickerson series) or in sandy eolian deposits on dunes on paleoterraces (Pratt series). Natrustalfs formed in loamy, calcareous alluvium on terraces (Darlow series). Endoaquolls formed in loamy alluvium on flood plains (Ninnescah series). Ustipsamments (Tivin series) are on the steeper hummocks and dunes. Nearly level Argiaquolls (Carbika series) in depressions and in areas with no defined drainage pattern are moderately extensive throughout the area. Haplustolls on flood plains (Imano series) and terraces (Willowbrook series) are along the major streams.

Biological Resources

This area supports tall prairie grasses. Sand bluestem, big bluestem, little bluestem, switchgrass, and Indiangrass are the dominant species. Sand bluestem, little bluestem, sand lovegrass, and giant sandreed grow on sandy soils.

The major wildlife species in this area include white-tailed deer, mule deer, coyote, black-tailed jackrabbit, prairie dog, bobwhite quail, blue quail, ducks, and geese.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 67%
Grassland—private, 23%; Federal, 1%
Forest—private, 1%
Urban development—private, 5%
Water—private, 1%
Other—private, 2%

Nearly all of this area is in farms or ranches. Most of the area is cropland. Cash-grain farming is the principal enterprise. Hard winter wheat is the major crop, but grain sorghum and alfalfa also are grown. The grassland in the area consists of sandy soils and steeply sloping areas. It supports native grasses grazed by beef cattle.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter in the soils, and soil moisture management. The major management concerns on grassland are plant health and vigor and control of noxious and invasive weeds.

Conservation practices on cropland generally include high-residue crops in the cropping system; systems of crop residue management, such as no-till and strip-till systems; conservation crop rotations; wind stripcropping; and nutrient and pest management. Conservation practices on rangeland generally include brush management, prescribed burning, control of noxious weeds, pest management, watering facilities, and proper grazing use. ■

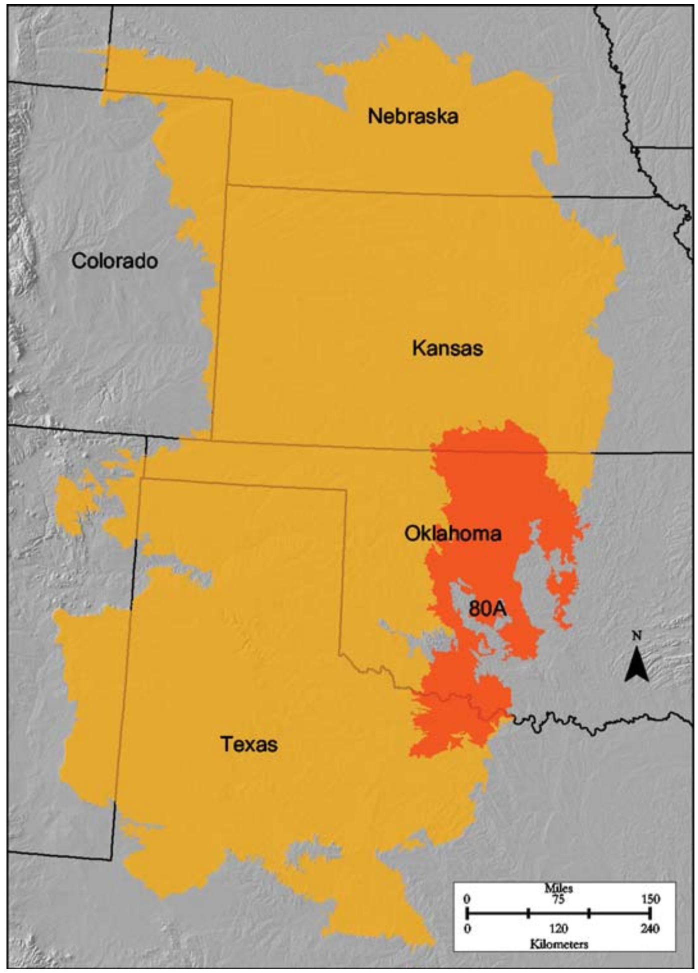

Figure 80A-1: Location of MLRA 80A in Land Resource Region H.

80A—Central Rolling Red Prairies

This area (shown in fig. 80A-1) is in Oklahoma (82 percent), Texas (11 percent), and Kansas (7 percent). It makes up about 19,925 square miles (51,635 square kilometers). It includes the towns or cities of Enid, Stillwater, Oklahoma City, Chickasha, and Ft. Sill, Oklahoma; Wichita Falls, Texas; and Wellington, Kansas. Interstates 35, 40, and 44 cross this area. The Sheppard Air Force Base in Texas and the Salt Plains National Wildlife Refuge in Oklahoma are in this area.

Physiography

This area is in the Osage Plains Section of the Central Lowland Province of the Interior Plains. It is characterized by dark red Permian rocks that are exposed dominantly on gently sloping plains. The plains are dissected by rivers flowing from northwest to southeast. Elevation ranges from about 850 to 1,500 feet (260 to 455 meters). Local relief commonly is less than 100 feet (30 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Red-Washita (1113), 34 percent; Arkansas-Keystone (1106), 27 percent; Lower Cimarron (1105), 23 percent; Lower Canadian (1109), 8 percent; and North Canadian (1110), 8 percent. From north to south, the major rivers draining this area include the Chickaskia and Bluff Rivers in Kansas; the Salt Fork of the Arkansas River and the Cimarron, North and South Canadian, Washita, Cache, and Red Rivers in Oklahoma; and branches of the Wichita River in Texas.

Geology

The plains in this area consist mainly of Pleistocene-age, loamy and clayey sediments that overlie Permian sandstones and shales. The Pleistocene sediments are primarily stream terrace deposits that follow the gradient of the major streams from northwest to southeast. The shales and sandstones are part of the El Reno Group. They dip gently southwestward toward the Anadarko Basin.

Climate

The annual average precipitation in this area is 25 to 38 inches (635 to 965 millimeters). The annual amount of precipitation may fluctuate widely from year to year. Most of the rainfall occurs as high-intensity, convective thunderstorms during spring and fall. The average annual temperature is 57 to 64 degrees F (14 to 18 degrees C). The freeze-free period averages 235 days and ranges from 205 to 265 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 25.7%; ground water, 11.9%
Livestock—surface water, 3.8%; ground water, 2.7%
Irrigation—surface water, 8.4%; ground water, 23.4%
Other—surface water, 15.3%; ground water, 8.8%

The total withdrawals average 330 million gallons per day (1,250 million liters per day). About 47 percent is from ground water sources, and 53 percent is from surface water sources. The moderate, somewhat erratic precipitation is the source of water for crops and pasture. Several large rivers that cross the area from west to east are potential sources of irrigation water. A fairly high content of salts in these rivers limits use of the river water. The North Canadian and Washita Rivers have good-quality water and are used for municipal supplies. Small ponds on individual farms provide flood control, opportunities for recreation, irrigation water, and livestock water. A few large ponds and reservoirs are sources of municipal water and are used for recreation.

Most of the ground water in this area comes from alluvial and terrace aquifers and is used for irrigation, livestock, and domestic supply. The median level of total dissolved solids in the water in these aquifers ranges from 485 to 585 parts per million (milligrams per liter) from Oklahoma to Kansas. The Garber-Wellington aquifer is along the southeastern edge of this MLRA in Oklahoma. This aquifer provides drinking water to many communities in the area near Oklahoma City. The water in this aquifer is as hard as the water in the alluvial and terrace deposits, but the median level of total dissolved solids is only 372 parts per million (milligrams per liter). Ground water is scarce and generally is highly mineralized in sloping areas where the underlying sandstone and shale are near the surface. There are no significant aquifers in the part of this MLRA in Texas.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a thermic soil temperature regime, an ustic soil moisture regime, and mixed, siliceous, or smectitic mineralogy. They generally are shallow to very deep, are well drained, and generally are loamy or clayey. Paleustolls (Bethany, Tabler, Renfrow, Kirkland, Norge, Foard, and Deandale series) and Argiustolls (Teller and Pond Creek series) formed in clayey and loamy alluvium of Pleistocene age. They are on plains. Argiustolls (Zaneis, Coyle, Mulhall, Grant, and Kingfisher series) and Haplustolls (Lucien series) formed in Permian sandstone residuum on ridges and hillslopes. Haplustalfs (Grainola and Steedman series) formed in Permian shale residuum on hillslopes. Haplustolls (Port, Ashport, Dale, Miller, and Reinach series) formed in Holocene alluvium on flood plains.

Biological Resources

This area supports tall and mid prairie grasses. Tracts of native vegetation still occur on farms and ranches throughout the area. Big bluestem, Indiangrass, switchgrass, and little bluestem are the dominant species. The plant diversity, including grasses, forbs, legumes, and woody species, is very high.

The major wildlife species in this area include white-tailed deer, coyote, cottontail rabbit, bobwhite quail, doves, meadowlark, scissortail flycatcher, ducks, and geese. Numerous manmade reservoirs and ponds provide good opportunities for fishing.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 43%
Grassland—private, 43%; Federal, 1%
Forest—private, 4%
Urban development—private, 6%
Water—private, 2%
Other—private, 1%

Farms and ranches make up nearly all of the private land in this area. Cropland and grassland (rangeland and pasture) make up nearly all of the land area. Most farms include both cropland and grassland and produce a combination of grain crops and beef cattle. Wheat is the principal crop, but soybeans, corn, grain sorghum, and cotton also are grown in the area. The grassland in the area is used for cow-calf and stocker cattle operations.

The main resource concerns on cropland include water erosion, surface compaction, conservation of soil moisture, and maintenance of the content of organic matter in the soils. The main resource concerns on grassland include plant health and vigor and control of noxious and invasive species.

Conservation practices on cropland generally include high-residue crops in the cropping system; systems of crop residue management, such as no-till and strip-till; conservation crop rotations; and nutrient and pest management. Conservation practices on grassland generally include brush management, prescribed burning, control of noxious weeds, pest management, development of watering facilities, and proper grazing use. ■

80B—Texas North-Central Prairies

This area is in two separate parts in north-central Texas (fig. 80B-1). It makes up about 6,195 square miles (16,055 square kilometers). The towns of Breckenridge, Brownwood, Eastland, Graham, Jacksboro, and Mineral Wells are in this area.

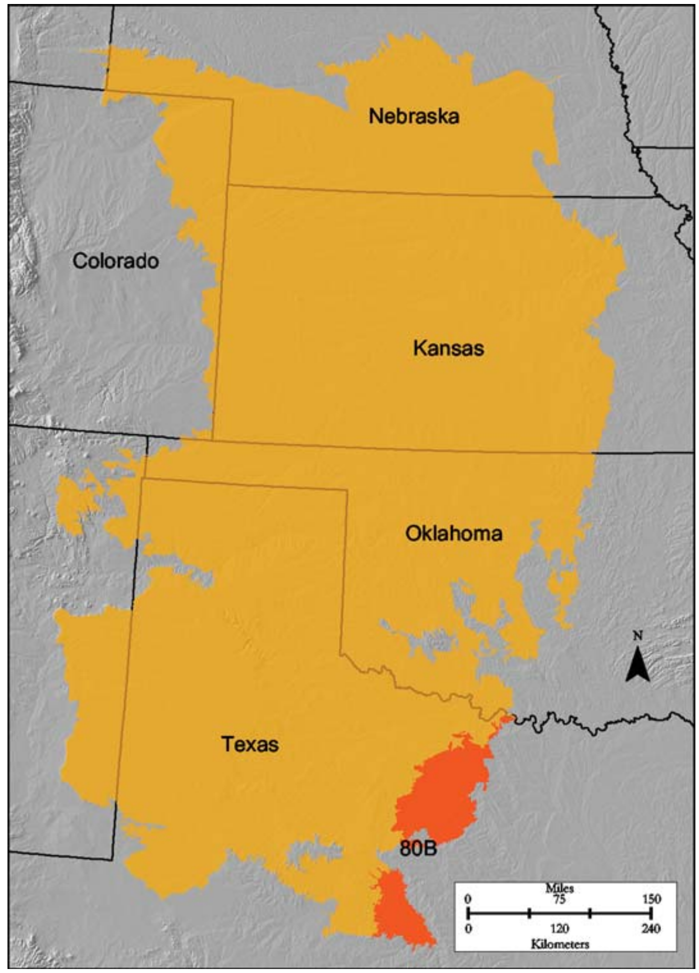

Figure 80B-1: Location of MLRA 80B in Land Resource Region H.

Physiography

The northern part of this area is in the Osage Plains Section of the Central Lowland Province of the Interior Plains. The southern part is in the Central Texas Section of the Great Plains Province of the Interior Plains. The area is primarily an eroded plateau. The drainage divides are dissected and are gently rolling to steep, and the valleys are narrow and have steep sides. Stream terraces and flood plains are associated with present-day streams, and erosional remnants of older terraces are indicative of relict stream courses. Well developed flood plains are along the Brazos and Clear Fork Rivers. Elevation ranges from 660 to 2,310 feet (200 to 705 meters). Geologic weathering has produced a subdued, terraced topography. Prominent scarps with relief of 15 feet (5 meters) to more than 100 feet (30 meters) are common throughout the area.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Middle Brazos (1206), 49 percent; Lower Colorado-San Bernard Coastal (1209), 29 percent; Trinity (1203), 18 percent; Red-Washita (1113), 2 percent; and Lower Brazos (1207), 2 percent. The Brazos River and the Clear Fork of the Brazos River drain the northern part of this area, and the Colorado River drains the southern part.

Geology

This area is underlain primarily by limestones and shales of Pennsylvanian age and by Cretaceous sandstone. The Canyon Group of Pennsylvanian age crops out throughout most of the area. It consists of the Wolf Mountain Shale, Winchell Limestone, Placid Shale, Ranger Limestone, Colony Creek Shale, and Home Creek Limestone. The overlying Thrifty and Graham Formations (Cisco Group) consist of interbedded light gray and brown limestones, sandstones, and shales of Pennsylvanian age. Erosional remnants of the Antlers Sandstone of Cretaceous age crop out in the southern part of this area. In places stones and boulders cover the surface. Sandy and loamy stream terrace deposits occur in the river valleys. Erosional remnants of older stream terraces are on uplands.

Climate

The average annual precipitation in this area is 26 to 33 inches (660 to 840 millimeters). Most of the rainfall occurs as high-intensity, convective thunderstorms during spring and fall. The average annual temperature is 63 to 66 degrees F (17 to 19 degrees C). The freeze-free period averages 260 days and ranges from 245 to 270 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 34.7%; ground water, 0.0%
Livestock—surface water, 23.8%; ground water, 0.7%
Irrigation—surface water, 34.0%; ground water, 0.0%
Other—surface water, 6.8%; ground water, 0.0%

The total withdrawals average 15 million gallons per day (55 million liters per day). About 1 percent is from ground water sources, and 99 percent is from surface water sources. The moderate, somewhat erratic rainfall is the source of water for crops and range. Summer droughts are common. The larger rivers, such as the Brazos and Colorado Rivers, flow most of the year, but local streams flow intermittently. Several large lakes and flood-detention reservoirs are in the area. Some rural residents depend on rural water systems supplied from lakes for water; others depend on private lakes. Most livestock water comes from streams or ponds. Ground water is scarce in this MLRA.

Soils

The dominant soil orders in this MLRA are Alfisols, Inceptisols, Mollisols, and Vertisols. The soils in the area dominantly have a thermic soil temperature regime, an ustic soil moisture regime, and mixed, carbonatic, or smectitic mineralogy. Most of the soils formed in material weathered from Cretaceous sedimentary rocks. The soils are very shallow to very deep, are well drained or moderately well drained, and generally are loamy or clayey.

Haplustolls (Palopinto and Eckrant series) formed in limestone residuum on hills, ridges, and plains. Argiustolls (Rumple and Speck series) formed in colluvium over limestone residuum on low-relief plateaus and cuestas. Haplusterts (Leeray series) and Haplustolls (Nukrum series) formed in clayey alluvium on footslopes at the base of cuesta scarps. Haplustepts (Owens and Throck series) formed in claystone residuum on escarpments, plains, and footslopes. Haplustalfs (Exray and Callahan series) and Paleustalfs (Bonti and Truce series) formed in residuum on hills and ridges. Calciustolls formed in residuum on plains (Rowena and Set series) and in alluvium on alluvial fans and stream terraces (Nuvalde series). Argiustolls (Sagerton series), Paleustalfs (Winters and Wichita series), and Haplustalfs (Thurber series) formed in loamy and clayey alluvium on stream terraces. Haplustolls (Clearfork, Deleon, Gageby, and Gowen series) formed in loamy and clayey alluvium on flood plains. Ustifluvents (Bunyan, Lincoln, Westola, and Yahola series) formed in sandy and loamy alluvium on flood plains.

Biological Resources

This area supports oak savanna vegetation with an understory of tall grasses. Little bluestem, big bluestem, Indiangrass, and switchgrass can grow on the deeper soils. Texas wintergrass, little bluestem, silver bluestem, buffalograss, and sideoats grama are dominant on shallow soils. Post oak, blackjack oak, sumac, bumelias, mesquite, and elm are the dominant woody species. The area supports numerous perennial forbs, including Maximilian sunflower, heath aster, bush sunflower, and Engelmann's daisy.

The major wildlife species in this area are white-tailed deer, coyote, cottontail rabbit, bobwhite quail, doves, meadowlark, scissortail flycatcher, ducks, and geese. Numerous manmade reservoirs and ponds provide good opportunities for fishing.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 10%
Grassland—private, 84%
Urban development—private, 3%
Water—private, 2%
Other—private, 1%

Farms and ranches make up nearly all of this area. Rangeland and pasture are the dominant land uses. Most of the rangeland and pasture is grazed by beef cattle, but a small acreage is grazed by sheep and goats. Many ranches are managed not only for livestock but also for wildlife, including white-tailed deer, dove, and quail. A minor acreage of cropland in areas of deep soils is used for wheat, oats, cotton, or grain sorghum.

The main resource concerns are the encroachment of woody species, conservation of soil moisture, and control of water erosion. The important conservation practices in this area generally include reasonable stocking rates and rotational grazing. ■

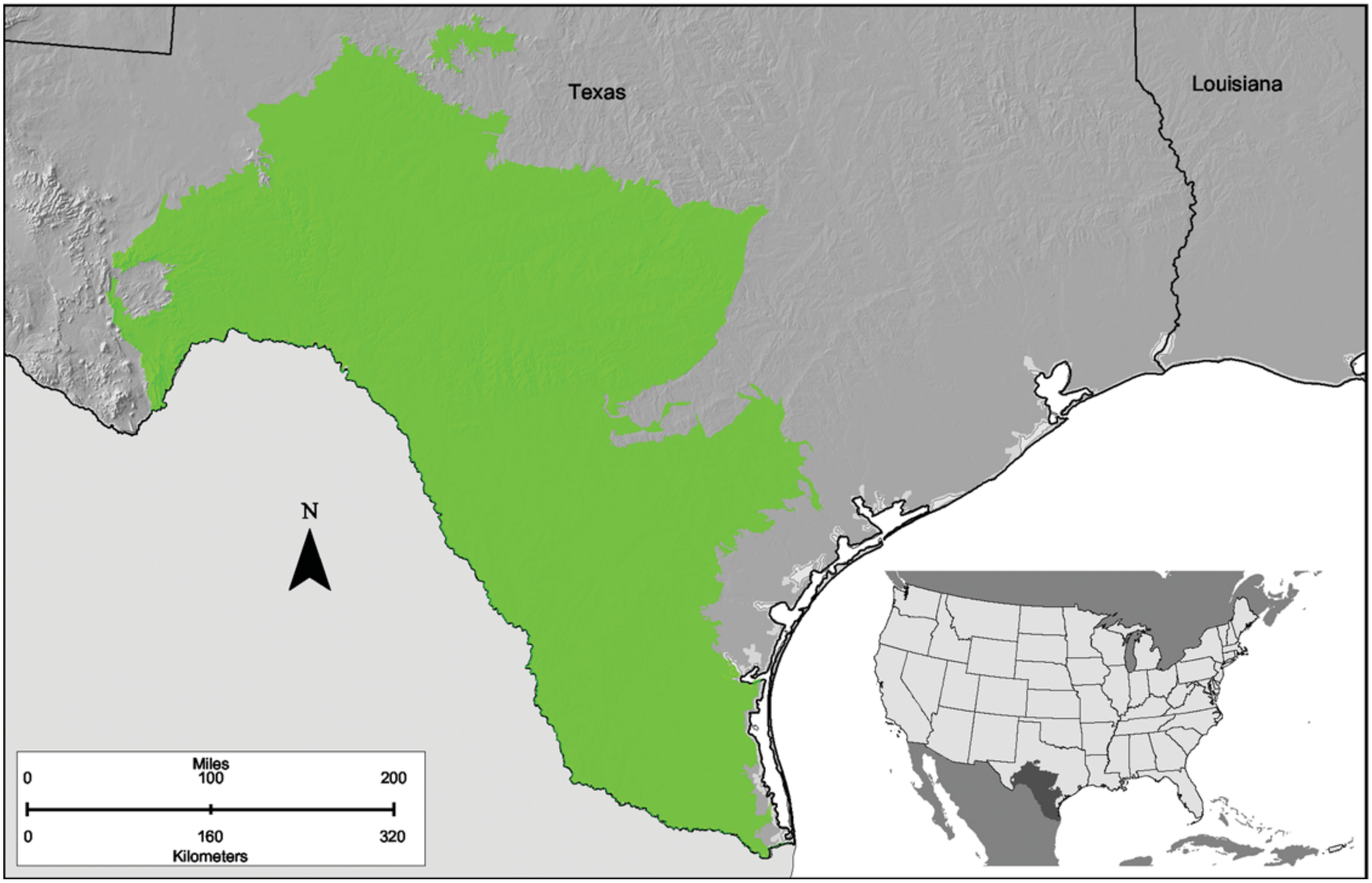

Figure I-1: Location of Land Resource Region I.

I—Southwest Plateaus and Plains Range and Cotton Region

This region is entirely in Texas (fig. I-1). It makes up 72,340 square miles (187,460 square kilometers).

In the northern and western parts of the region, there are mesas, plateaus, and limestone ridges and hills, deeply incised canyons are common, and the valley floors are level to gently sloping. The rest of the region is either on the Gulf Coast Plain or in the Rio Grande Valley and is a nearly level to gently undulating plain with low hills.

This region is in the warmer part of the southern Great Plains. Moderate precipitation is accompanied by high temperatures, and the effectiveness of precipitation is low. The average annual precipitation ranges from 20 to 29 inches (510 to 735 millimeters). Generally, much of the precipitation falls in spring and autumn. The average annual temperature ranges from 66 to 70 degrees F (19 to 21 degrees C). The freeze-free period ranges from 265 to 320 days, increasing in length from north to south. Freeze-free years are common in the extreme southern part of the region.

The total withdrawals of freshwater in this region average about 2,920 million gallons per day (11,050 million liters per day). About 57 percent is from surface water sources, and 43 percent is from ground water sources. About 47 percent of the water is used for irrigation, 32 percent is used for cooling thermoelectric power plants, and 19 percent is used for public supply.

The soils in this region are dominantly Alfisols, Aridisols, Inceptisols, Mollisols, and Vertisols. The major soil suborders on uplands are Calcids in the western part of the region and Ustalfs, Ustolls, Usterts, and Ustepts in the eastern part. Ustolls and Usterts are especially prominent in the southeastern part. The soils in this region dominantly have a hyperthermic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy.

About 99 percent of the land in this region is privately owned. The native vegetation consists mainly of shrubs interspersed with grasses and scattered trees (fig. I-2). Grazing is

Figure I-2: Vegetation along the Pecos River in an area of Land Resource Region I.

the dominant land use in most of the region, but wheat, grain sorghum, and other small grain crops are grown in areas where the soils, topography, and moisture supply are favorable. Irrigated cotton is an important crop in the southeastern part of the region. Citrus fruits and winter vegetables are grown in the lower Rio Grande Valley. The major resource concern is overgrazing. The invasion of undesirable species also is a concern. ■

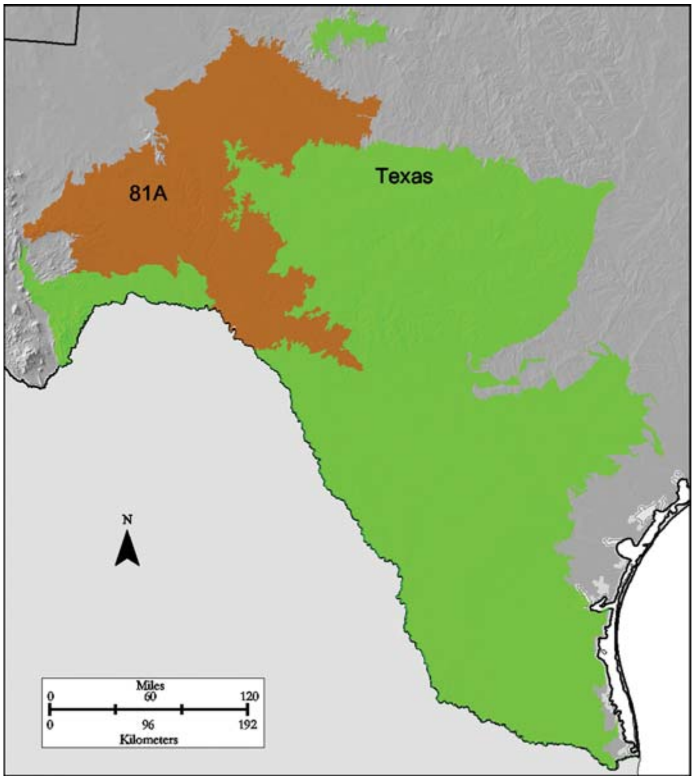

Figure 81A-1: Location of MLRA 81A in Land Resource Region I.

81A—Edwards Plateau, Western Part

This area is entirely in Texas (fig. 81A-1). It makes up about 16,550 square miles (42,885 square kilometers). The cities of San Angelo and Fort Stockton and the towns of Big Lake, McCamey, Ozona, and Sheffield are in this MLRA. Interstate 20 crosses the northern part of the area, and Interstate 10 crosses the middle of the area. The eastern part of Amistad National Recreation Area is in this MLRA.

Physiography

This area is primarily in the Edwards Plateau Section of the Great Plains Province of the Interior Plains. The southwest corner is in the Mexican Highland Section of the Basin and Range Province of the Intermontane Plateaus. Mesas, plateaus, and limestone ridges and hills with deep canyons and nearly level to gently sloping valley floors characterize the area. Elevation of the Rio Grande decreases from 1,200 feet (365 meters) at the western end of the area to 1,000 feet (305 meters) at the eastern end, and the upland areas increase in elevation northward to 2,700 feet (825 meters) on plateaus and mesas.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Colorado-San Bernard Coastal (1209), 34 percent; Lower Pecos (1307), 32 percent; Rio Grande-Amistad (1304), 26 percent; Upper Colorado (1208), 4 percent; Rio Grande-Falcon (1308), 2 percent; and Nueces-Southwestern Texas Coastal (1211), 2 percent. The Concho and Pecos Rivers and the Big Canyon and Devil's Rivers, northern tributaries of the Rio Grande, drain this area. The International Amistad Reservoir, on the Rio Grande, is in the southern part of the area.

Geology

This area is underlain primarily by limestones in the Austin Chalk, Boquillas Flags, Devil's River, Edwards, Buda, and Del Rio Clay Formations of Cretaceous age. Quaternary alluvium is in river valleys.

Climate

The average annual precipitation is 15 to 26 inches (380 to 660 millimeters) in most of this area, but it is 13 to 15 inches (330 to 380 millimeters) in the southwestern third of the area. Precipitation fluctuates widely from year to year and occurs mainly in spring and fall. The average annual temperature is 61 to 69 degrees F (16 to 21 degrees C). The freeze-free period averages 275 days and ranges from 220 to 325 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 1.5%; ground water, 1.4%
Livestock—surface water, 0.9%; ground water, 4.0%
Irrigation—surface water, 16.4%; ground water, 71.7%
Other—surface water, 2.0%; ground water, 2.0%

The total withdrawals average 245 million gallons per day (925 million liters per day). About 79 percent is from ground water sources, and 21 percent is from surface water sources. Water is scarce throughout the area because of limited and erratic precipitation and few perennial streams. Reservoirs outside San Angelo provide public supply and municipal water and some limited irrigation water. The reservoir behind Amistad Dam, on the Rio Grande, also provides some irrigation water. The surface water is not of good quality. High suspended sediment and salt loads limit its use.

Ground water is generally very deep in the Edwards-Trinity Plateau aquifer. It is very hard water with a median level of total dissolved solids of 773 parts per million (milligrams per liter). This aquifer provides water for livestock, domestic use, and irrigation. About 35 percent of the samples from this aquifer contained nitrate in excess of the national drinking water standard of 10 parts per million (milligrams per liter). Rio Grande valley fill deposits provide some ground water for irrigation in the area. The ground water is recharged by the river, so the water quality is similar to that of the Rio Grande.

Soils

The dominant soil order in this MLRA is Mollisols. Most of the soils are Calciustolls or Haplustolls. They are well drained and generally are shallow and have a skeletal particle-size class. The soils have a thermic or hyperthermic soil temperature regime, an ustic soil moisture regime, and carbonatic or mixed mineralogy. Rock outcrop makes up a significant portion of the area. Shallow Calciustolls (Ector and Langtry series) formed on mesas, plateaus, and hills underlain by limestone bedrock. Other shallow Calciustolls (Mailtrail series) have a petrocalcic horizon and formed on uplands and footslopes. Very deep Haplustolls (Rio Diablo and Dev series) and very deep Calciustolls (Angelo series) formed in nearly level to gently sloping areas in valleys and on flood plains.

Biological Resources

This area supports a plant community of shrubs and short or mid grasses. The vegetation includes juniper, mesquite, lotebush, shin oak, sumac, Texas pricklypear, tasajillo, kidneywood, agarito, yucca, Lindheimer silktassel, sotol, catclaw, Mexican persimmon, sideoats grama, threeawn, Texas grama, hairy grama, curly mesquite, buffalograss, and hairy tridens.

Some of the major wildlife species in this area are white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 6%
Grassland—private, 92%
Urban development—private, 2%

Ranches managed for grazing and wildlife habitat make up nearly all of this area. Livestock grazing is the principal land use. Some of the cropland in the area is irrigated.

The major soil resource concern is the erosion caused by overgrazing. Conservation practices on rangeland generally include reasonable stocking rates, proper grazing use, timely deferment of grazing, and pasture rotation. ■

81B—Edwards Plateau, Central Part

This area is entirely in south-central Texas (fig. 81B-1). It makes up about 11,125 square miles (28,825 square kilometers). The towns of Fredericksburg, Junction, Menard, Rocksprings, and Sonora are in this MLRA. Interstate 10 crosses the middle part of the area. A few State parks and State historic sites are in this MLRA.

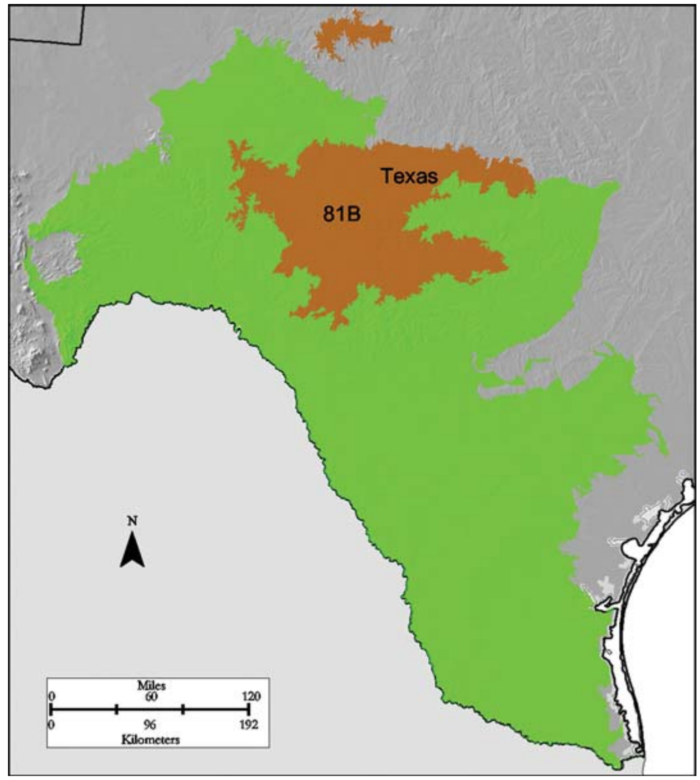

Figure 81B-1: Location of MLRA 81B in Land Resource Region I.

Physiography

Most of this area is in the Edwards Plateau Section of the Great Plains Province of the Interior Plains. The northern part is in the Central Texas Section of the same province and division. Plateaus and limestone hills, incised by deep canyons, and nearly level to gently sloping valley floors characterize the area. Elevation is 900 feet (275 meters) at the southern end of the area and increases northward to 2,500 feet (760 meters) on the limestone plateaus.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Colorado-San Bernard Coastal (1209), 67 percent; Rio Grande-Amistad (1304), 18 percent; Nueces-Southwestern Texas Coastal (1211), 5 percent; Middle Brazos (1206), 3 percent; Upper Colorado (1208), 3 percent; Central Texas Coastal (1210), 2 percent; and Lower Pecos (1307), 2 percent. The Guadalupe, Pedernales, West Nueces, Llano, and San Saba Rivers drain this area. The Colorado River crosses the northeast tip of the area.

Geology

This area is underlain primarily by limestones in the Austin Chalk, Boquillas Flags, Segovia, Fort Terrett, Devil's River, Salmon Peak, McKnight, Edwards, Buda, and Del Rio Clay

Formations of Cretaceous age. Quaternary alluvium is in river valleys.

Climate

The average annual precipitation in this area is 19 to 32 inches (485 to 815 millimeters). Most of the rainfall occurs in spring and fall. The average annual temperature is 62 to 68 degrees F (17 to 20 degrees C). The freeze-free period averages 250 days and ranges from 230 to 270 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 5.8%; ground water, 24.8%
Irrigation—surface water, 8.2%; ground water, 61.3%
Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average 24 million gallons per day (90 million liters per day). About 86 percent is from ground water sources, and 14 percent is from surface water sources. The amount of water is limited throughout most of the area but is abundant along the spring-fed, perennial streams. The surface water generally is of good quality, although high salt loads decrease water quality in a downstream direction. Most of the surface water is used for livestock or irrigation.

Ground water is generally very deep in the Edwards-Trinity Plateau aquifer. It is very hard water with a median level of total dissolved solids of 773 parts per million (milligrams per liter). This aquifer provides water for livestock, domestic use, and irrigation. About 35 percent of the samples from this aquifer contained nitrate in excess of the national drinking water standard of 10 parts per million (milligrams per liter). The Edwards-Trinity Plateau aquifer does not occur in the northeastern part of the area. Valley fill deposits along some of the larger streams in this MLRA supply some ground water for livestock, domestic use, and irrigation.

Soils

Most of the soils in this MLRA are Calciustolls and Haplustolls. They are well drained and generally are shallow and have a skeletal particle-size class. They have a thermic soil temperature regime, an ustic soil moisture regime, and carbonatic or mixed mineralogy. Rock outcrop makes up a significant portion of the area. Shallow Haplustolls and Calciustolls (Eckrant and Tarrant series) formed on mesas, plateaus, and hills underlain by limestone bedrock. Very deep Calciustolls (Nuvalde and Knippa series) formed in nearly level to gently sloping valleys. Very deep Haplustolls (Oakalla series) formed on flood plains.

Biological Resources

This area supports a plant community of trees, shrubs, and short or mid grasses. The vegetation includes live oak, juniper, Texas oak, shin oak, cedar elm, netleaf hackberry, flameleaf sumac, agarito, Mexican persimmon, Texas pricklypear, kidneywood, saw greenbriar, Texas wintergrass, little bluestem, curly mesquite, Texas grama, Halls panicum, purple threeawn, hairy tridens, cedar sedge, two-leaved senna, mat euphorbia, and rabbit tobacco.

Some of the major wildlife species in this area are white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 4%
Grassland—private, 95%
Urban development—private, 1%

Nearly all of this area is used for livestock grazing and wildlife habitat. Some areas are used as dry-farmed or irrigated cropland. Small grains and forage sorghum are the principal crops.

The major soil resource management concern is the erosion caused by overgrazing and cultivation. Conservation practices on rangeland generally include reasonable stocking rates, proper grazing use, timely deferment of grazing, and pasture rotation. Conservation practices on cropland generally include terraces, grassed waterways, conservation tillage, and irrigation water management. ■

81C—Edwards Plateau, Eastern Part

This area is entirely in Texas (fig. 81C-1). It makes up about 8,060 square miles (20,890 square kilometers). The towns of Bandera, Boerne, Medina, Johnson City, Burnet, Luckenbach, and Liberty Hill and the western half of Austin are in this MLRA. Interstate 10 crosses the western third of the area. The Lyndon B. Johnson National Historical Park is in this MLRA.

Physiography

The southern two-thirds of this area is in the Edwards Plateau Section of the Great Plains Province of the Interior Plains. The northern third is in the Central Texas Section of the same province and division. Limestone ridges and canyons and nearly level to gently sloping valley floors characterize the area. Elevation is

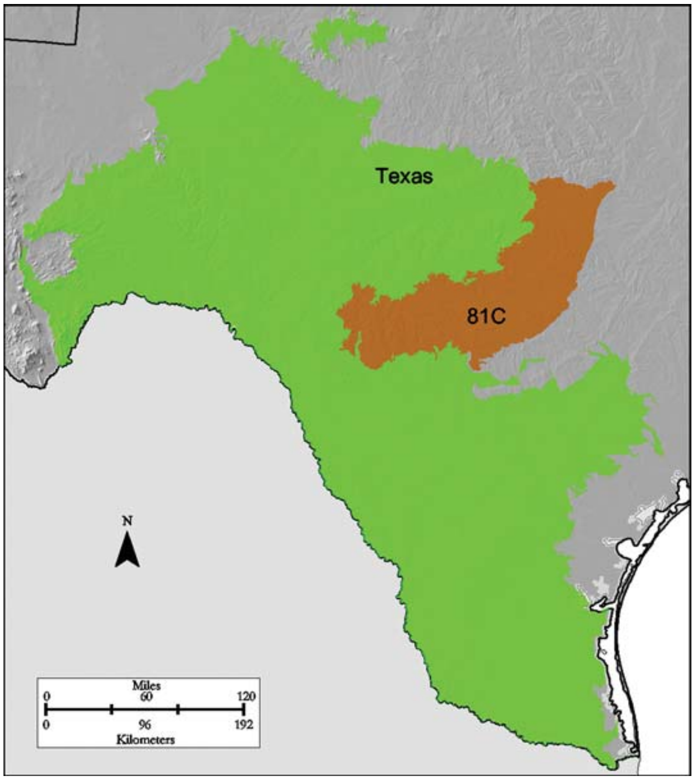

Figure 81C-1: Location of MLRA 81C in Land Resource Region I.

900 feet (275 meters) at the eastern end of the area and increases westward to 2,000 feet (610 meters) on ridges.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Central Texas Coastal (1210), 39 percent; Nueces-Southwestern Texas Coastal (1211), 25 percent; Lower Colorado-San Bernard Coastal (1209), 22 percent; and Lower Brazos (1207), 14 percent. From northeast to southwest, the Colorado, Pedernales, Blanco, Guadalupe, Medina, Frio, and Nueces Rivers cross this area.

Geology

This area is underlain primarily by limestones in the Glen Rose, Fort Terrett, and Edwards Formations of Cretaceous age. Quaternary alluvium is in river valleys.

Climate

The average annual precipitation in most of this area is 24 to 30 inches (610 to 760 millimeters). It is as high as 35 inches (890 millimeters) in the northeastern part of the area. Most of the rainfall occurs in spring and fall. The average annual temperature is 63 to 68 degrees F (17 to 20 degrees C). The freeze-free period averages 275 days and ranges from 235 to 310 days, lengthening to the south.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 17.0%; ground water, 17.1%
Livestock—surface water, 0.5%; ground water, 0.3%
Irrigation—surface water, 0.4%; ground water, 0.4%
Other—surface water, 56.5%; ground water, 7.8%

The total withdrawals average 1,210 million gallons per day (4,580 million liters per day). About 26 percent is from ground water sources, and 74 percent is from surface water sources. The amount of water is limited throughout most of the area but is abundant along spring-fed, perennial streams. A series of large reservoirs on the Colorado River in an area west of Austin provides abundant, good-quality surface water for public supply and for municipal and industrial uses. The Pedernales River empties into these reservoirs.

Ground water is generally deep. Three of the seven principal aquifers in Texas are beneath this MLRA. Sandstone and carbonate layers in the Trinity Group are the principal aquifers in the MLRA. The ground water in these layers is very hard and has a median level of 619 parts per million (milligrams per liter) total dissolved solids. About 30 percent of the samples from this aquifer exceeded the national drinking water standard of 10 parts per million (milligrams per liter) for nitrate. The aquifer provides water for livestock, domestic use, public supply, and some irrigation.

The Edwards-Trinity Plateau aquifer underlies the southwestern part of this area. The water in this aquifer is very hard and has a median level of total dissolved solids of 773 parts per million (milligrams per liter). This aquifer provides water for livestock, domestic use, and some irrigation. About 35 percent of the samples from this aquifer contained nitrate in excess of the national drinking water standard.

The Edwards-Balcones Fault Zone aquifer is in the southeastern part of this area and along the eastern boundary of the area. The water in this aquifer is near the surface. It is very hard and has a median level of 371 parts per million (milligrams per liter) total dissolved solids. This aquifer provides large amounts of water from springs. The water is used for public supply.

Valley fill deposits along some of the larger streams in this MLRA provide some ground water for livestock, domestic use, and irrigation.

Soils

The dominant soil orders in this MLRA are Inceptisols and Mollisols. Most of the soils are Calciustolls, Haplustolls, or Haplustepts. They are well drained and generally are shallow and have a skeletal particle-size class. They have a thermic soil temperature regime, an ustic soil moisture regime, and carbonatic or mixed mineralogy. Rock outcrop makes up a significant portion of the area. Shallow and moderately deep Haplustepts (Brackett and Kerrville series) formed on the side slopes of ridges. Shallow Haplustolls and Calciustolls (Eckrant and Tarrant series) formed on the summit on ridges. Very deep Calciustolls and Haplustolls (Lewisville and Krum series) formed in nearly level to gently sloping valleys. Very deep Haplustolls (Frio series) formed on flood plains.

Biological Resources

This area supports a plant community of trees, shrubs, and mid or tall grasses. The vegetation includes live oak, juniper, Texas oak, shin oak, cedar elm, evergreen sumac, escarpment cherry, saw greenbriar, mescal bean, poison oak, twistleaf yucca, elbowbush, cedar sedge, little bluestem, Neally grama, Texas grama, meadow dropseed, Texas wintergrass, curly mesquite, pellitory, noseburn, spreading sida, woodsorrel, and mat euphorbia.

Some of the major wildlife species in this area are white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 3%
Grassland—private, 84%; Federal, 1%
Urban development—private, 10%
Water—private, 1%
Other—private, 1%

Most of this area is used for grazing and wildlife habitat. A few areas are used as cropland. Small grains and forage sorghum are the principal crops.

The major soil resource concern is the erosion caused by overgrazing and cultivation. Conservation practices on rangeland generally include reasonable stocking rates, proper grazing use, timely deferment of grazing, and pasture rotation. The important conservation practices on cropland include terraces, grassed waterways, conservation tillage, and irrigation water management. ■

81D—Southern Edwards Plateau

This area is entirely in Texas (fig. 81D-1). It makes up about 2,495 square miles (6,465 square kilometers). The towns of Dryden, Langtry, and Sanderson are in this MLRA. U.S. Highway 90 connects those towns, and U.S. Highway 385 crosses the western end of the area. The Rio Grande, which is the national boundary between Texas and Mexico, borders the area on the south. The western part of the Amistad National Recreation Area and part of the Big Bend National Park are in this MLRA.

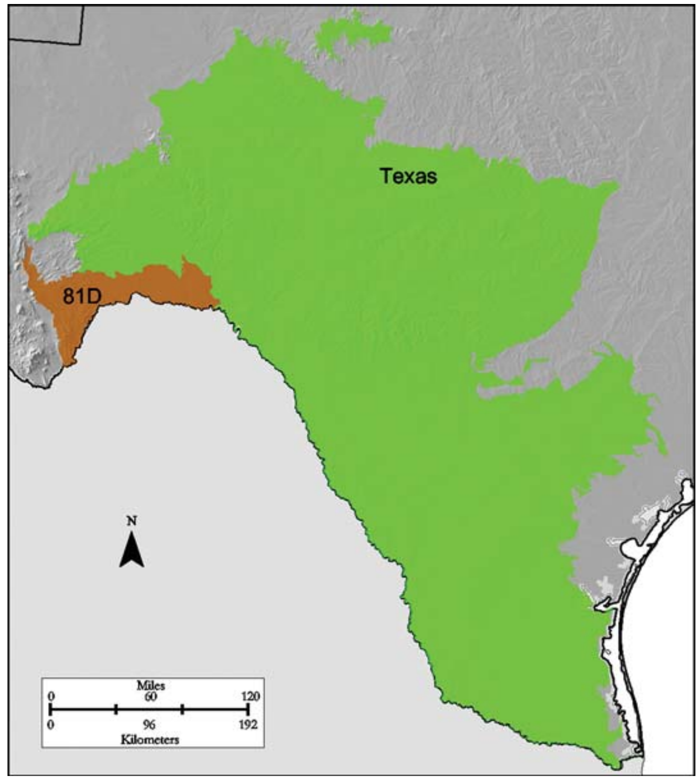

Figure 81D-1: Location of MLRA 81D in Land Resource Region I.

Physiography

The eastern half of this area is in the Edwards Plateau Section of the Great Plains Province of the Interior Plains. The western half is in the Mexican Highland Section of the Basin and Range Province of the Intermontane Plateaus. Steep limestone hills and mountains with deep canyons and nearly level to gently sloping valley floors characterize the area. Elevation of the Rio Grande decreases from 1,800 feet (550 meters) at the western end of the area to 1,200 feet (365 meters) at the eastern end, and upland areas increase in elevation northward to 3,500 feet (1,065 meters) in the mountains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Rio Grande-Amistad (1304), 96 percent, and Lower Pecos (1307), 4 percent. Short tributaries to the Rio Grande cross this area. From west to east, they include the Maravillas Canyon, San Francisco, and Big Canyon Rivers. The Pecos River joins the Rio Grande in the far eastern part of the area.

Geology

This area is underlain primarily by limestones in the Austin Chalk, Boquillas Flags, Devil's River, Santa Elena, Buda, and Del Rio Clay Formations of Cretaceous age. Quaternary sand and gravel are in the river valleys.

Climate

The average annual precipitation is 10 to 15 inches (255 to 380 millimeters) in most of this area. It increases to 18 inches (455 millimeters) in the far eastern part of the area. The precipitation fluctuates widely from year to year. Most of the precipitation is received in late summer. The average annual temperature is 63 to 70 degrees F (17 to 21 degrees C). The freeze-free period averages 270 days and ranges from 245 to 295 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 60.1%; ground water, 39.9%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average 3 million gallons per day (11 million liters per day). About 40 percent is from ground water sources, and 60 percent is from surface water sources. Water is scarce throughout the area because of limited and erratic precipitation and few perennial streams. Water in the Rio Grande is generally accessible only in the southeast and southwest corners of the area. The water is saline during low flows in winter and carries a heavy load of suspended sediment. Some of the water is diverted for livestock.

Ground water is generally very deep in the Edwards-Trinity Plateau aquifer in this area. The water in this aquifer is very hard and has a median level of total dissolved solids of 773 parts per million (milligrams per liter). This aquifer provides water for livestock, domestic use, and some limited irrigation. Rio Grande valley fill deposits provide some ground water for livestock, domestic use, and limited irrigation in this area. The ground water is recharged by the river, so the water quality is similar to that of the Rio Grande.

Soils

The dominant soil orders in this MLRA are Aridisols and Entisols. Most of the soils are Calcids, Cambids, or Orthents. They are well drained and generally are shallow and have a skeletal particle-size class. They have a thermic or hyperthermic soil temperature regime, an aridic soil moisture regime, and carbonatic or mixed mineralogy. Rock outcrop makes up a significant portion of the area. Shallow Haplocalcids (Lozier series) and Torriorthents (Mariscal series) formed on limestone hills. Shallow Petrocalcids (Upton series) and very deep Haplocambids (Sanderson series) formed on alluvial fans, uplands, and footslopes. Very deep Haplocalcids (Reagan series) formed in nearly level to gently sloping valleys.

Biological Resources

This area supports a desert plant community of low shrubs and short or mid grasses. Limestone hills and footslopes support black grama, bush muhly, chino grama, fluffgrass, and sideoats grama with a diverse shrub community, including cacti, creosotebush, feather dalea, lechuguilla, mariola, skeleton leaf goldeneye, and scattered juniper. Valleys and narrow drainageways support grasses, such as black grama, burrograss, cane bluestem, sideoats grama, tobosagrass, and vine-mesquite. Shrubs in narrow drainageways include fourwing saltbush, tarbush, and hackberry.

Some of the major wildlife species in this area are javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—private, 87%; Federal, 10%
Water—private, 2%
Other—private, 1%

Most of this MLRA is used for grazing and wildlife habitat. The Federal land in the MLRA is in parks and recreation areas along the Rio Grande.

The major soil resource concerns are the wind erosion and water erosion caused by overgrazing. Conservation practices on rangeland include reasonable stocking rates, proper grazing use, timely deferment of grazing, and pasture rotation. ■

82A—Texas Central Basin

This area is entirely in Texas (fig. 82A-1). It makes up about 2,635 square miles (6,830 square kilometers). The towns of Mason and Llano are in this MLRA. U.S. Highway 87 crosses the western half of the area. Enchanted Rock State Natural Area is in the southern part of the MLRA.

Physiography

This area is in the Central Texas Section of the Great Plains Province of the Interior Plains. Hills, ridges, and plains characterize the area. Elevation is 1,200 feet (365 meters) at the

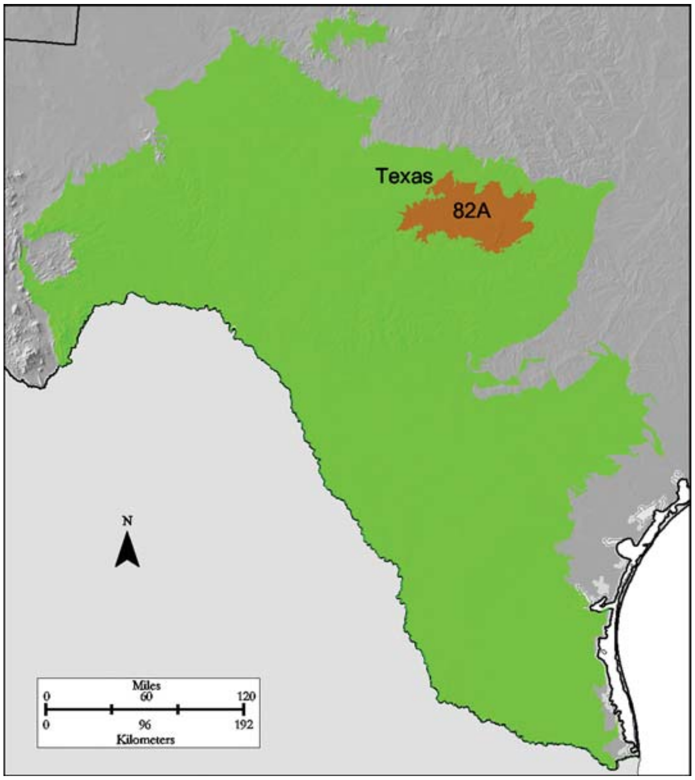

Figure 82A-1: Location of MLRA 82A in Land Resource Region I.

eastern end of the area and increases westward to 2,200 feet (670 meters) on ridges.

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is Lower Colorado-San Bernard Coastal (1209). The San Saba River cuts across the northwest corner of this area, and the Llano River drains the central part. Lakes Buchanan, Lyndon B. Johnson, and Marbles Falls, three major reservoirs on the Colorado River, are at the eastern end of this area.

Geology

This area is underlain primarily by igneous, metamorphic, and sedimentary rocks. Igneous and metamorphic outcrops include the Valley Spring Gneiss, Packsaddle Schist, and Town Mountain Granite of Precambrian age. Sedimentary rocks include the Hickory Sandstone and Lion Mountain Sandstone of Cambrian age and the Hensell Sand of Cretaceous age. Holocene alluvium is on flood plains.

Climate

The average annual precipitation in this area is 24 to 31 inches (610 to 785 millimeters). The higher rainfall usually occurs in the eastern part of the area. Most of the rainfall occurs in spring and fall. The average annual temperature is 65 to 67 degrees F (18 to 19 degrees C). The freeze-free period averages 260 days and ranges from 245 to 270 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 21.2%; ground water, 0.5%
Irrigation—surface water, 68.6%; ground water, 9.8%
Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average 10 million gallons per day (38 million liters per day). About 10 percent is from ground water sources, and 90 percent is from surface water sources. The amount of water is limited throughout most of the area but is abundant along perennial streams and in three major reservoirs on the Colorado River. Only a small quantity of water in the Llano and Colorado Rivers and in the three reservoirs is used for public supply, livestock, or irrigation in this area. The rivers are spring fed from the limestone aquifers outside this area and have water of good quality. Surface runoff, however, brings in salt loads, which degrade the quality of the water.

Nearly all of this area lacks principal aquifers. Ground water is in valley fill deposits along the perennial streams in the area. It is generally shallow. These deposits provide water for livestock, domestic use, and some limited irrigation. The quality of the ground water is similar to that of the surface water.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Inceptisols, and Mollisols. Most of the soils are Ustalfs, Ustepts, Orthents, or Ustolls. They are well drained and range from deep to shallow. They have a thermic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy. Rock outcrop makes up a significant portion of the area. Deep and moderately deep Paleustalfs (Pedernales and Castell series) formed on plains. Shallow and moderately deep Haplustalfs (Click and Oben series) formed on the summits of hills and ridges. Shallow Haplustepts (Keese series) and shallow Ustorthents (Nebgen series) formed on the side slopes of hills and ridges. Shallow Haplustolls (Harper series) and moderately deep Argiustolls (Rumple series) formed on plains.

Biological Resources

This area supports a mixed oak savanna plant community of live oak, post oak, and blackjack oak and mid and tall grasses, such as little bluestem, sideoats grama, Indiangrass, switchgrass, sand lovegrass, plains lovegrass, green sprangletop, purpletop, pinhole bluestem, and plains bristlegrass. Forbs, such as orange zexmania, bushsunflower, Engelmann's daisy, and trailing ratany, grow throughout the area. A mid grass community, with scattered live oak and post oak occurring as individual trees or in groves, grows on the shallow and more droughty soils. The major grass species on these soils are sideoats grama, meadow dropseed, pinhole bluestem, Arizona cottontop, vine-mesquite, Texas wintergrass, and little bluestem.

Some of the major wildlife species in this area are white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 4%
Grassland—private, 89%
Urban development—private, 3%
Water—private, 2%
Other—private, 2%

Almost all of this area is used for grazing and wildlife habitat. A few areas are used as cropland. Small grains and forage sorghum are the principal crops.

The major soil resource concern is the erosion caused primarily by overgrazing. Conservation practices on rangeland generally include reasonable stocking rates, proper grazing use, timely deferment of grazing, and pasture rotation. The important conservation practices on cropland are terraces, grassed waterways, conservation tillage, and irrigation water management. ■

83A—Northern Rio Grande Plain

This area is entirely in Texas (fig. 83A-1). It is south of San Antonio. It makes up about 11,115 square miles (28,805 square kilometers). The towns of Uvalde, Cotulla, and Hondo are in the western part of the area, and Beeville, Goliad, and Kenedy are in the eastern part. The town of Alice is just outside the southern edge of the area. Interstate Highways 35 and 37 cross this area. The Chase Field Naval Air Station is outside Beeville.

Physiography

This area is in the West Gulf Coastal Plain Section of the Coastal Plain Province of the Atlantic Plain. This plain generally is nearly level, but smooth hills and valleys are gently rolling. The valleys are narrow to broad. The hills are mostly in the eastern part of the area. Elevation ranges from 200 feet (60 meters) in the southeastern part of the area to 1,000 feet (305 meters) in the northwestern part.

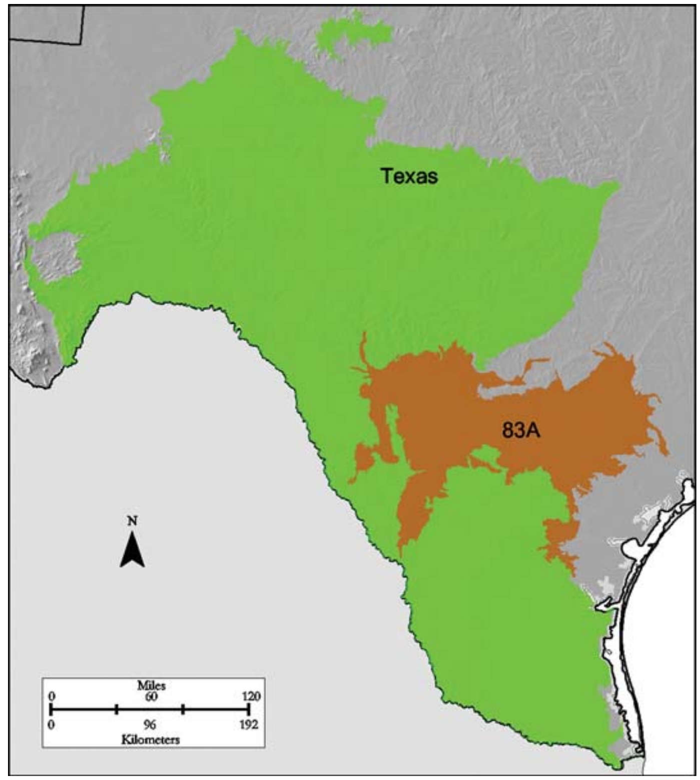

Figure 83A-1: Location of MLRA 83A in Land Resource Region I.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Nueces-Southwestern Texas Coastal (1211), 66 percent; Central Texas Coastal (1210), 33 percent; and Rio Grande-Falcon (1308), 1 percent. The Frio, Hondo, Leona, Medina, Nueces, Atascosa, Sabinal, and San Antonio Rivers cross this area. The Guadalupe River crosses the northeastern tip of the area.

Geology

Cretaceous limestone deposits underlie the northern edge of this MLRA. Most of the MLRA, however, lies within the coastal plain created when Cretaceous seas retreated towards the present-day Gulf of Mexico throughout Tertiary time. Lagoonal, estuarine, beach, and deltaic sediments were deposited in a wide swath paralleling the current coastline of Texas and other Gulf States. Fine textured sediment deposited in lagoons became shale layers, and the coarser textured sediments became sandstone layers. These Tertiary rocks are at the surface in this MLRA, and they are progressively younger from west to east. Several commercially mined lignite coal and uranium ore seams occur in these sediments. Natural gas production also occurs in the sediments. The sandstone layers are present-day aquifers.

Climate

The average annual precipitation is 21 to 37 inches (535 to 940 millimeters) in most of this area. Most of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. The annual precipitation increases from southwest to northeast. The typical storm pattern changes in the southern part of the area, where most of the rainfall occurs as moderate-intensity, tropical storms that produce large amounts of rain during winter. Hurricanes from the Gulf of Mexico occasionally trigger heavy rainfall early in autumn. The average annual temperature is 67 to 72 degrees F (20 to 22 degrees C). The freeze-free period averages 315 days and ranges from 275 to 350 days, increasing closer to the coast.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 2.4%; ground water, 2.0%
Livestock—surface water, 1.2%; ground water, 1.4%
Irrigation—surface water, 19.3%; ground water, 63.9%
Other—surface water, 4.8%; ground water, 5.0%

The total withdrawals average 415 million gallons per day (1,570 million liters per day). About 72 percent is from ground water sources, and 28 percent is from surface water sources. The rainfall is adequate for rangeland grasses but marginal for cultivated crops. High temperatures and high evaporation and transpiration rates limit crop production. The Nueces River provides some water for irrigation, and ponds provide some water for livestock and for domestic use. Some irrigation and public supply water (primarily for Corpus Christi, which is outside this area) is obtained from large reservoirs in this area, but most of the water used is ground water. The limited surface water available in this area is suitable for almost all uses. The level of total dissolved solids ranges from 300 to 500 parts per million (milligrams per liter). During late summer, low flows in the part of the San Antonio River below San Antonio consist primarily of municipal and industrial waste discharges.

Deep wells provide water for irrigation, livestock, public supply, and domestic use. The Balcones Fault Zone in the Edwards limestone aquifer underlies the northern edge of this area, and the Gulf Coast aquifer system underlies the eastern edge. The Carrizo-Wilcox aquifer underlies most of the area. Water from this aquifer is moderately hard and has a median level of total dissolved solids of 369 parts per million (milligrams per liter). Heavy pumping from this aquifer for irrigation has caused more saline water to leak into the aquifer from adjacent bedrock units. The Gulf Coast aquifer provides water for both public supply and irrigation in this area. Its water is very similar in quality to the water in the Carrizo-Wilcox aquifer. Deeper wells in both these aquifers encounter soft water where sodium is replacing calcium. Water from the Edwards aquifer is used primarily for public supply, but some wells also provide irrigation water. Much of the flow from the Frio, Leona, and Medina Rivers is lost to this aquifer as they cross it, but springs downstream from the seepage zone in the Balcones Fault Zone add some surface flow back to those rivers. The ground water in the Edwards aquifer is similar in quality to that in the other aquifers but is much harder. Also, more wells in this aquifer than in the others have nitrate levels exceeding the national standard for drinking water.

Soils

The dominant soil orders in this MLRA are Alfisols, Mollisols, and Vertisols. The soils in the area dominantly have a hyperthermic soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. A small area where the soil temperature regime is thermic is in the northern part of the MLRA. The soils are generally very deep, well drained or moderately well drained, and loamy or clayey. Haplustalfs (Duval series) formed in residuum on plains. Paleustalfs formed in loamy sediments on uplands (Floresville and Wilco series); in mixed loamy and clayey sediments on marine terraces, stream terraces, and plains (Miguel and Papalote series); and in residuum on uplands (Webb series). Argiustolls (Weesatche series) formed in loamy sediments on uplands. Calciustolls formed in alluvium on stream terraces and uplands (Knippa, Olmos, and Uvalde series) and in loamy sediments on uplands (Sarnosa series). Haplustolls (Odem series) formed in alluvium on natural levees and low stream terraces. Paleustolls (Poteet series) formed in alluvium in drainageways. Haplusterts (Monteola and Montell series) and Gypsiusterts (Esseville series) formed in clayey sediments on uplands.

Biological Resources

This area supports open grassland vegetation with scattered mesquite, live oak, and other trees. Little bluestem, sideoats grama, lovegrass tridens, fourflower trichloris, Arizona cottontop, plains bristlegrass, and other mid grasses are dominant on the deeper soils. These soils support a number of forbs, including orange zexmania, catclaw sensitivebrier, western indigo, and bushsunflower. Open grassland with scattered low-growing brush, such as guajillo, blackbrush, elbowbush, and kidneywood, characterize the shallower soils. Arizona cottontop, sideoats grama, green sprangletop, and twoflower trichloris are the dominant mid grasses on these soils.

Some of the major wildlife species in this area are white-tailed deer, coyote, bobcat, beaver, raccoon, cottontail, fox squirrel, turkey, bobwhite quail, and mourning dove. The species of fish in the area include largemouth bass, sunfish, catfish, and crappie.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 15%
Grassland—private, 81%
Urban development—private, 2%
Water—private, 1%
Other—private, 1%

About four-fifths of this area is rangeland grazed mainly by beef cattle and wildlife. A large acreage is cultivated. Grain sorghum, cotton, corn, wheat, and small grain for grazing are the main crops. Some areas, mostly in the western part of the MLRA, are used for irrigated vegetables. Hunting leases for deer, quail, and mourning dove are an important source of income.

The major soil resource concerns are maintenance of soil quality and the condition of the soils, water erosion in areas with a slope of more than 1 percent, and wind erosion. An adequate quantity of good-quality irrigation water is a concern in the western part of the area. A major management concern is controlling the brush and cactus that invade the grasslands.

Conservation practices on rangeland and pasture generally include prescribed grazing, fencing, development of watering facilities, and nutrient and pest management. The important conservation practices on cropland are conservation crop rotations, crop residue management, grassed waterways, contour farming and terraces (in areas with a slope of more than 1 percent), nutrient management, and pest management. Sprinkler irrigation systems, irrigation water conveyance pipelines, furrow diking, grassed waterways, and irrigation water management are important conservation practices that are used mainly on the cropland in the western part of the area. ■

83B—Western Rio Grande Plain

This area is entirely in Texas (fig. 83B-1). It makes up about 9,285 square miles (24,060 square kilometers). The border towns of Del Rio, Eagle Pass, Laredo, and Zapata are in this MLRA. Interstate 35 crosses the area just north of Laredo. The Amistad National Recreation Area is just outside this MLRA, northwest of Del Rio, and the Falcon State Recreation Area is southeast of Laredo. Laughlin Air Force Base is just east of Del Rio.

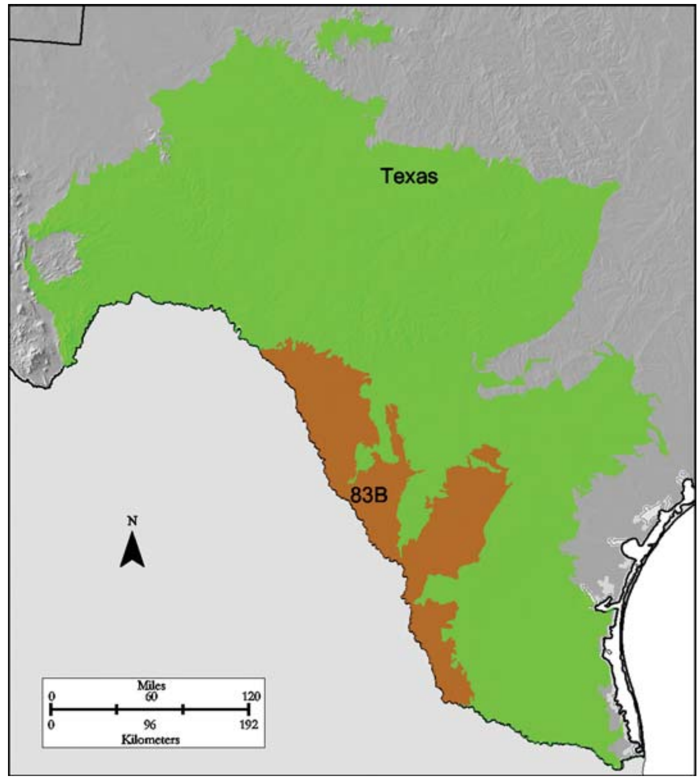

Figure 83B-1: Location of MLRA 83B in Land Resource Region I.

Physiography

This area is in the West Gulf Coastal Plain Section of the Coastal Plain Province of the Atlantic Plain. The area consists mainly of low hills with sandstone escarpments. Most of the escarpments occur in the western half of the area. The area is gently undulating and somewhat dissected by intermittent streams. Elevation ranges from 165 feet (50 meters) in the southeastern part of the area to 1,200 feet (365 meters) in the northwestern part.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Nueces-Southwestern Texas Coastal (1211), 54 percent; Rio Grande-Falcon (1308), 42 percent; and Lower Rio Grande (1309), 4 percent. The Rio Grande forms the international border between Texas and Mexico in this area.

Geology

Surficial Cretaceous limestone and shale deposits occur in the northernmost part of this MLRA. Most of the MLRA, however, lies within the coastal plain created when the Cretaceous seas retreated towards the present-day Gulf of Mexico throughout Tertiary time. Lagoonal, estuarine, beach, and deltaic sediments were deposited in a wide swath paralleling the current coastline of Texas and other Gulf States. Fine textured sediment deposited in lagoons became shale layers, and the coarser textured sediments became sandstone layers. These Tertiary rocks are at the surface in this area, and they are progressively younger from west to east. Several commercially mined lignite coal seams occur in these sediments. Natural gas production also occurs in the sediments. The sandstone layers are present-day aquifers. The Rio Grande flows on the southwest side of the Rio Grande Embayment, a structural feature that formed in Tertiary time when extension in response to plate tectonics caused the formation of a rift zone. This rift zone became a low-lying area that eventually was occupied by the Rio Grande. Recent alluvial sediments are adjacent to the Rio Grande.

Climate

The average annual precipitation is 18 to 25 inches (455 to 635 millimeters) in most of the area. It increases from north to south. Most of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. The average annual temperature is 67 to 73 degrees F (20 to 23 degrees C). The freeze-free period averages 325 days and ranges from 285 to 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 4.5%; ground water, 4.5%
Livestock—surface water, 1.9%; ground water, 1.0%
Irrigation—surface water, 50.9%; ground water, 29.4%
Other—surface water, 2.9%; ground water, 4.8%

The total withdrawals average 185 million gallons per day (700 million liters per day). About 40 percent is from ground water sources, and 60 percent is from surface water sources. The rainfall is adequate for the growth of rangeland grasses. In most years it is inadequate for cropland because of saline soils, high temperatures, and high evaporation and transpiration rates. The Rio Grande is the major perennial stream in this area. Other major streams flow intermittently. Two major reservoirs have been constructed on the Rio Grande by the United States and Mexico. The International Amistad Reservoir is just outside the northern end of this area, and the International Falcon Reservoir is just southeast of the town of Laredo. The water quality in the Rio Grande is poor upstream from the International Amistad Reservoir. It improves dramatically in the area between the Amistad and Falcon Reservoirs. The median level of total dissolved solids is about 500 parts per million (milligrams per liter). The Rio Grande water is used for irrigation in this area. The Choke Canyon Reservoir lies just west of Three Rivers. Away from the valley of the Rio Grande, ponds provide water for livestock, wildlife, domestic use, and irrigation.

Deep wells provide water for livestock, domestic use, and irrigation in this area. The Carrizo-Wilcox aquifer underlies the central third of the area. Other than the Rio Grande valley fill, there are no principal aquifers under the northern and southern thirds of the area. Water from the Carrizo-Wilcox aquifer is moderately hard and has a median level of total dissolved solids of 369 parts per million (milligrams per liter). Heavy pumping from this aquifer for irrigation has caused more saline water to leak into the aquifer from adjacent bedrock units. Rio Grande valley fill deposits provide some ground water for irrigation in this area. The ground water is recharged by the river, so its water quality is similar to that of the Rio Grande.

Soils

The dominant soil orders in this MLRA are Alfisols, Aridisols, Inceptisols, Mollisols, and Vertisols. The soils in the area have a hyperthermic soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They generally are moderately deep to very deep, well drained or moderately well drained, and loamy or clayey. Haplustalfs (Brennan and Hebbronville series) formed in loamy sediments on uplands. Natrustalfs (Brundage series) formed in alluvium on stream terraces. Paleustalfs (Brystal series), Haplustepts (Maverick series), and Haplargids (Pryor series) formed in residuum on uplands. Petrocalcids (Kimbrough series) formed in eolian deposits on plains and ridges. Calciustepts (Copita series) formed in mixed colluvium and residuum on uplands. Calciustolls (Elindio, Jimenez, and Uvalde series) formed in alluvium on stream terraces. Haplusterts formed in mixed alluvium and colluvium (Catarina series) and outwash or alluvium (Montell series) on plains and in drainageways.

Biological Resources

This area supports open grassland vegetation with scattered shrubs. Mid grasses, such as alkali sacaton, twoflower trichloris, pink pappusgrass, white tridens, whiplash pappusgrass, and vine-mesquite, are dominant on deep, clayey soils. Guayacan, spiny hackberry, desert yaupon, and fourwing saltbush are the principal shrubs. Bundleflower, bushsunflower, Texas varilla, and other forbs make up a minor but significant part of the plant communities. The more gravelly soils support semi-open grassland vegetation of mid grasses interspersed with low-growing shrubs. Guajillo, blackbrush, and kidneywood are the principal shrubs. Arizona cottontop, sideoats grama, pink pappusgrass, pinhole bluestem, green sprangletop, and tanglehead are the dominant grasses. Several species of forbs grow on these soils, mainly bushsunflower, orange zexmania, snoutbean, dalea, and gaura.

Some of the major wildlife species in this area are white-tailed deer, javelina, coyote, fox, bobcat, ringtail cat, beaver, nutria, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, mourning dove, and white-winged dove. The species of fish in the area include channel catfish, black bass, and sunfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 3%
Grassland—private, 94%
Urban development—private, 2%
Water—private, 1%

Almost all of this area is rangeland grazed by beef cattle and wildlife. About 3 percent of the area is cropland used mainly for grain sorghum, small grain, cotton, and improved pasture. Small grain generally is grazed for winter pasture. Watermelons, cantaloupes, and onions are grown under irrigation in alluvial areas along the Rio Grande. Hunting leases for deer, quail, mourning dove, wild turkey, and javelina are an important source of income.

The major soil resource concerns are maintenance of soil quality and the condition of the soils, water erosion in areas with a slope of more than 1 percent, and soil salinity. Wind erosion also is a concern on sandy and loamy soils in areas where irrigated cropland is left fallow. Soil moisture is a major concern throughout most of the area. Locally, saline and alkali soils are a land use problem. An adequate quantity of good-quality irrigation water is a concern along the Rio Grande. A major management concern is controlling brush and cactus that invade the native grasslands.

Conservation practices on rangeland and pasture generally include prescribed grazing, fencing, development of watering facilities, and nutrient and pest management. The important conservation practices on cropland are conservation crop rotations; irrigation systems, including micro-irrigation; irrigation water conveyance pipelines; and irrigation water management. ■

83C—Central Rio Grande Plain

This area is entirely in Texas (fig. 83C-1). It makes up about 4,275 square miles (11,075 square kilometers). The towns of Freer, George West, and Hebbronville are in this area. The town of Alice is on the east edge of the area. U.S. Highways 59 and 281 cross the area.

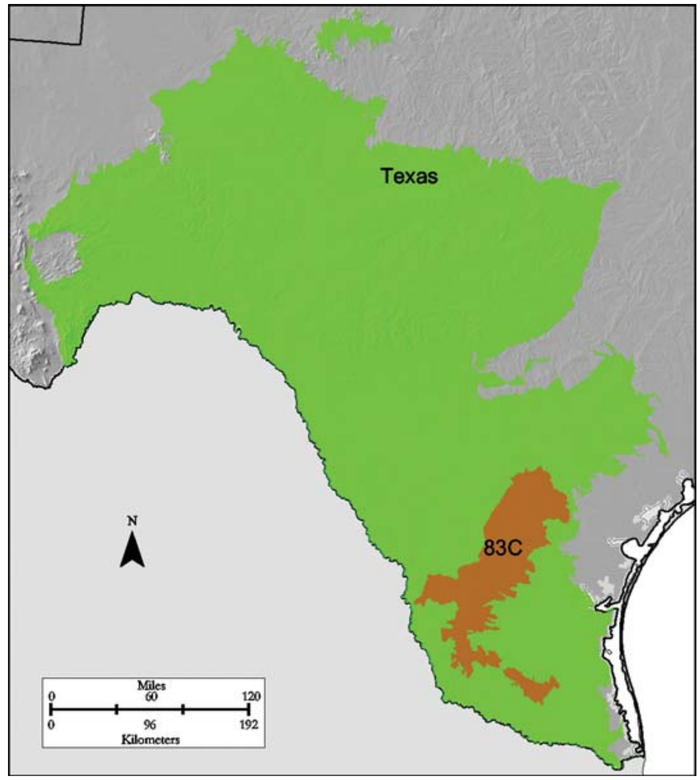

Figure 83C-1: Location of MLRA 83C in Land Resource Region I.

Physiography

This area is in the West Gulf Coastal Plain Section of the Coastal Plain Province of the Atlantic Plain. It is a nearly level to gently undulating plain that is weakly dissected by intermittent drainageways. The landscape features are influenced by thin eolian deposits occurring as a surficial sand sheet that covers most of the area. The eolian deposits moved downwind from southeast to northwest along the prevailing wind direction. Elevation ranges from 150 feet (45 meters) on the east side of the area to 860 feet (260 meters) on the west side.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Nueces-Southwestern Texas Coastal (1211), 82 percent; Rio Grande-Falcon (1308), 14 percent; and Lower Rio Grande (1309), 4 percent. The Nueces and Frio Rivers are the only major streams in this area.

Geology

This area is underlain by Tertiary sediments that trend generally parallel to the Texas Gulf Coast and are progressively younger approaching the coastline (eastward). The western part of the area is underlain by calcareous clays, claystones, and friable sandstones with some beds of white volcanic ash in the Jackson Group of Eocene age. The central part is underlain by soft or weakly cemented siltstones, sandstones, and tuff in the Catahoula Formation of Miocene age. The eastern part is underlain by clays, sandy clays, and weakly cemented sandstones in the Fleming Formation of Miocene age and the overlying Goliad Formation of Pliocene age. Recent alluvial sediments are along the Nueces and Frio Rivers.

Climate

The average annual precipitation in this area is 21 to 29 inches (535 to 735 millimeters). Most of the rainfall occurs during the growing season. Hurricanes from the Gulf of Mexico trigger heavy rainfall in the area from time to time in late summer and early fall. The average annual temperature is 70 to 73 degrees F (21 to 23 degrees C). The freeze-free period averages 335 days and ranges from 305 to 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 4.4%; ground water, 31.1%
Livestock—surface water, 6.7%; ground water, 24.4%
Irrigation—surface water, 11.1%; ground water, 22.2%
Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average 4.5 million gallons per day (17 million liters per day). About 78 percent is from ground water sources, and 22 percent is from surface water sources. The rainfall is adequate for the growth of rangeland vegetation. Crop yields, however, are limited by periods of moisture stress caused by high temperatures and high evaporation and transpiration rates. Ponds provide water for livestock, domestic use, wildlife, and some irrigation and public supply. The surface water is generally of good quality and is suitable for most uses. The precipitation that accompanies hurricanes and major storms cannot be discharged by the small drainage systems in the area. Local drainageways may be flooded for days, maybe even weeks, following a major storm.

Deep wells provide water for livestock, domestic use, wildlife, and some irrigation and public supply. The Carrizo-Wilcox aquifer system is beneath the northwest corner of the area. Water from this aquifer is moderately hard and has a median level of 369 parts per million (milligrams per liter) total dissolved solids. The Gulf Coast aquifer system underlies most of the area. It consists of a complex of young, interbedded clays, silts, sands, and gravel. The water from this aquifer is generally of good quality. It is hard and typically has 300 to 500 parts per million (milligrams per liter) total dissolved solids. Deeper wells in both the Gulf Coast and Carrizo-Wilcox aquifers encounter soft water where sodium is replacing calcium. There are no principal aquifers in the southwestern third of this area.

Soils

The main soil orders in this MLRA are Alfisols, Inceptisols, Mollisols, and Vertisols. The dominant soils in this area are Ustalfs, Ustolls, Ustepts, and Usterts. They are moderately deep or deep and moderately coarse textured or coarse textured. They have a hyperthermic soil temperature regime, an ustic soil moisture regime, and carbonatic or mixed mineralogy.

Very deep, well drained Paleustalfs (Comitas, Nueces, and Sarita series) formed in sandy sediments on sandy eolian plains. Shallow and moderately deep, nearly level to gently sloping Paleustalfs (Delmita and Randado series) have a strongly cemented caliche horizon and formed on eolian plains in the central and eastern parts of this area. Deep, moderately well drained Paleustalfs (Delfina series) formed on loamy eolian plains in the central and eastern parts of the area. Nearly level to gently undulating Haplustalfs (Brennan and Hebbronville series) formed on loamy eolian plains in the central and western parts of the area. Shallow, well drained Calciustolls (Olmos series) have an indurated caliche horizon and formed in limestone alluvium in undulating areas. Deep, well drained Calciustolls (Hidalgo series) formed in calcareous sediments in nearly level to gently sloping areas. Very shallow, well drained Calciustepts (Zapata series) have an indurated caliche horizon and formed on plains in the western part of the area. Moderately deep, well drained Calciustepts (Copita series) formed in clayey sediments over sandstone bedrock in the western part of the area. Deep, fine textured, well drained Haplusterts (Tordia series) formed in sediments overlying weakly consolidated shale, siltstone, or sandstone that contains volcanic ash. Deep, fine textured, moderately well drained and somewhat poorly drained Haplusterts (Coquat, Cochina, and Buchel series) formed in clayey alluvium along rivers.

Biological Resources

This area supports prairie vegetation with a few scattered trees and shrubs. The major species on deep soils that have a surface layer of fine sand are tall and mid grasses, such as seacoast bluestem, Indiangrass, crinkleawn, and tanglehead, with a variety of perennial legumes and forbs. The species commonly occurring on loamy soils in the central and eastern parts of the area are mid grasses, such as Arizona cottontop, fourflower trichloris, tanglehead, plains lovegrass, and pinhole bluestem. Many forbs and low-growing shrubs, including condalia, vine ephedra, and guajillo, also grow on these loamy soils. Woody vegetation consists of mesquite, huisache, and a few oak trees.

Some of the major wildlife species in this area are white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, white-winged dove, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 7%
Grassland—private, 89%
Urban development—private, 2%
Water—private, 1%
Other—private, 1%

Almost all of this area is rangeland grazed by beef cattle and wildlife. About 7 percent of the area is cropland used mainly for grain sorghum, cotton, wheat, and small grains for grazing. Some areas are irrigated. Hunting leases for deer, wild turkey, quail, mourning dove, javelina, and exotic game animals are an important source of income in this area.

The major soil resource concerns include wind erosion and water erosion. They also include accessory soil minerals, including salts, in some areas. Rangeland site suitability and plant productivity, health, and vigor are major concerns because of the invasion of brush and cactus.

Conservation practices on rangeland generally include brush control, range planting, prescribed grazing management, prescribed burning, firebreaks, fences, adequate water distribution systems, and development of upland wildlife habitat. The important conservation practices on cropland are crop rotations, nutrient management, pest management, crop residue management, and mulch tillage and/or no-till systems. On the more sloping cropland, terraces and grassed waterways may be needed, depending on the type of crop residue management and tillage system being used. ■

83D—Lower Rio Grande Plain

This area is entirely in Texas (fig. 83D-1). It makes up about 2,500 square miles (6,475 square kilometers). The towns of Brownsville, Edinburg, Harlingen, McAllen, and Raymondville are in this area. U.S. Highways 77 and 281 terminate in Brownsville and McAllen, respectively. The Santa Ana National Wildlife Area is along the Rio Grande in this area.

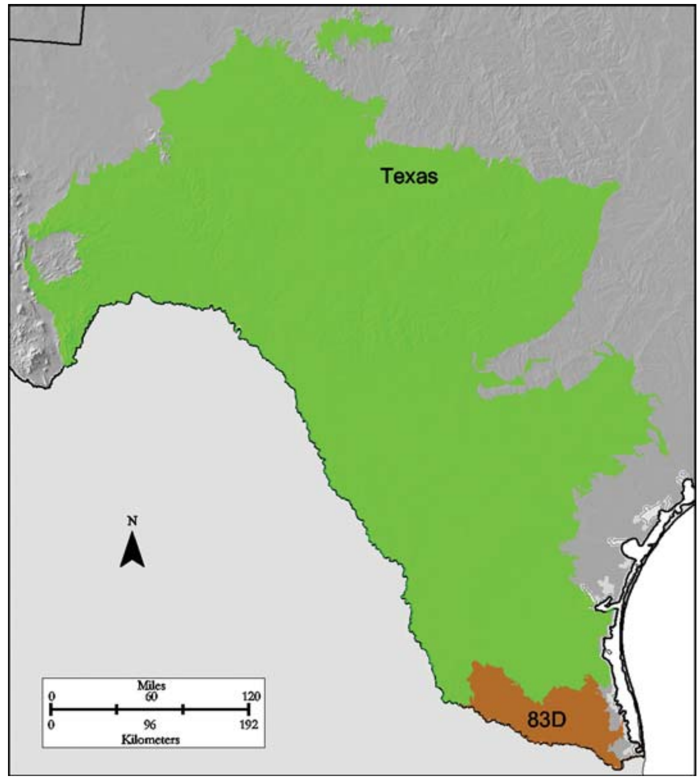

Figure 83D-1: Location of MLRA 83D in Land Resource Region I.

Physiography

This area is in the West Gulf Coastal Plain Section of the Coastal Plain Province of the Atlantic Plain. It is a broad, nearly level alluvial plain. Drainageways are shallow and have low gradients. Elevation ranges from about 15 feet (5 meters) in the eastern part of the area to about 600 feet (185 meters) in the northwestern part. It is mainly less than 275 feet (85 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Nueces-Southwestern Texas Coastal (1211), 73 percent, and Lower Rio Grande (1309), 27 percent. The Rio Grande forms the international boundary between the United States and Mexico in this MLRA. The river flows into the Gulf of Mexico just east of the MLRA.

Geology

Most of this area is on the coastal plain created when Cretaceous seas retreated towards the present-day Gulf of Mexico throughout Tertiary time. Lagoonal, estuarine, beach, flood-plain, and deltaic sediments were deposited in a wide swath paralleling the current coastline of Texas and other Gulf States. Fine textured sediments deposited in lagoons became shale layers, and the coarser textured sediments became sandstone layers. The rocks at the surface in this area are primarily alluvial sediments of the Goliad Formation of Miocene age and the Beaumont Formation of Pleistocene age.

Older sandstone layers below the alluvial sediments yield saline ground water in this area. Recent alluvial sediments are adjacent to the Rio Grande.

Climate

The average annual precipitation is 22 to 27 inches (560 to 685 millimeters) in most of this area. Most of the rainfall occurs as low- to moderate-intensity, Pacific frontal storms during winter. Hurricanes from the Gulf of Mexico occasionally trigger heavy rainfall in late summer and early fall in this area. The average annual temperature is 72 to 74 degrees F (22 to 23 degrees C). The freeze-free period averages 350 days and ranges from 330 to 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 6.2%; ground water, 5.4%
Livestock—surface water, 0.1%; ground water, 0.1%
Irrigation—surface water, 40.5%; ground water, 37.3%
Other—surface water, 10.0%; ground water, 0.3%

The total withdrawals average 800 million gallons per day (3,030 million liters per day). About 43 percent is from ground water sources, and 57 percent is from surface water sources. The rainfall is adequate for the growth of rangeland grasses. It is low in the western and central parts of the area and marginal in the eastern part. High temperatures and high evaporation and transpiration rates limit crop production. The Rio Grande, the only perennial stream in this area, provides water for irrigation and public supply. Two major reservoirs on the Rio Grande upstream from this area, the International Amistad and Falcon Reservoirs, dramatically improve the water quality in the river. The level of total dissolved solids can exceed 10,000 parts per million (milligrams per liter) at times above the Amistad Reservoir. The level is about 500 parts per million (milligrams per liter) below the Falcon Reservoir. In the uplands away from the valley of the Rio Grande, ponds provide water for livestock, domestic use, and irrigation. Reservoirs have been constructed on most of the larger, although intermittent, tributaries of the Rio Grande. Many irrigation and drainage channels are throughout this area.

Deep wells provide water for livestock, domestic use, public supply, and irrigation. The ground water in the part of the Gulf Coast aquifer beneath this area is typically more saline than that in the rest of this aquifer. It has 1,000 to 1,500 parts per million (milligrams per liter) total dissolved solids in the valley of the Rio Grande. The national standard for total dissolved solids in drinking water is 1,000 parts per million (milligrams per liter). Water from the upper part of the aquifer is moderately hard, but it becomes soft at greater depths as sodium displaces calcium. As more water is pumped from this aquifer, even more saline water at greater depths can move up into the pumping zone.

Soils

The dominant soil orders in this MLRA are Alfisols, Mollisols, Vertisols, and Inceptisols. The soils in the area have a hyperthermic soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They are generally very deep, well drained or moderately well drained, and loamy or clayey. Haplustalfs (Brennan series) formed in mixed colluvium and residuum on ridges. Paleustalfs (Delfina series) and Calciustepts (McAllen series) formed in loamy sediments on old terraces and uplands. Haplustolls (Laredo and Ramadero series), Argiustolls (Racombes and Willacy series), and Calciustolls (Hidalgo and Raymondville series) formed in alluvium on deltas and stream terraces and in drainageways. Haplusterts (Harlingen and Mercedes series) formed in alluvium on stream terraces.

Biological Resources

The open grassland in this area supports mid prairie grasses with scattered woody plants and some perennial forbs and legumes on soils in the uplands. Twoflower and fourflower trichloris, plains bristlegrass, and lovegrass tridens are among the dominant grasses on these soils. Desert yaupon, spiny hackberry, and blackbrush are the major woody plants. Tall and mid grasses, such as switchgrass, giant sacaton, fourflower trichloris, big sandbur, little bluestem, and southwestern bristlegrass, are dominant in savanna plant communities on bottom land. Hackberry, mesquite, elm, and palm trees are the major woody plants. Forbs are important but minor components of the plant communities.

Some of the major wildlife species in this area are white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 54%
Grassland—private, 27%; Federal, 3%
Urban development—private, 11%
Water—private, 2%
Other—private, 3%

Most of this area is cropland or improved pasture that is extensively irrigated. A large acreage is rangeland grazed mainly by beef cattle and wildlife. The major crops are cotton, grain sorghum, citrus, onions, cabbage, and other truck crops. Almost all of the crops are grown under irrigation. Hunting leases for white-tailed deer, quail, white-winged dove, and mourning dove are an important source of income in the area. The area has some urban land, mainly in the southern part.

The major soil resource concerns are soil quality and the condition of the soils, salinity, subsurface drainage, water erosion, wind erosion, and an adequate quality and quantity of irrigation water. The major land use problems are saline soils and inadequate subsurface drainage on cropland.

Conservation practices on cropland generally include conservation crop rotations, nutrient management, pest management, crop residue management, surface roughening, irrigation systems, irrigation water conveyance pipelines, and irrigation water management. Conservation practices on rangeland include reasonable stocking rates, proper grazing use, timely deferment of grazing, and pasture rotation. ■

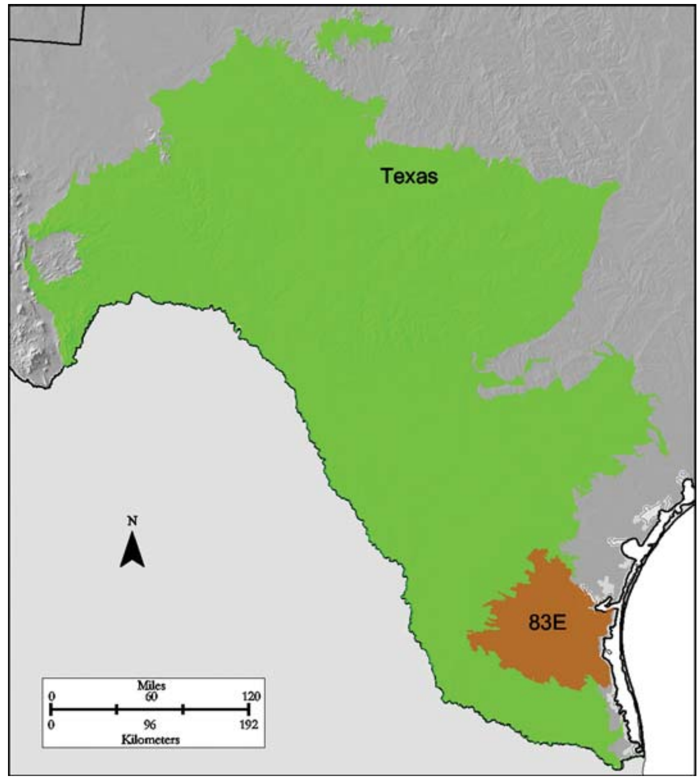

Figure 83E-1: Location of MLRA 83E in Land Resource Region I.

83E—Sandsheet Prairie

This area is entirely in Texas (fig. 83E-1). It makes up about 4,300 square miles (11,150 square kilometers). The towns of Falfurrias, Premont, and Sarita are in this area. U.S. Highways 77 and 281 run through the area in a north-south direction.

Physiography

This area is in the West Gulf Coastal Plain Section of the Coastal Plain Province of the Atlantic Plain. It is a nearly level to undulating eolian sand sheet. The surface consists of small mounds or elongated ridges and closed saline depressions aligned from southeast to northwest in response to prevailing southeasterly winds. These features result from the deposition of windblown sand into elongated dunes and from erosion of elongated blowouts or wind-eroded depressions. Native grasses and live oaks have stabilized most of the dune ridges. Dunes that have not been stabilized are active and move slowly to the northwest during dry summer months. Elevation ranges from sea level near the shore of the Gulf of Mexico in the eastern part of the area to 920 feet (280 meters) in the western part of the area.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Nueces Southwestern Texas Coastal (1211), 97 percent; Rio Grande Falcon (1308), 2 percent; and Lower Rio Grande (1309), 1 percent. This area has no major rivers.

Geology

Recent (Holocene) alluvium and wind-deposited sand sheet, silt sheet, clay dune, and base-level plain sediments were deposited on Pleistocene and Tertiary geologic formations in this area. The eolian sediments conceal these formations in most of the area. These older formations include (from east to west across the area) the Beaumont and Lissie Formations of Pleistocene age, the Goliad Formation of Pliocene age, the Catahoula Formation of Miocene age, and the Frio Formation of Oligocene age. The soils in this MLRA formed during the Holocene, but the duration of soil formation depended on landform stability and the period when eolian deposition ended. Soil formation initiated with sand dune stabilization. Wind-deposited silts and fine sands of the Riviera Loess Sheet are in the extreme northern part of the area. The soils in this part of the area have a higher content of clay and salts, particularly in the subsoil, than similar soils in other parts of the area. Loamy dunes, locally referred to as clay dunes, are wind-deflation deposits that border the western and northern margins of relict lakes. They resulted from eolian deposition of sand-sized aggregates of silt and clay particles that eroded from dry lakebed sediments.

Climate

The average annual precipitation in this area is 22 to 28 inches (560 to 710 millimeters). Most of the rainfall occurs in spring and fall. The average annual temperature is 71 to 73 degrees F (22 to 23 degrees C). The freeze-free period averages 345 days and ranges from 325 to 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 8.7%; ground water, 23.9%
Irrigation—surface water, 11.2%; ground water, 56.2%
Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average 9 million gallons per day (34 million liters per day). About 80 percent is from ground water sources, and 20 percent is from surface water sources. The rainfall is adequate for the growth of rangeland vegetation. Crop yields, however, are limited by periods of moisture stress caused by high evaporation and transpiration rates and in some areas by salinity. Ponds provide water for livestock, limited irrigation, and domestic use. This area does not have an integrated stream drainage network. The small amount of surface water in the area is somewhat saline and is not generally suitable for most uses. The amount of rainfall that accompanies hurricanes and major storms cannot be discharged by the small drainage systems. Therefore, broad areas may be flooded for weeks following a major storm.

Deep wells in the Gulf Coast aquifer system provide water of fairly good quality for livestock, limited irrigation, and domestic use. This aquifer consists of a complex of young, interbedded clays, silts, sands, and gravel. The water is hard and slightly saline. It typically has 1,000 to 1,500 parts per million (milligrams per liter) total dissolved solids. Wells more than 500 feet deep encounter soft water where sodium is replacing calcium.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, and Inceptisols. Most of the soils are Ustalfs, Psamments, Aqualfs, or Aquepts. They are deep or very deep and are moderately coarse textured or coarse textured. They have a hyperthermic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy. Very deep, excessively drained Ustipsamments (Falfurrias series) formed on recently stabilized sand dunes. Well drained Paleustalfs (Sarita and Nueces series) formed in sandy sediments on the stabilized parts of the sand-sheet landscape.

Natrustalfs, Natraqualfs, and Halaquepts are associated with salt-affected areas near Laguna Madre and inland depressions and flats. Deep, moderately well drained Natrustalfs (Palobia, Quiteria, and Padrones series) have a thick surface layer of sand and a sandy to loamy subsoil with redoximorphic features. Deep, somewhat poorly drained Natraqualfs (Sauz series) and very deep, poorly drained Halaquepts (Saucel series) formed on nearly level, low coastal terraces adjacent to tidal flats.

Biological Resources

The dominantly open grassland in this area has a mixture of mid and tall grasses and perennial forbs. Stable dunes support live oaks in the form of thickets and large motts separated by low-lying areas of grassland. Salt-affected, poorly drained or very poorly drained soils are dominated by gulf cordgrass. Seacoast bluestem, brownseed paspalum, tanglehead, switchgrass, Indiangrass, snoutbean, and western indigo dominate soils that formed in the thicker deposits of sand. Once denuded, these sands are very difficult to revegetate. As thickness of the sandy surface soil decreases to less than 20 inches (50 centimeters), fourflower trichloris, Arizona cottontop, plains bristlegrass, hooded windmillgrass, and partridge pea become more dominant and make up a major part of the vegetation. A mixture of brush species also dominates the soils as retrogression occurs.

Some of the major wildlife species in this area are white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, white-winged dove, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 5%
Grassland—private, 88%; Federal, 3%
Urban development—private, 1%
Water—private, 2%
Other—private, 1%

Most of this area is rangeland grazed by beef cattle and wildlife. Some areas have been converted to pasture, which generally is seeded to coastal bermudagrass or kleingrass. Hunting leases for deer, wild turkey, quail, mourning dove, white-winged dove, javelina, and numerous species of exotic game are an important source of income in the area.

The major soil resource concerns are accessory soil minerals, including salts, and rangeland site stability. Plant productivity, health, and vigor and undesirable woody species and cactus, which compete with adapted grassland species, are other major concerns.

Conservation practices on rangeland generally include brush control, range planting, prescribed grazing management, prescribed burning, firebreaks, fencing, adequate water distribution systems, and development of upland wildlife habitat. ■

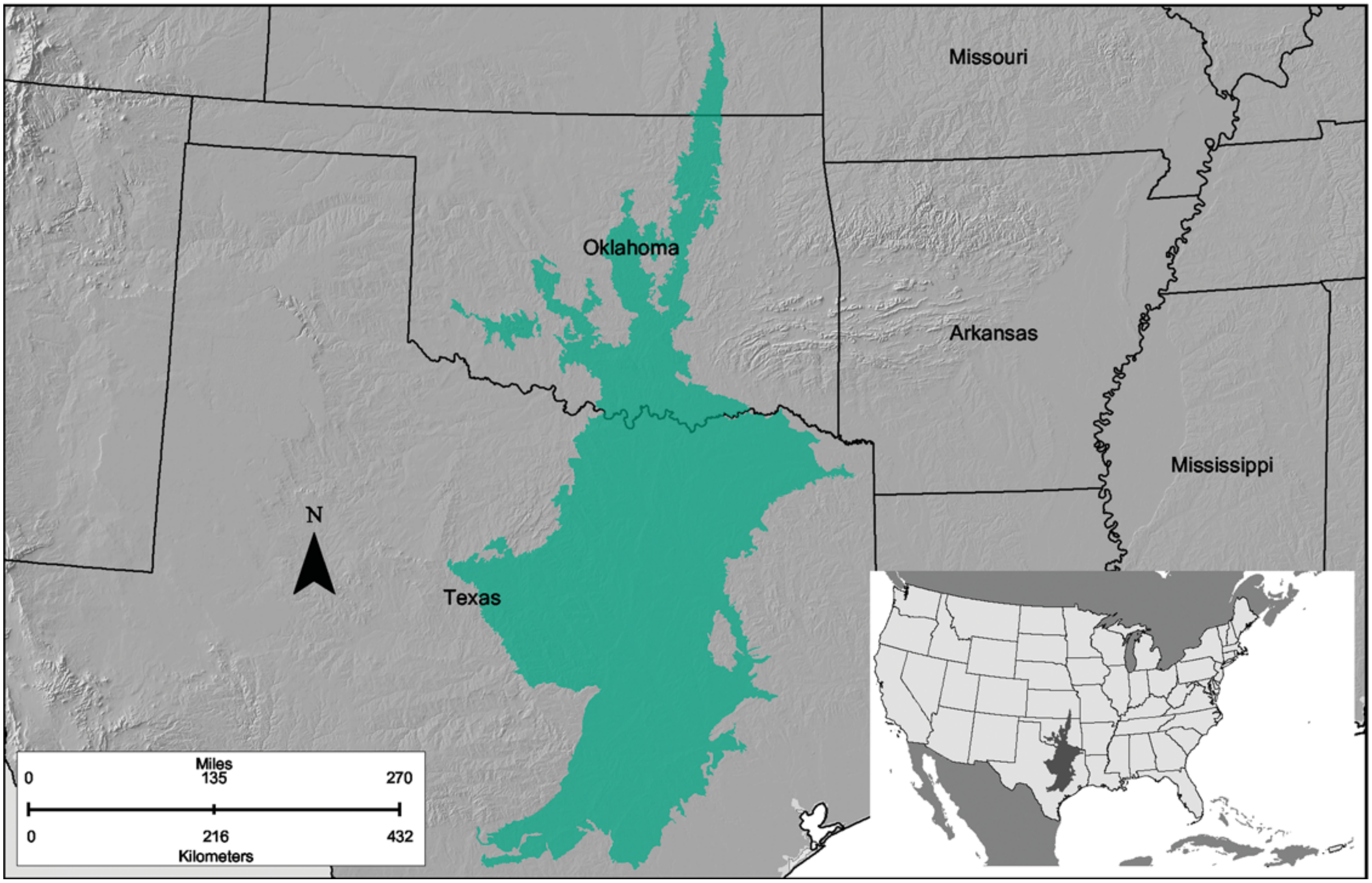

Figure J-1: Location of Land Resource Region J.

J—Southwestern Prairies Cotton and Forage Region

This region (shown in fig. J-1) is in Texas (78 percent), Oklahoma (21 percent), and Kansas (1 percent). It makes up 59,700 square miles (154,695 square kilometers). It is in the southern Great Plains. Most of the population in Texas, away from the coast, lives in this region.

The northern and western parts of this region consist of gently rolling to hilly uplands dissected by numerous streams, and the rest of the region is mainly a nearly level to gently sloping, dissected plain. The Arbuckle and Wichita Mountains are in the northern part of the region.

Moderate precipitation is accompanied by moderately high temperatures. The average annual precipitation ranges from 31 to 44 inches (785 to 1,120 millimeters). Most of the precipitation falls in spring and summer. The average annual temperature ranges from 62 to 67 degrees F (17 to 19 degrees C). The freeze-free period ranges from 245 to 290 days, increasing in length from north to south.

The total withdrawals of freshwater in this region average about 4,935 million gallons per day (18,680 million liters per day). About 86 percent is from surface water sources, and 14 percent is from ground water sources. In this heavily populated region, about 62 percent of the water is used for municipal and industrial supply and 28 percent is used for public supply.

The soils in this region are dominantly Mollisols, Entisols, Alfisols, and Vertisols. The major soil suborders are Paleustalfs, Haplustolls, Haplusterts, and Argiustolls. All of the soils in the region have a thermic soil temperature regime, and most have an ustic soil moisture regime. Mineralogy is dominantly mixed or smectitic, but it is siliceous in the Cross Timbers area and carbonatic on the Edwards Plateau, the central part of the region.

About 98 percent of this region is privately owned. The native vegetation consists mainly of grasses and scattered trees. The areas of trees are concentrated in the Cross Timbers area. Grasslands include mixtures of range, pasture, and improved pasture. Grazing by beef cattle is the dominant land use in most of the region, but hay, grain sorghum, and small grains are grown in areas where the soils, topography, and moisture

Figure J-2: Cotton and prairie grasses in an area of Land Resource Region J.

supply are favorable. Other locally important crops include corn, cotton (fig. J-2), and peanuts. Pecans are grown on well drained soils that are not flooded very often and are on the higher terraces along many of the major rivers crossing the region. Vegetables are grown in areas where irrigation water is available.

The major resource concerns are overgrazing and the invasion of undesirable plant species. Water erosion also is a major resource concern, especially on cropland. Surface compaction, moisture management, and maintenance of the content of organic matter in the soils are additional concerns in areas of cropland. ■

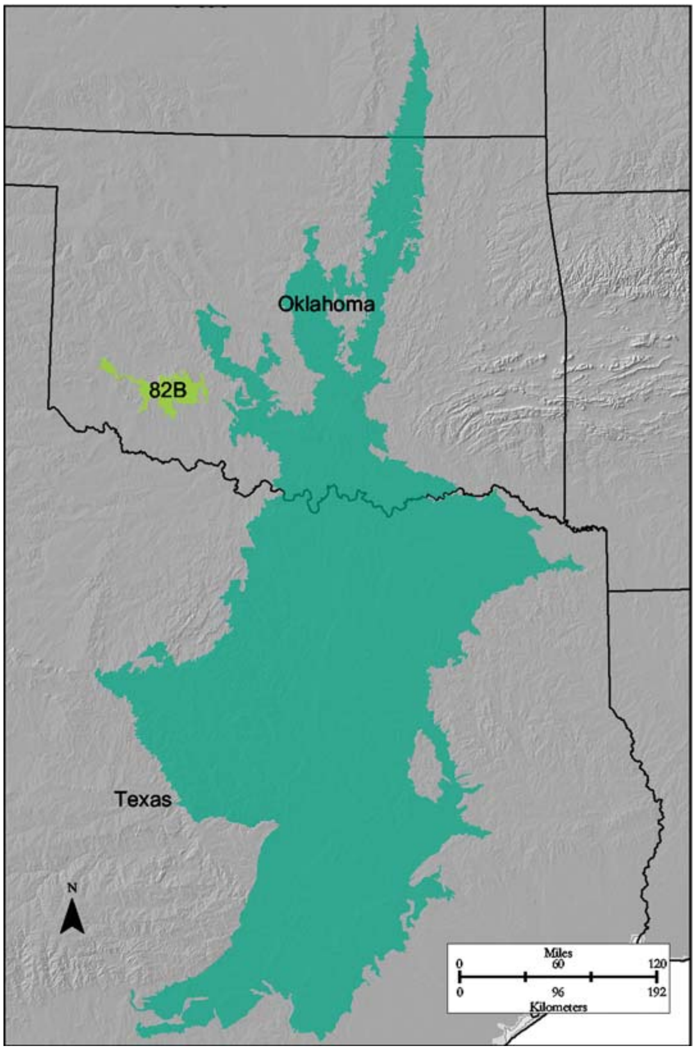

Figure 82B-1: Location of MLRA 82B in Land Resource Region J.

82B—Wichita Mountains

This area is entirely in southwestern Oklahoma (fig. 82B-1). It makes up about 1,060 square miles (2,740 square kilometers). The towns of Granite, Snyder, Medicine Park, and Meers are in this MLRA. U.S. Highways 62 and 183 intersect in the area, and Interstate 44 crosses the far eastern end. Quartz Mountain State Park, the Wichita Mountains Wildlife Refuge, and the Fort Sill Military Reservation are in this area.

Physiography

This area is in the Osage Plains Section of the Central Lowland Province of the Interior Plains. The landscape of the area is characterized by rugged hills and mountains made up mainly of extrusive granite. Areas where the granite is at the surface are nearly barren of vegetation. The faulted granite blocks stand (at the highest point) about 1,000 feet (305 meters) above the surrounding plains. A smooth, nearly level to moderately sloping erosional surface (pediment) is at the base of the hills and mountains. Elevation ranges from 1,100 feet (335 meters) to 2,020 feet (615 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Red-Washita (1113), 64 percent, and Red Headwaters (1112), 36 percent. The North Fork of the Red River crosses the west end of this area, and the Cache River drains the eastern part.

Geology

The surface geology of this MLRA is dominated by intrusive igneous rocks (primarily granite) of Precambrian age with associated limestone, sandstone, dolomite, chert, and shale of Cambrian age. This area is underlain by both igneous and sedimentary rocks in a structurally complex setting. Igneous rocks primarily include granite, rhyolite, gabbro, and anorthosite of Precambrian age. Sedimentary rocks include limestone, sandstone, dolomite, and chert in the Lower Arbuckle Formation (Timber Hills Group) of Cambrian age and limestone with minor inclusions of sandstone, chert, dolomite, and shale in the Upper Arbuckle Formation of Ordovician age. A large outcrop known as the “Limestone Hills” is part of this unit. The Meers Fault is a prominent geologic feature in this area.

Climate

The average annual precipitation in this area is 26 to 31 inches (660 to 785 millimeters). The annual amounts may fluctuate widely. Most of the rainfall occurs in spring and fall. The average annual temperature is 59 to 62 degrees F (15 to 17 degrees C). The freeze-free period averages 230 days and ranges from 220 to 245 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 31.3%; ground water, 18.8%
Irrigation—surface water, 31.3%; ground water, 18.8%
Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average 1.6 million gallons per day (6.0 million liters per day). About 38 percent is from ground water sources, and 62 percent is from surface water sources. Water is scarce throughout the area because of the low and erratic precipitation and few perennial streams. A few small areas of irrigated cropland are served by the Luger-Altus Irrigation District, which delivers water by canal from the Altus Reservoir on the North Fork of the Red River. Naturally occurring brine seeps make the river water saline.

Ground water in this area is used for domestic purposes, livestock, and some limited irrigation. Many springs and seeps occur locally throughout the area. The Arbuckle-Timbered Hills aquifer occurs in a very small area in Oklahoma. It is within this MLRA, and it provides water for domestic use and irrigation. The water in this aquifer is soft and has a median level of 772 parts per million (milligrams per liter) total dissolved solids. Naturally high levels of chloride and fluoride preclude use of the water for public supply. The only other principal aquifer in this area is a valley fill deposit in the valley of the North Fork of the Red River, in the northwest corner of the area. This aquifer provides water primarily for livestock and some limited irrigation. This ground water is similar in quality to the surface water.

Soils

Most of the soils in this MLRA are Mollisols or Ustolls. They have a thermic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy. Deep, nearly level to moderately sloping Argiustolls (Lawton series) formed on pediment surfaces. Very deep, moderately sloping to steep Argiustolls (Brico series) formed in cobbly, granitic colluvium on footslopes below granitic mountains. Shallow, very gently sloping to steep Haplustolls (Kiti series) formed in limestone residuum. Much of this area is covered by barren, granitic rock outcrop that is highly fractured.

Biological Resources

This area supports mid and tall prairie grasses interspersed with trees, particularly along fault lines. The diverse vegetation includes big bluestem, Indiangrass, little bluestem, switchgrass, sideoats grama, blue grama, buffalograss, post oak, blackjack oak, maple, buckbrush, Jersey tea, goldenrod, scurfpea, gayfeather, and Maximilian sunflower.

The major wildlife species in this area include white-tailed deer, coyote, black-tailed jackrabbit, prairie dog, bobwhite quail, ducks, and geese. The area has many manmade lakes that provide good opportunities for recreational fishing.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 30%
Grassland—private, 38%; Federal, 22%
Forest—private, 3%; Federal, 1%
Urban development—private, 2%
Water—private, 3%
Other—private, 1%

Farms and ranches make up nearly all of the private land in this area. Livestock grazing is the dominant land use, and most of the rangeland is used for cow-calf operations. Cropland makes up less than one-third of the area. Small grains, cotton, and grain sorghum are the principal crops. Recreation and tourism play a large part in the local economy. Most of the Federal land in the area is used for recreation, grazing, or military training and maneuvers.

The major soil resource concerns on cropland are control of water erosion and conservation of soil moisture. The major concern on rangeland is overgrazing. Conservation practices on cropland generally include conservation tillage, pest management, and irrigation water management. Conservation practices on rangeland generally include reasonable stocking rates, proper grazing use, and timely deferment of grazing. ■

84A—North Cross Timbers

This area (shown in fig. 84A-1) is in Oklahoma (91 percent) and Kansas (9 percent). It makes up about 7,705 square miles (19,965 square kilometers). It occurs in two separate parts. The towns of Ada, Norman, Shawnee, Sapulpa, and Sand Springs, Oklahoma, are in the larger eastern part of the area. Some areas of the western suburbs of Tulsa and the eastern suburbs of Oklahoma City, Oklahoma, also are in this part. Interstate 44 and the Cimarron Turnpike (U.S. Highway 412) cross the southern part of the area. Interstate 44 links Oklahoma City and Tulsa. The western part of this area is west of Interstate 35 and southwest of Oklahoma City. It includes the town of Duncan and is crossed by Interstate 44. There are no large towns in the part of this area in Kansas. The Osage Indian Reservation (Osage County, Oklahoma) makes up a large acreage in the center of the eastern part of this MLRA, just below the Kansas-Oklahoma border.

The Cross Timbers ecosystem once covered about 30,525 square miles (79,105 square kilometers), extending from central Texas, across Oklahoma, and into southeastern Kansas. Settlers had difficulty making their way through this area because of the tangled trees. The geographic name reflects this phenomenon. The short oak trees are not very marketable for lumber, so many areas have not been cleared for urban expansion or agriculture. Therefore, the Cross Timbers is one of the least disturbed forest types remaining in the eastern United States. The Cross Timbers ecosystem has been subdivided into three subunits—North Cross Timbers (MLRA 84A), West Cross Timbers (MLRA 84B), and East Cross Timbers (MLRA 84C).

Physiography

This area is in the Osage Plains Section of the Central Lowland Province of the Interior Plains. It is an area of rolling to hilly uplands. Summits and divides on the hilltops are nearly

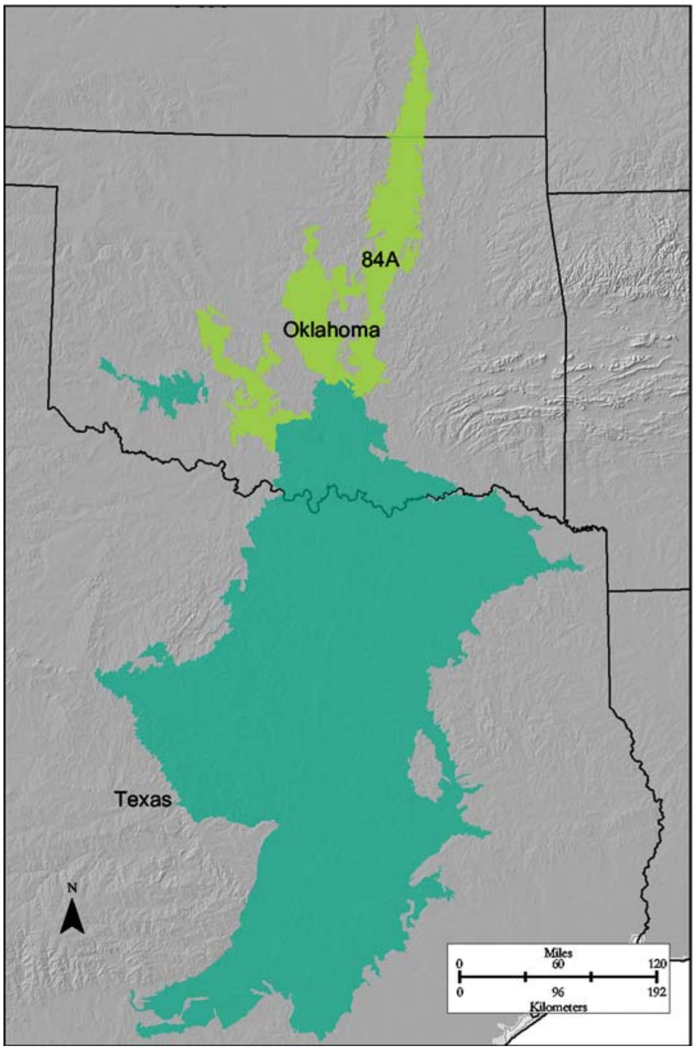

Figure 84A-1: Location of MLRA 84A in Land Resource Region J.

level to strongly rolling and narrow to moderately broad. Stream valleys are narrow and have steep gradients. Bedrock outcrops occur on both the hilltops and hillsides. Elevation ranges from 985 to 1,300 feet (300 to 395 meters). Local relief is mostly 65 to 100 feet (20 to 30 meters), but the large valleys are 165 feet (50 meters) or more below the adjacent uplands.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: North Canadian (1110), 24 percent; Neosho-Verdigris (1107), 24 percent; Red-Washita (1113), 19 percent; Lower Canadian (1109), 18 percent; Lower Arkansas (1111), 6 percent; Lower Cimarron (1105), 5 percent; Arkansas-Keystone (1106), 3 percent; and Red-Sulphur (1114), 1 percent. The major rivers in the area include the Verdigris River in Kansas and the Arkansas, Cimarron, and South Canadian Rivers in Oklahoma. Many large reservoirs on tributaries to these rivers are in this area.

Geology

Sandstones and shales of Permian age underlie the western part of this area. The eastern part, including the part in Kansas, is underlain by Pennsylvanian shale and sandstone. Pleistocene stream terraces are a minor part of the area. They are alongside the rivers.

Climate

The average annual precipitation is 30 to 40 inches (760 to 1,015 millimeters) in most of this area. It is closer to 30 inches (760 millimeters) in the extreme western part of the area. The maximum precipitation occurs in spring, and a small amount occurs in winter. Most of the rainfall occurs as high-intensity, convective thunderstorms in spring and summer. The annual snowfall ranges from 12 inches (30 centimeters) in the northern part of the area to 4 inches (10 centimeters) in the southern part. The average annual temperature is 56 to 63 degrees F (13 to 17 degrees C). The freeze-free period averages 230 days and ranges from 210 to 250 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 61.9%; ground water, 7.4%
Livestock—surface water, 9.4%; ground water, 1.8%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 17.2%; ground water, 2.2%

The total withdrawals average 180 million gallons per day (680 million liters per day). About 12 percent is from ground water sources, and 88 percent is from surface water sources. The moderate and somewhat erratic rainfall is the source of water for rangeland and cropland. Large reservoirs provide water for cities and towns and for recreation and flood control. Farm ponds are a major source of water for livestock.

In most of this area, shallow wells supply water for domestic use, but ground water is scarce in areas where sandstone and shale are near the surface. The Vamoosa-Ada aquifer underlies most of the area. It is a Pennsylvanian-age sandstone. It supplies soft to hard ground water primarily for public supply and municipal and industrial uses. The median level of total dissolved solids is 325 parts per million (milligrams per liter). This water is suitable for drinking unless some local contamination has resulted from oil and gas exploration and development activities.

The Rush Springs aquifer underlies the separate western part of this MLRA. It provides water primarily for irrigation. The median level of total dissolved solids is 408 parts per million (milligrams per liter). The water is very hard, but it can be used for public supplies, except in local areas where the national drinking water standards for chloride and sulfate are exceeded.

Ground water is pumped from alluvial sediments and terrace deposits along the major rivers that cross this area. This water is used primarily for irrigation and domestic supply. It has a slightly higher median level of total dissolved solids than the water in the Rush Springs aquifer, but otherwise it is very similar in quality.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Mollisols, and Inceptisols. The soils in the area dominantly have a thermic soil temperature regime, an ustic or udic soil moisture regime, and mixed, siliceous, or smectitic mineralogy. They generally are shallow to very deep, somewhat excessively drained to somewhat poorly drained, and loamy or clayey. Haplustalfs formed in alluvium on stream terraces (Dougherty and Konawa series) and in residuum on hills (Newalla, Steedman, and Stephenville series). Hapludalfs (Niotaze and Bartlesville series), Eutrudepts (Bigheart series), and Haplustepts (Darnell series) formed in residuum on hills. Paleustalfs (Harrah series) formed in colluvium on footslopes. Ustifluvents (Pulaski series) and Hapludolls (Verdigris series) formed in alluvium on flood plains. Paleudalfs (Prue series) formed in colluvium and/or residuum on footslopes.

Biological Resources

This area supports an open stand of oak trees with an understory of mid and tall grasses, forbs, and low woody plants. Post oak and blackjack oak are the dominant tree species. Big bluestem, little bluestem, Indiangrass, sunflower, and lespedezas are the major species in the herbaceous understory.

Some of the major wildlife species in this area are white-tailed deer, coyote, fox, bobcat, badger, beaver, raccoon, opossum, skunk, muskrat, jackrabbit, cottontail, mink, squirrel, prairie dog, bobwhite quail, mourning dove, Mississippi kite, and rattlesnake. The species of fish in the area include black bass and channel catfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 7%
Grassland—private, 41%; Federal, 15%
Forest—private, 27%
Urban development—private, 6%
Water—private, 3%
Other—private, 1%

Much of this area is in farms and ranches. More than one-half is rangeland, less than one-third is woodland, less than one-tenth is pasture, and less than one-tenth is cropland. The Osage Indian Reservation makes up almost all of the Federal land. Some areas are used for urban development and for other purposes. All of the areas of rangeland, woodland, and pasture are grazed by beef cattle, but there are dairy cattle in some areas. Small grains, grain sorghum, cotton, alfalfa, and other hay crops are important in much of the area. Peanuts, tree fruits, and vegetables are grown on a large acreage in the southern part of the area.

The major soil resource concerns are water erosion, surface compaction, moisture conservation, and conservation of organic matter in the soils. Plant health, plant vigor, and noxious and invading plants are the major management concerns on grassland. Conservation practices on cropland generally include terraces, grassed waterways, nutrient management, grade-control structures, conservation tillage, and pest management. Conservation practices on rangeland generally include brush management, fencing, nutrient management, proper grazing, and range planting. ■

84B—West Cross Timbers

This area (shown in fig. 84B-1) is in Texas (73 percent) and Oklahoma (27 percent). It makes up about 6,165 square miles (15,970 square kilometers). The city of Stephenville, Texas, is at the southern end of this long, narrow MLRA. The towns of Weatherford and Gainesville, Texas, are just outside the eastern border of the area, in the middle and northern parts, respectively. The part of this area in Oklahoma is between the cities of Ardmore and Durant. Interstate 35 crosses the northern part of the MLRA, and Interstate 20 crosses the middle. The Tishomingo National Wildlife Refuge is in the northeast corner of the area, in Oklahoma. The Lyndon B. Johnson National Grasslands is in the part of this area in Texas, and Dinosaur Valley State Park is on the southeastern boundary, in Texas.

Physiography

Most of this area is in the Osage Plains Section of the Central Lowland Province of the Interior Plains. The southeastern part of the area is in the Central Texas Section of the Great Plains Province of the Interior Plains, and the northeast corner is in the West Gulf Coastal Plain Section of the Coastal Plain Province of the Atlantic Plain. This MLRA is mainly undulating and has low relief and numerous narrow streams. The uplands are nearly level to rolling and are moderately dissected. The northern part of the area has a higher average slope gradient than the southern part and is gullied. The southern part is nearly level to undulating and has been significantly affected by wind erosion. Stream valleys are narrow and have steep gradients. Elevation is mainly 1,000 to 1,300 feet (305 to 395 meters), but it is about 660 feet (200 meters) along the Red River. Local relief is mostly 10 to 50 feet (3 to 15 meters).

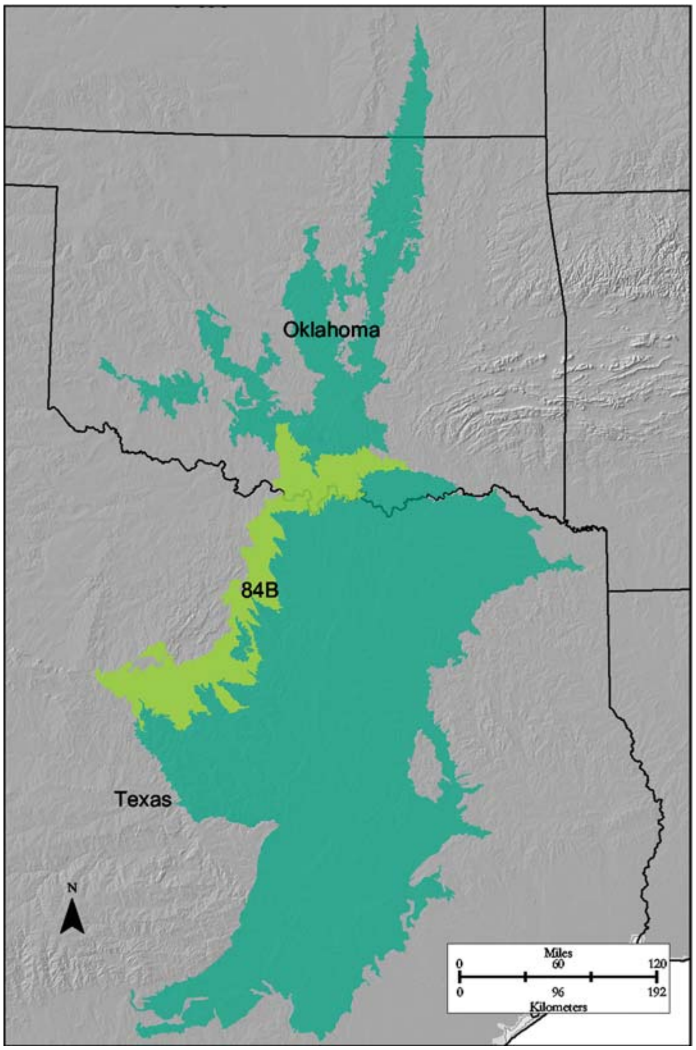

Figure 84B-1: Location of MLRA 84B in Land Resource Region J.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Red-Washita (1113), 32 percent; Middle Brazos (1206), 24 percent; Lower Brazos (1207), 20 percent; Trinity (1203), 19 percent; Lower Colorado-San Bernard Coastal (1209), 3 percent; and Red-Sulphur (1114), 2 percent. The Red River separates the States of Oklahoma and Texas in this area. Lake Texoma, on the Washita River, covers a significant portion of this area in Oklahoma. The Brazos and Trinity Rivers cross the part of this area in Texas. Denton Creek and many other streams forming the headwaters of the Trinity River also are in the Texas part of the area.

Geology

Cretaceous rocks of the Trinity Group are the primary aquifers underlying the surface throughout the length of this MLRA. Because of the southeast dip of these rocks, the oldest units are exposed along the west side of the area and successively younger units are exposed to the south and east. From youngest to oldest, the four units in the Trinity Group are the Antlers, Paluxy, Glen Rose, and Twin Mountains Formations. The Antlers and Twin Mountains Formations consist of alternating beds of sandstone, claystone, and conglomerate. The Paluxy Formation is primarily fine grained sandstone. The Glen Rose Formation is primarily a massive limestone and dolomite unit at its base and grades upwards into limestone, shale, marl, and gypsum beds. The Cretaceous Fredericksburg Formation, an interbedded limestone, shale, and clay unit overlying the Antlers Formation, is not an aquifer in this area. Unconsolidated sands and gravel fill the valleys along the Brazos and Trinity Rivers and their larger tributaries.

Climate

The average annual precipitation in most of this area is 26 to 42 inches (660 to 1,065 millimeters). It is 26 to 30 inches (660 to 760 millimeters) in the extreme southern part of the area. It declines from east to west. Most of the rainfall occurs as high-intensity, convective thunderstorms during summer. Almost 75 percent of the total annual precipitation falls during the freeze-free period. The typical summer moisture deficit ranges from about 7 to 10 inches (180 to 255 millimeters). Snow can occur in this area, but it does not remain on the ground for long periods. The average annual temperature is 62 to 66 degrees F (17 to 19 degrees C). The freeze-free period averages 255 days and ranges from 230 to 275 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 12.5%; ground water, 4.7%
Livestock—surface water, 9.8%; ground water, 1.7%
Irrigation—surface water, 31.0%; ground water, 13.0%
Other—surface water, 24.8%; ground water, 2.5%

The total withdrawals average 80 million gallons per day (300 million liters per day). About 22 percent is from ground water sources, and 78 percent is from surface water sources. The moderate and somewhat erratic rainfall is the source of water for pasture and crops. Farm ponds are a major source of water for livestock. Local streams flow intermittently. A few large reservoirs provide water for cities and towns and for recreation and irrigation. The surface water is generally of good quality and is suitable for almost all uses.

In most of this area, shallow wells supply water for domestic use, but ground water is scarce in areas where sandstone and shale are near the surface. The sandstone and carbonate layers in the Trinity Group are the primary aquifers throughout the area. Water in these units is very hard and has a median level of total dissolved solids of 619 parts per million (milligrams per liter). About 30 percent of the wells sampled in areas of these aquifers showed levels of nitrate in excess of the national drinking water standard of 10 parts per million (milligrams per liter). Public supply, irrigation, and some industrial supply wells occur throughout the area. Shallow wells for irrigation are common in the southern part of the area, but the availability and quantity of water vary greatly. Water levels have been declining because of overuse, so future development of ground water resources in this area is in jeopardy. Contamination from nitrate sources is a problem in these shallow aquifers.

Another source of ground water in this area is the unconsolidated deposits of sand and gravel that fill the major river valleys. This calcium-magnesium, carbonate-bicarbonate type of water is very hard, and almost half the samples tested showed levels of total dissolved solids that exceeded 1,000 parts per million (milligrams per liter). This aquifer also contained nitrate at concentrations greater than 10 parts per million (milligrams per liter) in 40 percent of the samples tested.

Soils

The dominant soil orders in this MLRA are Alfisols and Entisols. The soils in the area dominantly have a thermic soil temperature regime, an ustic soil moisture regime, and mixed or siliceous mineralogy. They generally are deep or very deep, well drained or moderately well drained, and loamy or clayey. Ustifluvents (Pulexas series) formed in alluvium on flood plains. Paleustalfs formed in residuum on plains (Chaney series) and in sandy, loamy, and/or clayey sediments on uplands (Demona, Duffau, Nimrod, Pedernales, Selden, and Windthorst series). Paleudalfs (Bernow series) formed in loamy sediments on uplands.

Biological Resources

This area supports savanna vegetation. Tall grasses are interspersed with trees and underbrush. Little bluestem, purpletop tridens, Indiangrass, switchgrass, big bluestem, sand lovegrass, post oak, blackjack oak, elm, coralberry, greenbrier, and elbowbush are the dominant species. Engelmann's daisy, Maximilian sunflower, and trailing wildbean are among the numerous perennial forbs.

Some of the major wildlife species in this area are white-tailed deer, coyote, fox, bobcat, raccoon, skunk, opossum, rabbit, armadillo, squirrel, quail, and mourning dove. The species of fish in the area include largemouth bass, channel catfish, and bream.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 12%
Grassland—private, 66%; Federal, 2%
Forest—private, 5%
Urban development—private, 10%
Water—private, 4%
Other—private, 1%

Most of this area is in farms and ranches. About 70 percent of the area is native grass pasture, improved pasture, or noncommercial oak forests that are used for grazing. Most of the areas of pasture, rangeland, and woodland are grazed by beef cattle, but dairy cattle are important in some areas. Generally, the acreage of cropland is decreasing and that of improved pasture is increasing. The main crops are peanuts, grain sorghum, small grains, and forage sorghum. Improved bermudagrass and other hay crops also are important in the area. Locally, peaches, apples, pecans, and vegetables are important crops. About one-tenth of the area is used for urban development and other purposes.

The major natural resource concerns include wind erosion; water erosion (gully, sheet, and rill erosion); streambank erosion; plant productivity, health, and vigor; and water for livestock.

Conservation practices on cropland generally include nutrient and pest management, crop residue management, critical area planting, development of ponds, and streambank and shoreline protection. Conservation practices on pasture, rangeland, and forestland generally include riparian forest buffers, fencing, forage harvest management, brush management, prescribed burning, and proper grazing use. ■

84C—East Cross Timbers

This area is entirely in north-central Texas (fig. 84C-1). It makes up about 1,320 square miles (3,425 square kilometers). The cities of Arlington, Cleburne, Denton, Gainesville, and Fort Worth are in this MLRA. Interstate 20 crosses the area from east to west, and Interstate 35E roughly forms the eastern boundary. Ray Roberts State Park, on Lake Ray Roberts, and the Eisenhower State Parks, on Lake Texoma, are two of the more well known recreational areas in the MLRA.

Physiography

The boundary between two major physiographic divisions occurs in this area. Most of the western half of the area is in the Osage Plains Section of the Central Lowland Province of the Interior Plains. The eastern half is in the West Gulf Coastal

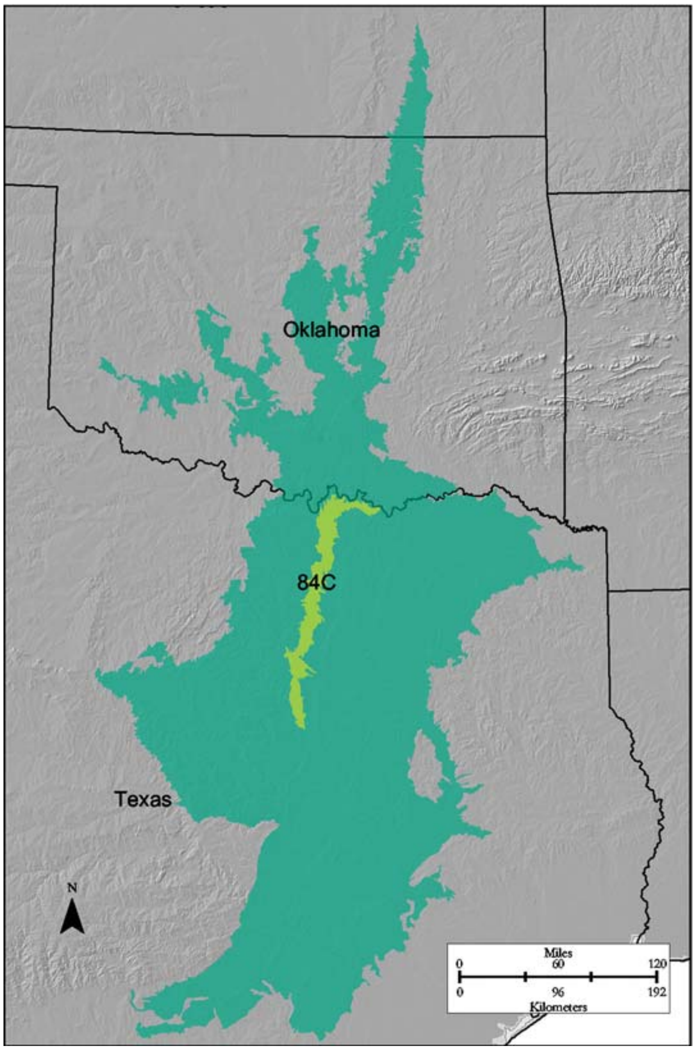

Figure 84C-1: Location of MLRA 84C in Land Resource Region J.

Plain Section of the Coastal Plain Province of the Atlantic Plain. The area is characterized by gently sloping to rolling uplands that are moderately dissected. Sandstone-capped hills and ridges rise prominently above the surrounding landscape. Stream valleys are narrow and have steep gradients. Elevation ranges from about 500 to 1,000 feet (150 to 305 meters). Local relief is mostly 3 to 50 feet (1 to 15 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Trinity (1203), 65 percent; Red-Washita (1113), 16 percent; Middle Brazos (1206), 15 percent; and Red-Sulphur (1114), 4 percent. The Brazos, Red, and Trinity Rivers dissect the MLRA. Lake Texoma, on the Red River, is in the northern part of the area. Lakes Arlington, Grapevine, Lewisville, and Ray Roberts are in the central part, on tributaries of the Trinity River. Lake Aquilla is in the southern part of the MLRA, on a tributary of the Brazos River.

Geology

This area is underlain by interbedded sandstones and shales in the Woodbine Formation of Cretaceous age. On this gently sloping to rolling landscape, the more resistant sandstones form ridges and hilltops and the more erodible sediments form side slopes, hillsides, and valleys.

Climate

The average annual precipitation in this area is 34 to 41 inches (865 to 1,040 millimeters). Most of the rainfall occurs in spring and fall. The average precipitation during the freeze-free period is about 24 to 26 inches (610 to 660 millimeters). The average annual temperature is 62 to 66 degrees F (17 to 19 degrees C). The freeze-free period averages about 265 days and ranges from 255 to 280 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 15.2%; ground water, 9.6%
Livestock—surface water, 0.1%; ground water, 0.0%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 74.5%; ground water, 0.5%

The total withdrawals average 1,510 million gallons per day (5,715 million liters per day). About 10 percent is from ground water sources, and 90 percent is from surface water sources. The moderate and somewhat erratic rainfall is generally sufficient for quality native forage and for watering livestock. Also, it is the major source of water for pasture and crops. Local streams flow intermittently. Large reservoirs on the major streams provide water for cities and towns. The lake water is used for public supply, industry, and recreation. Farm ponds are a major source of water for livestock. The surface water is generally of good quality and is suitable for most uses.

In most of this area, shallow wells supply water for domestic use. A few small irrigation wells supply a limited quantity of water. Sandstone and carbonate layers in the Trinity Group are the principal aquifers in this MLRA. The ground water in these aquifers is very hard and has a median level of 619 parts per million (milligrams per liter) total dissolved solids. About 30 percent of the samples from areas of these aquifers exceeded the national drinking water standard for nitrate. Falling water tables limit the use of this aquifer.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, and Mollisols. They are moderately deep or deep, medium textured to coarse textured, and moderately well drained to somewhat excessively drained. They have a thermic soil temperature regime, an ustic soil moisture regime, and smectitic, siliceous, or mixed mineralogy. Shallow and moderately deep Haplustalfs (Rayex series) and Paleustalfs (Birome series) formed on sandstone-capped hills and ridges. Deep, well drained and moderately well drained Paleustalfs (Callisburg and Crosstell series) formed in clayey material on hillsides. Very deep, well drained, moderately permeable Ultic Paleustalfs (Gasil and Konsil series) formed in sandy material on hillsides. Very deep, well drained Arenic Paleustalfs (Silstid series) and very deep, somewhat excessively drained Psammentic Paleustalfs (Eufaula series) formed in sandy material and have a thick, sandy surface layer. Deep, gently sloping Paleustalfs (Bastrop and Bastsil series) formed on stream terraces and footslopes on erosional remnants. Nearly level Haplustolls (Whitesboro series) and Ustifluvents (Pulexas and Bunyan series) formed on narrow flood plains along tributaries.

Biological Resources

The native vegetation in this area consists of mid and tall grasses interspersed with blackjack oak and post oak. The area supports oak savanna vegetation with an understory of tall grasses. Little bluestem, purpletop tridens, Indiangrass, switchgrass, big bluestem, post oak, blackjack oak, elm, coralberry, American beautyberry, bumelia, greenbrier, and elbowbush are some of the dominant species. Engelmann's daisy, lespedezas, and trailing wildbean are among the numerous perennial forbs.

Some of the major wildlife species in this area are white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 13%
Grassland—private, 47%; Federal, 4%
Forest—private, 1%
Urban development—private, 25%
Water—private, 8%
Other—private, 2%

Most of this area is in farms and ranches, but sizable tracts in the central part of the area are rapidly being converted to urban uses. Some of the large tracts are being fragmented into smaller ranches. Most of this rural area is used as improved pasture, native grass pasture, or noncommercial oak forest and is grazed mainly by beef cattle. Some areas are used for peanuts, small grains, forage sorghum, fruits, or vegetables.

The major resource concerns are water quality, wind erosion, and water erosion. Conservation practices that are important for water quality are nutrient management and riparian buffers. Also, proper management of septic tank absorption fields can help to prevent pollution of the lakes in the MLRA. Wildlife habitat is an important management objective of the landowners in the MLRA. Warm-season improved pastures are established to protect the area from erosion and to produce forage for livestock. ■

85—Grand Prairie

This area (shown in fig. 85-1) is in north-central Texas (83 percent) and south-central Oklahoma (17 percent). It makes up about 10,400 square miles (26,955 square kilometers). It occurs in two separate parts. The cities and towns of Belton, Cleburne, Denton, Fort Worth, Gainesville, Killeen, and Weatherford, Texas, and Ardmore and Sulphur, Oklahoma, are in this MLRA. Interstate 35 crosses this area in both States, and Interstate 20 crosses Interstate 35 in Fort Worth, Texas. The Fort Hood Military Reservation, most of Dinosaur Valley State Park, and the eastern tip of the Lyndon B. Johnson National Grasslands are in the part of this area in Texas. The Chickasaw National Recreation Area is in the part in Oklahoma.

Physiography

The northern one-third of this area, in Oklahoma and Texas, is in the Osage Plains Section of the Central Lowland Province of the Interior Plains. The southern two-thirds is in the Central Texas Section of the Great Plains Province of the Interior Plains. This area is characterized by gently rolling to hilly, dissected limestone plateaus and the adjacent gently sloping valleys. Steep slopes commonly border the valleys along the major streams that cross the area. The Arbuckle Mountains, in southern Oklahoma, consist mainly of rugged hills and plateaus with deeply dissected canyons and steep slopes bordering valleys. Elevation ranges from 500 to 1,310 feet (150 to 400 meters) in most of the area, but it ranges from 1,310 to 1,650 feet (400 to 505 meters) in the Arbuckle Mountains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Brazos (1207), 32 percent; Middle Brazos (1206), 26 percent; Trinity (1203), 19 percent; Red-Washita (1113), 11 percent; Lower Colorado-San Bernard Coastal (1209), 6 percent; Red-Sulphur (1114), 4 percent; and Lower Canadian (1109), 2 percent. The upper tributaries and reaches of the Trinity and Brazos Rivers are in the part of this area in Texas. The Colorado River is just outside the southern end of the area. The Washita River is in the northern part of the area, in

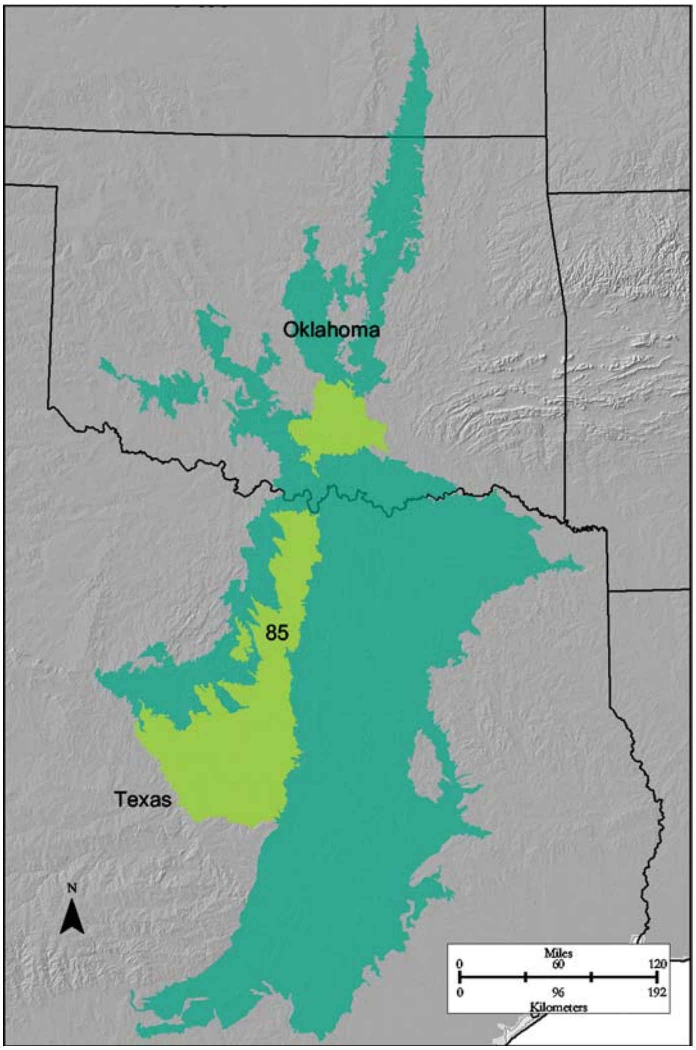

Figure 85-1: Location of MLRA 85 in Land Resource Region J.

Oklahoma. Numerous flood-control and water-supply reservoirs are throughout this area.

Geology

Most of this area is underlain by limestones and shales in the Glen Rose Formation, Walnut Clay, Comanche Peak Limestone, Edwards Limestone, Duck Creek Limestone, and the Kiamichi Formation of Cretaceous age. These are mostly flat-lying formations. The more resistant members form the summits of ridges and hills, and the less resistant members form hillslopes and valleys. There is a gentle southeastward dip of about 15 feet per mile (3 meters per kilometer). In the structurally complex Arbuckle Mountains of southern Oklahoma, outcropping rocks are primarily limestone, sandstone, dolomite, quartzite, and chert. These units are exposed as alternating beds of Paleozoic rocks that have been faulted, tilted, and deformed to form a tombstone-like topography. Deep oil and gas wells have been drilled into these folded sediments. This area has significant exposures of granite, rhyolite, and gabbro of Precambrian age.

Climate

The average annual precipitation in this area is 27 to 41 inches (685 to 1,040 millimeters). Most of the rainfall occurs in spring and fall. The average precipitation during the freeze-free period is 23 to 26 inches (585 to 660 millimeters). The average annual temperature is 60 to 67 degrees F (16 to 19 degrees C). The freeze-free period averages 260 days and ranges from 235 to 290 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 11.4%; ground water, 6.3%
Livestock—surface water, 2.1%; ground water, 0.3%
Irrigation—surface water, 14.0%; ground water, 5.0%
Other—surface water, 59.9%; ground water, 0.9%

The total withdrawals average 545 million gallons per day (2,060 million liters per day). About 13 percent is from ground water sources, and 87 percent is from surface water sources. In most years the moderate and often erratic rainfall is adequate for crops, pasture, and rangeland. Summer droughts commonly reduce yields. The large rivers flow all year, and large reservoirs provide municipal water and opportunities for recreation. Most of the lakes and reservoirs within the Brazos River watershed are brackish and used mainly for flood control and recreation. Small farm ponds are an important source of water for farm use (primarily livestock) and wildlife.

Deep ground water is abundant in the Cretaceous limestone and sandstone layers of the Trinity Group aquifer in Texas. This aquifer is at the surface throughout most of the part of this area in Texas, and many seeps, springs, and local streams provide water, mostly during spring and winter. The median level of total dissolved solids in this ground water is 619 parts per million (milligrams per liter), and the water is very hard. About 30 percent of all the wells tested in this aquifer have nitrate concentrations that exceeded the national drinking water standard of 10 parts per million (milligrams per liter). This aquifer is heavily used for public supply, for municipal and industrial water, and for irrigation. Some areas where water levels have dropped significantly have begun to limit pumping from this aquifer.

The Arbuckle-Simpson aquifer is in the part of this area in Oklahoma. It supplies drinking water to domestic users but has not been fully developed. The water is generally of good quality, although chloride and fluoride levels exceed the national standards for drinking water in some areas. The median level of total dissolved solids in this ground water is

369 parts per million (milligrams per liter), and the water is very hard.

Soils

The dominant soil orders in this MLRA are Vertisols and Mollisols. The soils generally have a thermic soil temperature regime, an ustic soil moisture regime, and smectitic, carbonatic, or mixed mineralogy. Moderately deep to very deep Haplusterts (Crawford, Sanger, and Slidell series) have smectitic mineralogy and typically formed in nearly level to gently sloping areas. Very deep, moderately well drained Haplusterts (Branyon series) have smectitic mineralogy and formed on stream terraces. Shallow and very shallow, gravelly and stony Calciustolls (Aledo and Purves series) formed over limestone bedrock in gently sloping to steep areas. Moderately deep and deep, well drained Calciustolls (Bolar and Denton series) formed over limestone bedrock primarily in gently sloping areas. Shallow Haplustolls (Eckrant series) with smectitic mineralogy and shallow Ustorthents (Maloterre series) with carbonatic mineralogy formed in limestone residuum in gently sloping to moderately steep areas on ridges and plateaus. Shallow Haplustepts (Brackett series) and shallow Calciustolls (Real and Doss series) have carbonatic mineralogy and formed in limestone residuum in sloping to steep areas. Shallow, nearly level to sloping Argiustolls (Speck and Tarpley series) formed over limestone bedrock on ridges and plateaus. Very deep, well drained Haplustolls (Krum series), Calciustolls (Venus and Lewisville series), and Argiustolls (Blanket series) formed on stream terraces and the lower valley slopes. Very deep, well drained Haplustolls (Frio, Bosque, and Gowen series) have significant accumulations of organic matter and formed on flood plains. Rock outcrop occurs along ridgetops throughout the area.

In the Arbuckle Mountains of Oklahoma, most of the soils are Ustolls, Ustalfs, or Ustepts. They have a thermic soil temperature regime, an ustic soil moisture regime, and mixed, siliceous, or smectitic mineralogy. Very shallow to deep, gently sloping to steep Haplustolls (Kiti, Rayford, and Timhill series), Haplustalfs (Bromide series), Argiustolls (Scullin series), and Haplustepts (Travertine and Tussy series) formed on plateaus and mountain slopes. Very deep, gently sloping Paleustalfs (Bastrop and Gasil series) and Haplustalfs (Konawa series) formed on stream terraces. Very deep, nearly level Haplustolls (Dale series) and Ustifluvents (Yahola series) formed on flood plains along the major drainageways. Rock outcrop occurs throughout the Arbuckle Mountains.

Biological Resources

The native vegetation in this area consists of mid and tall grasses interspersed with scattered oaks. Little bluestem, Indiangrass, big bluestem, and switchgrass are typical species on the deeper soils. Texas wintergrass, little bluestem, silver bluestem, buffalograss, and sideoats grama, as well as scattered shin oak, live oak, elm, ash, and juniper, are characteristic plant species on shallow soils and on soils along escarpments. Areas of deteriorated rangeland commonly have increased amounts of short grasses, annuals, weeds, pricklypear, elm, mesquite, and blueberry juniper.

The Arbuckle Mountains support mid and tall grasses. Sideoats grama and little bluestem are the major species. Indiangrass, big bluestem, switchgrass, hairy grama, dropseed, and forbs are common. Sycamore and willow grow along creeks. Prairie fires restrict the spread of sumac, skunkbush, and other shrubs. Resource deterioration results in a higher percentage of short grasses, annuals, pricklypear, and eastern redcedar.

Some of the major wildlife species in this area are white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 13%
Grassland—private, 71%; Federal, 4%
Forest—private, 2%
Urban development—private, 7%
Water—private, 2%
Other—private, 1%

Most of this area is in ranches, farms, and other private holdings. The dominant land use is livestock grazing on rangeland. A smaller acreage is used as cropland or improved pasture. Many ranches are involved in wildlife management. The major crops in the area are small grains and forage sorghum, which are used as supplemental feed for livestock and wildlife. Pastured areas support mainly improved bermudagrass and kleingrass. Native pecan orchards are common on flood plains. Deer and wild turkey hunting leases are an important source of income in the southern part of the area. Urban land is rapidly expanding adjacent to the major cities.

The major resource concerns on cropland are encroachment of woody species, maintenance of the content of organic matter in the soils, conservation of soil moisture, and water erosion. The major resource concerns on rangeland are overgrazing and the invasion of undesirable plant species.

Conservation practices on cropland generally include grassed waterways and terraces. Conservation practices on rangeland include control of brush and invasive weeds, reasonable stocking rates, and rotational grazing. ■

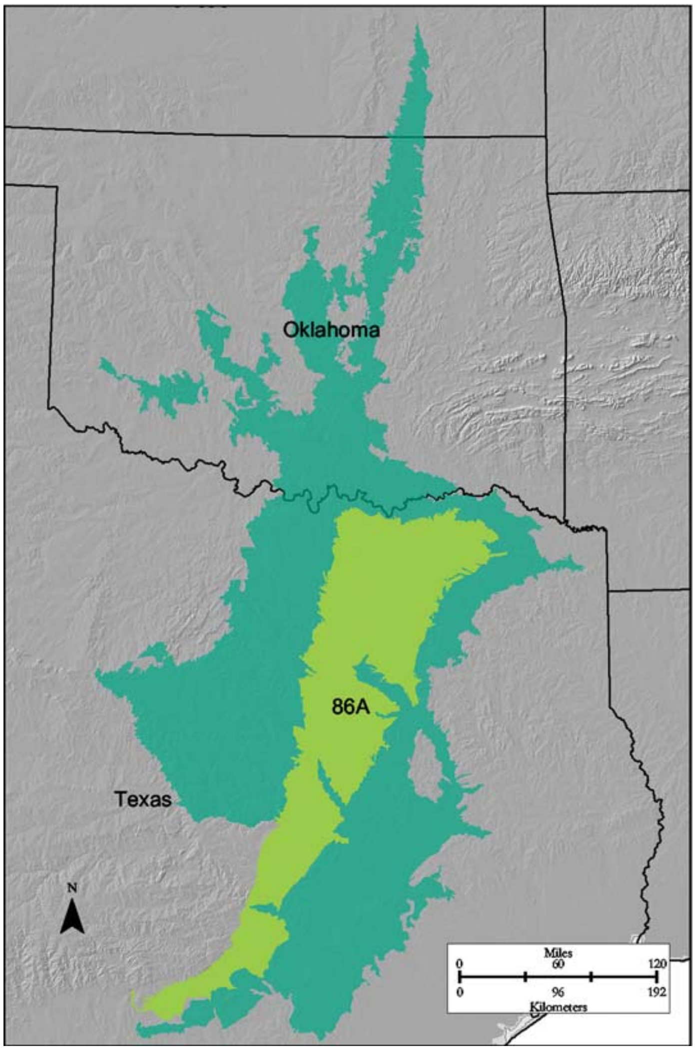

Figure 86A-1: Location of MLRA 86A in Land Resource Region J.

86A—Texas Blackland Prairie, Northern Part

This area is entirely in Texas (fig. 86A-1). It makes up about 15,110 square miles (39,150 square kilometers). The cities of Austin, Dallas, San Antonio, San Marcos, Temple, and Waco are in this MLRA. Interstate 35, a major thoroughfare for commerce and travel, traverses the length of the MLRA from San Antonio to Dallas. Bergstrom, Randolf, and Lackland Air Force Bases are in the southern end of this area. The Caddo National Grasslands are in the northern part of the area.

Physiography

Almost all of this area is in the West Gulf Coastal Plain Section of the Coastal Plain Province of the Atlantic Plain. The west-central edge of the area is in the Central Texas Section of the Great Plains Province of the Interior Plains. Most of this MLRA is a nearly level to gently sloping, dissected plain. Dissected areas with steeper slopes occur along entrenched river and creek valleys. Broad meander belts are associated with the major streams, and wide flood plains are flanked by nearly level stream terraces. Elevation ranges from 300 to 600 feet (90 to 185 meters), increasing gradually from southeast to northwest. Areas of hilly land are associated with the Austin Chalk escarpment near the western edge of the area.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Trinity (1203), 39 percent; Lower Brazos (1207), 20 percent; Red-Sulphur (1114), 14 percent; Central Texas Coastal (1210), 9 percent; Sabine (1201), 7 percent; Middle Brazos (1206), 6 percent; and Lower Colorado-San Bernard Coastal (1209), 5 percent. The headwaters of the Sabine and Sulphur Rivers are in the northern end of this area. The Trinity and Brazos Rivers cross the center of the area. The rivers in the south end of the area include the Colorado, Lavaca, Guadalupe, and San Antonio Rivers.

Geology

This area is underlain by chalk, claystone, marl, and shale in the Eagle Ford Group, Austin Chalk, and the Navarro Group (including the “Taylor marl”) of Cretaceous age. These Cretaceous rocks are incised by several major stream systems. Quaternary stream terraces and alluvium are associated with the rivers, and drainage patterns are controlled by more resistant Cretaceous bedrock.

Climate

The average annual precipitation is 30 to 46 inches (760 to 1,170 millimeters) in most of this area, but it is less than 30 inches in the southern tip. Most of the rainfall occurs in spring and fall. The average precipitation during the freeze-free period is about 24 to 26 inches (610 to 660 millimeters). The average annual temperature is 63 to 69 degrees F (17 to 21 degrees C). The freeze-free period averages about 280 days and ranges from 250 to 310 days. Average annual temperatures and the length of the freeze-free period increase to the south.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 18.2%; ground water, 11.0%
Livestock—surface water, 0.5%; ground water, 0.3%
Irrigation—surface water, 1.3%; ground water, 0.6%
Other—surface water, 67.5%; ground water, 0.4%

The total withdrawals average 2,315 million gallons per day (8,760 million liters per day). About 12 percent is from ground water sources, and 88 percent is from surface water sources. In most years the moderate rainfall is adequate for crops and pasture, but summer droughts commonly reduce crop yields. Large reservoirs on the major streams provide municipal water. The water from the reservoirs is supplemented by some ground water. The reservoirs not only provide water for public supply and industry but also serve as recreational facilities. Small farm ponds are an important source of water for farm use (primarily livestock) and recreation. The surface water is of good quality and is suitable for almost all uses.

Shallow ground water is scarce throughout this area, but several areas obtain small quantities of ground water from wells. Sandstone and carbonate layers in the Trinity Group are the principal aquifers in the MLRA. This ground water is very hard and has a median level of 619 parts per million (milligrams per liter) total dissolved solids. About 30 percent of the samples from this aquifer exceeded the national drinking water standards for nitrate. Falling water tables limit the use of this aquifer.

Soils

The dominant soil orders in this MLRA are Entisols, Mollisols, and Vertisols. The soils are well drained or moderately well drained and fine textured or medium textured. They have a thermic soil temperature regime, an ustic soil moisture regime, and smectitic, carbonatic, or mixed mineralogy. Moderately deep to very deep, nearly level to gently sloping Haplusterts (Branyon, Burleson, Heiden, Houston Black, Dalco, Leson, and Fairlie series) formed on uplands and stream terraces. Deep and very deep, gently sloping to strongly sloping Haplusterts (Ellis, Ferris, and Vertel series) formed on hillsides. Moderately deep to very deep, gently sloping to moderately sloping Haplustolls (Austin, Krum, Lott, and Stephen series) formed on side slopes and stream terraces. Very deep, gently sloping Calciustolls (Lewisville and Venus series) formed on stream terraces and footslopes below hills and ridges. Shallow, gently sloping to strongly sloping Ustorthents (Eddy series) formed on hillsides and breaks. Very deep, nearly level to gently sloping Haplustalfs (Wilson series) and Paleustalfs (Crockett and Mabank series) formed on ancient stream terraces. Very deep, nearly level Haplustolls (Gowen series) and Hapluderts (Kaufman, Tinn, and Trinity series) formed on flood plains.

Biological Resources

This area supports mixed tall and mid prairie grasses. Little bluestem is the dominant species. Indiangrass, big bluestem, switchgrass, tall dropseed, silver bluestem, sideoats grama, eastern gamagrass, and vine mesquite are the major herbaceous species. The plant community has many forbs, such as prairie clover, western ragweed, Maximilian sunflower, gayfeather, rattlesnake master, and Indian plantain. Areas along the major rivers and streams support savanna vegetation. Oak, elm, cottonwood, hackberry, and pecan trees produce a canopy cover of about 30 percent.

Some of the major wildlife species in this area are white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 29%
Grassland—private, 48%; Federal, 1%
Forest—private, 2%
Urban development—private, 15%
Water—private, 3%
Other—private, 2%

Nearly all of this area is improved pasture, cropland, or rangeland. Urban development is rapidly increasing adjacent to the major cities. Cotton, corn, and grain sorghum are the major crops. Other crops are small grains, soybeans, and hay. Native and improved pecan orchards are common on the flood plains where better drainage or less frequent flooding occurs. The current land use trend is a decrease in the acreage of cropland on the more sloping and eroded soils and an increase in the acreage of improved pasture. The main kind of livestock is beef cattle.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include terraces, grassed waterways, buffer strips, crop residue management in reduced till and no-till systems, and nutrient management. Conservation practices on pasture and hayland generally include grazing management systems, applications of the proper kinds and amounts of fertilizer, and control of brush and weeds. The most important conservation practice on rangeland is prescribed grazing. Generally, cultural practices are not used to increase forage production on the rangeland in this area. ■

86B—Texas Blackland Prairie, Southern Part

This area is in two separate parts in east-central Texas (fig. 86B-1). It makes up about 2,925 square miles (7,585 square kilometers). The towns of Brenham, Caldwell, La Grange, Schulenberg, Hallettsville, Bellville, and Navasota are in the eastern part of this MLRA. A very small part of the Sam

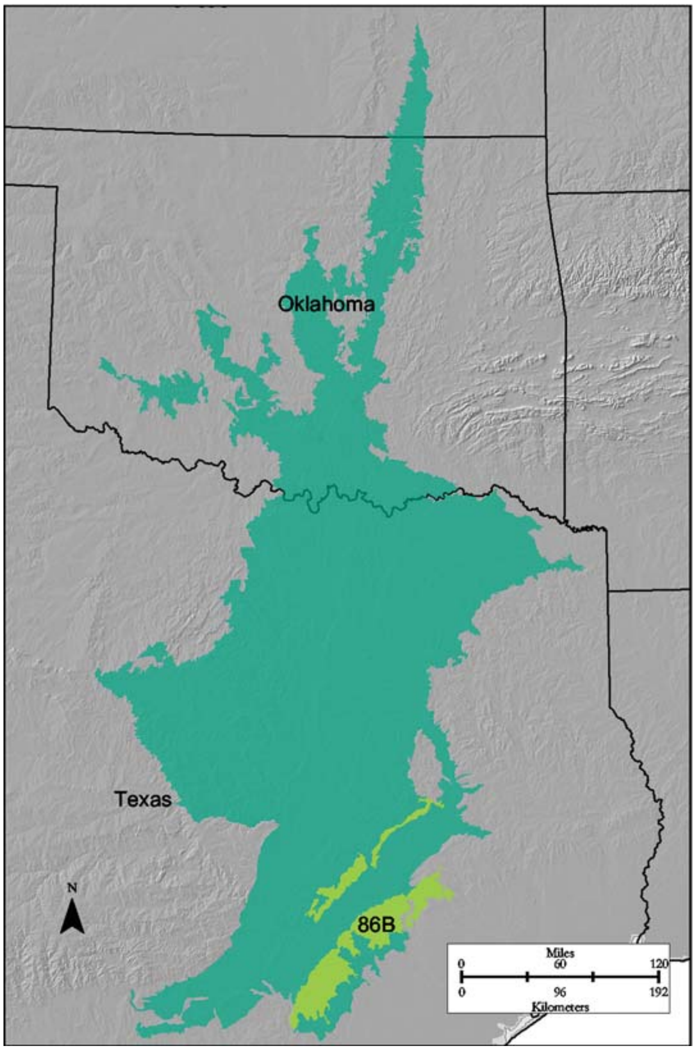

Figure 86B-1: Location of MLRA 86B in Land Resource Region J.

Houston National Forest is in the northern tip of the area. The towns of Lincoln, Hogg, Benchley, and Normangee are in the separate western part of this area. Interstate 10 and U.S. Highways 77 and 290 cross various parts of this MLRA.

Physiography

This area is in the West Gulf Coastal Plain Section of the Coastal Plain Province of the Atlantic Plain. Most of the area is a nearly level to gently sloping, dissected plain. Dissected areas with steeper slopes occur along entrenched river and creek valleys. Broad meander belts are associated with major streams, and wide flood plains are flanked by nearly level stream terraces. Elevation ranges from 200 to 600 feet (60 to 185 meters), increasing gradually from southeast to northwest. Hilly areas are associated with the more deeply eroded areas adjacent to the major streams.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Brazos (1207), 53 percent; Central Texas Coastal (1210), 25 percent; Lower Colorado-San Bernard Coastal (1209), 12 percent; Galveston Bay-San Jacinto (1204), 6 percent; and Trinity (1203), 4 percent. Some of the major rivers crossing the eastern part of this area include the Navasota, Brazos, Colorado, San Bernard, and Lavaca Rivers. Some of the major rivers crossing the western part include the Navasota, Brazos, and Yegua Rivers.

Geology

This area is underlain by calcareous clays, sandstones, and marls in the Fleming Formation and Oakville Sandstone of Miocene age and the Cook Mountain Formation of Eocene age. These Tertiary sediments trend generally parallel to the Texas Gulf Coast and are incised by several major stream systems. Quaternary stream terraces and alluvium are associated with the meander belts of the major streams.

Climate

The average annual precipitation in this area is 35 to 44 inches (890 to 1,120 millimeters). Most of the rainfall occurs in spring and fall. The average precipitation during the freeze-free period is about 29 inches (735 millimeters). The average annual temperature is 66 to 69 degrees F (19 to 21 degrees C). The freeze-free period averages about 295 days and ranges from 270 to 320 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 7.2%; ground water, 6.3%
Livestock—surface water, 3.3%; ground water, 1.7%
Irrigation—surface water, 52.6%; ground water, 26.3%
Other—surface water, 1.3%; ground water, 1.3%

Total withdrawals average 76 million gallons per day (290 million liters per day). About 36 percent is from ground water sources, and 64 percent is from surface water sources. In most years the moderate rainfall is adequate for crops and pasture; however, summer droughts commonly reduce crop yields. Large reservoirs on the major streams provide some municipal water. The water from these reservoirs is supplemented by some ground water. The reservoirs primarily provide water for irrigation, but they are also used for recreation. Small farm ponds are an important source of water for farm use (primarily livestock) and recreation. The surface water is of good quality and is suitable for almost all uses.

The principal source of ground water in the eastern part of this area is the Oakville Sandstone, which is underlain by impermeable clays. This unit is part of the Gulf Coast aquifer system, which consists of a complex of young, interbedded clays, silts, sands, and gravel. The water from this aquifer is generally of good quality. It is hard and typically contains 300 to 500 parts per million (milligrams per liter) total dissolved solids. The separate western part of this area obtains its ground water from the Carrizo-Wilcox aquifer system. The water from this aquifer is moderately hard and contains a median level of 369 parts per million (milligrams per liter) total dissolved solids. Where this aquifer is pumped heavily for irrigation, more saline water from the adjacent aquifers may move into it. Deeper wells in both the Gulf Coast and the Carrizo-Wilcox aquifers encounter soft water where sodium is replacing calcium.

Soils

The dominant soil orders in this MLRA are Vertisols, Inceptisols, Mollisols, and Entisols. The soils are deep or very deep, well drained or moderately well drained, and medium textured to fine textured. They have a thermic soil temperature regime, an ustic soil moisture regime, and smectitic, mixed, or carbonatic mineralogy.

Very deep, moderately well drained Haplusterts (Bleiblerville, Dimebox, and Luling series) have smectitic mineralogy and formed on nearly level to gently sloping uplands. Some very deep, moderately well drained Haplusterts (Burleson series) have smectitic mineralogy and formed on stream terraces. Very deep, moderately well drained Calciusterts (Frelsburg and Latium series) have smectitic mineralogy and formed in very gently sloping to moderately steep areas. Very deep Calciustolls (Brenham series) formed in very gently sloping to moderately sloping areas associated with silty clays and marls in the Fleming Formation. Moderately deep Calciustolls (Carbengle series) and shallow Haplustolls (Renish series) formed in gently sloping to moderately steep areas associated with Oakville Sandstone escarpments. Moderately well drained, fine textured Argiustolls (Benchley series) and Paleustalfs (Crockett series) have vertic properties and smectitic mineralogy and formed on ridges. Very deep, moderately well drained, fine textured Paleustalfs (Mabank series) and Haplustalfs (Wilson series) have a seasonal high water table and smectitic mineralogy and formed on stream terraces. Fine-loamy Argiustolls (Smithville series) and fine-silty Haplustolls (Bergstrom series) have significant accumulations of organic matter and formed on flood plains and low stream terraces. Fine-silty Haplustepts (Weswood series), coarse-loamy Ustifluvents (Yahola series), and coarse-silty Ustifluvents (Coarsewood series) have an irregular decrease in content of organic matter with depth and formed on flood plains. Clayey, very slowly permeable Haplusterts (Ships series) also formed on flood plains.

Biological Resources

This area supports mixed tall and mid prairie grasses. Little bluestem is the dominant species. Additional herbaceous species include sedges, Virginia and Canada wildrye, rustyseed paspalum, beaked panicum, switchgrass, Indiangrass, big bluestem, eastern gamagrass, sideoats grama, and vine mesquite. Many forbs grow in the area, including tickclover, trailing wildbean, lespedezas, and gayfeather. Areas along the major rivers and streams support a savanna plant community. Oak, elm, cottonwood, hackberry, and pecan trees produce a canopy cover of about 30 percent.

Some of the major wildlife species in this area are white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 9%
Grassland—private, 80%
Forest—private, 3%
Urban development—private, 4%
Water—private, 2%
Other—private, 2%

Pasture and rangeland make up about 80 percent of this area. Cotton, corn, and grain sorghum are the major crops. Other important crops are small grains, soybeans, and hay. Native and improved pecan orchards are common on flood plains where better drainage or less frequent flooding occurs. The current land use trend is a decrease in the acreage of cropland on the more sloping and eroded soils and an increase in the acreage of improved pasture. The main kind of livestock is beef cattle.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include terraces, grassed waterways, buffer strips, crop residue management in reduced till and no-till systems, and nutrient management. Conservation practices on pasture and hayland generally include grazing management systems, applications of the proper kinds and amounts of fertilizer, and control of brush and weeds. The most important conservation practice on rangeland is prescribed grazing. Generally, cultural practices are not used to increase forage production on the rangeland in this area. ■

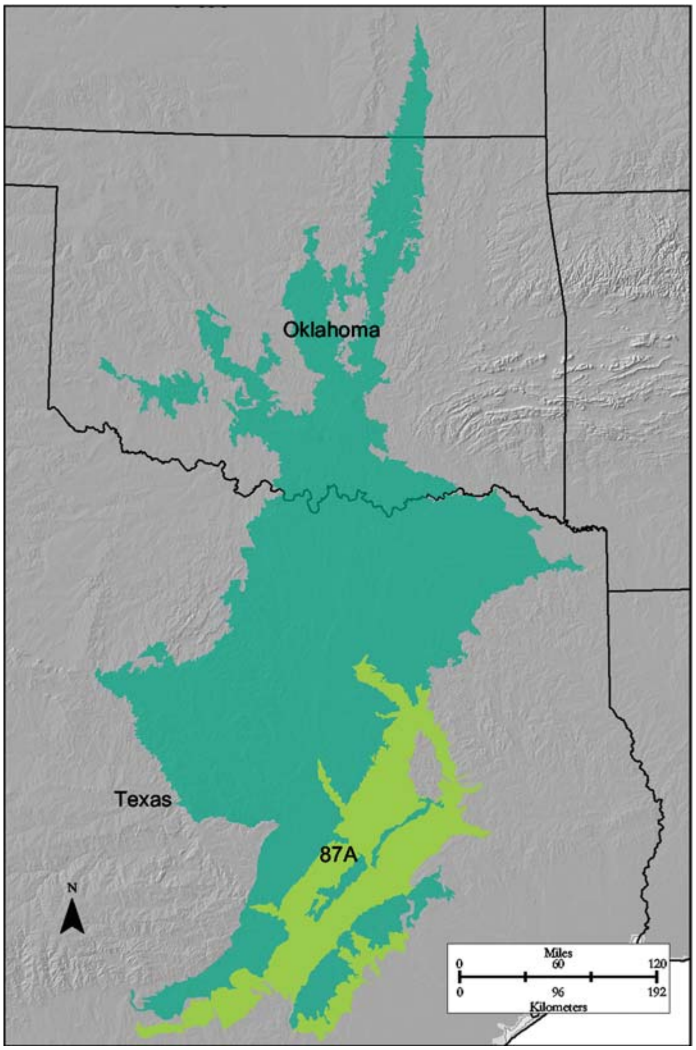

Figure 87A-1: Location of MLRA 87A in Land Resource Region J.

87A—Texas Claypan Area, Southern Part

This area is entirely in south-central Texas (fig. 87A-1). It makes up about 10,535 square miles (27,295 square kilometers). The towns of Ennis, Fairfield, Groesbeck, Franklin, Centerville, Madisonville, Rockdale, Bryan, College Station, Bastrop, Giddings, Luling, and Gonzales are in this MLRA. Interstate 45 crosses the northern part of the area, and Interstate 10 crosses the southern part. A number of State parks are throughout this area. They are commonly associated with reservoirs.

Physiography

This area occurs in the West Gulf Coastal Plain Section of the Coastal Plain Province of the Atlantic Plain. It is a nearly level to gently sloping plain that is dissected by broad river systems. Gently sloping uplands merge into narrow valleys that have sloping valley walls. Large rivers with broad, long valleys cross the area. Elevation ranges from 200 to 750 feet (60 to 230 meters), increasing gradually from south to north. Slopes generally range from 1 to 8 percent.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Brazos (1207), 39 percent; Trinity (1203), 25 percent; Central Texas Coastal (1210), 21 percent; Lower Colorado-San Bernard Coastal (1209), 13 percent; and Nueces-Southwestern Texas Coastal (1211), 2 percent. From north to south, the major rivers crossing this area are the Trinity, Navasota, Brazos, Colorado, Lavaca, and Guadalupe Rivers. A number of large reservoirs are in the area.

Geology

This area is underlain by fluviodeltaic and marine sediments of Tertiary age. Tertiary units include the Wilcox Group, Carrizo Sand, Reklaw Formation, Queen City Sand, Weches Formation, Sparta Sand, and Yegua Formation of Eocene age; the Jackson Group of Eocene and Oligocene age; and the Catahoula Formation of Miocene age. Sediments in these Tertiary units consist of interbedded sandstone, siltstone, and shale and unconsolidated to weakly coherent sands, silts, and clays. The boundaries of these Tertiary sediments trend generally parallel to the Texas Gulf Coast and are incised by several major stream systems. Quaternary stream terraces and alluvium are associated with the meander belts of the major rivers.

Climate

The average annual precipitation in this area is 27 to 45 inches (685 to 1,145 millimeters). Most of the rainfall occurs in spring and fall. The average precipitation during the freeze-free period is about 30 inches (760 millimeters). The average annual temperature is 64 to 70 degrees F (18 to 21 degrees C). The freeze-free period averages about 285 days and ranges from 260 to 310 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 13.2%; ground water, 14.6%
Livestock—surface water, 5.2%; ground water, 2.6%
Irrigation—surface water, 38.1%; ground water, 20.5%
Other—surface water, 2.9%; ground water, 2.9%

The total withdrawals average 170 million gallons per day (645 million liters per day). About 41 percent is from ground water sources, and 59 percent is from surface water sources. In most years the moderate rainfall is adequate for crops and pasture; however, summer droughts commonly reduce yields.

Large reservoirs on the major streams provide municipal and irrigation water and also serve as recreational facilities. Ponds provide water for farm use. The surface water is generally of good quality and is suitable for almost all uses.

Ground water in this area is used for domestic purposes, for livestock, and for some irrigation. The principal source of the ground water is the Oakville Sandstone, which is underlain by impermeable clays. This unit is part of the Gulf Coast aquifer system, which consists of a complex of young, interbedded clays, silts, sands, and gravel. The water in this aquifer is generally of good quality. It is hard and typically contains 300 to 500 parts per million (milligrams per liter) total dissolved solids. Deep wells in the Gulf Coast aquifer can encounter soft water where sodium is replacing calcium.

Soils

The dominant soil orders in this MLRA are Alfisols, Vertisols, Mollisols, and Entisols. The soils are very deep to moderately deep and are somewhat excessively drained to somewhat poorly drained. They have a thermic soil temperature regime, an ustic soil moisture regime, and smectitic, siliceous, or mixed mineralogy.

Moderately well drained and well drained, fine textured Paleustalfs (Arol, Chazos, Edge, Gredge, Shiro, and Singleton series) border on a udic soil moisture regime. Moderately well drained, very slowly permeable, fine textured Paleustalfs (Axtell, Crockett, Normangee, Zack, and Zulch series) border on a udic soil moisture regime and have vertic properties. Very deep, very slowly permeable, fine textured Paleustalfs (Lufkin, Mabank, and Tabor series) have vertic properties and a seasonal high water table. Moderately deep and very deep, fine textured Paleustalfs (Burlewash, Falba, and Rosanky series) formed over weakly cemented sandstone bedrock. Very deep, moderately well drained, fine textured Paleustalfs (Rader and Straber series) have a perched water table. Very deep, coarse textured, gently sloping Paleustalfs (Demona, Robco, Silstid, and Tremona series) have a sandy surface layer and formed in nearly level to sloping areas. Deep, moderately well drained, coarse textured Paleustalfs (Ellen series) formed on stream terraces. Very deep, well drained, coarse textured Paleustalfs (Padina and Faula series) and Quartzipsamments (Arenosa series) have a thick, sandy surface layer and a sandy subsoil. Very deep, fine textured, nearly level to gently sloping Haplusterts (Burleson and Lexton series) formed on terraces and uplands. Very deep and deep, medium textured, gently sloping Ultic Paleustalfs (Gasil and Silawa series) and Udic Paleustalfs (Margie series) formed in gently sloping areas.

Very deep, medium textured Haplustolls (Bergstrom, Gowen, Smithville, and Whitesboro series) formed on flood plains and low terraces. Very deep, fine textured Hapluderts (Trinity and Ships series), Endoaquerts (Gladewater series), and Hapluderts (Zilaboy series) formed on flood plains. Deep, coarse textured and medium textured Ustifluvents (Yahola series), Udifluvents (Hatliff series), Fluvaquents (Nahatche series), and Haplustepts (Sandow, Uhland, and Weswood series) also formed on flood plains.

Biological Resources

This area supports oak savanna vegetation. Little bluestem is dominant on most sites. Little bluestem and beaked panicum are dominant on poorly drained soils. Indiangrass, brownseed paspalum, beaked panicum, switchgrass, and big bluestem grow throughout the area. The woody species are dominantly post oak and blackjack oak. The area supports a wide variety of forbs, legumes, shrubs, and woody vines, such as dayflower, spiderwort, bundleflower, lespedezas, sensitivebrier, hackberry, hawthorn, yaupon, elbowbush, greenbrier, and honeysuckle. Some mixed pine-hardwood forests are in the southwestern part of the area. Hardwood forests of oak, elm, pecan, and other species are on bottom land.

Some of the major wildlife species in this area are white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 7%
Grassland—private, 79%; Federal, 1%
Forest—private, 4%
Urban development—private, 5%
Water—private, 2%
Other—private, 2%

Most of the farmland in this area is used for pasture and livestock grazing. Most of the pastured areas formerly were cultivated. About one-half of present-day pasture supports improved grasses that are fertilized. Urban land is expanding in several areas. Although significant areas of rangeland have been overgrazed, conservation efforts are improving the rangeland condition. The cropland in the area is used primarily for corn. Other important crops are cotton, peanuts, hay, and truck crops.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture.

Conservation practices on cropland generally include reduced till or no-till systems, crop residue management, and nutrient management. Conservation practices on pasture and hayland include grazing management, applications of the proper kinds and amounts of fertilizer and lime, and control of brush and weeds. The most important conservation practice on rangeland is prescribed grazing. Generally, cultural practices are not used to increase forage production on the rangeland in this area. ■

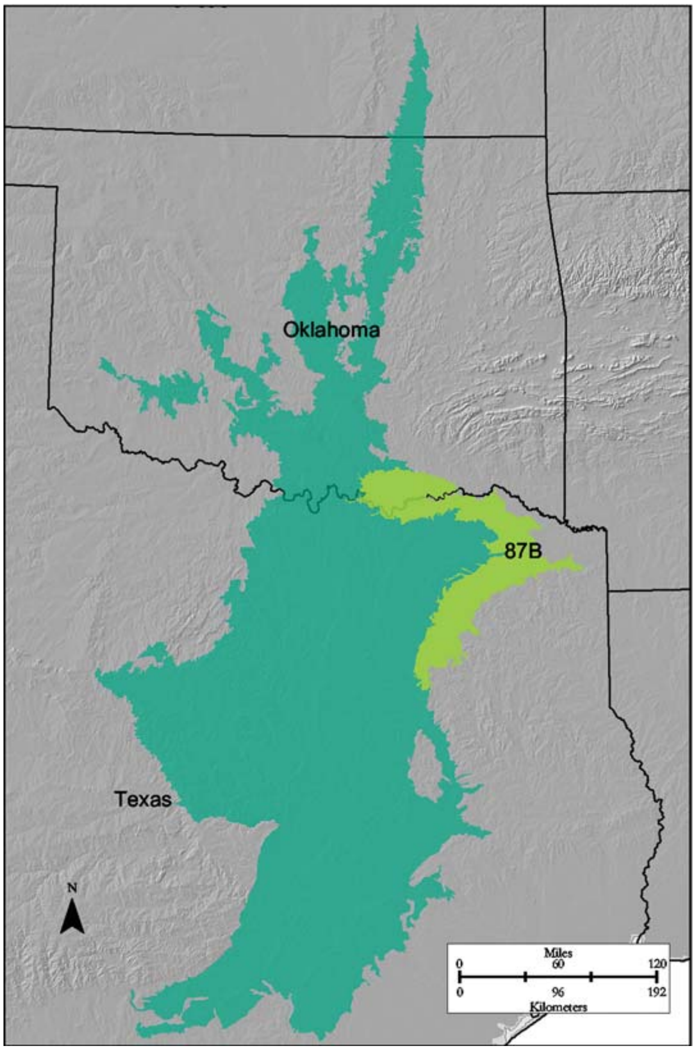

Figure 87B-1: Location of MLRA 87B in Land Resource Region J.

87B—Texas Claypan Area, Northern Part

This area (shown in fig. 87B-1) is in northeastern Texas (79 percent) and southeastern Oklahoma (21 percent). It makes up about 4,480 square miles (11,610 square kilometers). The towns of Greenville, Sulphur Springs, Paris, Mount Vernon, Canton, and Athens, Texas, and Durant, Oklahoma, are in this MLRA. Interstates 30 and 20 and U.S. Highways 69, 70, 80, and 82 cross the area. The Caddo National Grasslands is in the north end of the area.

Physiography

This area is in the West Gulf Coastal Plain Section of the Coastal Plain Province of the Atlantic Plain. It is a nearly level to gently sloping, dissected plain. Dissected areas with steeper slopes occur along entrenched river and creek valleys. Broad meander belts are associated with the major streams, and wide flood plains are flanked by nearly level stream terraces. Elevation ranges from 250 to 750 feet (75 to 230 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Red-Sulphur (1114), 66 percent; Sabine (1201), 21 percent; Trinity (1203), 6 percent; Neches (1202), 4 percent; and Red-Washita (1113), 3 percent. The border between Oklahoma and Texas is formed by the Red River in this MLRA. The Sulphur and Sabine Rivers cross the part of this area in Texas. Lake Texoma forms the northwest corner of the MLRA.

Geology

This area is underlain by unconsolidated to weakly coherent marine sands, silts, and clays, mainly in the Wilcox Group of Eocene age. The boundaries of these Tertiary sediments trend generally parallel to the Texas Gulf Coast and are incised by several major stream systems. Quaternary stream terraces and alluvium are associated with these meander belts.

Climate

The average annual precipitation is 39 to 45 inches (990 to 1,145 millimeters) in most of this area, but it can be as much as 49 inches (1,245 millimeters) in the northeast corner. Most of the rainfall occurs in spring and winter. The average annual temperature is 62 to 66 degrees F (17 to 19 degrees C). The freeze-free period averages 260 days and ranges from 245 to 275 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 37.8%; ground water, 31.6%
Livestock—surface water, 9.3%; ground water, 2.9%
Irrigation—surface water, 1.8%; ground water, 4.4%
Other—surface water, 7.0%; ground water, 5.3%

The total withdrawals average 57 million gallons per day (215 million liters per day). About 44 percent is from ground water sources, and 56 percent is from surface water sources. Precipitation, supplemented by ponds and small reservoirs, is the main source of water for agricultural use. Summer rainfall is erratic, and in most years crop yields are affected by reduced levels of soil moisture. Large reservoirs on the major streams provide municipal water and also serve as recreational facilities. The surface water is generally of good quality and is suitable for almost all uses.

The Carrizo-Wilcox and Trinity Group aquifer systems provide water for municipal use, domestic use, livestock, and some irrigation in this area. The eastern part of the area obtains its ground water from the Carrizo-Wilcox aquifer system. The water from this aquifer is moderately hard and contains a median level of 369 parts per million (milligrams per liter) total dissolved solids. Where this aquifer is pumped heavily for irrigation, more saline water from adjacent aquifers may move into it. Deep wells in the Carrizo-Wilcox aquifer can encounter soft water where sodium is replacing calcium.

The western part of this area obtains its ground water from sandstone and carbonate layers in the Trinity Group aquifer system. This ground water is very hard and has a median level of 619 parts per million (milligrams per liter) total dissolved solids. About 30 percent of the samples from this aquifer exceeded the national drinking water standards for nitrate. Falling water tables limit the use of this aquifer.

Soils

The dominant soil orders in this MLRA are Alfisols, Vertisols, and Ultisols. The soils are deep and have a medium textured or moderately coarse textured surface layer and a moderately permeable to very slowly permeable, clayey or loamy subsoil. They have a thermic soil temperature regime, a udic soil moisture regime, and mixed or smectitic mineralogy. The soils are well drained to poorly drained and are nearly level to gently sloping. The well drained and moderately well drained soils are Paleudalfs (Annona and Freestone series), Hapludults (Kirvin series), Hapludalfs (Woodtell, Karma, and McKamie series), and Paleudults (Ruston series). Moderately well drained Glossic Paleudalfs (Bernaldo, Whakana, and Vesey series) and Aquic Glossudalfs (Raino series) formed on high stream terraces and the erosional remnants of terraces. The poorly drained soils are Glossaqualfs (Talco, Wrightsville, and Derly series) and Epiaqualfs (Ivanhoe series). Very deep, well drained soils with a thick sandy surface layer are Grossarenic Paleudalfs (Pickton series) and Arenic Paleudalfs (Wolfpen series). Very deep Entisols (Nahatche, Oklared, and Severn series) formed on flood plains. Moderately well drained Hapluderts (Kaufman and Billyhaw series) and somewhat poorly drained Hapluderts (Gladewater and Texark series) also formed on flood plains. Moderately well drained, very slowly permeable Haplusterts (Burleson series) formed on clayey terraces along the Trinity and Red Rivers.

Biological Resources

This area supports oak savanna vegetation. Hardwoods consist of post oak, blackjack oak, hickory, and red oak. Native pines occur in some areas. Pinehill bluestem is dominant on most sites. Pinehill bluestem and beaked panicum are dominant on poorly drained soils. Brownseed paspalum, purpletop, longleaf uniola, Indiangrass, and beaked panicum grow throughout the area. The area also supports a wide variety of forbs, legumes, shrubs, and woody vines, such as spiderwort, bundleflower, lespedeza, sensitivebrier, hackberry, hawthorn, yaupon, elbowbush, greenbrier, and honeysuckle. This MLRA is a transitional area between the cropland of MLRA 86A to the west and the forested MLRA 133B to the east.

Some of the major wildlife species in this area are white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 8%
Grassland—private, 54%
Forest—private, 26%; Federal, 1%
Urban development—private, 5%
Water—private, 4%
Other—private, 2%

Farmland makes up nearly all of this area. Most of the farmland is used as pasture or woodland, and most of the woodland is in pine plantations. In general, the soils in the area have moderate to high suitability for woodland. Some of the pasture was formerly cultivated cropland. About one-half of present-day pasture supports improved grasses that are fertilized. The cropland in the area is used primarily for corn, peanuts, or hay. Truck crops are important in some areas. Urban land is expanding in several areas.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include reduced till or no-till systems, grassed waterways, buffer strips, crop residue management, and nutrient management. Conservation practices on pasture generally include grazing management systems, applications of the proper amounts and kinds of fertilizer and lime, and control of brush and weeds. The most important conservation practices on woodland are control of runoff and understory management. ■

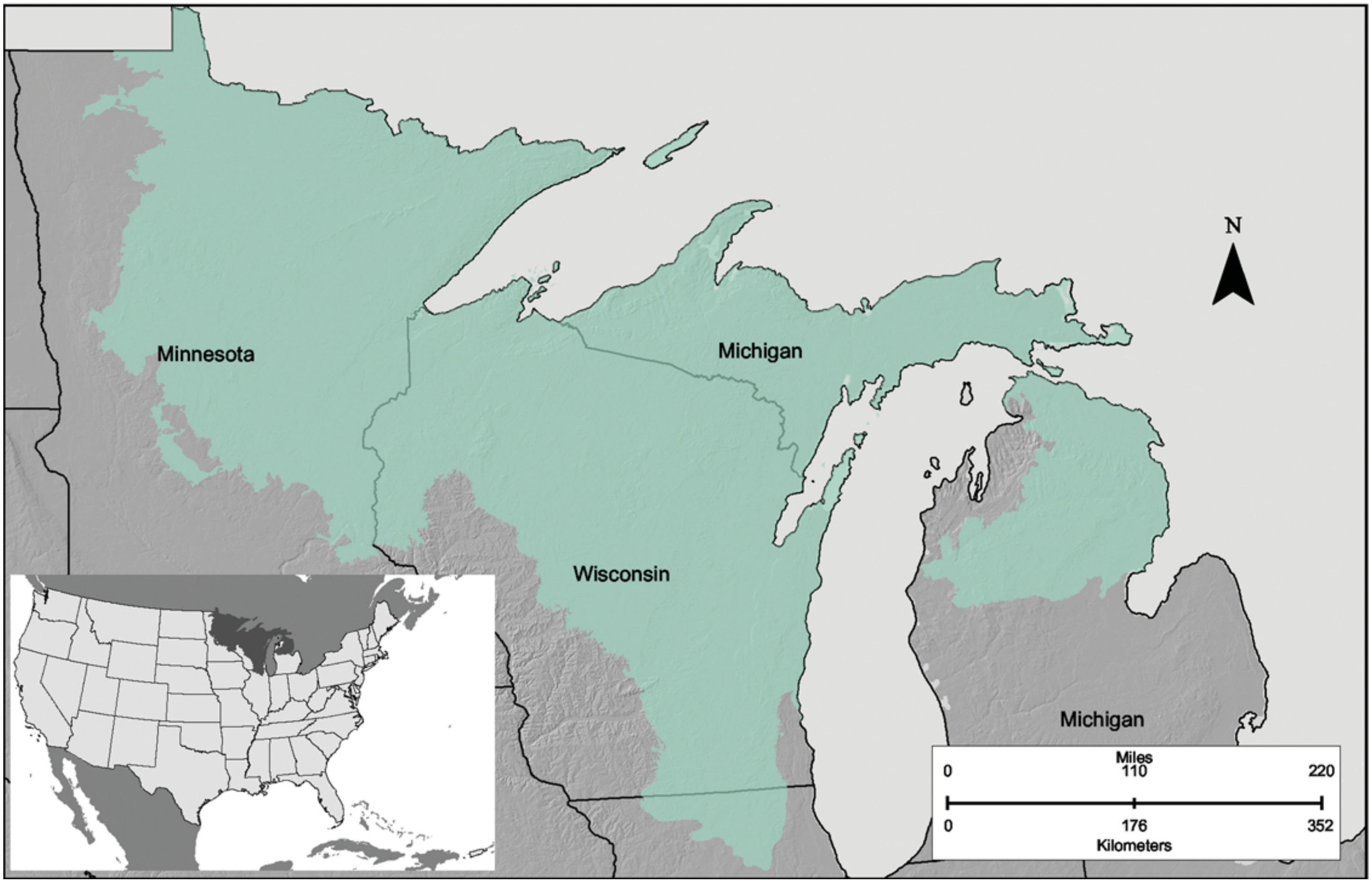

Figure K-1: Location of Land Resource Region K.

K—Northern Lake States Forest and Forage Region

This region (shown in fig. K-1) is in Wisconsin (37 percent), Minnesota (37 percent), Michigan (24 percent), and Illinois (2 percent). It makes up 118,775 square miles (307,795 square kilometers).

This region is in the Central Lowland areas south and west of the western Great Lakes. It is a glaciated region with numerous lakes and wetlands. Slopes are nearly level to gently undulating in areas of glacial lake deposits, gently undulating to rolling on till plains and ground moraines, and steep on end moraines, on valley sidewalls, and on escarpments along the margins of lakes.

Winters are cold in this region, and significant amounts of snow can accumulate. The average annual precipitation ranges from 26 to 34 inches (660 to 865 millimeters). Most of the precipitation falls in spring and summer. The average annual temperature ranges from 39 to 44 degrees F (4 to 7 degrees C). The freeze-free period ranges from 120 to 175 days, increasing in length from north to south.

The total withdrawals of freshwater in this region average about 5,650 million gallons per day (21,385 million liters per day). About 82 percent is from surface water sources, and 18 percent is from ground water sources. Most of the region is used for farming or timber production, but the region is heavily populated from the center of the west shore of Lake Michigan to its southern end. About 75 percent of the water in the region is used for municipal and industrial supply, and 18 percent is used for public supply. Wood pulp, paper, mining, and food-processing industries use significant amounts of the water.

The soils in this region are dominantly Histosols, Alfisols, Spodosols, and Entisols. Some areas also have a significant acreage of Mollisols or Inceptisols. Almost all of the soils in the region have a frigid soil temperature regime, and all have an aquic or udic soil moisture regime. Soils with a mesic soil temperature regime are in many areas in the southern part of the region. Mineralogy is dominantly mixed, but it is isotic in some areas.

About 90 percent of the land in this region is privately owned. Most of the Federal land is in national forests. The native vegetation consists of forest species in about 58 percent of the region (fig. K-2). The rest of the region is mainly

Figure K-2: A dominantly forested area of Land Resource Region K in Otter Tail County, Minnesota.

cropland or grassland. Important crops include corn, wheat, alfalfa, oats, barley, and soybeans. Much of the forage and feed grain grown in the region is used by onsite dairy and beef cattle industries. Other locally important crops include sunflowers, potatoes, edible beans, sweet corn, peas, berries, and fruit. Water erosion, especially on cropland, is a major resource concern. Wind erosion is a hazard in areas of silty and sandy soils. Soil wetness, fertility, and tilth and protection of water quality are additional resource concerns. ■

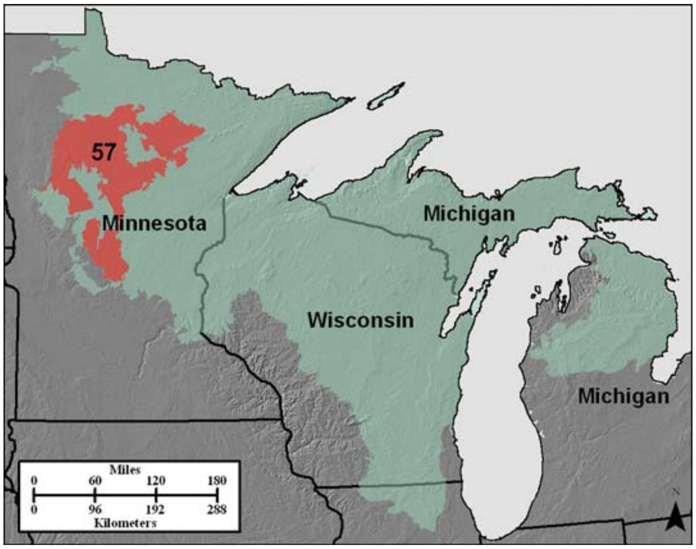

Figure 57-1: Location of MLRA 57 in Land Resource Region K.

57—Northern Minnesota Gray Drift

This area is entirely in north-central Minnesota (fig. 57-1). It makes up about 9,785 square miles (25,355 square kilometers). The towns of Bagley, Bemidji, Blackduck, Detroit Lakes, Grand Rapids, Mahnomen, Northhome, and Walker are in the northern part of this MLRA, and Albany, Sauk Centre, and Browerville are in the southern part. U.S. Highways 2, 10, 59, 71, and 169 cross the northern part, and Interstate 94 and U.S. Highway 71 cross the southern part. The northern part has a considerable acreage of State forestland and numerous lakes, including Leech Lake and Lake Winnibigoshish. It also includes parts of the Chippewa National Forest, the southern part of the Red Lake Indian Reservation, and most of the White Earth and Leech Lake Indian Reservations. Some of the Camp Riley Military Reservation is in the northeast corner of the southern part of this MLRA.

Physiography

This area is in the Western Lake Section of the Central Lowland Province of the Interior Plains. The landscape developed through a series of glaciations and subsequent retreating and wasting of the ice sheets. A complex pattern of moraines, outwash plains, drumlins, lake plains, and drainages characterizes the area. Lakes, ponds, and marshes are common. Elevation is about 985 to 1,640 feet (300 to 500 meters). On this choppy and complex landscape, relief typically is 15 to 50 feet (5 to 15 meters) within short distances.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Mississippi Headwaters (0701), 67 percent; Red (0902), 22 percent; Rainy (0903), 10 percent; and Western Lake Superior (0401), 1 percent. This area is on a watershed divide in North America. Surface water in most of the northern and western parts of the area drains into the Red River of the North, eventually entering Hudson Bay. The rest of the area is drained by the Mississippi River, southward into the Gulf of Mexico. The headwaters of the Mississippi River are in the northern part of the area. The Mississippi River and its tributaries drain most of the area.

Geology

All of this area is covered by Wisconsin-age drift. The glacial deposits are from four major ice lobes—Des Moines, Rainy, Superior, and Wadena. The thickness of the glacial till ranges from 300 to 600 feet (90 to 185 meters). Some areas of these deposits are overlain by outwash or lacustrine sediments. Some depressional areas have an accumulation of organic matter. These organic deposits are more than 8 feet (2.5 meters) thick in some areas.

Climate

The average annual precipitation in this area is 23 to 29 inches (585 to 735 millimeters). About 65 percent of the annual precipitation falls as rain during the 5-month growing season (May through September), and about 18 percent falls as snow. The average annual temperature is 37 to 43 degrees F (3 to 6 degrees C). The freeze-free period averages 150 days and ranges from 120 to 175 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 7.0%; ground water, 4.5%
Livestock—surface water, 1.5%; ground water, 4.1%
Irrigation—surface water, 7.8%; ground water, 28.1%
Other—surface water, 46.9%; ground water, 0.0%

The total withdrawals average 64 million gallons per day (240 million liters per day). About 37 percent is from ground water sources, and 63 percent is from surface water sources. This area has abundant supplies of both surface and ground water that meet all of the current needs of the area. The surface water generally is of good quality, and its use is not limited. Many lakes provide ample opportunities for recreation.

Abundant supplies of good-quality ground water are in both surficial and buried drift aquifers throughout this area. Water from these aquifers is a calcium-magnesium-bicarbonate type that is hard. The median concentrations of total dissolved solids are about 350 parts per million (milligrams per liter) in the surficial drift aquifer and 450 in the buried drift aquifer. Nitrate concentrations can approach the harmful limit of 10 parts per million (milligrams per liter) in the surficial drift aquifer. Glacial till generally caps the buried drift aquifer, which is thus more protected from contamination by surface activities than the surficial drift aquifer. The deeper aquifer, however, has very high levels of iron.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, and Histosols. Some Mollisols are in the westernmost part of the area. The soils in the area have a frigid soil temperature regime, an aquic or udic soil moisture regime, and mixed or smectitic mineralogy. They are very deep and generally are sandy to loamy. Their natural drainage class is related to landscape position. Endoaqualfs (Effie, Talmoon, and Willosippi series) formed in till on moraines. Epiaqualfs (Nokay, Paddock, and Watab series) and Glossudalfs (Blowers, Sol, and Steamboat series) formed in till on drumlins and moraines. Hapludalfs (Beltrami, Mahkonce, Naytahwaush, Nebish, Snellman, Sugarbush, Suomi, Two Inlets, and Waukon series) formed in till or outwash on moraines. Udipsamments (Eagleview, Graycalm, and Nymore series) formed in outwash on moraines. Haplosaprists (Cathro and Markey series) formed in organic material over outwash or till on moraines. Haplohemists (Rifle series) and Haplosaprists (Seelyeville series) formed in a thick layer of organic material on moraines.

Biological Resources

Prior to settlement, the vegetation in this area was mainly a mixture of deciduous trees and conifers. White pine and red pine grew on moraines. Jack pine was dominant on outwash plains and sandy lake plains. Red oak, sugar maple, and basswood grew in sheltered areas close to lakes. Forested lowlands were dominated by black spruce, tamarack, white cedar, and black ash. Wetlands that were not forested were dominated by sedge meadow communities. The western part of the area was dominated by tall prairie grasses. Most of this area is still forested. Aspen is the most common species both in pure stands and in mixed stands with birch, maple, oak, white spruce, and red pine.

Some of the major wildlife species in this area are white-tailed deer, black bear, ruffed grouse, and sharp-tailed grouse. Because of its relatively unaltered landscape, this MLRA supports a high percentage of the rare plants and animals that occur in Minnesota. These species include the bald eagle and the eastern timber wolf.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 16%
Grassland—private, 8%; Federal, 1%
Forest—private, 51%; Federal, 8%
Urban development—private, 3%
Water—private, 8%
Other—private, 5%

About 25 percent of this area is in farms. The farms generally are small and are used mainly for forage and feed grain for livestock. Livestock operations are in scattered areas throughout the MLRA. Sunflowers, wheat, soybeans, and other cash crops are grown on some farms, mainly in the western part of the MLRA. Almost 60 percent of this area is forested. Part of the forestland is in State and national forests. Hardwood forest types make up most of the area. Aspen is the dominant species. It is used in chipboard and pulp production. Softwood species (fir, pine, and spruce) are used for pulp. This area has many lakes, ponds, and marshes, and water-based recreation and summer home development are significant economic enterprises.

The major resource concerns are poor soil drainage, which affects crop production; poor grazing management in areas of forestland and grassland; water erosion and wind erosion; and water quality. Conservation practices on cropland generally include crop residue management and conservation crop rotations, both of which help to control water erosion and wind erosion. Drainage ditches are used to improve drainage. Filter strips are installed along drainage ditches and streams to preserve water quality. Prescribed grazing systems are used to improve grazing management and remove livestock from forested areas. Exclusion from use as needed, forest stand improvement, riparian forest buffers, and proper establishment of trees and shrubs restore damaged forests and improve water quality. Field windbreaks reduce the hazard of wind erosion and improve crop production. ■

88—Northern Minnesota Glacial Lake Basins

This area is entirely in Minnesota (fig. 88-1). It makes up about 11,695 square miles (30,300 square kilometers). The towns of Baudette, Big Falls, International Falls, Little Fork, and Warroad are in the northern part of this MLRA. The towns of Floodwood, Meadowlands, and McGregor are in the

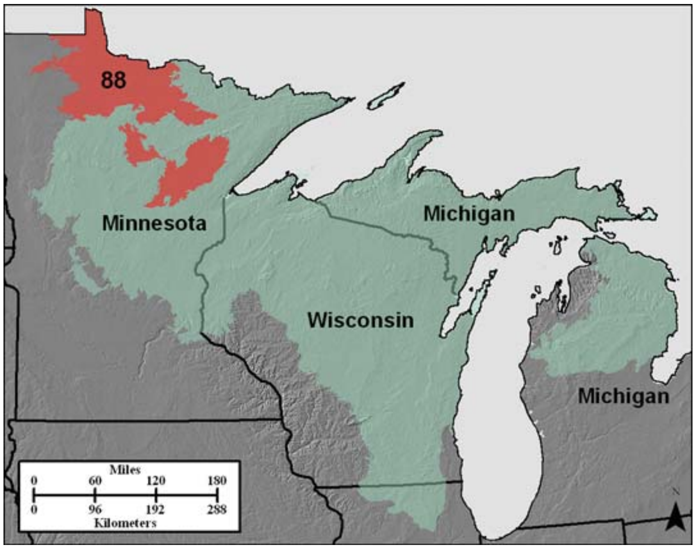

Figure 88-1: Location of MLRA 88 in Land Resource Region K.

southern part. Small parts of the Superior and Chippewa National Forests are in this area, but most of the area is in State forests. This MLRA includes the Big Bog and Nett Lake Indian Reservations, part of the Leech Lake Indian Reservation, and most of the Red Lake Indian Reservation.

Physiography

Most of this area is in the Western Lake Section of the Central Lowland Province of the Interior Plains. The eastern one-eighth of the area is in the Superior Upland Province of the Laurentian Upland. This MLRA is in the glacial lakebeds of Agassiz, Upham, and Aitkin. These glacial lake plains have remnants of gravelly beaches, strandlines, deltas, and sandbars. The mostly level or nearly level plains are bordered by some gently sloping strandlines and rolling dune land. Elevation is 1,350 feet (410 meters), decreasing gradually to 900 feet (275) meters) in the north. Ditches have been used in an attempt to drain the many wet areas in the MLRA, but low gradients commonly prevent adequate removal of surface and subsurface water for cropping.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Rainy (0903), 48 percent; Red (0902), 24 percent; Western Lake Superior (0401), 14 percent; and Mississippi Headwaters (0701), 14 percent. Most of this area was inundated by glacial Lake Agassiz. The general slope and drainage are toward the north into the Rainy River and eventually into Hudson Bay. The Clearwater, Moose, Red Lake, and Roseau Rivers drain the southwestern part of the area and eventually flow into the Red River. The divide between the Rainy and Red River drainage basins lies in this area. The drainage of the glacial Lake Upham basin is to the east to Lake Superior. The St. Louis, Whiteface, Swan, and Savanna Rivers drain this basin. The drainage of the glacial Lake Aitkin basin is to the south by way of the Mississippi River. Numerous small lakes occur in this area.

Geology

The surface of this area is covered mostly by silty and clayey lacustrine sediments and lake-modified glacial till. Crystalline metamorphic rocks underlie the glacial deposits.

Climate

The average annual precipitation in this area is 20 to 29 inches (510 to 735 millimeters). About 68 percent of the annual precipitation falls as rain during the 5-month growing season (May through September), and about 20 percent falls as snow. The average annual temperature is 36 to 41 degrees F (2 to 5 degrees C). The freeze-free period averages about 135 days and ranges from 115 to 150 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 80.0%
Livestock—surface water, 6.7%; ground water, 13.3%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average 1.5 million gallons per day (5.5 million liters per day). About 93 percent is from ground water sources, and 7 percent is from surface water sources. This area has abundant supplies of both surface and ground water that meet all of the current needs of the area. The surface water generally is of good quality, and its use is not limited. Many lakes provide ample opportunities for recreation.

Abundant supplies of good-quality ground water are in both surficial and buried drift aquifers throughout this area. Water from these aquifers is a calcium-magnesium-bicarbonate type that is hard. The median concentrations of total dissolved solids are about 350 parts per million (milligrams per liter) in the surficial drift aquifer and 450 in the buried drift aquifer. Nitrate concentrations can approach the harmful limit of 10 parts per million (milligrams per liter) in the surficial drift aquifer. Glacial till generally caps the buried drift aquifer, which is thus more protected from contamination by surface activities than the surficial drift aquifer. The deeper aquifer, however, has very high levels of iron.

Ground water for domestic use is obtained from the Proterozoic Metasedimentary aquifer in the southeastern part of this MLRA. This aquifer consists of argillite, slate, and metagraywacke and has calcium-magnesium-bicarbonate type water that is hard. The water has a median level of total dissolved solids of about 250 parts per million (milligrams per liter). This aquifer has the best quality water of all the crystalline rock aquifers in Minnesota.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, and Histosols. The soils in the area have a frigid soil temperature regime, an aquic or udic soil moisture regime, and mixed, smectitic, or isotic mineralogy. They are very deep, are sandy to clayey, and are dominantly somewhat poorly drained to very poorly drained. Extensive areas of organic soils occur in the MLRA. Most of the organic soils in the Agassiz Basin are slightly lower on the landscape than the surrounding mineral soils, whereas the large areas of organic soils in the Upham and Aitkin Basins typically are slightly domed and are slightly higher on the landscape than the surrounding mineral soils.

Aqualfs (Chilgren, Indus, and Spooner series) formed in glaciolacustrine sediments or water-worked till. Udalfs (Baudette, Kooch, and Taylor series) formed in water-modified till or glaciolacustrine sediments. Psamments (Clearriver, Cormant, Graycalm, Hiwood, Menahga, Redby, Two Inlets, and Zimmerman series) formed in glaciolacustrine sediments on lake plains. Haplosaprists (Cathro, Berner, Dora, and Markey series) formed in organic material over glaciolacustrine sediments or water-modified till. Haplohemists (Greenwood and Rifle series), Haplosaprists (Seelyeville series), and Sphagnofibrists (Lobo series) formed in a thick layer of organic material on lake plains.

Biological Resources

Prior to settlement, the vegetation in this area was a mixture of deciduous trees and conifers. White pine and red pine grew on moraines. Jack pine was dominant on outwash plains and sandy lake plains. Red oak, sugar maple, and basswood grew in sheltered areas close to lakes. Forested lowlands were dominated by black spruce, tamarack, white cedar, and black ash. Wetlands that were not forested were dominated by sedge meadow communities. Much of this area remains forested, but small areas of prairie occur in the western part of the area. Aspen is the most common tree species both in pure stands and in mixed stands with birch, maple, oak, white spruce, and red pine.

Some of the major wildlife species in this area are white-tailed deer, black bear, ruffed grouse, and sharp-tailed grouse. Because of its relatively unaltered landscape, this area supports a high percentage of the rare plants and animals that occur in Minnesota. These species include the bald eagle and the eastern timber wolf.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 7%
Grassland—private, 2%; Federal, 1%
Forest—private, 73%; Federal, 2%
Urban development—private, 1%
Water—private, 11%
Other—private, 3%

About 75 percent of this area is forested, dominantly by the aspen cover type. Hardwood and softwood species are harvested mostly for pulp. Most of the cropland in this MLRA is in the western part of the area. The main crops are alfalfa, barley, oats, sunflowers, and wheat. A short growing season, excessive periods of rainfall, and poor drainage can reduce yields in some years. Specialty crops, including bluegrass seed, foundation seed potatoes, and wild rice, are grown in some areas. Scattered livestock operations are throughout the area. Two large, frequently used lakes are in this MLRA. These are Leech Lake and Cass Lake. Water-based recreation and summer home development are significant economic enterprises.

The major resource concerns are excessive soil wetness, the short growing season, and surface compaction. Some sandy areas are subject to wind erosion. The important conservation practices on cropland include selection of crops that are tolerant of wetness and a short growing season. They also include timely tillage, which improves yields. Cover crops and minimum tillage can help to overcome the effects of strong winds on sandy soils. Timely harvesting of trees can minimize compaction when the soils are wet and can enhance the regeneration of tree species. ■

89—Wisconsin Central Sands

This area is entirely in Wisconsin (fig. 89-1). It makes up about 3,420 square miles (8,860 square kilometers). The cities of Black River Falls, Friendship, Mauston, New Lisbon, Stevens Point, Tomah, Wisconsin Dells, and Wisconsin Rapids are in the area. Interstates 90 and 94 join in the western part of the area, and U.S. Highway 51 crosses the northeastern part. The north end of the Fort McCoy Military Reservation is in the southwest part of the area. The Meadow Valley Wildlife Area and the Necedah Wildlife Refuge are completely within this MLRA. The Ho-Chunk Nation (formerly the Wisconsin Winnebago Tribe) does not have a defined reservation, but the Nation's center of government is in Jackson County and the majority of Ho-Chunk tribal lands are within this MLRA.

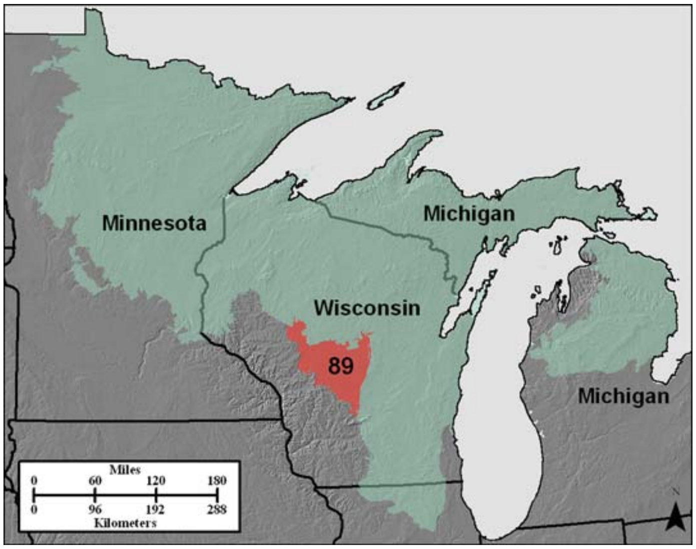

Figure 89-1: Location of MLRA 89 in Land Resource Region K.

Physiography

This area is in the Wisconsin Driftless Section of the Central Lowland Province of the Interior Plains. It is an area of isolated buttes and mesas, valley trains, flood plains, and extensive wetlands. The southern and eastern parts of the area are on a large glacial lake and outwash plain, and the northern and western parts are mostly on low hills and pediments. Elevation is 880 feet (270 meters) in the southern part of the area, at the village of Lyndon Station, with a gradual slope to about 1,110 feet (340 meters) in the northeastern part of the area, at the city of Stevens Point. The maximum elevation is about 1,400 feet (425 meters). It is on Saddle Mound, in Jackson County. The maximum local relief is about 400 feet (120 meters), but relief is considerably lower in most of the area.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Wisconsin (0707), 70 percent; Upper Mississippi-Black-Root (0704), 24 percent; and Chippewa (0705), 6 percent. The Chippewa, Black, and Wisconsin Rivers, major tributaries of the Mississippi River, drain this area.

Geology

This area is underlain dominantly by weak Cambrian sandstone and interbedded sandstone and shale formations locally named Wonewoc, Eau Claire, and Mount Simon. Some areas are underlain by Precambrian metamorphic and igneous rocks. Some were most likely glaciated between 25,000 and about 2,400,000 years ago, and others probably were not glaciated. Although this part of Wisconsin is often referred to as the “Driftless Area,” it still has remnants of very old glacial drift and also has outwash and glacial lacustrine sand from the more recent Wisconsin Glaciation. Glacial Lake Wisconsin covered more than 1,825 square miles (4,730 square kilometers), most of which was in this MLRA.

Climate

The average annual precipitation in this area is 30 to 33 inches (760 to 840 millimeters). Most of the rainfall occurs as convective thunderstorms during the growing season. The annual snowfall ranges from about 35 to 50 inches (90 to 125 centimeters). It generally occurs from October through April. The average annual temperature is 42 to 45 degrees F (6 to 7 degrees C). The freeze-free period averages about 150 days and ranges from 135 to 165 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 10.4%; ground water, 12.5%
Livestock—surface water, 0.8%; ground water, 4.1%
Irrigation—surface water, 0.7%; ground water, 69.5%
Other—surface water, 2.1%; ground water, 0.0%

The total withdrawals average 145 million gallons per day (550 million liters per day). About 86 percent is from ground water sources, and 14 percent is from surface water sources. The supply of surface and ground water is abundant, but in years of normal precipitation, the moderate precipitation is inadequate for crops and pasture on sandy soils. In years of little or no precipitation, crop yields are seriously reduced. Irrigation is widely used for high-value crops. Drainage of the soils on wet lowlands is needed for good crop production. The surface water is in streams, rivers, and flowages. It is used mainly for power generation, irrigation, recreation, habitat for fish and wildlife, and disposal of effluent from sewage treatment plants.

Ground water is the major supply used to meet most domestic, agricultural, municipal, and industrial needs in this area. The water comes from aquifers in unconsolidated sand and gravel deposits overlying Cambrian sandstone or from the sandstone itself. Probable yields from wells in sand and gravel aquifers range from 100 to more than 1,000 gallons per minute (380 to more than 3,785 liters per minute). Wells in glacial till on moraines yield 50 to 1,000 gallons per minute (190 to 3,785 liters per minute). Wells in the sandstone bedrock typically yield 100 to 800 gallons per minute (380 to 3,030 liters per minute). The water is a calcium-magnesium-bicarbonate type that is moderately hard or hard and ranges from 80 to 220 parts per million (milligrams per liter) calcium carbonate. It is of good quality, containing less than 300 parts per million (milligrams per liter) total dissolved solids. The sand and gravel deposits lie over Precambrian crystalline rocks in the northern part of this area. The water from these deposits has less total dissolved solids and is less hard than the water that lies over sandstone in the southern part of the area. Minor water use problems are caused by hardness and locally by high concentrations of iron produced by reducing conditions in marshes and swamps. The regional flow of ground water is towards the Wisconsin River.

Soils

The soil orders in this MLRA are dominantly Entisols, Alfisols, Histosols, and Spodosols. Mollisols occur to a much lesser extent. The soil temperature regime is dominantly mesic, but it is frigid in the soils in low-lying depressions that are wet for long periods and in areas on the northern fringe of the MLRA. The soils in this MLRA have a udic or aquic soil moisture regime and dominantly have mixed or siliceous mineralogy. They generally are moderately deep to very deep, well drained to very poorly drained, and sandy to clayey. In much of the area, loess occurs in thin layers or does not occur at all. On some flood plains, however, silty alluvium is derived from the thicker mantles of loess on soils in the adjacent MLRAs.

Hills and pediments, which are generally in the northern and western parts of this MLRA, have Haplorthods (Ludington and Humbird series) and Epiaquods (Fairchild and Merrillan series), which formed dominantly in sandy and loamy residuum derived from interbedded sandstone and shale, and Quartzipsamments, which formed in sandy slope alluvium and sandy residuum (Boone series) and in sandy pedisediment (Tarr series). The glacial lakes, outwash plains, and valley trains in the eastern and southern parts of the area have Udipsamments (Plainfield series), Psammaquents (Newlang series), Hapludalfs (Wyeville series), and Haplosaprists (Dawsil series), all of which formed dominantly in outwash sand; lacustrine sand, silt, and clay; and organic material. The flood plains throughout the area are dominated by Udipsamments (Algansee and Scotah series) and Fluvaquents (Kalmarville series).

Biological Resources

This area is in the southern part of the conifer-hardwood forest, which includes xeric pine savannas and oak barrens. Jack pine, northern pin oak, black oak, and white oak are the dominant trees. The extensive wetlands in the area support red maple, aspen, paper birch, and speckled alder.

Some of the major wildlife species in this area are white-tailed deer, ruffed grouse, wild turkey, fox and gray squirrels, cottontail rabbits, ducks, and geese. Red fox, gray fox, coyote, muskrat, raccoon, and beaver are the main furbearers. Small populations of prairie chickens inhabit the area. Fishing is limited mostly to constructed impoundments and rivers. Local fish species include rainbow trout, brook trout, walleye pike, largemouth bass, smallmouth bass, bluegill, yellow perch, and northern pike. Colburn, Sandhill, Wood County, and Meadow Valley State Wildlife Areas, along with Buena Vista Marsh, Black River State Forest, and the Necedah National Wildlife Refuge, provide wildlife habitat throughout the area.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 20%
Grassland—private, 6%
Forest—private, 53%; Federal, 5%
Urban development—private, 6%
Water—private, 4%
Other—private, 6%

Most of this area is forestland. Lumber and pulp production is an active industry. The rest of the area is used mainly for cash-grain crops, dairy farms, livestock grazing, irrigated vegetables, Christmas trees, or cranberries. Most of the irrigated areas are used for potatoes, snap beans, peas, or sweet corn. Tourism, recreation, and wildlife management are important in this MLRA. Dams in two areas on the Wisconsin River have formed the Petenwell Flowage and Castle Rock Lake. Because of the abundance of water, the thousands of acres of State and county forests, and many large public hunting grounds, hunting and fishing are popular activities.

The major soil resource management concern is wind erosion. Maintenance of the content of organic matter and productivity of the soils and soil moisture management are additional concerns. The important conservation practices on cropland include systems of crop residue management (especially no-till systems that eliminate the need for summer fallow tillage), cover crops, windbreaks, vegetative wind barriers, wind stripcropping, and nutrient management. ■

90A—Wisconsin and Minnesota Thin Loess and Till, Northern Part

This area (shown in fig. 90A-1) is in Wisconsin (69 percent), Minnesota (26 percent), and Michigan (5 percent). It makes up about 17,535 square miles (45,440 square kilometers). It includes the cities and towns of Frederic, Ladysmith, Park Falls, Crandon, and Wittenberg, Wisconsin; Cloquet, Hinckley, and Milaca, Minnesota; and Iron River, Michigan. Interstate 35 crosses the part of this MLRA in Minnesota, and U.S. Highway 8 crosses much of the area from east to west. Parts of the Chequamegon, Nicolet, and Ottawa National Forests and numerous State parks are in this area. Parts or all of the St. Croix Chippewa Communities, Lac Court Oreilles, Lac Du Flambeau, Menominee, Potawatomi, Stockbridge, and Mole Lake Indian Reservations are in the area.

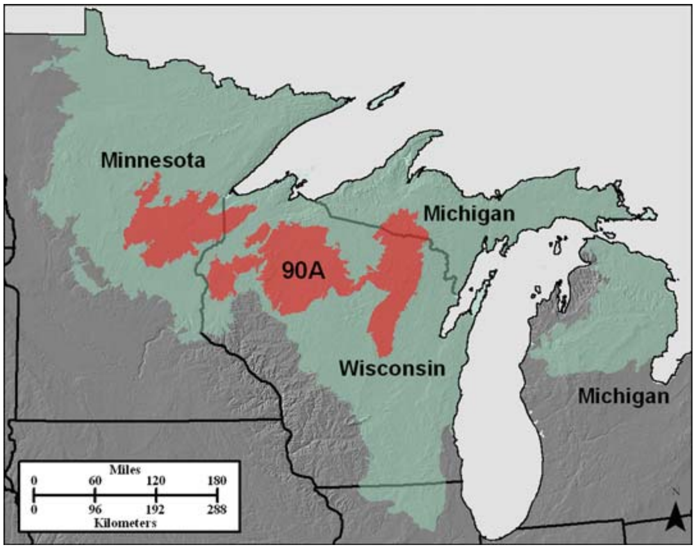

Figure 90A-1: Location of MLRA 90A in Land Resource Region K.

Physiography

The part of this area in Minnesota is mostly in the Western Lake Section of the Central Lowland Province of the Interior Plains. Nearly all of the parts in Wisconsin and Michigan are in the Superior Upland Province of the Laurentian Upland. Three distinct lobes of the Laurentian Ice Sheet (Superior, Chippewa, and Green Bay) played major roles in shaping the landscape in this area. The landscape is characterized by gently undulating to rolling, loess-mantled till plains, drumlin fields, and end moraines mixed with outwash plains associated with major glacial drainageways, swamps, and bogs. In some areas lake plains and ice-walled lakes are significant. Steeper areas occur mostly as valley side slopes along flood plains and as escarpments along the margins of lakes. Lakes are common, and streams generally have a dendritic pattern. Elevation ranges from 1,100 to 1,950 feet (335 to 595 meters). Local relief is mainly less than 10 feet to 20 feet (3 to 6 meters), but some major valleys and hills are 200 feet (60 meters) above the adjacent lowland.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Chippewa (0705), 29 percent; St. Croix (0703), 24 percent; Northwestern Lake Michigan (0403), 23 percent; Mississippi Headwaters (0701), 13 percent; Wisconsin (0707), 8 percent; and Western Lake Superior (0401), 3 percent. The major rivers crossing this area are the Chippewa, St. Croix, Mississippi, and Wisconsin Rivers. The St. Croix and Wolf Rivers in Wisconsin have been designated National Scenic Rivers. The Pine and Popple Rivers in Wisconsin and the Rum and Kettle Rivers in Minnesota have been designated as National Wild and Scenic Rivers. Lakes, ponds, and marshes are common throughout the area.

Geology

Precambrian-age bedrock underlies most of the glacial deposits in this MLRA. The bedrock is a complex of folded and faulted igneous and metamorphic rocks. The bedrock terrain has been modified by glaciation and is covered in most areas by Pleistocene deposits and windblown silts. The glacial deposits form an almost continuous cover in most areas. The drift is as much as several hundred feet thick in many areas. Loess covered the area shortly after the glacial ice melted.

Climate

The average annual precipitation in this area is 26 to 34 inches (660 to 865 millimeters). The precipitation is fairly well distributed throughout the year but reaches a slight peak in spring. Rainfall commonly occurs as convective thunderstorms during the growing season. Snowfall generally occurs from October through April. The average annual temperature is 38 to 45 degrees F (3 to 7 degrees C). The freeze-free period averages about 145 days and ranges from 110 to 180 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 14.5%; ground water, 8.3%
Livestock—surface water, 2.1%; ground water, 3.1%
Irrigation—surface water, 1.5%; ground water, 6.9%
Other—surface water, 63.2%; ground water, 0.5%

The total withdrawals average 205 million gallons per day (775 million liters per day). About 19 percent is from ground water sources, and 81 percent is from surface water sources. The moderate precipitation generally is adequate for crops and pasture, but in years of little or no precipitation, crops on sandy soils are damaged by a shortage of moisture. Drainage of most of the soils on wet lowlands is needed for good crop and forage production. Surface water and ground water are abundant and readily available. The sources of surface water are the many lakes and streams. This water is used mostly for recreational activities, partly for watering livestock, and occasionally for irrigation. Water quality is generally good. Landlocked lakes and lakes and streams that border bogs and swamps are more acid than the other surface water in the area. Spring-fed lakes have the highest pH value. The water is very soft in most of the lakes, but hard water occurs in the spring-fed lakes and in streams.

Ground water is abundant in deep glacial deposits in most of this area. It also occurs in sedimentary and volcanic rocks in the western part of the area. It is scarce in areas where the layer of drift is thin. The water meets the domestic, agricultural, municipal, industrial, rural, and irrigation needs in the area. The content of dissolved solids in the ground water from all the various aquifers in this area is low, typically about 200 parts per million (milligrams per liter), and the water generally is moderately hard or hard. The level of total dissolved solids in some of the water can be much higher because of a high content of limestone in some of the glacial deposits. Most of this area obtains ground water from unconsolidated glacial sand and gravel deposits on or very near the surface. Some wells tap the Cambrian sandstone in the southwestern part of the area, in Wisconsin.

In northwest Wisconsin (Ashland and Bayfield Counties), where the glacial deposits do not occur, and in much of the part of this area in Minnesota, ground water from sedimentary and volcanic rock aquifers is used. This water is of very good quality, but many soils have very porous layers that are poor filters of domestic waste and agricultural chemicals, so there is a risk of contamination from development and agriculture. Minor problems may be caused by hardness and in some areas by high concentrations of iron. About 65 percent of the wells in the part of this area in Michigan had water with more than 1,500 parts per billion (micrograms per liter) iron. Yields of water from the glacial deposits vary. Glacial drift consisting mainly of sand and gravel yields 100 to more than 1,000 gallons per minute (380 to more than 3,785 liters per minute). Glacial till yields generally less than 100 gallons per minute (380 liters per minute).

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Histosols, and Spodosols. The soils in the area have a frigid soil temperature regime, a udic or aquic soil moisture regime, and mixed mineralogy.

Glossudalfs (Amery, Brennyville, Freeon, Frogcreek, Glendenning, Haugen, Magnor, Milaca, Mora, Stinnett, and Santiago series) formed in a thin, discontinuous silty mantle over firm or friable till. Glossudalfs formed in outwash mantled with silty material (Antigo, Sconsin, Billyboy, and Ossmer series) or in outwash mantled with loamy material (Rosholt, Scoba, Scott Lake, Chetek, and Oesterle series). Udipsamments (Grayling, Mahtomedi, and Friendship series) formed in sandy outwash on outwash plains and stream terraces. Haplorthods formed in sandy loam or loamy sand till mantled with silty material (Beaverbay, Chequamegon, Mudlake, Wabeno, and Soperton series) or entirely in till (Newot, Newood, Pesabic, Kennan, Sarona, Sarwet, Keweenaw, Parkfalls, and Stanberry series). Haplorthods are on outwash plains. They formed in outwash mantled with silty material (Stambaugh, Vanzile, and Spiderlake series), in outwash mantled with loamy material (Padus, Pence, Tipler, and Manitowish series), or in sandy outwash (Vilas, Lindquist, Croswell, and Chinwhisker series). Glossaqualfs (Cebana series) formed in till mantled with silty material. They are in swales. Epiaqualfs (Capitola and Wozny series) formed in sandy loam or loamy sand till in depressions on moraines. Haplosaprists (Lupton, Cathro, Loxley, and Beseman series) formed in organic deposits in basins and depressions. Fluvaquents (Fordum series) formed in loamy alluvium on flood plains.

Biological Resources

This area is in a conifer-hardwood forest. Sugar maple, basswood, yellow birch, white ash, red oak, white oak, aspen, eastern hemlock, red pine, and white pine are the dominant trees. Poorly drained soils support black ash, green ash, silver maple, red maple, swamp white oak, black spruce, tamarack, and speckled alder.

Some of the major wildlife species in this area are white-tailed deer, black bear, eastern gray wolf, ruffed grouse, sharp-tailed grouse, woodcock, fox squirrel, gray squirrel, snowshoe hare, ducks, and geese. Red fox, bobcat, coyote, muskrat, fisher, mink, otter, raccoon, and beaver are the main furbearers. A small herd of elk was released in this area, and the number of elk is increasing. State wildlife areas and substantial national and county forests provide good wildlife habitat. Fishing occurs in constructed impoundments, flowages, lakes, and rivers. The species of fish in the area include rainbow trout, brook trout, walleye pike, largemouth bass, smallmouth bass, bluegill, black crappie, yellow perch, musky, and northern pike.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 10%
Grassland—private, 7%; Federal, 3%
Forest—private, 58%; Federal, 7%
Urban development—private, 3%
Water—private, 5%; Federal, 2%
Other—private, 5%

This area has a significant acreage of public and private forestland used to support the paper and lumber industry. Sap collection from sugar maple and syrup production are important forestry enterprises. Agricultural enterprises include row crops, dairy farms, and beef operations. Crops include corn, soybeans, oats, wheat, and alfalfa. Tourism, recreation, and wildlife management are important. Because of the abundance of water, the many acres of national and county forests, and public hunting grounds, hunting, fishing, snowmobiling, hiking, and skiing are popular activities.

The major soil resource management concerns are water erosion, wetness, soil fertility, and soil tilth. Conservation practices on cropland generally include crop rotations, conservation tillage systems (especially no-till systems), contour farming, contour stripcropping, and grassed waterways. A combination of surface and subsurface drainage systems is needed in most areas of poorly drained soils. ■

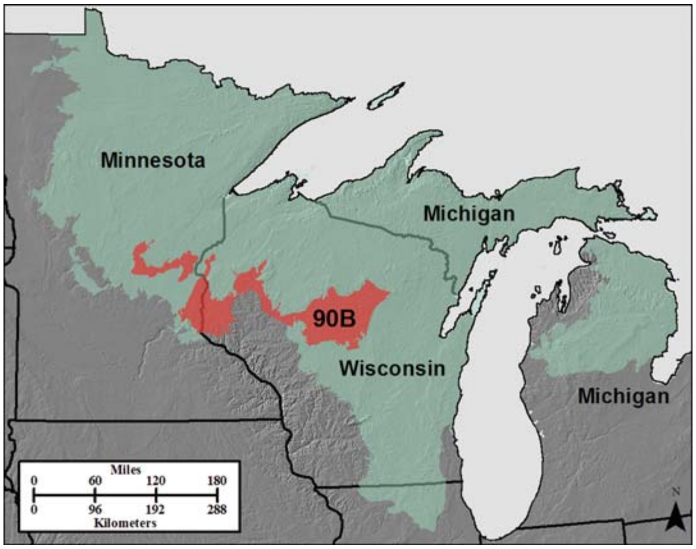

Figure 90B-1: Location of MLRA 90B in Land Resource Region K.

90B—Wisconsin and Minnesota Thin Loess and Till, Southern Part

This area (shown in fig. 90B-1) is in Wisconsin (79 percent) and Minnesota (21 percent). It makes up about 8,935 square miles (23,155 square kilometers). The cities of River Falls, Marshfield, Wausau, Rice Lake, and St. Croix Falls, Wisconsin, and North St. Paul, Forest Lake, White Bear Lake, Stillwater, and Foley, Minnesota, are in this MLRA. Interstates 35, 94, and 694 cross parts of the MLRA. The area has no Federal land and has only a few State parks. It has numerous State wildlife areas, including the Paul J. Olson, George W. Mead, Dewey Marsh, Sportsman Lake, Ackley, and McMillan Marsh State Wildlife Areas.

Physiography

The smaller, separate part of this area in Minnesota is in the Western Lake Section of the Central Lowland Province of the Interior Plains. Most of the larger part of the area is in the Wisconsin Driftless Section of the same province and division. The northern edges of the part of the MLRA in Wisconsin are in the Superior Upland Province of the Laurentian Upland. This MLRA is characterized by ground moraines, outwash plains, valley trains, glacial lakes, and sandstone hills. Much of the area is gently undulating to rolling. The steepest areas are adjacent to river valleys. Natural lakes, bogs, swamps, flood plains, and depressions are fairly extensive. Elevation ranges from about 675 feet (205 meters) at the St. Croix River near Prescott, Wisconsin, to about 1,550 feet (470 meters) just north of Medford, Wisconsin. Local relief is commonly 10 to 20 feet (3 to 6 meters) but can be more than 300 feet (90 meters) along the St. Croix River.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Chippewa (0705), 34 percent; Wisconsin (0707), 28 percent; St. Croix (0703), 15 percent; Mississippi Headwaters (0701), 12 percent; and Upper Mississippi-Black-Root (0704), 11 percent. The Mississippi River and some of its major tributaries, including the Chippewa, Black, Wisconsin, and St. Croix Rivers, drain this MLRA. The Rum River is a National Wild and Scenic River that crosses the small, separate part of the area in Minnesota. The reaches of the St. Croix and Lower St. Croix Rivers, on the border between Minnesota and Wisconsin, are National Scenic Rivers.

Geology

This MLRA was most recently glaciated during a period that straddled the Early Wisconsin Ice Age (early St. Croix and early Chippewa phases) and other earlier glaciations (Baldwin, Dallas, Hamburg, and Nasonville phases). The glacial drift in this area was probably deposited 790,000 to 16,000 years ago and is dominantly from a Superior basin origin with no carbonates. It may, however, be underlain by older glacial drift that is from a western source and contains carbonates. This older drift was deposited 790,000 to 2,500,000 years ago. Outwash is generally confined to those river valleys that previously carried glacial meltwater. Ice-walled lakes and other glacial lakes are common in this MLRA, and they have distinctive landforms with smooth slopes and silty and clayey soils. The sandstone hills are dominantly weak Cambrian sandstones locally named the Tunnel City, Wonewoc, Eau Claire, and Mount Simon Formations. A mantle of loess is in most areas of the MLRA. It ranges from a few inches (50 millimeters) to more than 6.5 feet (2 meters) in thickness.

Climate

The average annual precipitation in this area is 27 to 33 inches (685 to 840 millimeters). Most of the rainfall occurs as convective thunderstorms during the growing season. The annual snowfall ranges from about 35 to 50 inches (90 to 125 centimeters). It generally occurs from October through April. The average annual temperature is 40 to 46 degrees F (4 to 8 degrees C). The freeze-free period averages about 160 days and ranges from 135 to 180 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 5.4%; ground water, 5.3%
Livestock—surface water, 0.2%; ground water, 0.3%
Irrigation—surface water, 0.2%; ground water, 1.5%
Other—surface water, 81.1%; ground water, 6.0%

The total withdrawals average 1,140 million gallons per day (4,315 million liters per day). About 13 percent is from ground water sources, and 87 percent is from surface water sources. Both surface water and ground water are abundant. Surface water occurs as ponds, lakes, streams, rivers, and flowages. It generally is of good quality, but it is mainly hard or very hard. It is used mainly for public supply, industry, power generation, recreation, fish habitat, sewage disposal, and livestock watering.

Ground water is used to meet some of the domestic, irrigation, and municipal needs in this MLRA. Most of the ground water in the eastern part of the area comes from unconsolidated sand and gravel aquifers in glacial deposits. In western Wisconsin and eastern Minnesota, the ground water also is obtained from Cambrian sandstone and dolomite aquifers. Precambrian crystalline rock provides some ground water for domestic use and livestock in the far western part of this area. The Prairie du Chien-Jordan aquifer in the part of this area in southeastern Minnesota is one of the most heavily used aquifers in the State. The ground water from all of the aquifers generally is moderately hard or hard. Water in the Cambrian sandstone in western Wisconsin may have some high concentrations of iron, manganese, and sulfides that limit its use. All of the aquifers typically have water with less than 500 parts per million (milligrams per liter) total dissolved solids. Nitrates have been detected in a majority of the wells.

Wells in the Cambrian formation yield less than 100 gallons per minute (380 liters per minute). The sand and gravel aquifer and the Prairie du Chien-Jordan aquifer yield 100 to more than 1,000 gallons per minute (380 to more than 3,785 liters per minute). Glacial till yields are generally less than 100 gallons per minute (380 liters per minute). The Precambrian formation is not dependable and yields generally less than 20 gallons per minute (75 liters per minute). The flow of the ground water generally is towards the local streams and rivers. The regional flow at depth is toward the Wisconsin and Chippewa Rivers.

Soils

The soil orders in this MLRA are dominantly Entisols, Alfisols, Histosols, Spodosols, and Inceptisols. Mollisols occur to a much lesser extent. The soil temperature regime is dominantly frigid but is mesic in a few soils along the St. Croix River. The soils in the area have a udic or aquic soil moisture regime. Mineralogy is dominantly mixed but is siliceous in a few areas. The soils generally are moderately deep to very deep, well drained to very poorly drained, and sandy to loamy. Thin to thick layers of loess are throughout the area. The thicker layers generally are closer to the St. Croix River. Alluvium is sandy to silty.

Most of the soils on ground moraines are Glossudalfs (Almena, Alstad, Branstad, Freeon, Loyal, Magnor, Spencer, and Withee series). Most of the soils that are in glacial lakebeds and formed mostly in silty and clayey sediments are Glossudalfs (Comstock, Crystal Lake, Grasston, and Longsiding series) and Hapludalfs (Dalbo series). The soils on outwash plains and valley trains commonly are Glossudalfs or Hapludalfs (Anigon, Brill, Antigo, Langlade, Brander, Blackriver, Ribriver, Rosholt, and Chetek series) that formed in silty or loamy alluvium over outwash or Udipsamments (Menahga and Mahtomedi series) that formed entirely in outwash. The major soils on sandstone hills are Glossudalfs (Dobie series) that formed in a thin loess mantle over loamy residuum, Hapludalfs (Hayriver series) that formed in loamy slope alluvium and loamy residuum, and Psamments (Twinmound series) that formed in sandy slope alluvium and sandy residuum. Typic Haplosaprists (Seelyeville series) and Terric Haplosaprists (Markey series) formed mostly in organic material underlain by outwash, till, alluvium, or lacustrine sediments. They are in bogs and swamps. The soils on flood plains throughout the area are Dystrudepts (Moppet series) and Fluvaquents (Fordum series) that formed in loamy and sandy alluvium. The soils on flood plains that drain loess-mantled areas are Endoaquolls (Vancecreek series) that formed dominantly in silty alluvium.

Biological Resources

This area is in the southern part of the conifer-hardwood forest. Oak savanna, prairie, and lowland swamps also occur in the area. Sugar maple, basswood, yellow birch, white ash, red oak, white oak, aspen, eastern hemlock, red pine, and white pine are the dominant trees. Swampy areas support black ash, green ash, silver maple, red maple, swamp white oak, black spruce, tamarack, and speckled alder.

Some of the major wildlife species in this area are white-tailed deer, black bear, ruffed grouse, wild turkey, woodcock, fox squirrel, gray squirrel, cottontail rabbits, ducks, and geese. Red fox, bobcat, coyote, muskrat, mink, otter, raccoon, and beaver are the main furbearers. Grassy lowlands and old pastures provide scattered habitat for prairie chickens and gray partridge. The numerous State wildlife areas and the substantial acreage of county forestland provide good wildlife habitat and opportunities for recreational hunting. Fishing occurs in constructed impoundments, flowages, and rivers. The species of fish in the area include rainbow trout, brook trout, walleye pike, largemouth bass, smallmouth bass, bluegill, yellow perch, and northern pike.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 43%
Grassland—private, 14%
Forest—private, 28%
Urban development—private, 8%
Water—private, 2%
Other—private, 5%

Cropland and forestland are the major land uses in this area. Lumber and pulp production is an active industry. Agricultural enterprises include row crops, dairy farms, and livestock operations. The major crops are corn, soybeans, oats, barley, and alfalfa. A small acreage is used for specialty crops, including sweet corn, potatoes, peas, snap beans, strawberries, apples, and ginseng. Tourism, recreation, and wildlife management are important. Damming of the Wisconsin River has formed Lake Dubay. Because of the abundance of water and the many acres of county forest and public hunting grounds, hunting and fishing are popular activities.

The major soil resource management concerns are water erosion, excessive soil wetness, soil fertility, and soil tilth. Conservation practices on cropland generally include crop rotations, conservation tillage systems (especially no-till systems), contour farming, contour stripcropping, and grassed waterways. A combination of surface and subsurface drainage systems is needed in most areas of poorly drained soils. ■

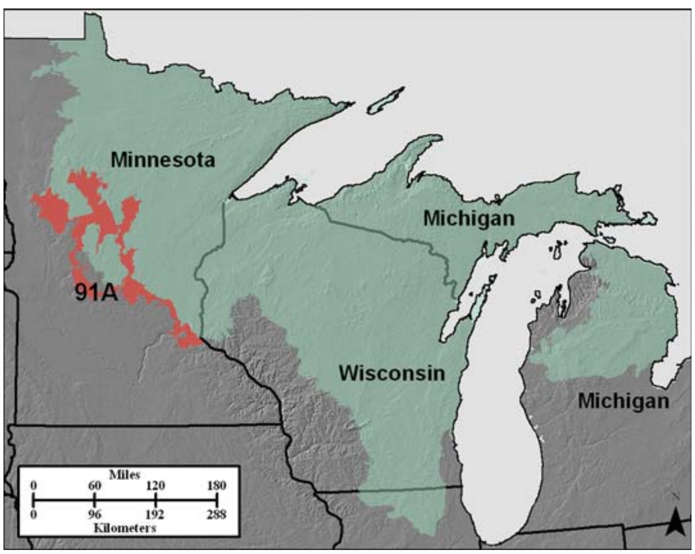

Figure 91A-1: Location of MLRA 91A in Land Resource Region K.

91A—Central Minnesota Sandy Outwash

This area is entirely in Minnesota (fig. 91A-1). It makes up about 4,600 square miles (11,920 kilometers). The cities and towns in this MLRA include Park Rapids, Perham, Wadena, Brainerd, Little Falls, St. Cloud, Monticello, and Rosemount. Interstate 94 and U.S. Highway 10 cross parts of the MLRA. The Camp Riley Military Reservation is in the central part of the area. A small part of the White Earth Indian Reservation is in the northwest corner of the area. This MLRA has numerous State parks and State forests.

Physiography

This area is in the Western Lake Section of the Central Lowland Province of the Interior Plains. The area consists mostly of large outwash plains and stream terraces. The outwash was deposited by Wisconsin-age glaciers. Most of the area is gently undulating to rolling. Some steep areas are on valley sidewalls or on escarpments along lake margins. Elevation ranges from 820 to 1,470 feet (250 to 450 meters). Local relief is mostly 10 to 20 feet (3 to 6 meters), but it as much as 80 feet (25 meters) in some areas.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Mississippi Headwaters (0701), 73 percent; Red (0902), 20 percent; Upper Mississippi-Black-Root (0704), 4 percent; and Minnesota (0702), 3 percent. The Mississippi River and its many tributaries drain much of this area. Lakes, ponds, and marshes are common throughout the area.

Geology

Most of this MLRA consists of coarse textured outwash with a thin, discontinuous mantle of loamy material. The thickness of the outwash ranges from 3 feet (1 meter) to more than 100 feet (30 meters). Loamy glacial till typically underlies the outwash. Organic material is in many of the larger basins and depressions. Recent loamy alluvium is on flood plains. In a few areas glacial till is along steep valley sidewalls. The western part of the area is underlain by undifferentiated Precambrian crystalline rocks, and the bedrock under the eastern part of the area consists of numerous Cambrian-age sandstone and shale sedimentary units.

Climate

The average annual precipitation in this area is 23 to 29 inches (585 to 735 millimeters). About 77 percent of the precipitation falls as rain during the growing season (May through September), and about 17 percent falls as snow. The average annual temperature is 39 to 44 degrees F (4 to 6 degrees C). The freeze-free period averages about 155 days and ranges from 135 to 175 days. It is longest in the southern part of the MLRA.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 5.7%; ground water, 3.6%
Livestock—surface water, 0.3%; ground water, 0.9%
Irrigation—surface water, 16.9%; ground water, 72.6%
Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average 39 million gallons per day (150 million liters per day). About 77 percent is from ground water sources, and 23 percent is from surface water sources. Surface water occurs in all parts of the MLRA. It is most abundant in the western half. In years of normal precipitation, the moderate precipitation is inadequate for crops and pasture on sandy soils. In years of little or no precipitation, crop yields are seriously reduced. Irrigation is widely used for high-value crops. Drainage of the wet lowland soils is needed for good crop production. The surface water is generally of good quality and is suitable for almost all uses.

Ground water is abundant in unconsolidated sand and gravel in the surficial drift and buried drift aquifers throughout this area. The deposits may be discontinuous in the buried drift, where lenses of sand and gravel are separated by lenses of till. The till helps to protect the buried drift aquifer from contamination from surface activities. The two aquifers have water with median levels of 350 and 450 parts per million (milligrams per liter) total dissolved solids, respectively. Both aquifers have calcium-magnesium-bicarbonate type water that is hard. The median level of iron in the buried drift aquifer exceeds 1,000 parts per billion (micrograms per liter), which is over three times the secondary standard for esthetics in drinking water. Except for these iron levels, the ground water is of good quality and is suitable for all uses with minimal treatment.

Good-quality ground water is available from a number of sedimentary rocks in the eastern half of this area. These aquifers include the St. Peter and Prairie du Chien sandstone and dolomite, the Ironton-Galesville sandstone, and the Mount Simon-Hinckley sandstone. The water from these aquifers averages about 250 to 350 parts per million (milligrams per liter) total dissolved solids. All of these aquifers have calcium-magnesium-bicarbonate type of water that is hard. They provide water primarily for municipal and industrial uses. The St. Peter aquifer is not utilized much in this area because good aquifers occur above it.

Soils

The dominant soil orders in this MLRA are Mollisols and Histosols. The soils have a frigid soil temperature regime in the northern part of the area and a mesic soil temperature regime in the extreme southern part. They have a udic or aquic soil moisture regime and mixed mineralogy. The soils on uplands generally are well drained to excessively drained. Very poorly drained Histosols are in basins and depressions. Hapludolls (Arvilla, Estherville, and Fairhaven series) and Argiudolls (Dorset, Malardi, and Verndale series) formed in outwash mantled with loamy material. They are on outwash plains and stream terraces. Hapludolls (Hawick, Hubbard, Sandberg, and Sparta series) formed in outwash on outwash plains and stream terraces. Haplosaprists (Houghton, Markey, and Seelyeville series) formed in organic material in basins and depressions.

Biological Resources

Historically, jack pine mixed with pin oak and bur oak grew on well drained soils on the outwash plains in this area. Oak savanna occurred in much of the area. Black spruce, tamarack, white cedar, and black ash were prominent on poorly drained and very poorly drained soils.

Some of the major wildlife species in this area are white-tailed deer, black bear, ruffed grouse, and sharp-tailed grouse. Because of its relatively unaltered landscape, this MLRA supports a high percentage of the rare plants and animals that occur in Minnesota.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 46%
Grassland—private, 10%
Forest—private, 15%; Federal, 1%
Urban development—private, 5%
Water—private, 13%
Other—private, 10%

The cropland in this MLRA is used mainly for feed grains and forage for livestock. Irrigation is common in some areas where corn, soybeans, potatoes, and canning crops, such as snap beans, peas, and corn, are grown. Without irrigation, droughtiness limits crop selection and yields in many areas. Dairy and beef operations are common. The forestland in the area is used mainly for pulp and timber production. Recreational hunting and fishing are important activities in the MLRA, especially in the northern part, which is forested.

The major resource concerns are water quality, nutrient management, improperly managed grazing, and wind erosion. Conservation practices on cropland generally include conservation crop rotations, crop residue management, and field windbreaks, all of which help to control wind erosion. Nutrient management and pest management are important because of water-quality concerns, especially on sandy soils and in areas where irrigated vegetable crops are grown. Pasture and hayland planting and prescribed grazing improve pastures and grazing management. Forest stand improvement and forest trails and landings reduce the impact of timber management activities on water quality. ■

91B—Wisconsin and Minnesota Sandy Outwash

This area (shown in fig. 91B–1) is in Wisconsin (60 percent) and Minnesota (40 percent). It makes up about 4,110 square miles (10,650 square kilometers). The cities and towns of

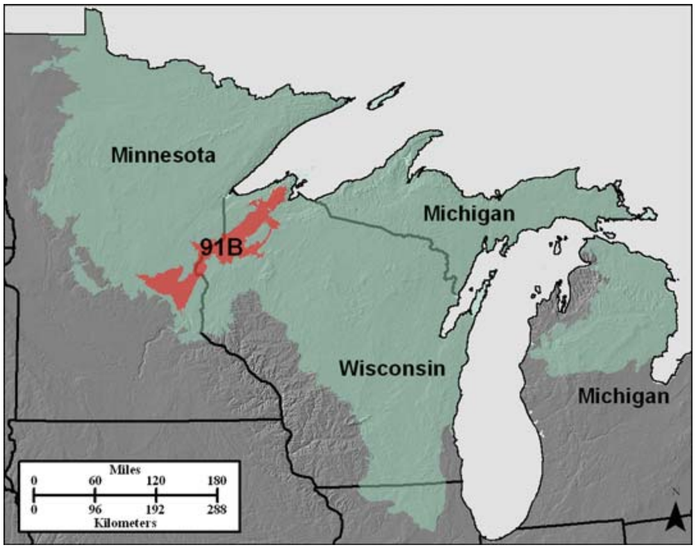

Figure 91B-1: Location of MLRA 91B in Land Resource Region K.

Spooner, Grantsburg, Solon Springs, and Siren, Wisconsin, and North Branch, Princeton, and Zimmerman, Minnesota, are in this MLRA. Interstates 35 and 94 cross the area. Some of the Chequamegon National Forest is in the far northern part of the area. All of the Crex Meadows Wildlife Area is in this MLRA.

Physiography

The eastern half of this area is in the Superior Upland Province of the Laurentian Upland, and the western half is in the Western Lake Section of the Central Lowland Province of the Interior Plains. Much of the area is nearly level to gently sloping, but some steeper escarpments occur along streams, rivers, and lake borders. The area is characterized by outwash plains, some of which are pitted or collapsed, and by small moraines, dunes, lake plains, swamps, bogs, and marshes. Lakes are common, and streams generally form a dendritic pattern. Elevation ranges from about 800 feet (245 meters) to 1,500 feet (455 meters). Local relief typically is only a few meters.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: St. Croix (0703), 69 percent; Mississippi Headwaters (0701), 20 percent; and Western Lake Superior (0401), 11 percent. The St. Croix, Namekagon, Rum, and Yellow Rivers are major rivers that drain this MLRA. The St. Croix River is a National Scenic River, and the Rum River is a National Wild and Scenic River.

Geology

Precambrian and Cambrian sandstone bedrock underlies most of the glacial deposits in this MLRA. The bedrock consists of Keweenawan sandstone in the northern part of the area and Cambrian sandstone with dolomite and shale in the southern part. In most areas the bedrock is covered by Pleistocene deposits as much as 330 feet (100 meters) thick. Bedrock exposures occur in some areas along the St. Croix River. Most of the Pleistocene deposits are late Wisconsin in age.

Climate

The average annual precipitation in this area is 25 to 34 inches (635 to 865 millimeters). About two-thirds of the rainfall occurs as convective thunderstorms during the growing season (May through September). Snowfall generally occurs from October through April. The average annual temperature is 38 to 46 degrees F (3 to 8 degrees C). The freeze-free period averages about 150 days and generally ranges from 120 to 180 days. It can be as short as 90 days in the northern part of the area.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 6.3%; ground water, 6.4%
Livestock—surface water, 0.3%; ground water, 0.2%
Irrigation—surface water, 1.2%; ground water, 5.5%
Other—surface water, 74.8%; ground water, 5.3%

The total withdrawals average 570 million gallons per day (2,155 million liters per day). About 17 percent is from ground water sources, and 83 percent is from surface water sources. Surface water and ground water are very abundant and readily available. In years of normal precipitation, the moderate precipitation is inadequate for crops and pasture on sandy soils. In years of little or no precipitation, crop yields are seriously reduced. Drainage of the wet soils on lowlands is needed for the field crops and tame pasture plants commonly grown in the area. Irrigation is widely used for high-value crops. The sources of surface water are the many lakes and streams. The surface water is used mostly for recreational activities in the part of this area in Wisconsin, but it is used for public supply and municipal and industrial purposes in the part in Minnesota. Water quality is generally good. Most of the lakes and streams are clear, but those that receive deposits of organic material from wetland vegetation are tinted brown.

This MLRA has three types of lakes—spring lakes, seepage lakes, and drainage lakes. Spring lakes seldom have an inlet, but they have an outlet with substantial flow. They are fed by ground water. Seepage lakes generally do not have an inlet or an outlet but may have an intermittent outlet. The water level is maintained by the water table or a well sealed bottom. Drainage lakes have an outlet and at least one inlet. Their main water source is runoff from streams. Spring lakes have a high mineral content because they receive the greatest amount of ground water. Drainage lakes have a lower mineral content than the spring lakes, and seepage lakes have a very low mineral content. Drainage lakes have the greatest range in reaction. Water in the spring lakes has reaction similar to that of the ground water. Seepage lakes commonly are acid, and some of the drainage lakes are alkaline. About 80 percent of the lakes are acid, having a pH of less than 7.0. The rest are neutral or alkaline, having a pH of 7.0 or higher.

Glacial deposits are the primary sources of ground water. Ground water supplies meet domestic, agricultural, municipal, and industrial needs. The quality of the water is good. The level of total dissolved solids is less than 150 parts per million (milligrams per liter). The main components in the water are calcium, magnesium, and bicarbonate ions. Locally, the dissolved mineral content may be relatively high because of a high content of limestone in the glacial deposits. Minor problems may be caused by hardness and in some areas by high concentrations of iron. Pollution of surface water is minimal because the area is relatively undeveloped and there is little municipal or industrial waste. Extensive building of cottages and houses along the lakes and streams is a potential problem. Effluent from sewage disposal facilities can pollute the water and result in the growth of weeds and algae. The problem is especially severe in seepage lakes, where there is little water exchange. Ground water yields from all the aquifers range from 100 to more than 1,000 gallons per minute (380 to more than 3,785 liters per minute).

Good-quality ground water is available from a number of sedimentary rocks in the part of this MLRA in Minnesota. These aquifers include the St. Peter and Prairie du Chien sandstone and dolomite, the Ironton-Galesville sandstone, and the Mount Simon-Hinckley sandstone. The level of total dissolved solids averages about 250 to 350 parts per million (milligrams per liter). All of these aquifers have a calcium-magnesium-bicarbonate type of water that is hard. They provide water primarily for municipal and industrial uses. The St. Peter aquifer is not utilized much in this area because good aquifers occur above it.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Histosols, and Spodosols. The soils have a frigid soil temperature regime, a udic or aquic soil moisture regime, and mixed or isotic mineralogy. The soils on uplands are very deep, excessively drained to somewhat poorly drained, and sandy. The soils on lowlands are very deep, poorly drained or very poorly drained, and sandy or mucky. Udipsamments (Cantlin, Graycalm, Grayling, Menahga, Mahtomedi, Grettum, Friendship, Wurtsmith, Zimmerman, Shawano, Crex, and Lino series) and Haplorthods (Croswell, Rubicon, Vilas, and Sayner series) formed in sandy outwash or windblown sediments. Hapludalfs formed in sandy outwash or windblown sediments over lacustrine clay on old glacial lake plains (Karlsborg, Meenon, and Perida series) or in sandy-skeletal alluvium along the major rivers (Dairyland and Bigisland series). Psammaquents (Newson series) and Endoaquods (Kinross and Au Gres series) formed in sandy outwash in depressions on outwash plains. Haplosaprists formed in sapric material in marshes (Markey and Seelyeville series) and in bogs (Dawson and Loxley series). The soils on flood plains include Udipsamments (Winterfield series) and Fluvaquents (Totagatic series), which formed in sandy alluvium, and Haplosaprists (Bowstring series), which formed in sapric material.

Biological Resources

This area is in a mixed coniferous-deciduous forest. Jack pine and scrub (Hill's) oak are the dominant trees. Barrens are common. Poorly drained soils support black spruce, tamarack, speckled alder, willow, and sedges.

Some of the major wildlife species in this area are white-tailed deer, black bear, eastern gray wolf, ruffed grouse, sharp-tailed grouse, woodcock, gray squirrel, red squirrel, snowshoe hare, porcupine, ducks, and geese. Red fox, bobcat, coyote, muskrat, fisher, mink, otter, raccoon, and beaver are the main furbearers. Private and public forestland mixed with scattered cropland provides substantial wildlife habitat. Fishing occurs in the many lakes and rivers. Local species include rainbow trout, brook trout, walleye pike, largemouth bass, smallmouth bass, bluegill, black crappie, yellow perch, musky, and northern pike.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 20%
Grassland—private, 7%; Federal, 1%
Forest—private, 43%; Federal, 3%
Urban development—private, 11%
Water—private, 6%; Federal, 1%
Other—private, 8%

Nearly 50 percent of this MLRA is forested. Two-thirds of the forestland consists of national and State forests and large, privately owned holdings, and one-third consists of small, privately owned holdings. The forestland is primarily in the eastern part of the MLRA, and it supports a pulp and timber industry and is used for recreational activities. About 28 percent of the MLRA, mostly in the western part, is used for agriculture. Irrigated corn, soybeans, and vegetable crops (such as potatoes, snap beans, and peas) and forage and feed grains for dairy cattle and other livestock are the principal crops. Other vegetable and fruit crops also are grown. Cranberries are grown on some wet soils. A substantial acreage in the MLRA, mainly in the southern part, is urban land. The urban areas are expanding rapidly.

The major resource management concerns in this area are water erosion, wind erosion, wetness, soil fertility, soil tilth, and water quality. Conservation practices on cropland generally include conservation crop rotations and crop residue management, which help to control water erosion and wind erosion. Cover crops are sometimes planted with low-residue canning crops. Nutrient management and pest management are important because of water-quality concerns, especially on irrigated cropland. Prescribed grazing and pasture and hayland planting improve pastures and grazing management. Forest stand improvement and forest trails and landings reduce the impacts of timber management activities on the quality of surface water and ground water. ■

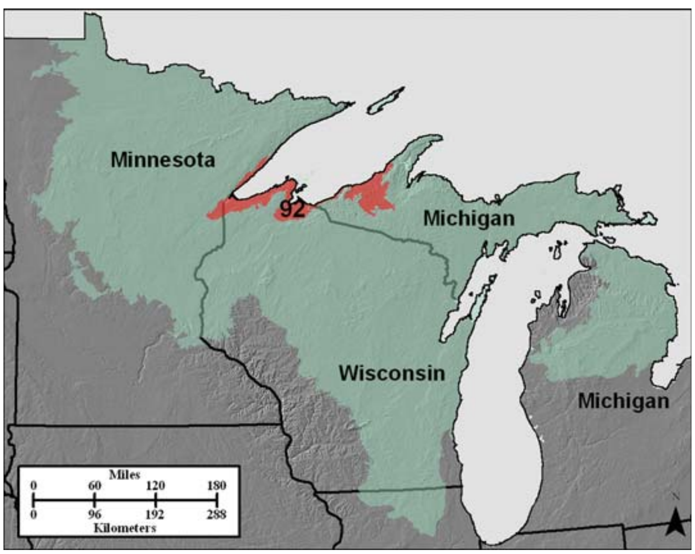

Figure 92-1: Location of MLRA 92 in Land Resource Region K.

92—Superior Lake Plain

This area (shown in fig. 92-1) is in Wisconsin (48 percent), Michigan (39 percent), and Minnesota (13 percent). It makes up about 2,920 square miles (7,570 square kilometers). The cities of Duluth, Minnesota, Superior, and Ashland, Wisconsin, and Ontonagon, Michigan, are in this MLRA. Interstate 35 ends in Duluth. A large part of the Ottawa National Forest is in the eastern half of this area. The Ontonagon, Bad River, and Red Cliff Indian Reservations are in the area. Numerous State parks and State forests are throughout the area. The Apostle Islands National Lakeshore is in this MLRA.

Physiography

All of this area is in the Superior Upland Province of the Laurentian Upland. The area is characterized by a till plain mixed with lake plains, lake terraces, beaches, flood plains, swamps, and marshes. Some rocky knobs, hills, and low mountains make up part of this nearly level lake plain. Elevation ranges from 600 to 1,400 feet (185 to 425 meters), increasing gradually from the lakeshore inland. Local relief on the lake plain is only 3 to 6 feet (1 to 2 meters), but the adjoining hills and low mountains rise sharply from 85 feet (25 meters) to more than 330 feet (100 meters) above the plains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Western Lake Superior (0401), 60 percent, and Southern Lake Superior-Lake Superior (0402), 40 percent. Some of the streams crossing this area and emptying into Lake Superior are the Bois Brule, Nemadji, Whittlesey, Montreal, Black, Presque Isle, and Ontonagon Rivers in Wisconsin and Michigan and numerous steep-gradient streams along the north shore of Minnesota.

Geology

This area has been glaciated, and most of the surface deposits are fine textured till derived from glacial lake sediments. The bedrock in the area is a mixture of late Precambrian and Cambrian sandstones and shales and mafic igneous rocks. It is known as the Keweenawan Group in Wisconsin and Minnesota. The bedrock units in Michigan are known as the Freda and Jacobsville sandstones, Nonesuch shale, the Portage Lake volcanics, and the Copper Harbor conglomerate.

Climate

The average annual precipitation in this area is 27 to 37 inches (685 to 940 millimeters). It is lowest along the lakeshore and highest in inland areas. The maximum precipitation occurs as high-intensity, convective thunderstorms in summer, and the lowest precipitation occurs in midwinter. Precipitation in winter occurs as snow. The average annual temperature is 38 to 42 degrees F (4 to 6 degrees C). The freeze-free period averages about 155 days and ranges from 125 to 190 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 3.4%; ground water, 0.0%
Livestock—surface water, 0.7%; ground water, 0.4%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 95.5%; ground water, 0.0%

The total withdrawals average 155 million gallons per day (585 million liters per day). Almost 100 percent is from surface water sources. Precipitation is adequate for crops and pasture. Drainage of level areas of wet soils is needed for good growth of crops. The area has few inland lakes, but much of the area has access to Lake Superior for water supply and recreation. Most of the "other" water use in this area is for the wood and paper products industries. Iron ore, limestone, and dolomite are shipped from the Great Lakes harbors at Duluth, Minnesota, and Superior, Wisconsin, and some surface water is used in handling those materials. The surface water is of good quality. It is hard but is suitable for most uses with little or no treatment.

Two sources of ground water occur in this area. One is the isolated pockets of unconsolidated sand and gravel in the glacial drift. The other is the Lake Superior Sandstone and Precambrian Lava Flows aquifer. Water from both of these aquifers is moderately hard to very hard and is typically very low in total dissolved solids, having less than 300 parts per million (milligrams per liter). About 30 percent of all the wells tested in these aquifers had iron and manganese concentrations that exceeded the national secondary standards for drinking water. These standards are for esthetics and do not affect human health. Staining and scale-buildup in pipes and on appliances occur when high amounts of iron and manganese occur in water.

Soils

The dominant soils in this MLRA are Alfisols, Spodosols, Inceptisols, and Entisols. The soils in the area have a frigid soil temperature regime, a udic or aquic soil moisture regime, and mixed or isotic mineralogy. The major soils formed in clayey to loamy till in some areas with a sandy mantle. Some soils, primarily along the edges of the MLRA, have stratified silty and clayey lacustrine deposits. The soils in some areas along the shore of Lake Superior formed in organic material or in sandy beach deposits.

Glossudalfs on till plains formed in very deep clayey or loamy till (Miskoaki, Amnicon, Cuttre, Odanah, Sanborg, Badriver, Watton, Flintsteel, and Big Iron series) or in clayey till that is deep to loamy or sandy lacustrine deposits (Anton, Borea, Cornucopia, Portwing, and Herbster series). Haplorthods formed in clayey till mantled with loamy material (Superior, Ubly, and Belding series), in clayey till mantled with sandy material (Manistee, Kellogg, and Ashwabay series), and in loamy till mantled with sandy material (Menominee and Morganlake series) on till plains and remnant beaches; in silty lacustrine deposits (Sporley and Fence series) on lake plains and remnant beaches; in sandy beach, dune, or lacustrine deposits (Rousseau, Neconish, Vilas, Croswell, Sultz, and Cublake series) on remnant beaches and dunes; and in clayey, loamy, and sandy deposits over sandstone bedrock (Lapoin, Abbaye, Brownstone, and Redrim series) in bedrock-controlled areas along Lake Superior. Epiaquepts formed in very deep clayey or loamy till (Bergland, Pickford, and Munuscong series); in clayey till that is deep to loamy and sandy lacustrine material (Lerch and Happyhollow series); or in clayey till mantled with sandy material (Wakeley series) in depressions on till plains. Haplohemists (Rifle series) formed in organic deposits in marshes along Lake Superior, and Haplosaprists (Seelyeville, Cathro, Lupton, Dorval, and Tawas series) formed in organic deposits in inland swamps and in side-hill seep areas. Udipsamments (Grayling, Wurtsmith, and Meehan series) formed in sandy beach and dune deposits on active beaches. Udifluvents formed in silty alluvium (Moquah series) or sandy alluvium (Pelkie and Dechamps series) on flood plains.

Biological Resources

This area supports deciduous and evergreen trees. Boreal forests (aspen, white birch, balsam fir, white spruce, white pine, red pine, white cedar, and tamarack) and mixed deciduous and coniferous forests (hemlock, sugar maple, yellow birch, red pine, and white pine) are dominant. Swamp conifers and lowland brush commonly grow on the wetter soils.

Some of the major wildlife species in this area include black bear, white-tailed deer, coyote, snowshoe hare, timber wolf, ruffed grouse, tree squirrel, bald eagle, and Canada goose. The species of fish in the area include northern pike, perch, walleye, largemouth bass, smallmouth bass, brook trout, steelhead trout, and panfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 10%
Grassland—private, 4%
Forest—private, 68%; Federal, 12%
Urban development—private, 3%
Water—private, 1%
Other—private, 2%

More than three-fourths of this area is forested, and about two-thirds is privately owned forestland used for timber production and recreation. About one-tenth of the MLRA is cropland used mainly for small grains and hay for dairy cattle and other livestock. Apples, blueberries, trefoil seed, and other specialty crops are important cash crops in some areas. Only a small part of the land is used for pasture.

The major soil resource management concerns are water erosion, wetness, soil fertility, and soil tilth. Conservation practices on cropland generally include crop rotations, conservation tillage systems, and grassed waterways. Surface drainage systems are needed to remove surface water from wet areas. ■

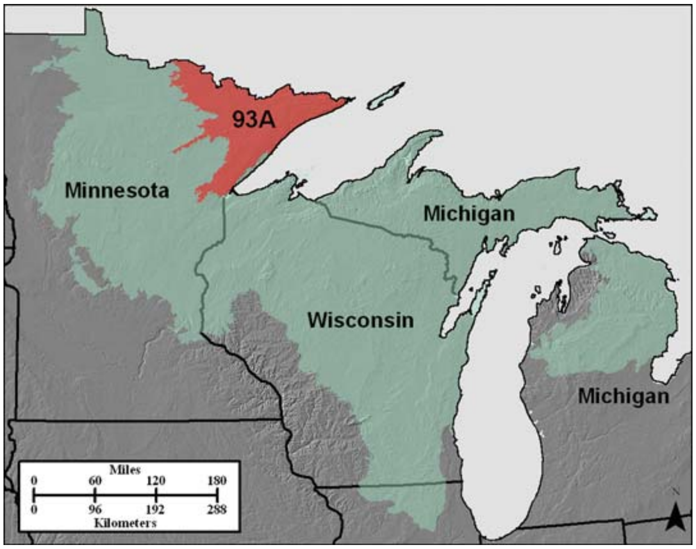

Figure 93A-1: Location of MLRA 93A in Land Resource Region K.

93A—Superior Stony and Rocky Loamy Plains and Hills, Western Part

This area is entirely in northeast Minnesota (fig. 93A-1). It makes up about 8,570 square miles (22,205 square kilometers). The towns of Ely, Finland, Grand Marais, Two Harbors, and Cloquet are in this MLRA. The main highways through the area are U.S. Highway 53 and Minnesota Highways 1 and 61. Most of the area is in the Superior National Forest, and the Boundary Waters Canoe Area Wilderness is in this MLRA. Because of its shape, this area is called the "Arrowhead region" of Minnesota. The Grand Portage Indian Reservation is at the tip of the "arrowhead." Part of the Fond du Lac Indian Reservation is in the southeast tip of the area, and the Vermilion Lake Indian Reservation is in the central part of the area.

Physiography

This area is in the Superior Upland Province of the Laurentian Upland. It was glaciated by numerous advances of the Superior, Rainy, and Des Moines glacial lobes during the Wisconsin and pre-Wisconsin glacial periods. Most of the surface of this area is young, dominated by drumlin fields, moraines, small glacial lake plains, outwash plains, and bedrock-controlled uplands. Elevation generally ranges from about 600 to 2,100 feet (185 to 640 meters). Eagle Mountain, at an elevation of 2,301 feet (701 meters), is the highest point in Minnesota. Closed depressions, lakes, ponds, and bogs are throughout the area. The several thousand lakes within the Boundary Waters Canoe Area Wilderness were formed by the scouring of the bedrock landscape by glacial ice. Local relief ranges from 10 to more than 100 feet (3 to 30 meters). It can be 600 feet (185 meters) or more in some areas adjacent to Lake Superior.

The extent of the major Hydrologic Unit Areas (identified by four digit numbers) that make up the MLRA is as follows: Rainy (0903), 53 percent; Western Lake Superior (0401), 45 percent; Mississippi Headwaters (0701), 1 percent; and St. Croix (0703), 1 percent. The surface drainage network in this area is immature. It is made up primarily of remnants of glacial meltwater channels. The major channels are occupied by the Vermilion, Whiteface, and St. Louis Rivers. Many small tributaries drain into Lake Superior from the uplands to the west, including the Lester, Baptism, and Temperance Rivers.

Geology

This area is covered by glacial till, drift, and outwash and by lake sediments, alluvium, and thin layers of loess. These deposits range from only a few inches to several hundred feet in thickness. Bedrock is on the surface or at a shallow depth in many areas. The bedrock formations in this area include Middle Precambrian graywacke and mudstone and their metamorphic equivalents, Upper Precambrian basalts, gabbroic rocks, including the Duluth complex, and Lower Precambrian granitics, metabasalt, and graywacke. Iron ore is mined in this area.

Climate

The average annual precipitation in almost all of this area is 25 to 30 inches (635 to 760 millimeters). It is as much as 33 inches (840 millimeters) at the tip of the "arrowhead." About 65 percent of the precipitation falls as rain during the growing season (May through September), and about 21 percent falls as snow. The average annual temperature is 36 to 40 degrees F (2 to 4 degrees C). The freeze-free period averages about 150 days and ranges from 120 to 175 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 8.4%; ground water, 0.0%
Livestock—surface water, 4.2%; ground water, 9.1%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 78.3%; ground water, 0.0%

The total withdrawals average 19 million gallons per day (72 million liters per day). About 9 percent is from ground water sources, and 91 percent is from surface water sources. The numerous lakes and streams are sources of water. The timber and mining industries use most of the surface water that is used in this area. This water is of very good quality and is suitable for most uses.

Ground water occurs in joints, fractures, and bedding planes in the Precambrian crystalline rocks underlying most of this area. This water typically has more than 500 parts per million (milligrams per liter) total dissolved solids and is hard. The median level of iron exceeds the national secondary standard for drinking water of 300 parts per billion (micrograms per liter). This aquifer may be the only source of ground water for domestic use and livestock in most of this area. Volcanic rocks along the shore of Lake Superior also contain ground water. The water in these basalt flows generally has a median level of total dissolved solids of about 200 parts per million (milligrams per liter) and is moderately hard. This aquifer provides water mostly for domestic use and livestock. Naturally occurring areas with very saline water are not used.

Soils

This MLRA is dominated by Entisols, Inceptisols, and Histosols. The soils have a frigid soil temperature regime, a udic soil moisture regime, and isotic or mixed mineralogy. The parent material is dominantly dense loamy till, coarse glacial drift and outwash, silty glaciolacustrine sediment, local loess, alluvium, and organic material. The soils are dominantly shallow or moderately deep in the northern part of the area and very deep in the southern part. They are very poorly drained to excessively drained and are level to very steep. Eutrudepts (Ahmeek, Brimson, Eveleth, Hermantown, Normanna, and Toimi series) formed in till. Dystrudepts (Conic, Insula, and Mesaba series) formed in till over bedrock. Udorthents (Quetico series) formed in loamy and very shallow loamy material over bedrock. Udipsamments (Grayling and Mahtomedi series) formed in sandy outwash. Haplohemists (Rifle and Greenwood series) formed in thick layers of organic material.

Biological Resources

This MLRA makes up the true forested region of Minnesota. Prior to settlement, the vegetation consisted almost entirely of forest communities. The forest types included white pine-red pine forest, aspen-birch forest, mixed hardwood-pine forest with sugar maple on ridges, and jack pine barrens in the uplands. Conifer swamps or bogs occupied the depressions and areas of outwash. Fire dependence characterizes all of these forest types. This MLRA is still dominantly forested. Much of the land is in public ownership and managed for wood products and recreation. Many areas on uplands support quaking aspen and paper birch. Some scattered areas have old-growth pine stands.

Some of the major wildlife species in this area are white-tailed deer, moose, and ruffed grouse. Because of its relatively unaltered landscape, this MLRA supports a high percentage of the rare plants and animals that occur in Minnesota. Such species include the bald eagle, the Canada lynx, and the eastern timber wolf. The thousands of kettle and bog lakes in this area support populations of common game fish, such as walleye, northern pike, and smallmouth bass. Numerous short, high-gradient streams lead directly from the highlands to the shores of Lake Superior. These cold-water streams support native, sustaining populations of brook trout and rainbow trout and also serve as breeding waters for several species of anadromous fish common to Lake Superior, including steelhead trout and lake trout.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 1%
Forest—private, 44%; Federal, 31%
Urban development—private, 2%
Water—private, 10%; Federal, 8%
Other—private, 2%; Federal, 2%

About 75 percent of this MLRA is forested, and nearly all of the forestland consists of county, State, or national forests. Lumbering, iron mining, and recreation are important. The many bodies of surface water in the area provide opportunities for recreation.

The major resource concerns include the water erosion and reduced water quality caused by timber harvesting. They also include management of wildlife habitat and riparian areas. Conservation practices on forestland generally include forest stand improvement and forest trails and landings. These practices reduce the impacts of timber management activities on water quality. Riparian forest buffers help to protect streams and rivers from timber harvesting activities, improve wildlife habitat, and protect water quality. ■

93B—Superior Stony and Rocky Loamy Plains and Hills, Eastern Part

This area (shown in fig. 93B-1) is in Michigan (86 percent) and Wisconsin (14 percent). It makes up about 6,900 square miles (17,880 square kilometers). The cities of Hurley and Mellen, Wisconsin, and Munising, Marquette, Houghton, Baraga, and Ironwood, Michigan, are in this MLRA. U.S. Highways 2, 41, and 45 cross the area. The K.I. Sawyer Air Force Base is in this area. The L’Anse, Keweenaw Bay, and Lac Vieux Desert Indian Reservations are in the part of the area in Michigan. The MLRA includes parts of the Ottawa and Hiawatha National Forests and parts of the Escanaba River, Copper Country, Baraga, and Lake Superior State Forests in Michigan; the Chequamegon National Forest in Wisconsin; and Isle Royale National Park, which is offshore in Lake Superior.

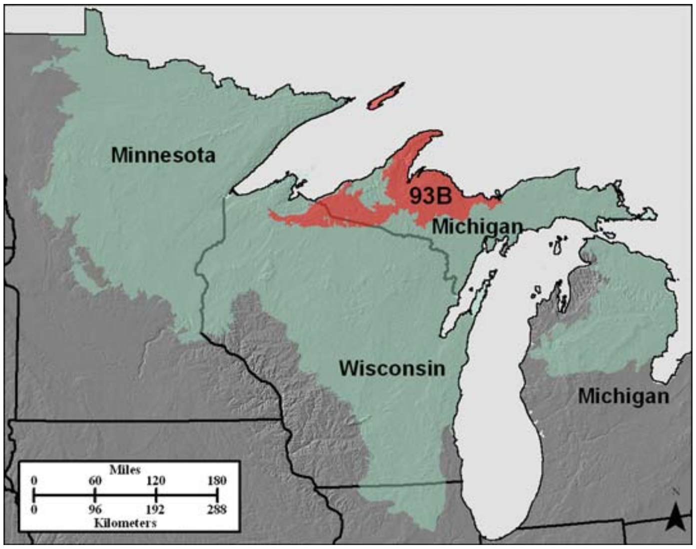

Figure 93B-1: Location of MLRA 93B in Land Resource Region K.

Physiography

This area is almost entirely in the Superior Upland Province of the Laurentian Upland. The eastern end of the area is in the Eastern Lake Section of the Central Lowland Province of the Interior Plains. This area has many glacial landscape features and is dissected by numerous streams and rivers. It is characterized by a mixture of high-relief bedrock-controlled moraines, end moraines, and ground moraines and nearly level areas of glaciofluvial deposits. Elevation generally ranges from 600 to 1,970 feet (185 to 600 meters). Mt. Arvon, the highest point in Michigan, rises to an elevation of 1,979 feet (603 meters). The peaks of some bedrock-controlled moraines in the steeper areas rise more than 300 feet (90 meters) above the adjacent lowlands.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Southern Lake Superior-Lake Superior (0402), 67 percent; Northwestern Lake Michigan (0403), 20 percent; Western Lake Superior (0401), 11 percent; and Chippewa (0705), 2 percent. Numerous rivers drain this MLRA, and many of the rivers, such as the Escanaba, Paint, Michigamme, and Fence Rivers in Michigan, empty into Lake Michigan. The Chocolay, Sturgeon, Ontonagon, Montreal, and Presque Isle Rivers in Michigan drain into Lake Superior.

Geology

This area is underlain dominantly by Precambrian igneous or metamorphic bedrock that contains significant amounts of commercially valuable iron and copper. A smaller percentage of the area is underlain by Cambrian or Precambrian sandstone. The surface of the area is covered by glacial till derived from these bedrock types, glaciofluvial deposits of very diverse origin, and organic deposits.

Climate

The average annual precipitation ranges from 30 to 38 inches (760 to 965 millimeters) in most of this area. It is 26 to 30 inches (660 to 760 millimeters) just inland from Chequamegon Bay in Wisconsin and Keweenaw Bay in Michigan. About two-thirds of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. Snow is common in winter. The average annual snowfall is more than 200 inches (510 centimeters) in the areas adjacent to Lake Superior. The average annual temperature is 38 to 43 degrees F (3 to 6 degrees C). The freeze-free period averages about 140 days and ranges from 100 to 180 days. It is longest adjacent to Lake Superior and shortest in inland areas that are farthest from the Great Lakes, in the part of the MLRA in Michigan.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 73.0%; ground water, 8.3%
Livestock—surface water, 8.6%; ground water, 10.1%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average 6 million gallons per day (23 million liters per day). About 18 percent is from ground water sources, and 82 percent is from surface water sources. Lake Superior and the numerous inland lakes and streams in this MLRA are the sources of surface water. This water is of good quality and is suitable for almost all uses.

Ground water can be obtained from glacial deposits in most of this area, except for a large part of the northern half. The water is in sand and gravel outwash, in silty and sandy glacial lake sediments, and in buried sand and gravel lenses within the glacial till. The water is of good quality and is suitable for almost all uses with minimal treatment. It typically has about 200 to 250 parts per million (milligrams per liter) total dissolved solids. The water from some wells has very high levels of iron, especially in the southern half of the area.

A Precambrian Sandstone aquifer occurs south and west of Keweenaw Bay, in the part of this area in Michigan. Little water-quality data are available for this aquifer. The Lake Superior Sandstone and Precambrian lava flow aquifers occur in the southwestern part of this area, in Wisconsin. Water from these aquifers is very similar in quality to the water in the glacial deposits.

Soils

The dominant soil orders in this MLRA are Histosols and Spodosols. The soils in the area dominantly have a frigid soil temperature regime, an aquic or udic soil moisture regime, and mixed or isotic mineralogy. They are shallow to very deep, excessively drained to very poorly drained, and sandy to clayey. Haplorthods (Amasa, Sundog, Pence, Padus, and Channing series) formed in loess over outwash on outwash plains, valley trains, and kames. Fragiorthods (Gogebic, Munising, Wabeno, Champion, and Schweitzer series) formed in till or loess over till on till plains and moraines. Haplorthods formed in sandy glacial deposits on outwash plains, valley trains, and moraines (Kalkaska, Karlin, Croswell, Au Gres, and Rubicon series), in till or loess over till (Sarona series), in till over igneous or metamorphic bedrock (Peshekee, Michigamme, Dishno, and Arcadian series), and in sandy eolian deposits (Rousseau and Deer Park series) on dunes and lake plains. Haplosaprists (Carbondale, Cathro, Lupton, Markey, and Tawas series) formed in organic material in depressions on lake plains, outwash plains, and till plains.

Biological Resources

The soils on uplands in this area support natural stands of mixed northern hardwoods and pine. Sugar maple, oak, white ash, elm, yellow birch, white pine, jack pine, and red pine are the principal tree species. Lowland areas support both mixed hardwoods and conifers. Elm, soft maple, black ash, black spruce, tamarack, and northern white-cedar are the major species.

Some of the major wildlife species in this area are white-tailed deer, black bear, red fox, raccoon, muskrat, cottontail rabbit, snowshoe hare, squirrel, pheasant, ruffed grouse, woodcock, mallard, blue-winged teal, and wood duck. Fishing occurs in Lake Superior, in other lakes, and in streams and rivers. The species of fish in the area include lake trout, rainbow trout, brook trout, walleye pike, largemouth bass, smallmouth bass, bluegill, black crappie, yellow perch, and northern pike.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 2%
Grassland—private, 1%
Forest—private, 68%; Federal, 20%
Urban development—private, 2%
Water—private, 3%; Federal, 2%
Other—private, 2%

Almost nine-tenths of this MLRA is forested, and nearly four-fifths of the forestland is privately owned. Feed grains and hay are the chief crops grown on the limited acreage used as cropland. Much of the grain is fed to dairy cattle and other livestock on the farms where it is grown. The rest of the farmland in the area is about equally divided between pasture and farm woodlots. Recreation is an important land use, especially along the major streams and on sites bordering Lake Superior.

The major soil resource management concerns are water erosion, soil wetness, soil fertility, and soil tilth. Conservation practices on cropland generally include crop rotations, conservation tillage systems (especially no-till systems), contour farming, contour stripcropping, and grassed waterways. A combination of surface and subsurface drainage systems is needed in most areas of poorly drained soils. ■

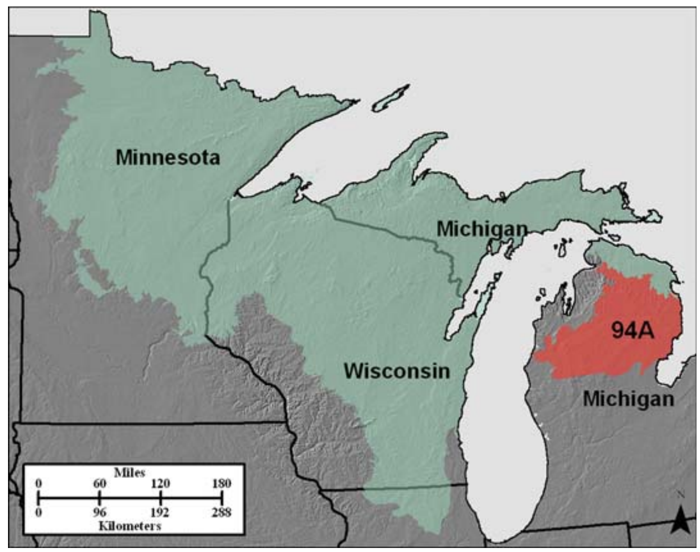

Figure 94A-1: Location of MLRA 94A in Land Resource Region K.

94A—Northern Michigan and Wisconsin Sandy Drift

This area is entirely in the northern part of the Lower Peninsula of Michigan (fig. 94A-1). It makes up 9,020 square miles (23,380 square kilometers). The towns of Grayling, Gaylord, Cadillac, Clare, and Tawas City are in this MLRA. Interstate 75 and U.S. Highways 10, 23, 27, and 131 pass through the area. Parts of the Au Sable, Mackinaw, and Pere Marquette State Forests and the Huron and Manistee National Forests occur in the area.

Physiography

This area is in the Eastern Lake Section of the Central Lowland Province of the Interior Plains. It is dominated by outwash plains and moraines. Scattered lake plains and till plains are throughout the area. The terrain can be steep on the moraines and flat in the areas of outwash and lake plains. Elevation ranges from 850 to 1,725 feet (260 to 525 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Northwestern Lake Huron (0407), 40 percent; Northeastern Lake Michigan-Lake Michigan (0406), 39 percent; and Southwestern Lake Huron-Lake Huron (0408), 21 percent. The Au Sable, Manistee, Au Gres, and Pine Rivers are the major streams draining this MLRA. Reaches of the Pigeon, Boardman, Au Sable, Betsie, Rifle, and Pere Marquette Rivers in this area are National Wild and Scenic Rivers.

Geology

This area is covered almost entirely by deposits of glacial till, outwash, and lake sediments. Bedrock consisting of Devonian limestone and dolomite with interbedded shale, chert, and anhydrite stringers is at various depths below the surface because of the curvature of the Michigan basin. Bedrock exposures are evident on the eastern and western shores in the MLRA, in areas where the outer edges of the basin rise to the surface.

Climate

The average annual precipitation is 27 to 30 inches (685 to 760 millimeters) in the eastern two-thirds of this area and 30 to 36 inches (760 to 915 millimeters) in the western one-third. The precipitation occurs as rain during the growing season and snow during the winter. The average annual snowfall is 45 to 150 inches (115 to 380 centimeters). Most of the precipitation comes from the west as storms pick up moisture from the Great Lakes. The average annual temperature is 41 to 47 degrees F (5 to 9 degrees C). The freeze-free period averages about 145 days and ranges from 105 to 185 days. The average annual air temperature is lower and the freeze-free period is shorter in most of the western half of this area than in the rest of the area.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 62.7%; ground water, 14.4%
Livestock—surface water, 0.7%; ground water, 1.2%
Irrigation—surface water, 11.7%; ground water, 4.5%
Other—surface water, 3.4%; ground water, 1.4%

The total withdrawals average 145 million gallons per day (550 million liters per day). About 22 percent is from ground water sources, and 78 percent is from surface water sources. This MLRA is a water-rich area. It is bordered on two sides by the Great Lakes. Also, it has many high-quality cold-water streams and lakes, which generally have a calcium bicarbonate type of water but can have high levels of dissolved solids. The surface water is of good quality and is suitable for almost all uses with minimal treatment.

Glacial deposits are the sole sources of ground water in this MLRA. The sedimentary rocks that underlie the glacial deposits are mostly shale and are not used as sources of water. Of the glacial deposits, outwash and lakebed sands are the most productive aquifers. Calcium and bicarbonate are the principal dissolved substances in the ground water. The median level of total dissolved solids is less than 200 parts per million (milligrams per liter). The ground water is hard and can have high levels of iron. Problems with nitrate contamination are related to land use practices, such as applications of fertilizer, manure management, and septic systems.

Soils

The dominant soils in this MLRA are Spodosols, Entisols, Alfisols, and Histosols. These soils have a frigid soil temperature regime, an aquic or udic soil moisture regime, and dominantly mixed mineralogy. They are very deep, excessively drained to poorly drained, and sandy. Nearly level to very steep Haplorthods (Rubicon, Kalkaska, and Blue Lake series) and Udipsamments (Graycalm and Grayling series) formed in sandy glaciofluvial deposits. Nearly level to very steep Glossudalfs (Klacking and Millersburg series) formed in sandy and loamy glacial till. Very poorly drained Haplosaprists (Tawas and Lupton series) formed in thick organic deposits or in organic deposits over sandy glaciofluvial material.

Biological Resources

This area is a large part of the Northern Lower Michigan Ecosystem Region and consists mainly of two major forest community types—the Pine Barrens and the Northern Hardwoods. Red pine, jack pine, white pine, white oak, black oak, and red maple formerly were and currently are the dominant species in the Pine Barrens. Sugar maple, beech, white pine, and yellow birch formerly were and currently are the dominant native species in the Northern Hardwoods. Other important native species include pin cherry, striped maple, and basswood in the uplands and balsam fir, eastern hemlock, speckled alder, and black spruce in the mosaic of wetlands throughout the area.

Some of the major wildlife species in the area are white-tailed deer, elk, black bear, snowshoe hare, coyote, ruffed grouse, woodcock, woodland songbirds, ducks, and geese. The species of fish in the numerous lakes, impoundments, rivers, and streams throughout the area include rainbow trout, brown trout, brook trout, Chinook salmon, coho salmon, northern pike, bass, yellow perch, bluegill, and sunfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 8%
Grassland—private, 8%; Federal, 1%
Forest—private, 59%; Federal, 11%
Urban development—private, 5%
Water—private, 2%; Federal, 1%
Other—private, 5%

About 70 percent of this area is forested, and about 15 percent is cropland or hayland. About one-third of the area is in small, privately owned holdings, and another one-third consists of national and State forests. The forests are used mainly for timber production and recreation. Dairy and beef operations are very important enterprises in the area. Forage and feed grains for dairy cattle and other livestock are the principal crops. Wheat, oats, corn, potatoes, and hay also are grown in the area.

The major soil resource concerns are wind erosion, water erosion, excessive soil wetness, soil moisture management, and maintenance of the fertility and productivity of the soils. Conservation practices on cropland generally include crop residue management systems (especially no-till and reduced-till systems), cover crops, wind barriers, stripcropping, and nutrient management. ■

94B—Michigan Eastern Upper Peninsula Sandy Drift

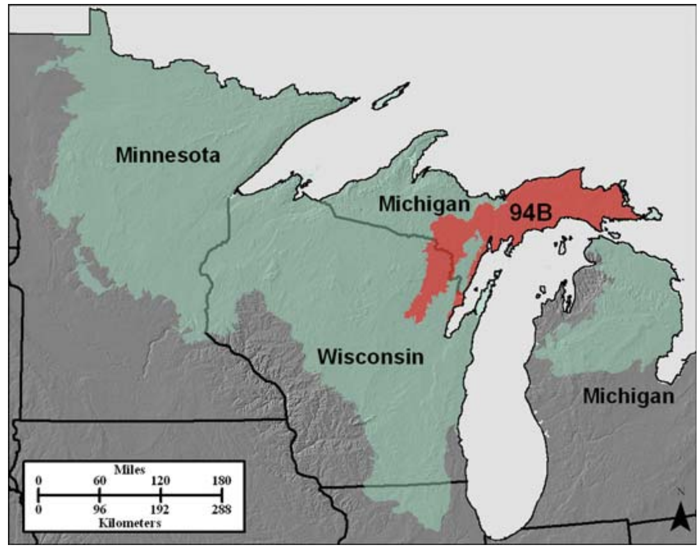

Figure 94B-1: Location of MLRA 94B in Land Resource Region K.

This area (shown in fig. 94B-1) is in Michigan (83 percent) and Wisconsin (17 percent). It makes up about 9,810 square miles (25,425 square kilometers). The cities of Shawano, Keshena, Pembine, and Wausaukee, Wisconsin, and Menominee, Iron Mountain, Escanaba, Manistique, St. Ignace, Newberry, Seney, Grand Marais, and Sault Ste. Marie, Michigan, are in this MLRA. Interstate 75 terminates in Sault Ste. Marie, and U.S. Highways 2 and 41 cross most of the area. The Menominee and Bay Mills Indian Reservations are in the parts of the area in Wisconsin and Michigan, respectively. The Hiawatha National Forest, parts of the Copper Country, Escanaba River, and Lake Superior State Forests in Michigan, and the Nicolet National Forest in Wisconsin also occur in the area. Most of this area is in the part of Michigan known as the "Upper Peninsula." Mackinac Island is included in the area, and part of the Mackinaw State Forest is on the island.

Physiography

Most of this area is in the Eastern Lake Section of the Central Lowland Province of the Interior Plains. The western one-fifth is in the Superior Upland Province of the Laurentian Upland. The area has many glacial landscape features and is dissected by numerous streams and rivers. It is characterized by a mixture of low-relief ground moraines, lacustrine deposits, and glaciofluvial deposits and some higher relief, bedrock-controlled moraines in the extreme southwest part. Elevation ranges from 580 to 1,400 feet (175 to 425 meters). Local relief is mainly 25 feet (8 meters) or less, but some hills and drumlins rise more than 165 feet (50 meters) above the adjacent lowlands.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Northwestern Lake Michigan (0403), 46 percent; Northeastern Lake Michigan-Lake Michigan (0406), 21 percent; Southern Lake Superior-Lake Superior (0402), 20 percent; Northwestern Lake Huron (0407), 10 percent; and Southwestern Lake Huron-Lake Huron (0408), 3 percent. Numerous rivers drain this MLRA. The Oconto, Peshtigo, and Menominee Rivers in Wisconsin and the Escanaba, Ford, Whitefish, and Manistique Rivers in Michigan empty into Lake Michigan. The Two Hearted, Sucker, and Tahquamenon Rivers in Michigan drain into Lake Superior, and the Munuscong, Carp, and Pine Rivers drain into Lake Huron. The Pine and Pike Rivers are National Wild and Scenic Rivers, and the Wolf River is a National Scenic River in the part of this area in Wisconsin. The Two Hearted River in Michigan is a National Wild and Scenic River. This MLRA has a significant percentage of wetlands.

Geology

This area is covered about equally with glacial lake plain, till, and outwash deposits. The underlying bedrock is dominantly Silurian, Ordovician, or Cambrian sandstone or limestone bedrock types that are quarried extensively for building materials, steelmaking, and agriculture. Some granitic rocks and metamorphosed sediments and volcanics underlie the western edge of this MLRA

Climate

The average annual precipitation in most of this area is 30 to 36 inches (760 to 915 millimeters) but is as low as 28 inches (710 millimeters) in some areas. About two-thirds of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. Snow is common in the winter. The average annual temperature in most of this area is 39 to 42 degrees F (4 to 6 degrees C), but it can be as high as 44 degrees F (7 degrees C) in the extreme southern tip of the area, near Menominee, Wisconsin. The freeze-free period averages about 150 days and ranges from 120 to 180 days. It is longest in the southern end of the area and in a narrow belt along Lake Michigan. The Great Lakes help to moderate the climate of this MLRA.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 39.1%; ground water, 24.7%
Livestock—surface water, 2.3%; ground water, 5.4%
Irrigation—surface water, 2.7%; ground water, 4.1%
Other—surface water, 13.6%; ground water, 8.1%

The total withdrawals average 37 million gallons per day (140 million liters per day). About 42 percent is from ground water sources, and 58 percent is from surface water sources. Many small lakes, a few large lakes, and numerous perennial streams are sources of good-quality surface water in this area.

Ground water is abundant in the unconsolidated sand and gravel and lakebed sands in the glacial deposits that cover almost all of this area. No glacial deposits are used as aquifers in the far eastern tip of the area. The highest yielding wells are in the outwash deposits within the drift, but some domestic water also is pumped from glacial lake sediments and the till itself. This water is suitable for almost all uses with little or no treatment. The median level of total dissolved solids is about 200 to 250 parts per million (milligrams per liter). Glacial drift covers the bedrock aquifers in this area and helps to protect them from contamination. Agricultural activities, municipal and industrial waste discharges, and road salts are the primary sources of contamination.

Three bedrock aquifers, Silurian-Devonian sediments, Cambrian-Ordovician sandstone and dolomite, and Precambrian sandstone, occur in the part of this area in Michigan. The Cambrian-Ordovician sandstone extends south and west into the part of the area in Wisconsin. The water in these bedrock aquifers is similar in quality to the water in the glacial aquifers, but it has slightly more total dissolved solids. It tends to be fresher where the glacial aquifers are in contact with the bedrock aquifers and are recharging the water in the bedrock aquifers. Water from the bedrock aquifers is of good quality and is suitable for almost all uses.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Histosols, and Spodosols. The soils in the area dominantly have a frigid soil temperature regime, an aquic or udic soil moisture regime, and mixed or isotic mineralogy. They are shallow to very deep, excessively drained to very poorly drained, and sandy to clayey.

Hapludalfs formed in loess over outwash (Nadeau series) on outwash plains, valley trains, and kames and in till or loess over till (Emmet and Onaway series) on till plains, moraines, and drumlins. Glossudalfs formed in till (Pemene, Frechette, Kennan, Ellwood, Crossett, and Oconto series), in till over outwash (Perote series), and in sandy deposits over till (Rabe series) on till plains, moraines, and drumlins. Haplorthods formed in sandy glacial deposits on outwash plains, valley trains, and moraines (Kalkaska, Mancelona, Croswell, Au Gres, and Rubicon series) and in till or loess over till (Trenary, Tilleda, Charlevoix, Greylock, and Shoepac series), sandy deposits over till (Menominee and Iosco series), till over limestone bedrock (Amadon, Longrie, and Reade series), sandy deposits over igneous bedrock (Ishpeming series), and sandy eolian deposits (Rousseau and Eastport series) on dunes and lake plains. Udipsamments formed in sandy eolian deposits on dunes and lake plains (Shawano series) or in sandy outwash on outwash plains, valley trains, and moraines (Menahga series). Haplosaprists (Carbondale, Cathro, Lupton, Markey, and Tawas series) formed in organic material in depressions on lake plains, outwash plains, and till plains.

Biological Resources

The soils on uplands in this area support natural stands of mixed northern hardwoods and pine. Sugar maple, oak, white ash, elm, yellow birch, white pine, jack pine, red pine, and American beech are the principal tree species. Lowland areas support both mixed hardwoods and conifers. Elm, soft maple, black ash, black spruce, tamarack, and northern white-cedar are the major species

Some of the major wildlife species in this area are white-tailed deer, black bear, red fox, raccoon, muskrat, cottontail rabbit, snowshoe hare, squirrel, pheasant, ruffed grouse, woodcock, mallard, blue-winged teal, and wood duck. Fishing occurs in Green Bay, Lake Michigan, Lake Huron, streams, inland lakes, and rivers. The species of fish in the area include lake trout, rainbow trout, brook trout, walleye pike, largemouth bass, smallmouth bass, bluegill, black crappie, yellow perch, and northern pike.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 3%
Grassland—private, 3%; Federal, 1%
Forest—private, 67%; Federal, 16%
Urban development—private, 3%
Water—private, 2%; Federal, 1%
Other—private, 4%

More than 80 percent of this MLRA is forested, and about 80 percent of the forestland is privately owned. The part of the MLRA in Michigan is about three-fourths forestland and one-fourth cropland. Feed grains and hay are the chief crops. Much of the grain is fed to dairy cattle and other livestock on the farms where it is grown. Fruits and other specialty crops also are important. The rest of the land in farms is about equally divided between pasture and farm woodlots. Recreation is an important land use, especially along the major streams and on sites bordering Green Bay and Lake Michigan.

The major soil resource management concerns are water erosion, excessive soil wetness, soil fertility, and soil tilth. Conservation practices on cropland generally include crop rotations, conservation tillage systems (especially no-till systems), contour farming, contour stripcropping, and grassed waterways. A combination of surface and subsurface drainage systems is needed in most areas of poorly drained soils. ■

94C—Michigan Northern Lower Peninsula Sandy Drift

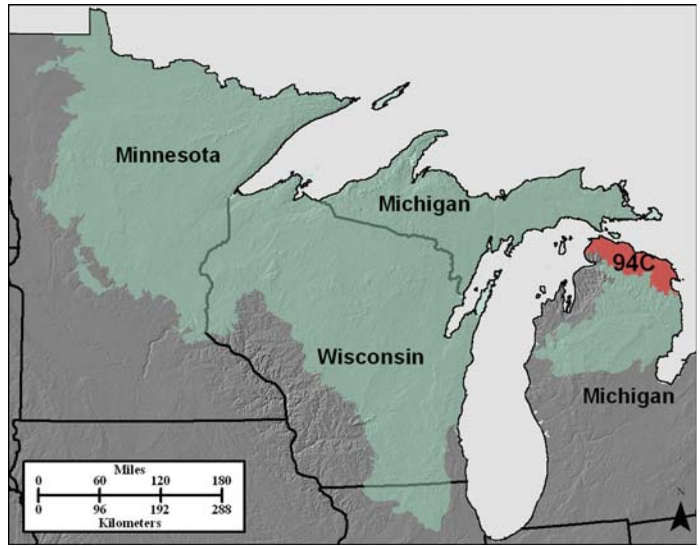

Figure 94C-1: Location of MLRA 94C in Land Resource Region K.

This area is entirely in the northern part of the Lower Peninsula of Michigan (fig. 94C-1). It makes up 2,000 square miles (5,185 square kilometers). The towns of Cheboygan, Rogers City, and Alpena are in this MLRA. Interstate 75 and U.S. Highways 23 and 31 pass through the area. Numerous parts of the Mackinaw State Forest occur in the area.

Physiography

This area is in the Eastern Lake Section of the Central Lowland Province of the Interior Plains. It is dominated by lake plains, some of which are till-floored plains. Scattered drumlins, moraines, and outwash plains are throughout the area. The terrain includes flat outwash and lake plains and steep slopes in areas of moraines. Elevation ranges from 580 to 960 feet (175 to 295 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Northwestern Lake Huron (0407), 92 percent, and Northeastern Lake Michigan-Lake Michigan (0406), 8 percent. The Cheboygan, Ocqueoc, and Thunder Bay Rivers are the major streams in the area. A reach of the Pigeon River is a National Wild and Scenic River in the south-central part of this MLRA.

Geology

This area is covered with thin to thick glacial deposits. Bedrock is generally at shallow depths and is evident throughout the area. It consists of Devonian limestone and dolomite with interbedded shale, chert, and anhydrite stringers. Karst features are very common in the area.

Climate

The average annual precipitation is 28 to 34 inches (710 to 865 millimeters). The western one-third of the area is wetter than the eastern two-thirds. The precipitation occurs as both rain during the growing season and snow in winter. The average annual snowfall is 51 to 90 inches (130 to 230 centimeters). Most of the precipitation comes from the west as air masses pick up moisture from Lake Michigan. The major storms generally come from the east or northeast. The average annual temperature is 42 to 45 degrees F (5 to 7 degrees C). The freeze-free period averages about 160 days and ranges from 125 to 190 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 33.4%; ground water, 8.4%
Livestock—surface water, 17.2%; ground water, 41.0%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 0.0%; ground water, 0.0%

Total withdrawals average 1.2 million gallons per day (4.5 million liters per day). About 49 percent is from ground water sources, and 51 percent is from surface water sources. This MLRA is a water-rich area. It is surrounded by Lake Michigan and Lake Huron. It has many high-quality cold-water streams and lakes, which generally have a calcium bicarbonate type of water that can have high levels of dissolved solids.

Ground water is abundant in the unconsolidated sand and gravel and lakebed sands in the glacial deposits that cover almost all of this area. The highest yielding wells are in outwash deposits within the drift, but some domestic water also is pumped from glacial lake sediments and the till itself. This water is suitable for almost all uses with little or no treatment. It is hard, and the median level of total dissolved solids is about 200 to 250 parts per million (milligrams per liter). Agricultural activities and road salts are the primary sources of potential contamination in the shallow glacial deposits.

Silurian-Devonian sedimentary rocks underlie the glacial deposits. They are mostly shale and are not used as sources of water in this area. Dolomite and anhydrite are in the bedrock, and karst features are common on the land surface. There is potential for contamination reaching other bedrock aquifers through the solution cracks and openings in the limestone or dolomite bedrock.

Soils

The dominant soils in this MLRA are Spodosols, Alfisols, Entisols, and Histosols. These soils have a frigid soil temperature regime, an aquic or udic soil moisture regime, and dominantly mixed mineralogy. They are very deep, excessively drained to poorly drained, and sandy. Nearly level to very steep Haplorthods (Rubicon and Croswell series) and Udipsamments (Graycalm, Grayling, and Deford series) formed in sandy glaciofluvial deposits. Nearly level to very steep Glossudalfs (Onaway, Emmet, Krakow, and Ossineke series) formed in sandy and loamy glacial till. Very poorly drained Haplosaprists (Tawas and Lupton series) formed in thick organic deposits or in organic deposits over sandy glaciofluvial material.

Biological Resources

This area is part of the Northern Lower Michigan Ecosystem Region and consists mainly of the major forest community types of northern hardwoods, pines, and coniferous wetlands. Red pine, white pine, jack pine, white oak, black oak, and red maple formerly were and currently are the dominant species in the pine community. Sugar maple, beech, white pine, and yellow birch formerly were and currently are the dominant native species of northern hardwoods. Black spruce, tamarack, northern white-cedar, and white spruce formerly were and currently are the dominant native species in the coniferous wetlands. Other important native species include pin cherry, striped maple, and basswood in the uplands and balsam fir, eastern hemlock, and speckled alder in the mosaic of wetlands throughout the area.

Some of the major wildlife species in this area are white-tailed deer, elk, black bear, snowshoe hare, coyote, ruffed grouse, woodcock, woodland songbirds, ducks, and geese. Fishing is common in the Great Lakes, numerous inland lakes, rivers, and streams in the area. The species of fish in the area include rainbow trout, brown trout, brook trout, Chinook salmon, coho salmon, northern pike, bass, yellow perch, bluegill, and sunfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 6%
Grassland—private, 8%
Forest—private, 71%
Urban development—private, 3%
Water—private, 6%
Other—private, 6%

About two-thirds of this MLRA is in small, privately owned holdings, and the other third consists of State forestland. The forests are used mainly for timber production and recreation. Dairy and beef operations are very important enterprises in the area. Forage and feed grain crops for dairy cattle and other livestock are the principal crops. Wheat, oats, corn, potatoes, and hay also are grown.

The major soil resource concerns are wind erosion, water erosion, excessive soil wetness, soil moisture management, and maintenance of the fertility and productivity of the soils. The important conservation practices on cropland are systems of crop residue management (such as no-till or reduced-till systems), cover crops, wind barriers, stripcropping, and nutrient management. ■

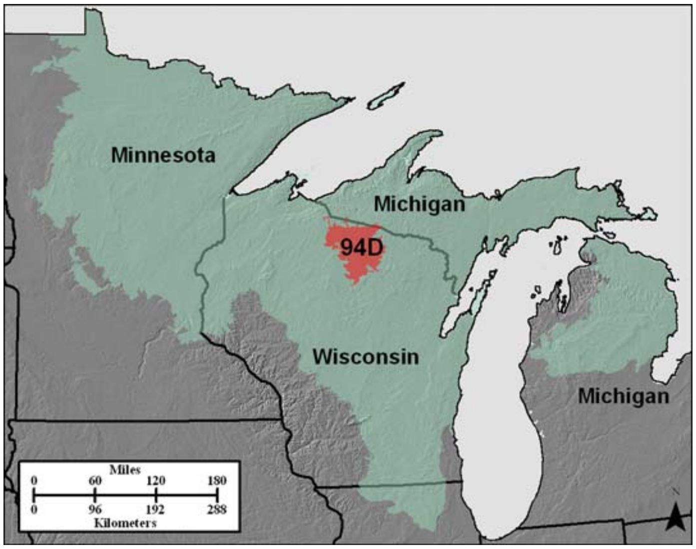

Figure 94D-1: Location of MLRA 94D in Land Resource Region K.

94D—Northern Highland Sandy Drift

This area (shown in fig. 94D-1) is in Wisconsin (99 percent) and Michigan (1 percent). It makes up about 2,100 square miles (5,445 square kilometers). It includes Rhinelander, Eagle River, Minocqua, Tomahawk, Mercer, and Land O'Lakes, Wisconsin. Almost all of the Northern Highland-American Legion State Forest is in the north-central part of the area. Small parts of the Chequamegon and Nicolet National Forests are just inside the northwestern and northeastern boundaries of this area, respectively. Almost all of the Lac du Flambeau Indian Reservation is in the northwestern part of the area.

Physiography

This area is in the Superior Upland Province of the Laurentian Upland. Three distinct glacial lobes of the Laurentian Ice Sheet (Wisconsin Valley, Langlade, and Ontonagon) have played major roles in shaping the landscape. The area is characterized by outwash plains (some of which are pitted or collapsed) and kame moraines intermixed with bogs and swamps and a few isolated drumlins. It has many lakes. The streams generally form a dendritic drainage pattern. Elevation ranges from about 1,500 feet (455 meters) to about 1,850 feet (565 meters). In much of the area, slopes are nearly level to gently rolling and local relief is only 10 to 20 feet (3 to 6 meters). Relief ranges from 20 to more than 330 feet (6 to more than 100 meters) on the moraines.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Wisconsin (0707), 68 percent; Chippewa (0705), 29 percent; Southern Lake Superior-Lake Superior (0402), 2 percent; and Western Lake Superior (0401), 1 percent. The Wisconsin, Tomahawk, and Manitowish Rivers are the major rivers that drain this MLRA.

Geology

Precambrian-age bedrock underlies most of the glacial deposits in this MLRA. The bedrock is a complex of folded and faulted igneous and metamorphic rock that has been modified by glaciation. The bedrock is covered in most areas by Pleistocene deposits as much as 330 feet (100 meters) thick. Most of the Pleistocene sediment was deposited during the last part of the Wisconsin Glaciation.

Climate

The average annual precipitation in this area is 30 to 35 inches (760 to 890 millimeters). About two-thirds of the rainfall occurs as convective thunderstorms during the growing season. Snowfall generally occurs from October through April. The average annual temperature is 39 to 41 degrees F (4 to 5 degrees C). The freeze-free period averages about 140 days and ranges from 125 to 155 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 64.3%; ground water, 0.0%
Livestock—surface water, 18.0%; ground water, 17.7%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average 4 million gallons per day (15 million liters per day). About 18 percent is from ground water sources, and 82 percent is from surface water sources. Surface water and ground water are very abundant and readily available. The sources of surface water are the many lakes and streams. Water quality is generally good. Most of the lakes and streams are clear, but those that receive deposits of organic material from wetland vegetation are tinted brown. The surface water is used mostly for recreational activities. Extensive building of cottages and houses along the lakes and streams is a potential problem for maintaining water quality. Effluent from sewage disposal facilities pollutes the water and results in the growth of weeds and algae. This problem is especially severe in seepage lakes where there is little water exchange.

This MLRA has three types of lakes—spring lakes, seepage lakes, and drainage lakes. Spring lakes seldom have an inlet, but they have an outlet with substantial flow. They are fed by ground water. Seepage lakes generally do not have an inlet or an outlet but may have an intermittent outlet. The water level is maintained by the water table or a well sealed lake bottom. Drainage lakes have an outlet and at least one inlet. Their main water source is drainage from streams. Spring lakes have a high mineral content because they receive the greatest amount of ground water. Drainage lakes have a lower mineral content than spring lakes, and seepage lakes have a very low mineral content. Drainage lakes have the greatest range in reaction. Water in the spring lakes has reaction similar to that of the ground water. Seepage lakes commonly are acid, and some of the drainage lakes are alkaline. About 80 of the lakes are acid, having a pH of less than 7.0. The rest are neutral or alkaline, having a pH of 7.0 or higher.

Good-quality ground water comes from glacial deposits. The total mineral content in this water is commonly less than 150 parts per million (milligrams per liter). The main components of the water are calcium, magnesium, and bicarbonate ions. Locally, the dissolved mineral content can be much higher because of a high content of limestone in some of the glacial deposits. In some areas minor problems may be caused by hardness or by high concentrations of iron. Pollution of surface water is minimal because the area is relatively undeveloped and there is little municipal or industrial waste. Ground water meets domestic, agricultural, municipal, and industrial needs in this MLRA.

Ground water yields from glacial deposits vary. Glacial drift consisting mainly of sand and gravel yields 100 to more than 1,000 gallons per minute (380 to more than 3,785 liters per minute). Glacial till yields generally less than 100 gallons per minute (380 liters per minute). Supplies of ground water may be inadequate where glacial deposits are thin over crystalline bedrock. Generally, the fractured crystalline bedrock does not supply much water, although locally it provides a small amount (8 gallons, or 30 liters, per minute) for domestic uses.

Soils

The dominant soil orders in this MLRA are Spodosols and Histosols. The soils have a frigid soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. The soils on uplands are very deep, excessively drained to somewhat poorly drained, and sandy or loamy. The soils on lowlands are very deep, poorly drained or very poorly drained, and sandy, loamy, or mucky.

Haplorthods formed in sandy outwash (Croswell, Rubicon, Vilas, Sayner, and Karlin series) or loamy drift over sandy outwash (Manitowish, Tipler, Pence, and Padus series) on outwash plains (some of which are pitted or collapsed) or kame moraines, in sandy mudflow sediments or till (Keweenaw and Springstead series) on kame moraines and drumlins, or in loamy and silty glaciolacustrine sediments (Annalake, Alcona, and Fence series) on lake plains. Endoaquods formed in sandy outwash (Kinross and Au Gres series) or loamy drift over sandy outwash (Wormet and Worcester series) on outwash plains or in sandy mudflow sediments (Pequaming series) on kame moraines. Haplosaprists formed in sapric material in swamps (Markey, Carbondale, and Seelyeville series) and bogs (Dawson, Loxley, and Greenwood series).

Biological Resources

This area supports conifer-hardwood forest. Sugar maple, yellow birch, white ash, red oak, aspen, white birch, balsam fir, white spruce, eastern hemlock, red pine, white pine, and jack pine are the dominant trees. Poorly drained soils support black ash, green ash, red maple, black spruce, tamarack, and speckled alder.

Some of the major wildlife species in this area are white-tailed deer, black bear, eastern gray wolf, ruffed grouse, sharp-tailed grouse, woodcock, gray squirrel, red squirrel, snowshoe hare, porcupine, ducks, and geese. Red fox, bobcat, coyote, muskrat, fisher, mink, otter, raccoon, and beaver are the main furbearers. The many lakes and forests in this area provide substantial wildlife habitat. Fishing occurs in the many lakes and rivers. The species of fish in the area include rainbow trout, brook trout, walleye pike, largemouth bass, smallmouth bass, bluegill, black crappie, yellow perch, musky, and northern pike.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 2%
Grassland—private, 2%
Forest—private, 65%; Federal, 5%
Urban development—private, 6%
Water—private, 13%; Federal, 1%
Other—private, 6%

Forests make up most of this area. Timber production and the production of large amounts of pulp are important land uses. The paper industry is the largest manufacturer. Sap collection from sugar maple and syrup production are important forestry enterprises. Agriculture is a minor land use because of sandy soils and the short growing season. Some corn silage, oats, and alfalfa hay are grown. Specialty crops include snap beans, potatoes, strawberries, and cranberries. Tourism, recreation, and wildlife management are extremely important. The vast number of lakes and public forests provide year-round opportunities for recreation and tourism, especially recreational hunting, fishing, and hiking.

The major soil resource management concerns are water erosion, excessive soil wetness, soil fertility, and soil tilth. Conservation practices on cropland generally include crop rotations, conservation tillage systems (especially no-till systems), contour farming, contour stripcropping, and grassed waterways. A combination of surface and subsurface drainage systems is needed in most areas of poorly drained soils. Conservation practices on forestland include forest stand improvement and forest trails and landings. These practices reduce the impact of timber management activities on water quality. Riparian forest buffers help to protect streams and rivers from timber harvesting activities, improve wildlife habitat, and protect water quality. ■

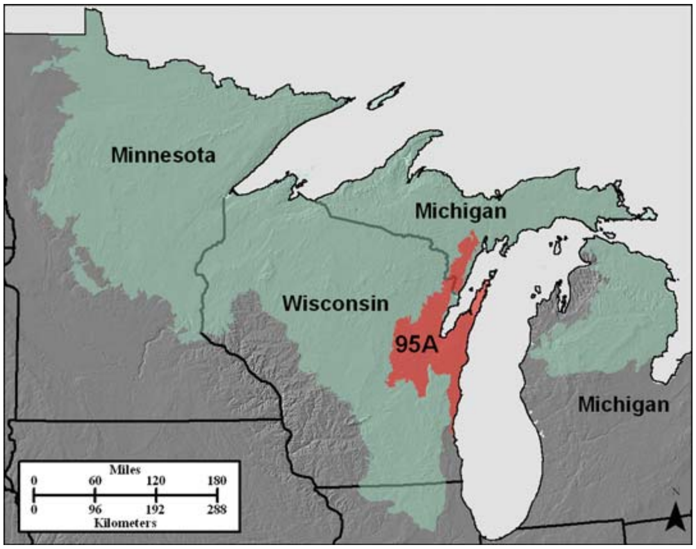

Figure 95A-1: Location of MLRA 95A in Land Resource Region K.

95A—Northeastern Wisconsin Drift Plain

This area (shown in fig. 95A-1) is in Wisconsin (88 percent) and Michigan (12 percent). It makes up about 6,495 square miles (16,825 square kilometers). It includes the shorelines of Lake Winnebago and Lake Michigan. The cities of Green Bay, Appleton, Oshkosh, Fond du Lac, Manitowoc, Sheboygan, and Whitefish Bay, Wisconsin, and the town of Powers, Michigan, are in this MLRA. Interstate 43 connects Whitefish Bay, Sheboygan, and Green Bay, and U.S. Highways 41 and 141 are important routes north of Green Bay. The Oneida and Hannahville Indian Reservations are in the parts of this area in Wisconsin and Michigan, respectively. Small parts of the Escanaba River and Copper Country State Forests in Michigan also occur in this area. A number of State parks are along the shore of Lake Michigan. The Door County area, the peninsula northeast of Green Bay, is a popular resort area for tourists.

Physiography

This area is in the Eastern Lake Section of the Central Lowland Province of the Interior Plains. The area is characterized by nearly level to rolling till plains, lake plains, and outwash plains mixed with drumlin fields, bedrock-controlled moraines, lake terraces, flood plains, beaches, dunes, swamps, and marshes. The drumlins, moraines, and beaches form low hills and ridges. Lakes and streams are numerous, and streams generally form a dendritic drainage pattern. Elevation ranges from 660 to 1,310 feet (200 to 400 meters). Local relief is mainly 25 feet (8 meters), but some hills rise more than 165 feet (50 meters) above the adjacent lowlands.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Northwestern Lake Michigan (0403), 99 percent, and Southwestern Lake Michigan (0404), 1 percent. Numerous small rivers drain this MLRA, and many of the rivers, such as the Peshtigo, Manitowoc, Menominee, Fox, and Wolf Rivers in Wisconsin and the Escanaba River in Michigan, empty into Lake Michigan. Lake Winnebago, east of Oshkosh, is the largest lake in Wisconsin.

Geology

This area is covered about equally with glacial lake plain, till, and outwash deposits. Some of the higher areas are moraines that appear as ridges aligned from north to south. Most of the bedrock consists of early Paleozoic shale, limestone, and dolomite rocks. Some granitic rocks and metamorphosed sediments and volcanics underlie the western edge of the area. Silurian, Ordovician, and Cambrian sandstone, dolomite, and shale influence the landscape in some areas. Bedrock is moderately deep throughout much of the Door Peninsula.

Climate

The average annual precipitation is 30 to 36 inches (760 to 915 millimeters) in most of this area. It is only 29 inches (735 millimeters) south of and around Green Bay and along Lake Michigan. About two-thirds of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. Snow is common in winter. The average annual temperature is 41 to 47 degrees F (5 to 8 degrees C). The freeze-free period averages about 170 days and ranges from 130 to 205 days. It is longest in the southern part of the area and in a narrow belt along Lake Michigan. Lake Michigan helps to moderate the climate of this MLRA.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 6.0%; ground water, 9.2%
Livestock—surface water, 0.5%; ground water, 1.6%
Irrigation—surface water, 0.0%; ground water, 0.2%
Other—surface water, 77.1%; ground water, 5.3%

The total withdrawals average 845 million gallons per day (3,200 million liters per day). About 16 percent is from ground water sources, and 84 percent is from surface water sources. The moderate precipitation generally is adequate for crops and pasture, but in years of little or no precipitation, lack of moisture damages crops growing on sandy soils. Lakes and streams are additional sources of water. Drainage of wet soils on lowlands is needed for good crop and forage production. The surface water in this area is generally of excellent quality. Many of the streams are trout streams. The Fox River from Lake Winnebago to the city of Green Bay, along Lake Michigan, is heavily polluted. Many communities discharge their treated sewage effluent into this reach, and numerous paper companies discharge wastewater into the river.

Ground water is plentiful in unconsolidated sand and gravel deposits in glacial drift, except in areas where the drift is clayey. All of the ground water in this area primarily contains calcium, magnesium, and bicarbonate ions. This water is moderately hard to very hard. It has an average of 220 parts per million (milligrams per liter) total dissolved solids in the western part of the area and an average close to 310 parts per million (milligrams per liter) in the unconsolidated sand and gravel aquifer in the eastern half of the area, closer to Lake Michigan. The levels of iron and manganese can exceed the State drinking water standards and may require treatment for esthetics.

The western part of this area has a sandstone, dolomite, dolomite-sandstone, and siltstone aquifer beneath the glacial deposits. The water in this aquifer is similar in quality to that in the glacial drift, but the levels of manganese do not exceed State standards for drinking water. Naturally occurring radium and fluoride levels do exceed drinking water standards in the Green Bay area.

Poorer quality ground water is in the Silurian Dolomite aquifer along the east edge of this area. This is typically the hardest ground water in the area. The levels of total dissolved solids commonly exceed the national secondary standard for drinking water of 500 parts per million (milligrams per liter). The water also is high in iron, but manganese levels are not so high as those of the water in the other aquifers.

Soils

The dominant soil orders in this MLRA are Alfisols, Histosols, and Spodosols. The soils in the area dominantly have a mesic or frigid soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. They are very deep, excessively drained to very poorly drained, and sandy to clayey. Hapludalfs formed in loess over outwash (Fox and Spinks series) on outwash plains, valley trains, and kames and in till or loess over till (Emmet, Kewaunee, Kidder, Manawa, Ozaukee, and Onaway series) on till plains, moraines, and drumlins. Glossudalfs (Hortonville and Keenan series) formed in till on till plains, moraines, and drumlins. Argiudolls (Hochheim series) formed in loess over till on drumlins and moraines. Haplorthods formed in sandy glacial deposits on outwash plains, valley trains, and moraines (Kalkaska series) and in sandy eolian deposits on dunes, lake plains, and outwash plains (Rousseau series). Udipsamments (Coloma, Menahga, and Plainfield series) formed in sandy glacial deposits on outwash plains, valley trains, and moraines. Haplosaprists (Carbondale, Cathro, Houghton, Lupton, Markey, and Tawas series) formed in organic material in depressions on lake plains, outwash plains, and till plains.

Biological Resources

The soils on uplands in this area support natural stands of mixed northern hardwoods and pine. Sugar maple, oak, white ash, elm, yellow birch, white pine, red pine, and American beech are the principal species. Lowland areas support both mixed hardwoods and conifers. Elm, soft maple, black ash, and northern white-cedar are the major species. Lowland brush and sedge meadows also occur in the low-lying areas.

Some of the major wildlife species in this area are white-tailed deer, red fox, raccoon, muskrat, cottontail, squirrel, pheasant, ruffed grouse, woodcock, mallard, blue-winged teal, and wood duck. Fishing occurs in the many lakes and rivers. The species of fish in the area include rainbow trout, brook trout, walleye pike, largemouth bass, smallmouth bass, bluegill, black crappie, yellow perch, musky, and northern pike.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 49%
Grassland—private, 5%
Forest—private, 26%
Urban development—private, 10%
Water—private, 5%
Other—private, 5%

Almost all of this MLRA is in farms. The area is used dominantly as cropland or pasture. Feed grains and hay are the chief crops. Much of the grain is fed to dairy cattle and other livestock on the farms where it is grown. Canning crops, fruits, and other specialty crops also are important. The rest of the land in farms is about equally divided between tame pasture and farm woodlots. About one-tenth of the MLRA is urban land, and development pressure is high. Recreation is an important land use, especially along the major streams and on sites bordering Green Bay and Lake Michigan.

The primary resource concerns are water erosion on cropland and construction sites, storm-water management, nutrient management, surface and ground water quality, and wetland habitat management and restoration. Conservation practices on cropland generally include systems of crop residue management, such as mulch-till; cover crops; conservation cropping systems; and crop rotations. They also include grassed waterways, filter strips, and nutrient management. ■

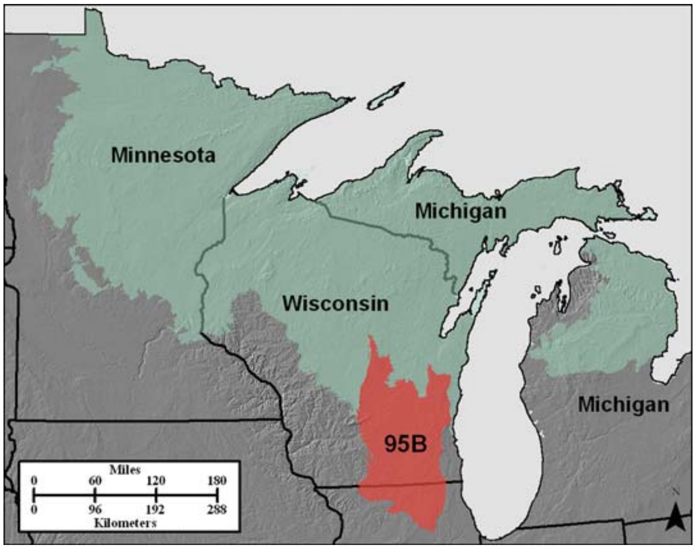

Figure 95B-1: Location of MLRA 95B in Land Resource Region K.

95B—Southern Wisconsin and Northern Illinois Drift Plain

This area (shown in fig. 95B-1) is in Wisconsin (81 percent) and Illinois (19 percent). It makes up about 10,880 square miles (28,200 square kilometers). Beloit, Madison, Waukesha, West Bend, and Beaver Dam, Wisconsin, and Rockford and McHenry, Illinois, are in this MLRA. Interstates 90 and 94 cross the area. Interstate 43 begins in the southeastern part of the area, in Wisconsin. Part of the Wisconsin Dells, numerous other Wisconsin State parks, and many Illinois State parks are in this area. The MLRA includes the valley of the Wisconsin River, the eastern Baraboo Hills, and some large lakes and wetlands.

Physiography

This area is in the Central Lowland Province of the Interior Plains. Most of the area is in the Eastern Lake Section of the province, a narrow strip along the western edge of the area is in the Wisconsin Driftless Section, and the southwestern quarter is in the Till Plains Section. This area is characterized by gently sloping ground moraines, lake plains, outwash plains, drumlin fields, end moraines, flood plains, swamps, and marshes. Most of the area has belts of morainic hills and ridges and nearly level outwash terraces. Drumlins (steep-sided, elongated or oval hills) are prominent features in the north-central part of the area. The area is dissected by numerous streams and rivers. Elevation ranges from 660 to 980 feet (200 to 300 meters). Local relief is mainly 25 feet (8 meters), but the moraines, drumlins, and bedrock escarpments rise 80 to 330 feet (25 to 100 meters) above the adjacent lowlands.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Rock (0709), 56 percent; Northwestern Lake Michigan (0403), 21 percent; Upper Illinois (0712), 10 percent; Wisconsin (0707), 7 percent; and Southwestern Lake Michigan (0404), 6 percent. A short reach of the Wisconsin River is in the western part of this area. The Fox River in Wisconsin, the Kishwaukee River in Illinois, and the Pecatonica and Rock Rivers in both States occur in this MLRA.

Geology

This area is almost entirely covered with glacial drift. The eastern extent of the “Driftless Area” in southwest Wisconsin occurs in the western part of the area. Where glacial deposits are on the surface, the higher areas are moraines that appear as arc-shaped ridges representing the retreat of the ice from south to north. Most of the bedrock in the southern half of this area consists of Ordovician shale, limestone, and dolomite. A sequence of Cambrian sandstone, limestone, and shale beds underlies the glacial deposits in the northern half of the area. These bedrock units are exposed in the “Driftless Area” along the southwest margins of the MLRA.

Climate

The average annual precipitation in this area is 30 to 38 inches (760 to 965 millimeters). Most of the rainfall occurs as high-intensity, convective thunderstorms during the summer. Snowfall is common in winter. The average annual temperature is 43 to 48 degrees F (6 to 9 degrees C). The freeze-free period averages about 170 days and ranges from 150 to 190 days, decreasing in length from south to north and from the shore of Lake Michigan inland.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 10.8%; ground water, 9.0%
Livestock—surface water, 0.3%; ground water, 1.1%
Irrigation—surface water, 0.0%; ground water, 1.2%
Other—surface water, 74.2%; ground water, 3.4%

The total withdrawals average 2,280 million gallons per day (8,630 million liters per day). About 15 percent is from ground water sources, and 85 percent is from surface water sources. The moderate precipitation generally is adequate for crops and pasture, but in years of little or no precipitation, some crops on coarse textured soils are damaged by a lack of moisture. Many of the fine textured soils require water management practices that facilitate tillage and harvesting. Drainage of poorly drained soils is needed for good production of cultivated crops.

The many inland lakes and streams typically have good-quality water. The surface water can be impacted by agricultural and municipal pollution, but it is generally suitable for most uses.

Ground water is abundant in unconsolidated sand and gravel deposits throughout the areas covered by glacial drift. All of the ground water in this MLRA is a calcium-magnesium-bicarbonate type. It is moderately hard to very hard. It has an average of 220 parts per million (milligrams per liter) total dissolved solids in the western part of the area and an average closer to 310 parts per million (milligrams per liter) in the unconsolidated sand and gravel aquifer in the eastern half of the area, nearer Lake Michigan. The levels of iron and manganese can exceed the State drinking water standards and may require treatment for esthetics.

A sandstone, dolomite, dolomite-sandstone, and siltstone aquifer is in the "Driftless Area" and beneath the glacial deposits in the western part of this area. The water in this aquifer is similar in quality to that in the glacial drift, but the levels of iron and manganese do not exceed State standards for drinking water. In the southeast corner of the area, naturally occurring radium and fluoride levels do exceed drinking water standards.

Ground water from the St. Peter and Ironton-Galesville sandstones in Illinois is used extensively. This water is typically low in total dissolved solids (having a median value of less than 500 parts per million, or milligrams per liter). It is very hard, but the levels of iron and manganese do not exceed the State and Federal drinking water standards. The water in this aquifer is polluted with volatile organic contaminants and nitrates from sewage effluent in the Rockford area.

Poorer quality ground water is in the Silurian Dolomite aquifer along the eastern edge of this area. This is typically the hardest ground water in the area. The levels of total dissolved solids commonly exceed the national secondary standard for drinking water of 500 parts per million (milligrams per liter). The water also is high in iron, but manganese levels are not so high as those of the water in the other aquifers.

Soils

The dominant soil orders in this MLRA are Alfisols, Histosols, and Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. They are very deep, generally well drained to poorly drained, and loamy. They formed dominantly in a mantle of silty or loamy sediments over loamy till, in sandy till or mudflow sediments, in a sandy or loamy mantle over glaciofluvial deposits, in silty or clayey glaciolacustrine sediments, in mixed alluvium, or in organic material. Hapludalfs formed in alluvium over outwash (Casco series) and loess over outwash (Fox series) on outwash plains, valley trains, and kames and in loess over till (Dodge, Kidder, McHenry, Miami, and St. Charles series) on till plains, moraines, and drumlins. Haplosaprists formed in organic material in depressions on lake plains, outwash plains, and till plains. Endoaquolls formed in loess over outwash (Drummer series) and in silty and loamy sediments (Pella series) on till plains, outwash plains, and stream terraces. Argiudolls formed in loess over outwash (Elburn series), loess over till (Hochheim, Plano, and Saybrook series), and till (Griswold series) on till plains, outwash plains, and stream terraces.

Biological Resources

This area supports hardwoods and prairie vegetation. The soils on uplands support natural stands of oak, sugar maple, and hickory and natural prairie vegetation characterized by little bluestem and big bluestem. Scattered oak and hickory trees grow on many of the prairies. Lowland areas support sedge and grass meadows and mixed stands of hardwoods and conifers. Elm, ash, cottonwood, soft maple, and white cedar are the major species in the lowland forests.

Some of the major wildlife species in this area are white-tailed deer, red fox, gray fox, raccoon, muskrat, mink, cottontail, gray squirrel, fox squirrel, pheasant, Wilson's snipe, woodcock, ducks, and geese. Fishing occurs in the many lakes and rivers. The species of fish in the area include rainbow trout, brook trout, walleye pike, largemouth bass, smallmouth bass, bluegill, black crappie, yellow perch, musky, and northern pike.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 55%
Grassland—private, 8%
Forest—private, 14%; Federal, 1%
Urban development—private, 12%
Water—private, 3%
Other—private, 7%

Most of this MLRA is in farms. More than one-half of the area is cropland. Agricultural uses include the production of dairy cattle, other livestock, forage, hay, feed grains, sweet corn, snap beans, canning peas, soybeans, winter wheat, barley, and fruit. Much of the hay, feed grain, and forage is fed to dairy cattle and other livestock on the farms where the feed is grown, but cash-grain farming also is important. Canning crops, potatoes, fruits, and other specialty crops are important, especially around urban centers. A significant part of the area is in small, private woodlots or is used for urban development. Some of the better farmland is increasingly used for urban development. Outdoor recreational uses are becoming more important.

The major soil resource concerns are water erosion on cropland and construction sites, surface water quality, storm-water management, drainage of wet soils, and protection and restoration of wetland wildlife habitat. Conservation practices on cropland generally include systems of crop residue management, such as mulch-till, no-till, and strip-till systems; cover crops; conservation cropping systems; and crop rotations. Grassed waterways, grade-stabilization structures, surface and subsurface drainage systems, and filter strips help to control concentrated runoff and protect water quality. Nutrient management and pest management also are important conservation practices in this area. ■

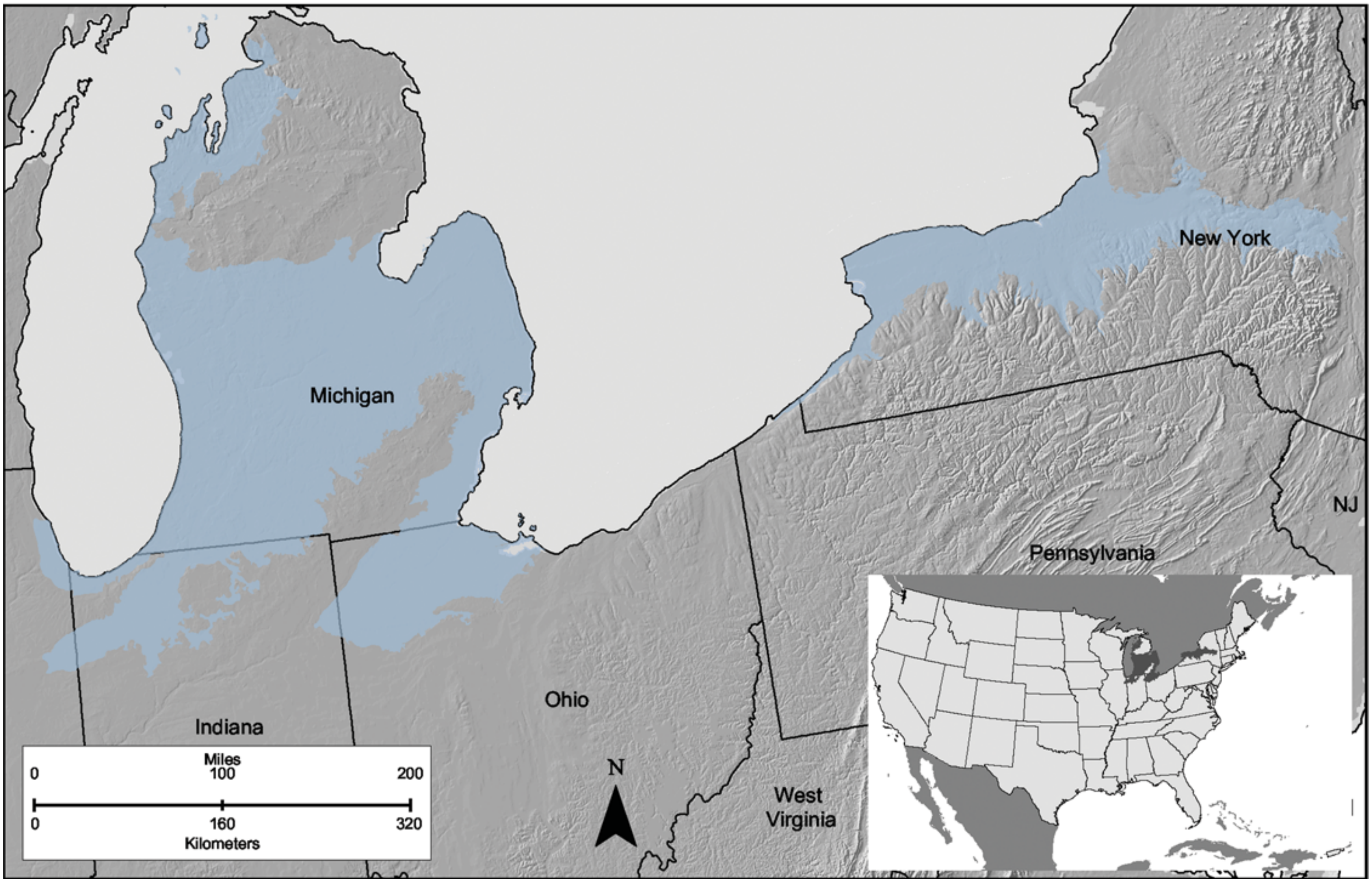

Figure L-1: Location of Land Resource Region L.

L—Lake States Fruit, Truck Crop, and Dairy Region

This region (shown in fig. L-1) is in Michigan (59 percent), New York (22 percent), Ohio (10 percent), Indiana (8 percent), and Illinois (1 percent). A very small part is in Pennsylvania. The region makes up 45,715 square miles (118,460 square kilometers).

Typically, the land surface is a nearly level to gently sloping glaciated plain (fig. L-2). The average annual precipitation is typically 30 to 41 inches (760 to 1,040 millimeters), but it is 61 inches (1,550 millimeters) in the part of the region east of Lake Erie. The precipitation is fairly evenly distributed throughout the year. In most of the region, the average annual temperature is 43 to 49 degrees F (6 to 10 degrees C). The freeze-free period generally is 145 to 205 days. It is longest in narrow belts adjacent to the Great Lakes.

The total withdrawals of freshwater in this region average about 25,540 million gallons per day (96,670 million liters per day). About 96 percent is from surface water sources, and 4 percent is from ground water sources. The abundant precipitation and numerous perennial streams provide ample supplies of good-quality surface water for all uses in the region. Almost all of the water used in the region is for municipal supply and industrial purposes.

The soils in this region are dominantly Alfisols, Entisols, or Spodosols. The dominant suborders are well drained Udalfs, which are in the southern part of the region, and Boralfs, which are in the northern part. Aqualfs and Aquepts are the dominant wet soils throughout the region. The sandy soils are Psamments or Orthods. Histosols are in bogs and in other low, wet areas. The soils in the region dominantly have a mesic or frigid soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy.

About 99 percent of the region is privately owned. The soils and climate favor agriculture, and the region has a wide variety of agricultural enterprises. Dairy farming is important, but some beef cattle also are produced. Canning crops, corn, soft winter wheat, beans, and sugar beets are among the leading crops. Fruits, especially sour cherries, are important in a narrow belt adjacent to the Great Lakes, and wine grapes are grown in the Finger Lakes area. Much of the cropland near the larger cities is being subdivided and developed for urban uses.

Figure L-2: Farmland in an area of Land Resource Region L.

The major soil resource concerns are controlling the pollution resulting from the movement of sediment and pesticides by water and wind, reducing excess wetness on cropland, conserving soil moisture in droughty soils, improving fertility and tilth, and preserving water quality, wetlands, habitat for fish and wildlife, and prime farmland. ■

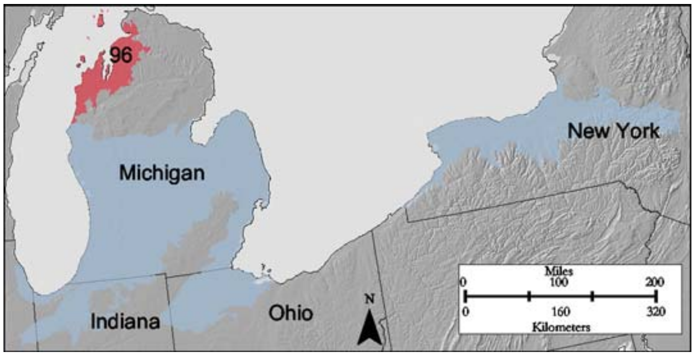

Figure 96-1: Location of MLRA 96 in Land Resource Region L.

96—Western Michigan Fruit Belt

This area is entirely in the western part of the northern portion of the Lower Peninsula of Michigan (fig. 96-1). It makes up 2,790 square miles (7,230 square kilometers). The towns of Manistee, Traverse City, and Petoskey are in this area. U.S. Highways 31 and 10 pass through the area. Sleeping Bear Dunes National Lakeshore is just west of Traverse City, and a small part of the Manistee National Forest is on the southern edge of the area. The Mackinaw and Pere Marquette State Forests make up a significant part of this MLRA. Numerous State parks are throughout the area.

Physiography

This area is in the Eastern Lake Section of the Central Lowland Province of the Interior Plains. It is in the glaciated areas of northern Michigan and is dominated by outwash plains and moraines. Scattered lake plains, till plains, and sand dunes are throughout the area. The terrain is steep on moraines and beach ridges and flat on outwash plains and lake plains. Elevation ranges from 580 to 960 feet (175 to 295 meters). Local relief is mainly 20 feet (6 meters), but some hills rise more than 160 feet (50 meters) above the adjacent lowlands. Much of the area rises sharply from the lakeshore to the adjoining hilltops.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Northeastern Lake Michigan-Lake Michigan (0406), 93 percent, and Northwestern Lake Huron (0407), 7 percent. The Manistee River is the longest river in this area. Its trout fishery is maintained by constant inflow of cool ground water. From north to south, the Jordan, Boardman, and Betsie Rivers have been designated as National Wild and Scenic Rivers. The Pine, Pere, and Marquette Rivers also occur in this MLRA.

Geology

Nearly all of this area has a glacially modified topography. The bedrock in the area is the Traverse Group and the Dundee Limestone. These Silurian-Devonian rocks are mostly limestone and dolomite with some interbedded shale, chert, and anhydrite stringers. These units are at various depths below the surface because of the curvature of the Michigan basin. A few bedrock exposures are on the western shore of the MLRA, where the outer edges of the basin rise. This MLRA also has several areas of sand dunes.

Climate

The average annual precipitation in this area is 30 to 36 inches (760 to 915 millimeters). The precipitation occurs as both rain during the growing season and snow during winter. The average annual snowfall is 70 to 118 inches (180 to 300 centimeters). Most of the precipitation comes from the west as prevailing winds pick up moisture from the Great Lakes. The average annual temperature is 41 to 47 degrees F (5 to 9 degrees C). The freeze-free period averages 155 days and ranges from 115 to 195 days, increasing in length from north to south and decreasing in length from the lakeshore inward.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 81,0%; ground water, 13.5%
Livestock—surface water, 0.3%; ground water, 0.7%
Irrigation—surface water, 2.8%; ground water, 1.7%
Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average 90 million gallons per day (340 million liters per day). About 16 percent is from ground water sources, and 84 percent is from surface water sources. In years of normal precipitation, soil moisture is adequate for crops, but in years of little or no precipitation, yields are reduced because of a lack of moisture, especially in the sandy soils and in areas where bedrock is at a shallow depth. Lake Michigan and high-quality cold-water streams and lakes in the area are sources of surface water. The surface water is suitable for almost all uses with little to no treatment. Streams and lakes generally have a calcium bicarbonate type of water but can have high levels of dissolved solids.

Ground water is abundant in areas of deep, sandy and loamy drift. These deposits consist of outwash, lake sediments, and till. Wells in the outwash yield the most amount of water, and wells in the till yield the least. The ground water is of good quality. The median level of total dissolved solids is less than 200 parts per million (milligrams per liter). Calcium and bicarbonate are the principal dissolved substances in the ground water, and the water is hard. The median concentration of iron is below the secondary standard for drinking water (300 parts per billion or micrograms per liter), but some wells exceed the secondary standard for iron. Problems with nitrate contamination are related to land use practices. Fertilizer, manure, and septic systems are the primary sources of nitrates in the ground water.

A Silurian-Devonian aquifer occurs along the lakeshore in this area. The quality of the water in this aquifer is very similar to that of the water in the overlying glacial deposits. This aquifer is generally below the glacial drift aquifers, so it is little used in this area. Other sedimentary rocks that underlie the glacial deposits are mostly shale and are not used as sources of water.

Soils

The dominant soils in this MLRA are Spodosols, Entisols, Alfisols, and Histosols. They have a mesic soil temperature regime, an aquic or udic soil moisture regime, and dominantly mixed mineralogy. They are very deep and are excessively drained to very poorly drained. The dominant suborders are nearly level to very steep Haplorthods (Benona and Grattan series) and Udipsamments (Coloma and Plainfield series) that formed in sandy glaciofluvial deposits. Nearly level to very steep Glossudalfs (Spinks and Remus series) formed in sandy and loamy glacial till. Very poorly drained Haplosaprists (Adrian and Houghton series) formed in thick organic deposits or in organic deposits over sandy glaciofluvial material.

Biological Resources

This area is part of the Northern Lower Michigan Ecosystem Region. It consists mainly of two major forest community types—the White Pine Community and the Northern Hardwoods. Red pine, jack pine, white pine, white oak, black oak, and red maple formerly were and currently are the dominant species in the White Pine Community. Sugar maple, beech, white pine, and yellow birch formerly were and currently are the dominant native species in the Northern Hardwoods. Other important native species include pin cherry, striped maple, and basswood in the uplands and balsam fir, eastern hemlock, speckled alder, and black spruce in the mosaic of wetlands throughout the area.

Some of the major wildlife species in this area are white-tailed deer, elk, black bear, snowshoe hare, coyote, ruffed grouse, woodcock, woodland songbirds, ducks, and geese. The species of fish in the numerous lakes, rivers, and streams in the area include rainbow trout, brown trout, brook trout, Chinook and coho salmon, northern pike, bass, yellow perch, bluegill, and sunfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 11%
Grassland—private, 11%
Forest—private, 54%; Federal, 3%
Urban development—private, 10%
Water—private, 7%; Federal, 1%
Other—private, 3%

About two-thirds of this area is in small, privately owned holdings, and one-third consists mostly of State forests. The forests are used mainly for timber production and recreation. The growth of orchard crops and other crops and dairy and beef operations are important enterprises in the area. Forage and feed grains for dairy and other livestock are the principal crops. Asparagus, wheat, oats, corn, and hay are commonly grown in the area. Orchard products include sweet and tart cherries, apples, plums, and peaches.

The major soil resource concerns are wind erosion, water erosion, wetness, soil moisture management, and maintenance of the fertility and productivity of the soils. Conservation practices on cropland generally include crop residue management systems, such as no-till or reduced-till, that leave crop residue on the surface. ■

97—Southwestern Michigan Fruit and Truck Crop Belt

This area wraps around the southern end of Lake Michigan (fig. 97-1). It is in Michigan (76 percent), Illinois (13 percent), and Indiana (11 percent). It makes up about 3,085 square miles (7,995 square kilometers). Gary and Michigan City, Indiana, and most of Chicago, Illinois, are in this MLRA. Interstates 55, 57, 80, 88, 90, and 94 intersect in or near Chicago. Interstate 65 crosses the Indiana Toll Road (Interstates 80 and 90) and ends in Gary, Indiana, in this area. Interstate 96 crosses the northern tip of the area, in Grand Rapids, Michigan. A number of forest preserves are in the urban area around Chicago. The Indiana Dunes National Lakeshore is in the southern part of the area.

Physiography

This area is in the Eastern Lake Section of the Central Lowland Province of the Interior Plains. It consists of a nearly level glacial drift plain and scattered areas of gently rolling to strongly rolling hills (moraines). Elevation generally is about 660 feet (200 meters) but is 1,000 feet (305 meters) on some hills. Local relief is only 5 to 15 feet (2 to 5 meters) in most areas but is 80 to 160 feet (25 to 50 meters) in the rolling areas.

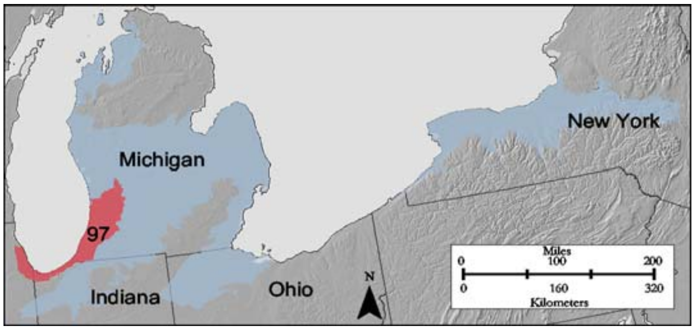

Figure 97-1: Location of MLRA 97 in Land Resource Region L.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Southeastern Lake Michigan (0405), 71 percent; Southwestern Lake Michigan (0404), 15 percent; and Upper Illinois (0712), 14 percent. Tributaries to the Grand River and the Kalamazoo National Wild and Scenic River are in the northern part of the area. Another Michigan river that drains into Lake Michigan in this area is the St. Joseph River. The Des Plaines River drains much of Chicago. It becomes the Illinois River just southwest of this area.

Geology

The surface of this area is covered mainly with deposits of glacial drift. Most of the drift consists of till, but some deposits of unconsolidated sand and gravel outwash are in the area. Some lake sediments are near the shoreline of Lake Michigan. The bedrock beneath the glacial deposits consists primarily of limestone and dolomite in the parts of this area in Illinois and Indiana and sandstone and shale in the part of the area in Michigan. Abandoned limestone and dolomite quarries in the Chicago area are now used to store urban runoff during storms.

Climate

The average annual precipitation in this area is 35 to 40 inches (890 to 1,015 millimeters). The precipitation occurs as both rain during the growing season and snow during winter. The average annual snowfall is 70 to 118 inches (180 to 300 centimeters). Most of the precipitation comes from the west as prevailing winds pick up moisture from the Great Lakes. The average annual temperature is 47 to 52 degrees F (8 to 11 degrees C). The freeze-free period averages 200 days and ranges from 175 to 225 days, increasing in length from north to south and decreasing in length from the lakeshore inward.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 5.8%; ground water, 2.1%
Livestock—surface water, 0.0%; ground water, 0.0%
Irrigation—surface water, 0.2%; ground water, 0.1%
Other—surface water, 89.9%; ground water, 1.9%

The total withdrawals average 7,790 million gallons per day (29,485 million liters per day). This MLRA ranks seventh among all of the MLRAs in amount of water used. About 4 percent is from ground water sources, and 96 percent is from surface water sources. In years of normal precipitation, soil moisture is adequate for crops, but in years of little or no precipitation, yields are reduced by a lack of moisture. Most of the fine textured soils require artificial drainage to ensure that tillage is not delayed in spring and fall. Wet areas must be drained before crops can grow well. The many small lakes in this area are used extensively for boating, fishing, and other forms of recreation. Lake Michigan is the source of municipal and industrial water for the Chicago area. The surface water is suitable for almost all uses, but it is very hard and requires some treatment.

The glacial deposits in this area yield some ground water for domestic, municipal, and industrial uses. The highest yielding wells in the area are in the outwash deposits within the drift, but some domestic water also is pumped from glacial lake sediments and from the till itself. This water is suitable for almost all uses with little to no treatment. The median level of total dissolved solids is 200 parts per million (milligrams per liter). The glacial drift covering the bedrock aquifers in this area helps to protect the aquifers from surface contamination. Agricultural activities, municipal and industrial waste discharges, road salts, brine disposal from oil well exploration and production, and pumping-induced movement of deeper, more saline water into the aquifers are the primary sources of contamination.

Two bedrock aquifers occur in this area. One is the shallow dolomite in northeastern Illinois, and the other is the Marshall Formation (sandstone) in the northeastern part of the MLRA. The water quality in the Marshall aquifer is similar to that in the glacial aquifers. Water in the shallow dolomite contains 400 to 1,200 parts per million (milligrams per liter) total dissolved solids, which can exceed the recommended level of 1,000 parts per million (milligrams per liter) for drinking water. The median iron concentration is 610 parts per billion (milligrams per liter), which exceeds the national secondary standard, an esthetics standard, for drinking water of 300 parts per billion (milligrams per liter). The ground water from the shallow dolomite is very hard and requires treatment before it is used.

Soils

The dominant soils in this MLRA are Spodosols, Entisols, Alfisols, and Histosols. They have a mesic soil temperature regime, an aquic or udic soil moisture regime, and dominantly mixed mineralogy. They are very deep and are excessively drained to very poorly drained. The dominant suborders are nearly level to very steep Haplorthods (Benona and Grattan series) and Udipsamments (Coloma and Plainfield series) that formed in sandy glaciofluvial deposits. Nearly level to very steep Glossudalfs (Spinks and Remus series) formed in sandy and loamy glacial till. Very poorly drained Haplosaprists (Adrian and Houghton series) formed in thick organic deposits or in organic deposits over sandy glaciofluvial material.

Biological Resources

This area supports broadleaf deciduous forest vegetation. Bitternut hickory, shagbark hickory, white oak, red oak, black oak, American beech, and sugar maple are the dominant tree species. White ash, red maple, quaking aspen, and black cherry are extensive on wet sites.

Some of the major wildlife species in this area are white-tailed deer, red fox, opossum, muskrat, mink, cottontail, woodchuck, tree squirrel, marsh hawk, wild turkey, pheasant, ruffed grouse, woodcock, kingfisher, quail, cardinal, heron, crane, Canada goose, snow goose, diving duck, and dabbling duck. The species of fish in the area include sunfish, perch, bass, trout, northern pike, walleye, bullhead, sucker, carp, steelhead, and salmon.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 34%
Grassland—private, 6%
Forest—private, 21%; Federal, 1%
Urban development—private, 29%
Water—private, 2%
Other—private, 7%

More than three-fifths of this MLRA is in farms. Slightly more than half of the acreage in farms is cropland. Fruits, especially peaches and grapes, are grown extensively near the shore of Lake Michigan. Many other fruits and vegetables also are grown. Forage and feed grains for dairy cattle and other livestock are important crops. Some areas are used as permanent pasture, but most of the farmland that is not cultivated is in woodlots. A large part of the area that is not in farms is in State forests and parks. Nearly 30 percent of the MLRA is used for urban development.

The major soil resource concerns are wind erosion, water erosion, wetness, soil moisture management, and maintenance of the fertility and productivity of the soils. Conservation practices on cropland generally include crop residue management systems, such as no-till or reduced-till, that leave crop residue on the surface. ■

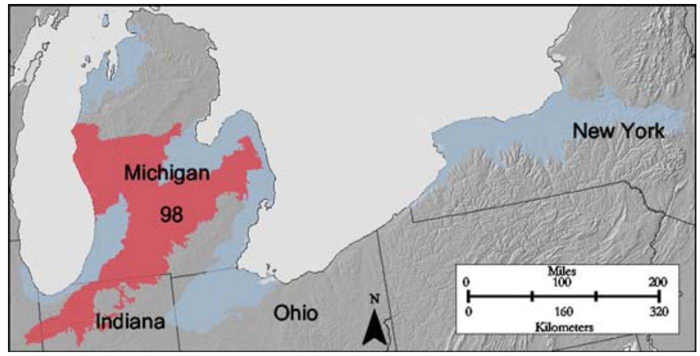

Figure 98-1: Location of MLRA 98 in Land Resource Region L.

98—Southern Michigan and Northern Indiana Drift Plain

This area (shown in fig. 98-1) is in Michigan (82 percent), Indiana (16 percent), and Illinois (2 percent). It makes up about 18,930 square miles (49,050 square kilometers). Interstate 69 connects the towns of Flint and Lansing, Michigan, in this area. Interstates 94 and 96 cross the center of the area. Interstate 94 connects the towns of Kalamazoo, Battle Creek, and Jackson, Michigan. Interstate 96 connects Grand Rapids, Lansing, and Detroit, Michigan. Interstates 80 and 90 become the Indiana Toll Road across the southern part of the area. The toll road connects South Bend, Mishawaka, and Elkhart, Indiana. The Manistee National Forest, the Pere Marquette State Forest, and a small part of the Au Sable State Forest are in the northwestern portion of the area. The Isabella Indian Reservation is in the northern part of the area.

Physiography

This area is in the Eastern Lake Section of the Central Lowland Province of the Interior Plains. It is a broad glaciated plain that is deeply mantled by till and outwash. Much of the area is nearly level to gently rolling. Elevation generally ranges from 570 to 1,100 feet (175 to 335 meters) but is more than 1,200 feet (365 meters) on some hills. Local relief is generally less than 15 feet (5 meters). It is 80 to 165 feet (25 to 50 meters) or more, however, in belts of hills (glacial moraines), which have stronger slopes.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Southeastern Lake Michigan (0405), 49 percent; Southwestern Lake Huron-Lake Huron (0408), 18 percent; Northeastern Lake Michigan-Lake Michigan (0406), 16 percent; Upper Illinois (0712), 10 percent; St. Clair-Detroit (0409), 4 percent; and Wabash (0512), 3 percent. The Flat, White, Rogue, and Pere Marquette Rivers are National Wild and Scenic Rivers in the northwestern part of the MLRA. Most of the rivers in this area are short because of their proximity to the Great Lakes east and west of the area.

Geology

The surface of this area is covered with glacial drift deposits that are 100 to 500 feet (30 to 150 meters) thick in most areas. In a few areas in the central part of the MLRA, the deposits are less than 10 feet (3 meters) thick. At the northern edge of the area, the drift is more than 600 feet (185 meters) thick. Most of the drift consists of till, but there are significant deposits of unconsolidated sand and gravel outwash throughout the area. Some lake sediments are in the northwest corner of the area, near the shoreline of Lake Michigan. The bedrock beneath the glacial deposits in this area is deformed in the shape of a basin. The center of this basin is in the north-central part of the area. Jurassic-age shale (red beds) and Pennsylvanian-age sandstone are in the center of the basin, and Mississippian-age sandstone and shale beds form the outer rings of the basin.

Climate

The average annual precipitation in most of this area is 29 to 40 inches (735 to 1,015 millimeters). It is lowest in the northeastern part of the area. The precipitation is fairly evenly distributed throughout the year, but the amount is slightly higher late in spring and early in summer. Rainfall occurs as high-intensity, convective thunderstorms in summer. Snowfall is common in winter. The average annual temperature is 44 to 50 degrees F (7 to 10 degrees C). Because of the prevailing west winds crossing Lake Michigan, winters are milder and summers are cooler than is typical in this part of the continent. The freeze-free period averages 175 days and ranges from 145 to 200 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 10.3%; ground water, 4.7%
Livestock—surface water, 0.2%; ground water, 0.4%
Irrigation—surface water, 2.8%; ground water, 2.4%
Other—surface water, 72.5%; ground water, 6.7%

The total withdrawals average 3,455 million gallons per day (13,075 million liters per day). About 14 percent is from ground water sources, and 86 percent is from surface water sources. In much of the area, the moderate precipitation is adequate for crops, but conserving moisture in the coarse textured soils is a major management concern. Many small and medium-size lakes and many perennial streams are sources of good-quality surface water. The lakes are used extensively for recreation. Municipalities, public-water suppliers, and industry in the western part of the area obtain surface water from Lake Michigan. The surface water in this area is very hard and requires softening prior to most uses.

Ground water is abundant in the deep glacial drift. The highest yielding wells are in the outwash deposits within the drift, but some domestic water also is pumped from glacial lake sediments and from the till itself. This water is suitable for almost all uses with little to no treatment. The median level of total dissolved solids is 200 parts per million (milligrams per liter). The glacial drift covering the bedrock aquifers in this area helps to protect the aquifers from contamination. Agricultural activities, municipal and industrial waste discharges, road salts, brine disposal from oil well exploration and production, and pumping-induced movement of deeper, more saline water into the aquifers are the primary sources of contamination.

Two bedrock aquifers, the Saginaw and Marshall Formations, occur in this area. The Saginaw Formation is a sandstone unit with some interbedded shale. The Marshall Formation is sandstone. Both aquifers are Mississippian in age. The water quality in the Marshall aquifer is similar to that in the glacial aquifers. Water in the Saginaw Formation contains about 350 parts per million (milligrams per liter) total dissolved solids and commonly contains levels of iron that exceed the national secondary standard, an esthetics standard, for drinking water of 300 parts per billion (micrograms per liter). The Saginaw ground water is the hardest water in all of the aquifers in Michigan, and it requires treatment prior to use. The water in these bedrock aquifers tends to be fresher where the glacial aquifers are in contact with them and they are being recharged by the water in the glacial aquifers.

Soils

The dominant soil orders in this MLRA are Alfisols, Histosols, and Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. They are very deep, well drained to very poorly drained, and loamy or sandy. Hapludalfs formed in outwash or glacial drift over outwash on outwash plains, kames, terraces, and deltas (Boyer, Oshtemo, and Spinks series) or in till (Hillsdale and Riddles series) or loess over till (Miami series) on till plains and moraines. Glossudalfs (Capac and Marlette series) and Endoaqualfs (Conover series) formed in till on till plains and moraines. Haplosaprists (Houghton series) formed in organic deposits in depressions on lake plains, till plains, and outwash plains. Argiaquolls (Sebewa series) and Endoaquolls (Gilford and Maumee series) formed in outwash in depressions on outwash plains, flood plains, and lake plains. Argiaquolls (Brookston series) also formed in silty material over till in depressions on till plains and moraines.

Biological Resources

This area supports broadleaf deciduous forests. Bitternut hickory, shagbark hickory, white oak, red oak, black oak, sugar maple, and beech are the dominant tree species. Red maple, white oak, and American basswood are extensive on the wetter soils.

Some of the major wildlife species in this area are white-tailed deer, coyote, red fox, gray fox, beaver, river otter, snowshoe hare, cottontail, fox squirrel, gray squirrel, black squirrel, red squirrel, mink, pheasant, sharp-tailed grouse, prairie chicken, ruffed grouse, and wood duck. The species of fish in the area include bass, sunfish, northern pike, rainbow trout, walleye, brown trout, coho salmon, Chinook salmon, and brook trout.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 47%
Grassland—private, 7%
Forest—private, 23%; Federal, 2%
Urban development—private, 12%
Water—private, 2%
Other—private, 7%

More than three-fourths of this MLRA is in farms. The rest is used mainly for urban development. Much of the farmland is in small woodlots. A small acreage is in State forests and parks. Nearly one-half of the area is cropland. Corn, other feed grains, and hay for dairy cattle and other livestock are the major crops. Soft winter wheat and dry beans are important cash crops, and fruits and vegetables are grown in many areas where the soils and markets are favorable. Less than one-tenth of the area is permanent pasture.

The major soil resource concerns are controlling the pollution resulting from the movement of sediment and pesticides by water and wind, reducing excess soil wetness on cropland, conserving soil moisture in droughty soils, improving the fertility and tilth of the soils, and preserving water quality, wetlands, and prime farmland. Conservation practices on cropland generally include grassed waterways, conservation borders and field borders, pest and nutrient management, windbreaks, field stripcropping, crop residue management, cover crops, conservation tillage, diversions, grade-stabilization structures, and waste management. ■

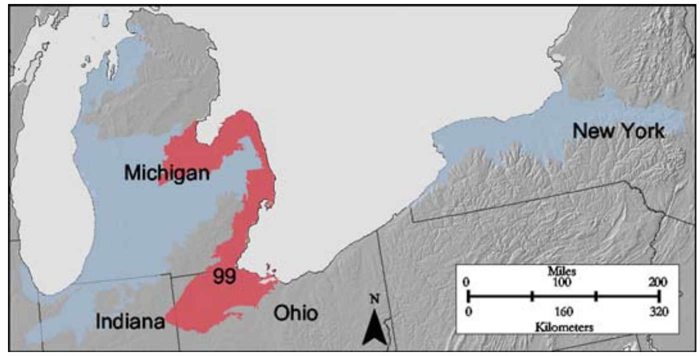

Figure 99-1: Location of MLRA 99 in Land Resource Region L.

99—Erie-Huron Lake Plain

This area (shown in fig. 99-1) is in Michigan (58 percent), Ohio (40 percent), and Indiana (2 percent). It makes up about 10,950 square miles (28,370 square kilometers). The cities and towns of Detroit, Saginaw, Midland, Port Huron, and Bay City, Michigan, and Toledo, Maumee, Bowling Green, Port Clinton, and Sandusky, Ohio, are in this MLRA. Interstates 80 and 90 become the Ohio Turnpike, a toll road, across the southern part of the area. Interstate 75 connects the towns of Bowling Green and Toledo, Ohio, with Detroit, Michigan. Interstate 75 leaves the area northwest of Detroit but enters the northern part of the area and passes through Saginaw, Midland, and Bay City, Michigan. Interstates 94 and 69 meet in Port Huron, Michigan, north of the center of the area. A number of State parks are along the shores of Lake Erie and Lake Huron. The Au Sable State Forest is in the northwestern part of this MLRA, in Michigan, and the Maumee State Forest is in the southern part, in Ohio.

Physiography

This area is in the Eastern Lake Section of the Central Lowland Province of the Interior Plains. It is a nearly level glacial lake plain with a few scattered ridges of sandy soils that represent past shorelines and moraines. Elevation is about 660 feet (200 meters), increasing gradually from the lakeshore inland. Local relief generally is only about 6 feet (2 meters), but some beach ridges and low moraines rise almost 30 feet (9 meters) above the general level of the landscape. The part of this MLRA in Ohio was probably a swamp prior to the introduction of drainage by early settlers. Remnant marshes are near the Lake Erie shore.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Western Lake Erie (0410), 49 percent; Southwestern Lake Huron-Lake Huron (0408), 33 percent; St. Clair-Detroit (0409), 17 percent; and Southeastern Lake Michigan (0405), 1 percent. The Maumee and Sandusky Rivers are National Wild and Scenic Rivers in the part of this area in Ohio. The Saginaw, Clinton, and Huron Rivers empty into the Great Lakes in the part of the area in Michigan.

Geology

The southern half of this area is covered with glacial deposits of till, lake sediments, and outwash from the Wisconsin and older glacial periods. The area also has some low moraines. Mississippian- to Silurian-age shale, limestone, and dolomite rocks are at the surface in the northern half of this area, along the shores of Lake Erie and Lake Huron in Michigan. These rocks underlie the glacial deposits in the southern half of the area.

Climate

The average annual precipitation is 30 to 36 inches (760 to 915 millimeters) in the southern half of this area and about 27 inches (685 millimeters) in the northern half. Most of the rainfall occurs as high-intensity, convective thunderstorms in summer. Snowfall is common in winter. The average annual temperature is 44 to 51 degrees F (7 to 10 degrees C). The average freeze-free period is 190 days and ranges from 155 to 220 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 5.0%; ground water, 0.5%
Livestock—surface water, 0.1%; ground water, 0.0%
Irrigation—surface water, 0.2%; ground water, 0.1%
Other—surface water, 92.8%; ground water, 1.2%

The total withdrawals average 10,050 million gallons per day (38,040 million liters per day). This MLRA ranks fifth among all of the MLRAs in amount of water used. About 2 percent is from ground water sources, and 98 percent is from surface water sources. In most years the moderate precipitation provides enough water for crops. Many of the soils require artificial drainage before they can be used for crops, and even the better drained soils require some drainage to ensure that tillage is not delayed in spring and fall. The Great Lakes supply water for large cities, are major transportation arteries, and are used for recreation. The surface water is abundant in this area and is of good quality. It is suitable for almost all uses with little treatment, except in reaches downstream from municipal or industrial waste discharge points.

The abundant ground water in this area is not used extensively because of the availability of good-quality surface water. The ground water meets most domestic and some municipal drinking water needs in the area. It is typically a calcium bicarbonate type of water in which the level of total dissolved solids is about 200 to 300 parts per million (milligrams per liter). In areas where the level of total dissolved solids is higher, the water type changes to sodium sulfate. All of the ground water is hard or very hard. Sources include unconsolidated sand and gravel deposits in the glacial till and glacial outwash in the southeastern part of the area. Some water also can be obtained from sands in the lake deposits. Around Saginaw, Michigan, and northwest Ohio, ground water is available in bedrock units, from the Saginaw Formation and from older carbonate rocks, respectively.

Soils

The dominant soils in this MLRA are Alfisols, Inceptisols, Mollisols, and Spodosols. The soils in the area dominantly have a mesic soil temperature regime, an aquic soil moisture regime, and mixed or illitic mineralogy. They are very deep, generally somewhat poorly drained to very poorly drained, and loamy or clayey. Epiaqualfs (Blount, Hoytville, Nappanee, and Shebeon series) and Glossudalfs (Capac series) formed in till (some of which is dense) on till plains, moraines, and lake plains. Epiaquepts formed in loamy till on till plains and moraines (Kilmanagh series) and in lacustrine deposits on lake plains (Lenawee and Paulding series). Endoaquepts formed in lacustrine deposits on lake plains (Latty and Toledo series) and in loamy till on moraines (Parkhill series). Endoaquolls formed in outwash deposits on outwash plains and lake plains and in drainageways (Granby series) and in loamy till on till plains and moraines (Tappan series). Endoaquods (Pipestone series) formed in outwash deposits on outwash plains, lake plains, and beach ridges. Epiaquods (Wixom series) formed in sandy sediments over till or lacustrine deposits on till plains, outwash plains, and lake plains.

Biological Resources

This area supports broadleaf deciduous forests. Bitternut hickory, shagbark hickory, white oak, red oak, and black oak are the dominant tree species. Red maple, white ash, American basswood, and quaking aspen are dominant on the wetter soils.

Some of the major wildlife species in this area are raccoon, rabbit, squirrel, pheasant, and quail.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 59%
Grassland—private, 3%
Forest—private, 12%
Urban development—private, 17%
Water—private, 4%
Other—private, 5%

Nearly three-fourths of this MLRA is in farms. About three-fifths of the area is cropland. The rest of the farmland is mostly in small farm woodlots, but some of the farmland is used for permanent pasture or other purposes. Cash crops are important. Corn, winter wheat, soybeans, and hay are the major crops. Sugar beets and canning crops also are important. Some fruit and truck crops are grown on the coarse textured soils. Dairying is an important enterprise on some farms near the larger cities. Almost one-fifth of the area is used for urban development.

The major resource concerns are seasonal wetness; maintenance of the content of organic matter and productivity of the soils; water erosion and wind erosion; excessive sediment, nutrients, and pesticides in surface water; nutrients and pesticides in ground water; and the loss of habitat for fish and wildlife. The conservation practices that are important in addressing these resource concerns generally include surface and subsurface drainage systems, conservation crop rotations, crop residue management, filter strips, riparian forest buffers, nutrient management, pest management, protection of streambanks and shorelines, agrichemical containment facilities, and management of upland and wetland wildlife habitat. ■

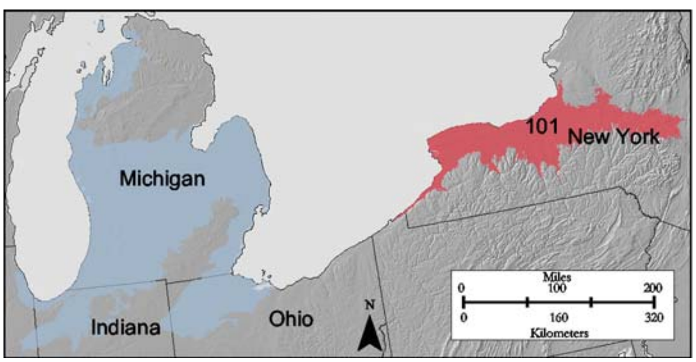

Figure 101-1: Location of MLRA 101 in Land Resource Region L.

101—Ontario-Erie Plain and Finger Lakes Region

This area (shown in fig. 101-1) is in New York (99 percent) and Pennsylvania (1 percent). It makes up about 9,960 square miles (25,815 square kilometers). The cities of Buffalo, Rochester, Syracuse, and Utica, New York, are connected by Interstate 90, which crosses the entire area. The town of Gloversville, New York, is in the eastern end of the area, and Watertown, New York, is in the northern part. Interstate 81 connects Syracuse and Watertown. This MLRA extends as far south as Ithaca, New York, and includes the Finger Lakes Region. Numerous State parks occur in the Finger Lakes Region and along the shores of Lake Erie and Lake Ontario. The western part of the Fort Drum Military Reservation is in the far northeast corner of this MLRA. The Tuscarora and Cattaraugus Indian Reservations also are in this MLRA. The New York State (Erie) Canal crosses the northwestern part of the area.

Physiography

Most of this area is in the Eastern Lake Section of the Central Lowland Province of the Interior Plains. The southeast quarter of the area is in the Southern New York Section of the Appalachian Plateaus Province of the Appalachian Highlands, and the northeast corner is in the Mohawk Section of the same province and division. Most of the MLRA is a nearly level to rolling plain. Low remnant beach ridges are commonly interspersed with a relatively level lake plain in the northern part of the area. Drumlins (long, narrow, steep-sided, cigar-shaped hills) are prominent in an east-west belt in the center of the area. The Finger Lakes Region consists of a gently sloping to rolling till plain. Elevation is 330 to 1,310 feet (100 to 400 meters), increasing gradually from the shores of Lake Ontario and Lake Oneida to the Allegheny Plateau, the southern border of the area. Local relief is mostly 10 feet (3 meters), but the larger drumlins and many valley sides rise 80 to 330 feet (25 to 100 meters) above the adjacent lowlands or valley floors.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Southeastern Lake Ontario (0414), 45 percent; Upper Hudson (0202), 20 percent; Southwestern Lake Ontario (0413), 18 percent; Eastern Lake Erie-Lake Erie (0412), 12 percent; and Susquehanna (0205), 5 percent. Many rivers cross this area and discharge into Lake Erie and Lake Ontario, which border the area on the north. Most of the streams in this area flow north, but the Mohawk River flows east.

Geology

The bedrock underlying this area consists of alternating beds of limestone, dolomite, sandstone, and shale of Ordovician to Devonian age. Most of the surface of the area is covered with glacial till or lake sediments. The texture of the lake sediments is silt, loam, or sand. Ancient beaches, formed at different lake levels, form ridges along the shoreline of Lake Erie and Lake Ontario. Stratified drift (eskers and kames) and glacial outwash deposits are in many of the valleys. A large drumlin field occurs in the Finger Lakes Region.

Climate

The average annual precipitation in most of this area is 29 to 45 inches (735 to 1,145 millimeters). It is as high as 61 inches (1,550 millimeters) in the extreme eastern end of the area, near the Adirondack Mountains, and in the extreme western end, along the shore of Lake Erie, and is less than 30 inches (760 millimeters) in a few areas near the center of the MLRA. The precipitation is evenly distributed throughout the year. Most of the rainfall occurs as high-intensity, convective thunderstorms in summer. Heavy snowfall is common in winter. The average annual temperature is 42 to 50 degrees F (5 to 10 degrees C). The freeze-free period averages 175 days and ranges from 145 to 205 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 21.8%; ground water, 0.5%
Livestock—surface water, 0.1%; ground water, 0.1%
Irrigation—surface water, 0.2%; ground water, 0.0%
Other—surface water, 75.1%; ground water, 2.2%

The total withdrawals average 4,155 million gallons per day (15,725 million liters per day). About 3 percent is from ground water sources, and 97 percent is from surface water sources. In most years the precipitation is adequate for crops, except for those on the coarse textured soils. Irrigation water for high-value fruit and vegetable crops is obtained from wells or from the Great Lakes. The wetter soils must be drained before they can be used for crops, and even the better drained soils benefit from drainage. Many of the larger cities in the area obtain water from the Great Lakes. The Great Lakes also provide transportation and are used extensively for recreation. The Finger Lakes also are used for recreation. The surface water in the area is suitable for almost all uses with little to no treatment.

Ground water is not used to any extent in this area because of the abundance of surface water. The ground water also is abundant and meets domestic, industrial, and municipal needs in parts of the area. All of the aquifers are fairly shallow and are subject to contamination from agriculture and urban and industrial wastes. A sandstone aquifer is used in the northeastern part of the area. The sandstone has very hard water, but the median value of total dissolved solids is only about 300 parts per million (milligrams per liter). The sandstone also has the highest levels of chloride of all the aquifers in this area. The median value of 100 parts per million (milligrams per liter), however, is well below the drinking water standard of 250 parts per million (milligrams per liter) for chloride.

A carbonate aquifer occurs all along the southern half of this area. It has naturally occurring saline zones in which evaporate deposits occur and the level of total dissolved solids exceeds 1,000 parts per million (milligrams per liter). Typically, water from this aquifer contains 500 parts per million (milligrams per liter) total dissolved solids, which is well below the national standard for drinking water. This aquifer produces the hardest water in New York and requires treatment prior to use.

Lake sediments and valley fill deposits of glacial outwash and stratified drift in this area have good-quality ground water. This water has low levels of total dissolved solids, 200 parts per million (milligrams per liter), but is very hard and requires softening prior to use. These shallow aquifers are very susceptible to contamination from surface activities.

Soils

The dominant soils in this MLRA are Alfisols and Inceptisols. The dominant suborders are Udalfs and Udepts. The soils in the area have a mesic soil temperature regime, a udic soil moisture regime, and mixed mineralogy. They are deep and are medium textured or moderately fine textured. Well drained and moderately well drained, undulating to moderately sloping Hapludalfs formed in glacial till high in content of lime (Honeoye, Cazenovia, and Hilton series). They also formed in lacustrine sediments (Schoharie and Galen series). Nearly level to gently sloping, somewhat poorly drained Endoaqualfs (Appleton and Niagara series) are extensive in low areas. Poorly drained and very poorly drained Endoaquepts (Canandaigua and Lamson series) formed in lacustrine sediments and are common at the lowest elevations in the northern part of the area. Hapludalfs that formed in calcareous outwash deposits (Palmyra and Wampsville series) and in moderately deep till (Aurora and Lairdsville series) are prominent locally but are of small extent. Well drained and moderately well drained Eutrudepts (Hamlin and Teel series) formed in alluvial deposits along streams.

Biological Resources

This area supports forest vegetation, particularly hardwoods. The potential forest types are elm-ash-red maple or beech-birch-sugar maple in varying proportions. Other species associated with these types include basswood, hemlock, white pine, black cherry, and some species of upland oak. Northern white-cedar, red maple, black ash, and aspen grow on the wet soils. Cattails and mosses grow on the organic soils and on other extremely wet sites.

Some of the major wildlife species in this area are white-tailed deer, cottontail, gray squirrel, pheasant, woodcock, and ruffed grouse.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 36%
Grassland—private, 10%
Forest—private, 31%; Federal, 1%
Urban development—private, 15%
Water—private, 4%
Other—private, 3%

Most of this area is in farms. About one-third of the acreage is cropland, which is used mainly for hay, corn, and small grains associated with dairy operations. Cash crops, including canning and truck crops, wheat, and dry beans, also are grown. Orchard crops are important locally, particularly near Lake Ontario. Vineyards are common near some of the Finger Lakes. About one-third of the area is forestland, mostly in farm woodlots. About 15 percent of the area is used for urban development, which is expanding around the larger cities, such as Buffalo, Rochester, and Syracuse.

The major soil resource concerns are sheet and rill erosion, the sedimentation caused by storm-water runoff, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include crop residue management; conservation tillage; winter cover crops; nutrient management, including manure management; and pesticide management. Excluding livestock from wetlands and watercourses and developing rotational grazing systems help to control erosion and protect water quality. Conservation practices that are important to community development include critical area treatment and urban storm-water management. ■

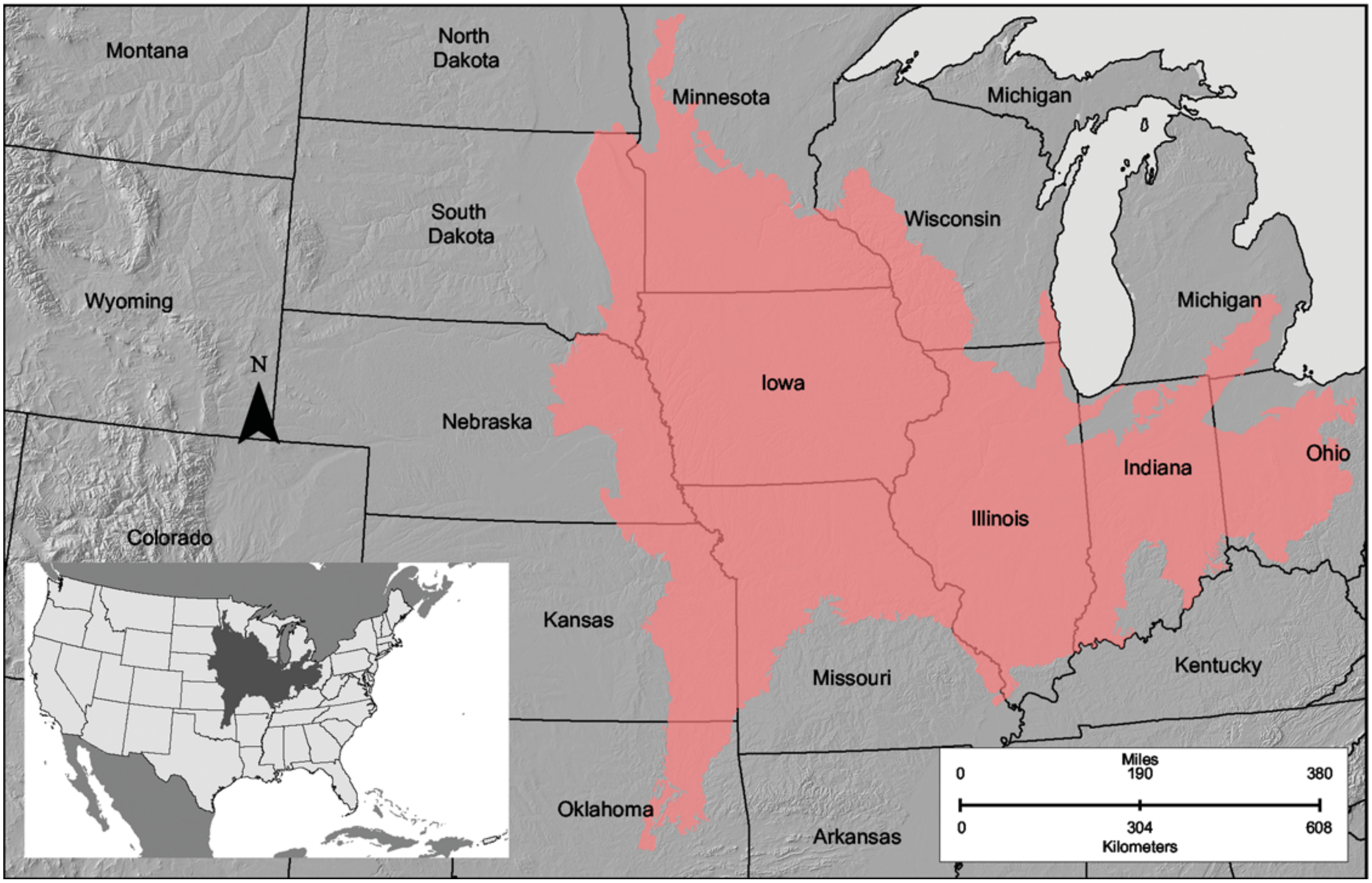

Figure M-1: Location of Land Resource Region M.

M—Central Feed Grains and Livestock Region

This region (shown in fig. M-1) is in Iowa (20 percent), Illinois (18 percent), Missouri (13 percent), Minnesota (11 percent), Indiana (9 percent), Kansas (6 percent), Nebraska (6 percent), Ohio (6 percent), Wisconsin (4 percent), South Dakota (4 percent), Oklahoma (2 percent), and Michigan (1 percent). Also, very small parts are in North Dakota and Kentucky. The region makes up 282,450 square miles (731,905 square kilometers).

Typically, the land surface is a nearly level to gently sloping, dissected glaciated plain (fig. M-2). The average annual precipitation is typically 32 to 39 inches (815 to 990 millimeters), but it ranges from 19 to 48 inches (485 to 1,220 millimeters), increasing from north to south. Most of the precipitation occurs during the growing season. In most of the region, the average annual temperature is 47 to 53 degrees F (8 to 12 degrees C), but it ranges from 38 to 62 degrees F (4 to 17 degrees C), increasing from north to south. The freeze-free period generally is 170 to 210 days. It increases in length from north to south.

The total withdrawals of freshwater in this region average about 35,945 million gallons per day (136,050 million liters per day). This is one of six land resource regions that use more than 30,000 million gallons per day (113,550 million liters per day). This region is second only to the Northwestern Wheat and Range Region (LRR B) in total amount of water used. About 87 percent is from surface water sources, and 13 percent is from ground water sources. Abundant precipitation and numerous perennial streams provide ample supplies of good-quality surface water for all uses in the region. The lower reaches of the large rivers in the southern part of the region have poor-quality water primarily because of sediment, nutrients, and pesticides from agricultural runoff.

The soils in this region are dominantly Alfisols, Entisols, Inceptisols, or Mollisols. Some Histosols occur on flood plains and in wetlands. The dominant suborders are Udalfs, Aqualfs, and Aquolls. The sandy soils are typically Psamments. The soils

Figure M-2: Riparian buffer in an area of Land Resource Region M.

in the region dominantly have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed or smectitic mineralogy.

About 99 percent of this region is privately owned. The soils and climate favor agriculture. This region produces most of the corn, soybeans, and feed grains produced in the U.S. The grains and hay grown in the region commonly are fed to beef cattle. Some specialty crops are grown near markets in the metropolitan areas. Much of the cropland near the larger cities is being subdivided and developed for urban uses. Small areas in the parts of this region in southern Indiana and in Illinois are strip-mined for coal.

The major soil resource concerns are water erosion, wetness, and maintenance of the content of organic matter and productivity of the soils. Wind erosion is a hazard in some of the northern parts of the region where the lighter textured soils occur. Protecting wildlife habitat and preserving the quality of surface water and ground water are additional concerns in many parts of this region. ■

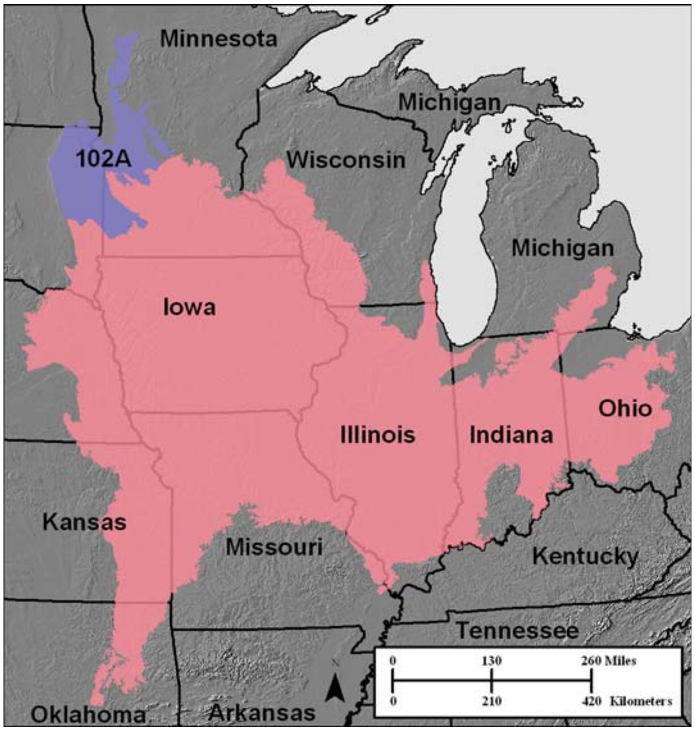

Figure 102A-1: Location of MLRA 102A in Land Resource Region M.

102A—Rolling Till Prairie

This area (shown in fig. 102A-1) is mostly in Minnesota (58 percent) and South Dakota (42 percent). A small part is in North Dakota. This MLRA makes up about 16,545 square miles (42,870 square kilometers). It includes the cities or towns of Fergus Falls, Marshall, Montevideo, and Morris, Minnesota, and Brookings, Milbank, and Watertown, South Dakota. The town of Willmar, Minnesota, is on the southeast boundary of the area. Interstates 29 and 94 cross parts of the MLRA. The Pipestone National Monument is in the part of this area in Minnesota. The eastern edge of the Central Flyway and the western edge of the Atlantic Flyway are in this MLRA, so numerous migrating waterfowl occur in the area. The MLRA has many public wildlife areas.

Physiography

Most of this area is in the Western Lake Section of the Central Lowland Province of the Interior Plains. The center of the Prairie Coteau, in northeastern South Dakota, is in the Dissected Till Plains Section of the same province and division. This MLRA is an area of nearly level to rolling topography that has many depressions and ill-defined drainages. “Prairie pothole” lakes and ponds are common. The steeper slopes occur on the sides of drainages and on breaks adjacent to some of the larger tributaries. Elevation generally ranges from 1,000 to 1,350 feet (305 to 410 meters) on lowlands and from 1,350 to 1,650 feet (410 to 505 meters) on uplands. Isolated highs on the Prairie Coteau, in northeastern South Dakota, are at an elevation of more than 2,000 feet (610 meters). The Prairie Coteau is one of the more prominent landforms in North America. The northern tip of this wedge-shaped highland is in North Dakota. This high area split the last continental ice sheet into the Des Moines and James Lobes.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Minnesota (0702), 42 percent; Missouri-Big Sioux (1017), 25 percent; Red (0902), 17 percent; James (1016), 10 percent; Mississippi Headwaters (0701), 5 percent; and Des Moines (0710), 1 percent. The headwaters of the Red River of the North (draining into Hudson Bay) and the Minnesota River (draining into the Mississippi River) are in this area. The part of the Minnesota River in the southeast corner of this area is a National Wild and Scenic River. Some of the major tributaries to the Red River are the Sand Hill, Poplar, Marsh, Wild Rice, Buffalo, Otter Tail, Mustinka, and Bois de Sioux Rivers. The major tributaries to the Minnesota River are the Chippewa, Pomme de Terre, Whetstone, Lac qui Parle, Yellow Medicine, and Cottonwood Rivers. The Big Sioux River begins in this area, near Watertown, South Dakota. Lake Traverse and Big Stone Lake are on the border between South Dakota and Minnesota. These lakes are on the continental divide where streams drain either north to Hudson Bay or south to the Gulf of Mexico. Lakes, ponds, and marshes are common in the area.

Geology

The dominant landforms in this area are stagnation moraines, end moraines, glacial outwash plains, terraces, and flood plains. The MLRA is dominated by till-covered moraines. The stagnation moraines are gently undulating to steep and have many depressions and poorly defined drainages. The steepest slopes are on escarpments adjacent to some of the larger tributaries. Small outwash areas are adjacent to the watercourses. The Cretaceous Pierre Shale underlies the till in most of the area. Precambrian rocks also occur at depth. Granite is quarried at Milbank, South Dakota, and outcrops of Sioux Quartzite are common. Layers of silt in the quartzite near Pipestone, Minnesota, were quarried by Native Americans, and the stone was carved for pipe bowls.

Climate

The average annual precipitation in this area is 19 to 29 inches (485 to 735 millimeters). Half or more of the precipitation falls during the growing season. Rainfall typically occurs as high-intensity, convective thunderstorms during the summer. Precipitation in winter occurs mostly as snow. The average annual temperature is 38 to 45 degrees F (4 to 7 degrees C). The freeze-free period averages about 155 days and ranges from 140 to 175 days. In the western part of the MLRA, rainfall is less abundant and is not always adequate for full maturation of crops.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 2.4%; ground water, 11.7%
Livestock—surface water, 0.4%; ground water, 11.1%
Irrigation—surface water, 34.9%; ground water, 30.2%
Other—surface water, 1.0%; ground water, 8.3%

The total withdrawals average 145 million gallons per day (550 million liters per day). About 61 percent is from ground water sources, and 39 percent is from surface water sources. Precipitation is the principal source of moisture for crops. In some years it is inadequate for maximum crop production. Small ponds and shallow wells are the principal sources of water for livestock. Both surface water and ground water are used for some irrigation in the area. Many natural glacial lakes are in the northern part of the area, and many of the larger ones are used for recreation. The water in the lakes and larger streams is generally suitable for all uses. The quality of the water in the smaller streams is generally poor. The water is slightly saline at low flows.

Shallow wells in glacial outwash deposits, primarily sand and gravel, provide water for livestock, domestic use, and irrigation in this area. This water is hard but is of good quality. The median level of total dissolved solids is 350 parts per million (milligrams per liter). Ground water also is available in deep wells in the Precambrian bedrock in this area or in the Dakota Sandstone. These aquifers are seldom utilized in this area because of an abundance of shallow glacial deposits and surface water.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a frigid soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. They generally are very deep, well drained to very poorly drained, and loamy. Hapludolls formed in loamy till (Barnes, Forman, and Hokans series), in loess or silty drift over till (Kranzburg, Poinsett, and Waubay series), in eolian deposits (Egeland and Embden series), and in glacial outwash (Arvilla, Fordville, and Renshaw series) on till plains and moraines. Calciudolls (Buse and Balaton series) formed in loamy till on rises and ridges. Argiaquolls (Parnell and Badger series) formed in loamy till and colluvial and alluvial sediment in swales and depressions. Argialbolls (Tonka series) and Endoaquolls formed in colluvial and alluvial sediment in depressions (Quam series) and in alluvial sediment on flood plains (Lamoure and Rauville series). Calciaquolls (Marysland and Moritz series) formed in alluvial sediments on flood plains.

Biological Resources

This area supports true prairie vegetation characterized by big bluestem, little bluestem, porcupinegrass, and green needlegrass. Needleandthread and prairie dropseed are important species on the steeper soils. Prairie cordgrass commonly grows in wet areas.

Some of the major wildlife species in this area are white-tailed deer, beaver, muskrat, mink, pheasant, gray partridge, giant Canada goose, mallard, blue-winged teal, wood duck, northern shoveler, pintail, ruddy duck, widgeon, redhead, canvasback, chestnut-collared longspur, marbled godwit, and upland plover. The species of fish in the area include walleye, northern pike, yellow perch, black crappie, white crappie, white bass, catfish, black bullhead, bluegill, carp, white sucker, buffalo, redhorse, and bait minnow.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 66%
Grassland—private, 17%; Federal, 1%
Forest—private, 3%
Urban development—private, 3%
Water—private, 4%
Other—private, 6%

Most of this area is in farms, and about two-thirds is cropland used for crops grown for sale or for feeding livestock. The principal crops are corn, soybeans, alfalfa, spring wheat, and oats. Wooded areas generally occur as narrow bands along streams and rivers or as shelterbelts around farmsteads. Recreational hunting and fishing are important land uses around the many natural lakes in the northern part of the area.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, soil wetness, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management, especially no-till or other conservation tillage systems that conserve moisture and contribute to soil quality. Other practices include terraces, vegetative wind barriers, grassed waterways, and nutrient management. ■

102B—Till Plains

This area is entirely in South Dakota (fig. 102B-1). It makes up about 2,215 square miles (5,735 square kilometers). The towns of Madison, Canton, and Parker are in this MLRA. Vermillion is on the southern edge of the area, and parts of

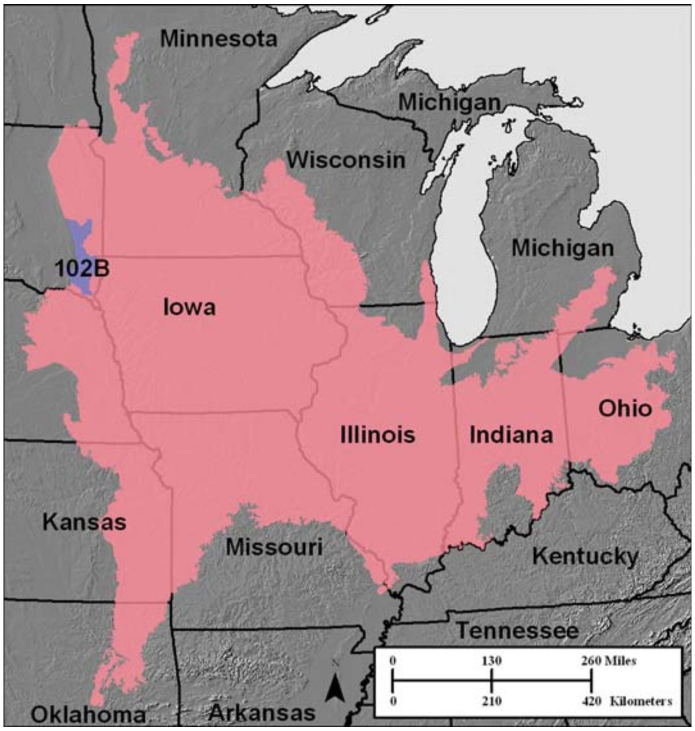

Figure 102B-1: Location of MLRA 102B in Land Resource Region M.

Sioux Falls are on the eastern edge. Interstate 90 bisects the area from east to west, and Interstate 29 parallels the east edge of the area, crossing it at the north and south ends.

Physiography

This area is in the Western Lake Section of the Central Lowland Province of the Interior Plains. It is characterized by glaciated, nearly level to hilly plains. It has many depressions and ill-defined drainageways. Elevation ranges from 1,140 feet (350 meters) on the edge of the bottom land along the Missouri River in the southern part of the area to 1,880 feet (575 meters) in central Lake County.

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is Missouri-Big Sioux (1017). The Vermillion River is just outside the western boundary of the MLRA, and the Big Sioux River is just outside the eastern boundary.

Geology

The major landforms in this MLRA are stagnation moraines, end moraines, glacial outwash terraces, and flood plains. The area is dominated by drift-covered moraines. The stagnation moraines generally are nearly level to gently rolling and have many depressions and ill-defined drainageways. The steeper slopes are on end moraines and on breaks adjacent to some of the larger tributaries. Small outwash areas are adjacent to the minor moraines. The dominant parent materials are silty drift, glacial till, glacial outwash, and alluvium.

Climate

The average annual precipitation in this area is 23 to 26 inches (585 to 660 millimeters). Most of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. Winter precipitation typically occurs as snow. The annual snowfall is 23 to 46 inches (60 to 120 centimeters). The average annual temperature is 43 to 49 degrees F (6 to 9 degrees C). The freeze-free period averages about 165 days and ranges from 155 to 175 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 2.0%; ground water, 19.1%
Livestock—surface water, 1.6%; ground water, 2.8%
Irrigation—surface water, 16.3%; ground water, 50.6%
Other—surface water, 2.1%; ground water, 5.5%

The total withdrawals average 61 million gallons per day (230 million liters per day). About 78 percent is from ground water sources, and 22 percent is from surface water sources. Precipitation is the principal source of moisture for crops. In some years it is inadequate for maximum crop production. Surface water is not plentiful in this area. Rural water systems supply domestic water to an increasing number of farms and communities in the area. The Missouri River, south of this area, has the best quality water in this region, so it is increasingly being used by rural water systems in the area.

A limited supply of ground water is in the glacial drift and alluvial aquifers near the surface in this area. These aquifers consist of unconsolidated sand and gravel. They provide fresh or saline water that is hard and is a calcium-magnesium, bicarbonate, and sulfate type. The median level of total dissolved solids, 670 parts per million (milligrams per liter), exceeds the national secondary (esthetic) standard for drinking water. The ground water is used primarily for domestic purposes and livestock, but some irrigation development has occurred in areas where the water supply is more abundant. Some public supplies are obtained from the shallow aquifers in the area. Many private wells have high levels of nitrate plus nitrite. Most of this contamination occurs because the wells are located downslope from septic tank absorption fields, feedlots, barnyards, or fertilizer storage areas.

Soils

The dominant soil order in this MLRA is Mollisols. The soils dominantly have a mesic soil temperature regime, an ustic soil moisture regime that borders on udic, and mixed or smectitic mineralogy. They generally are very deep, well drained to poorly drained, and clayey or loamy. Calciustolls (Ethan series) and Calciustepts (Betts series) formed in till on the steeper slopes on moraines. Calciaquolls formed in silty drift (Wakonda series) and glacial till (Davison series) in areas characterized by upward water movement. Haplustolls formed in lacustrine sediments (Huntimer series), silty drift (Wentworth and Trent series), silty drift over glacial till (Egan and Viborg series), or glacial till (Clarno series). They also formed in glaciofluvial deposits on outwash plains (Dempster, Graceville, Delmont, and Enet series). Argiaquolls (Chancellor series) formed in alluvium in wet drainageways. The soils that formed in alluvium in depressions include Argialbolls (Tetonka series), Argiaquolls (Worthing series), and Endoaquolls (Baltic series). Soils that formed in stream alluvium include Haplustolls (Bon, Davis, and Roxbury series), Endoaquolls (Lamo, Clamo, and Salmo series), Calciaquolls (Arlo and Storla series), and Fluvaquents (Chaska series).

Biological Resources

This area is in the western part of the tall grass prairie. Big bluestem, little bluestem, Indiangrass, porcupinegrass, and green needlegrass are the dominant species in the native plant communities. Needleandthread and prairie dropseed are important species on the steeper soils. Cattails, prairie cordgrass, bulrush, and reed canarygrass commonly grow in wet areas.

Some of the major wildlife species in this area are white-tailed deer, red fox, coyote, white-tailed jackrabbit, pheasant, gray partridge, ducks, and geese. Fishing is common in the pothole lake areas and rivers. The species of fish in the area include walleye pike, smallmouth bass, bluegill, yellow perch, northern pike, carp, channel catfish, and black bullhead.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 71%
Grassland—private, 16%; Federal, 1%
Forest—private, 1%
Urban development—private, 4%
Water—private, 2%
Other—private, 5%

Most of this area is in farms, and about 70 percent is cropland used for crops grown for sale or for feeding livestock. Corn, soybeans, alfalfa, and oats are the principal crops. Wooded areas generally occur as narrow bands along streams and rivers or as shelterbelts around farmsteads. Irrigation systems are used on droughty soils in areas where water supplies are available. Urban development is expanding around some of the larger towns.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, wetness, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management, especially no-till or conservation tillage systems that conserve moisture and contribute to soil quality. Other practices include terraces, vegetative wind barriers, grassed waterways, and nutrient management. ■

102C—Loess Uplands

This area (shown in fig. 102C-1) is in Nebraska (77 percent), South Dakota (13 percent), Iowa (6 percent), and Minnesota (4 percent). It makes up about 11,445 square miles (29,655 square kilometers). It includes the towns or cities of Albion, Bloomfield, Hartington, Wayne, Norfolk, West Point, Columbus, and Fremont, Nebraska; Yankton, Sioux Falls, and Vermillion, South Dakota; Canton, Iowa; and Luverne, Minnesota. Interstates 29 and 90 cross parts of this MLRA. Parts of the Santee, Winnebago, and Omaha Indian Reservations are in this area.

Physiography

Most of this area is in the Dissected Till Plains Section of the Central Lowland Province of the Interior Plains. The southwestern third is in the High Plains Section of the Great Plains Province of the Interior Plains. This MLRA has broad, undulating to rolling ridgetops and hilly to steep valley sides. The valleys are generally narrow, but broad flood plains and terraces are along the major rivers and the large tributaries. Elevation ranges from 1,100 to 2,000 feet (335 to 610 meters), increasing from southeast to northwest. Local relief is commonly 5 to 30 feet (2 to 9 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Elkhorn (1022), 44 percent; Missouri-Big Sioux (1017), 36 percent; Loup (1021), 9 percent; Platte (1020), 8 percent; Missouri-Little Sioux (1023), 2 percent; and Niobrara (1015), 1 percent. The Big Sioux River forms the boundary between Iowa

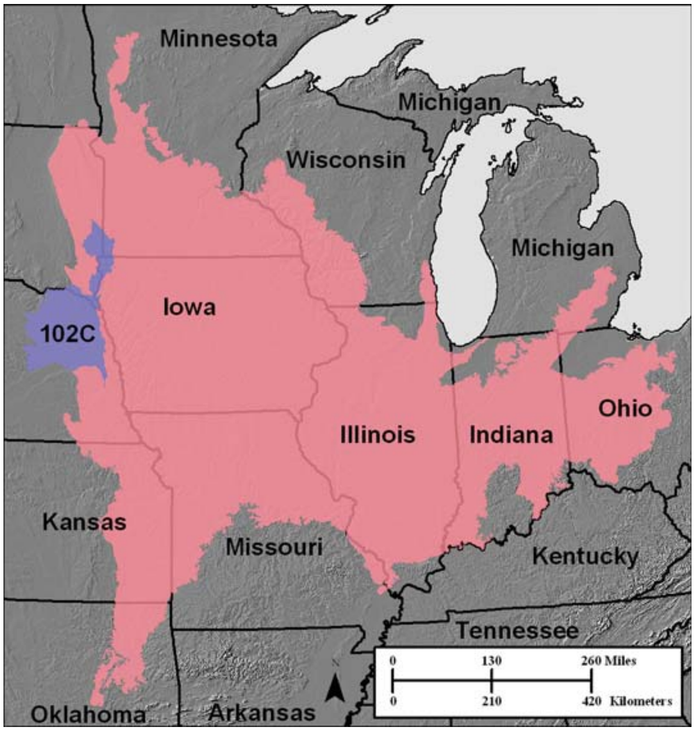

Figure 102C-1: Location of MLRA 102C in Land Resource Region M.

and South Dakota and joins the Missouri River in this area. The Missouri River is designated as a National Wild and Scenic River near Vermillion, South Dakota. The Elkhorn River, a major tributary to the Platte River in Nebraska, occurs in this area.

Geology

Loess covers most of this area. It consists of pale brown or light grayish brown, calcareous, silty material deposited by the wind. The loess is mainly of Peorian age. It ranges from 6 to 70 feet (2 to 20 meters) in thickness. Deposits of glacial till underlie the loess in most of the area. The till is more than 200 feet thick (60 meters) in some areas. Where no glacial deposits occur, bedrock generally is at or near the surface, except in areas where deposits of Pleistocene sand and gravel fill the principal stream valleys. The glacial till is underlain by deposits of Pleistocene sand and gravel in some buried bedrock valleys. It rests directly on bedrock, however, throughout much of the area. The Dakota Sandstone, a bedrock formation of Cretaceous age, underlies all but the southeastern part of the area, where rocks of Pennsylvanian age are at or near the surface. The Dakota Sandstone is exposed in many areas along the eastern boundary of the area for a distance of 50 miles south from the town of Ponca. Westward from a north-south line through Ponca, however, it is progressively more deeply buried.

Climate

The average annual precipitation in this area is 23 to 30 inches (585 to 760 millimeters). Most of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. The maximum precipitation occurs from the middle of spring to early in autumn. Precipitation in winter occurs as snow. The annual snowfall ranges from about 24 inches (60 centimeters) in the southern part of the area to 34 inches (85 centimeters) in the northern part. The average annual temperature is 43 to 51 degrees F (6 to 11 degrees C). The freeze-free period averages about 170 days and ranges from 150 to 190 days, increasing in length from northwest to southeast.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.6%; ground water, 10.9%
Livestock—surface water, 0.1%; ground water, 0.6%
Irrigation—surface water, 22.0%; ground water, 54.3%
Other—surface water, 9.0%; ground water, 2.4%

The total withdrawals average 1,135 million gallons per day (4,295 million liters per day). About 68 percent is from ground water sources, and 32 percent is from surface water sources. Precipitation is the principal source of moisture for crops. In some years it is inadequate for maximum crop production. The water in the Missouri River is of very good quality and is suitable for most uses with minimal treatment. Sediment, nutrients, and pesticides from agricultural activities impair the other major rivers in this area, but the surface water is still used for livestock, irrigation, public supply, and industry in parts of the area.

Ground water is obtained from shallow alluvial and glacial meltwater deposits of unconsolidated sand and gravel throughout most of this area. The water in these shallow aquifers has a median level of total dissolved solids of 350 to 390 parts per million (milligrams per liter) in the part of this area in Nebraska and 690 parts per million (milligrams per liter) in the part in South Dakota. It is typically a calcium-magnesium-bicarbonate type of water that is very hard. The glacial till is a poor source of ground water; yields to wells are small to negligible, and the water is commonly highly mineralized. Locally thick deposits of Pleistocene sand and gravel yield moderate or moderately large supplies of good-quality water to wells. The ground water in this MLRA is used for domestic purposes, livestock, irrigation, public supply, and industry.

The Cretaceous-age Dakota Sandstone is at a shallow or moderate depth in the eastern part of this area. It is tapped by many domestic and livestock wells. Not very many irrigation wells tap this aquifer, but a number of communities in eastern

Nebraska obtain their public supplies from it. Locally, the Dakota Sandstone has beds of gravel at its base. Moderately large yields can be obtained from these beds. Water quality varies in this bedrock aquifer, depending on whether the aquifer is being recharged locally, whether it has been leached of salts, and whether the residence time of the water within the aquifer has been long. Calcium is the principal cation in the ground water where the Dakota Sandstone is being recharged locally or where it has been leached. Sodium is the dominant cation in the water of poorer quality where no local recharge occurs, the salts in the aquifer have not been leached, or the water has been in the aquifer for a long time. The water from the Dakota Sandstone is very hard. Other bedrock formations in the area are generally poor sources of water.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep, moderately well drained to somewhat excessively drained, and loamy or clayey. Haplustolls formed in loess on uplands (Belfore, Moody, and Nora series), in loess over outwash on uplands (Dempster and Graceville series), in colluvium and alluvium on footslopes (Alcester series), and in eolian deposits on uplands (Flandreau, Grovena, and Thurman series). Endoaquolls (Colo, Gibbon, and Zook series) formed in alluvium on flood plains. Ustorthents (Crofton series) formed in loess in steep areas on uplands. Fluvaquents (Albaton series) and Udifluvents (Blake and Grable series) formed in alluvium on the Missouri River flood plain.

Biological Resources

This area supports natural prairie vegetation. Little bluestem, big bluestem, switchgrass, western wheatgrass, and sideoats grama characterize the vegetation on loamy soils. Porcupine, green needlegrass, and western wheatgrass characterize the vegetation on clayey soils on uplands.

Some of the major wildlife species in this area are mule deer, white-tailed deer, coyote, raccoon, pheasant, bobwhite quail, mourning dove, and meadowlark. The species of fish in the area include smallmouth bass, bluegill, channel catfish, and black bullhead.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 74%
Grassland—private, 16%
Forest—private, 2%
Urban development—private, 4%
Water—private, 1%
Other—private, 3%

Nearly all of this area is farmed. More than 70 percent of the area is cropland used mainly for corn and soybeans. Feed grains and hay crops also are widely grown. About 20 percent of the area is irrigated. Corn, alfalfa, small grains, and grass hay are grown extensively in the irrigated areas. The areas consisting of hilly and steep slopes bordering the drainageways support native grasses and shrubs used for grazing.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and tilth of the soils, and soil moisture management. Soils that formed in Peorian Loess are highly susceptible to water erosion. Pasture and rangeland are subject to wind erosion and water erosion when the plant cover is depleted by overgrazing. Conservation practices on cropland generally include high-residue crops in the cropping system, systems of crop residue management (such as no-till and mulch-till systems), level terraces, contour farming, contour stripcropping, irrigation water management, and nutrient management. Conservation practices on pasture and rangeland generally include fences and proper grazing management. ■

103—Central Iowa and Minnesota Till Prairies

This area (shown in fig. 103-1) is in Minnesota (56 percent) and Iowa (44 percent). It makes up about 27,640 square miles (71,630 square kilometers). It includes the cities or towns of Mankato, Marshall, Hutchinson, Minneapolis, and Willmar, Minnesota, and Des Moines, Ames, Carroll, and Fort Dodge, Iowa. The towns of Worthington and Fairmont and the city of Albert Lea, Minnesota, are connected by Interstate 90, which crosses the center of this area. Interstate 80 passes through Ankeny and Des Moines, and Interstate 35 extends from north of Des Moines to the cities of Minneapolis and St. Paul, Minnesota. Numerous State and county parks and public access areas are throughout the MLRA.

Physiography

This area is in the Western Lake Section of the Central Lowland Province of the Interior Plains. The area is called the “Des Moines Lobe” of the Wisconsin-age ice sheet. It is mostly on a young, nearly level to gently rolling glaciated till plain with moraines and glacial lake plains in some areas. The eastern part of the area has some higher hills (moraines). Natural lakes, marshes, and potholes occur throughout the area. Elevation ranges from 985 to 1,315 feet (300 to 400 meters). Relief is mainly less than 10 feet to 20 feet (3 to 6 meters), but some of the major valleys are 165 feet (50 meters) or more below the adjoining uplands.

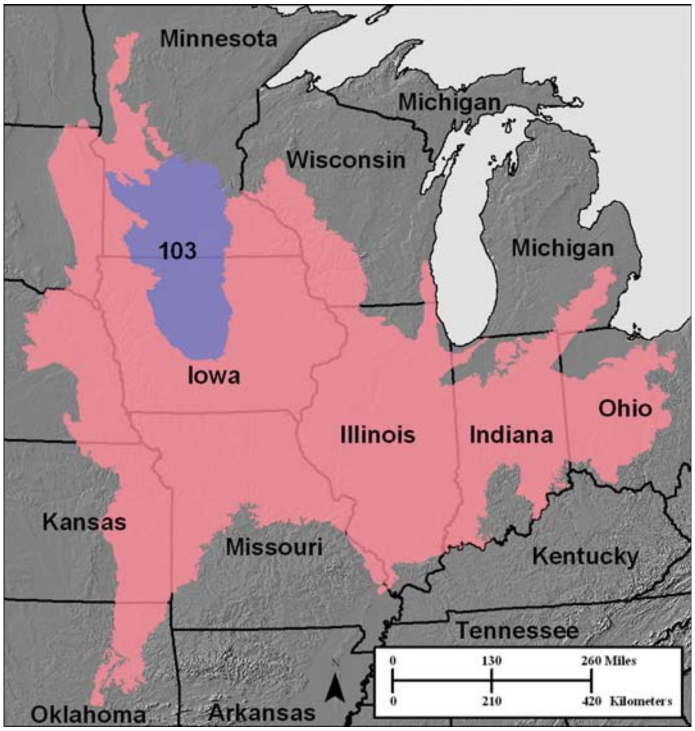

Figure 103-1: Location of MLRA 103 in Land Resource Region M.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Minnesota (0702), 35 percent; Des Moines (0710), 32 percent; Upper Mississippi-Iowa-Skunk-Wapsipinicon (0708), 14 percent; Mississippi Headwaters (0701), 11 percent; Upper Mississippi-Black-Root (0704), 4 percent; and Missouri-Little Sioux (1023), 4 percent. The major rivers that drain the MLRA include the Blue Earth, Boone, Cottonwood, Des Moines, Lizard, Minnesota, and Raccoon Rivers. The Minnesota, Crow, and Cannon Rivers are National Wild and Scenic Rivers in this MLRA.

Geology

This area is covered with glacial till, outwash, and glacial lake deposits. Recent alluvium consisting of clay, silt, sand, and gravel fill the bottoms of most of the major river valleys. Paleozoic bedrock sediments, primarily shale and limestone, underlie the glacial deposits in most of the area. Some Precambrian Sioux Quartzite is exposed on the western edge of the area, in southwestern Minnesota.

Climate

The average annual precipitation in most of this area is 23 to 35 inches (585 to 890 millimeters), increasing from northwest to southeast. Most of the rainfall occurs as high-intensity, convective thunderstorms during the summer. Two-thirds or more of the precipitation falls during the freeze-free period. Snowfall is common in winter. The average annual temperature ranges from 43 to 50 degrees F (6 to 10 degrees C). The freeze-free period averages about 175 days and ranges from 155 to 200 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 9.5%; ground water, 8.9%
Livestock—surface water, 1.1%; ground water, 3.0%
Irrigation—surface water, 0.6%; ground water, 2.1%
Other—surface water, 64.6%; ground water, 10.1%

The total withdrawals average 1,485 million gallons per day (5,620 million liters per day). About 24 percent is from ground water sources, and 76 percent is from surface water sources. The moderate precipitation is adequate for crops, but in years when rainfall is below normal, yields can be reduced. Lakes, ponds, and a few artificial reservoirs provide water and opportunities for recreation. The surface water is abundant, but its quality may be degraded by the nonpoint sources of sediment, nutrients, and pesticides in runoff from agricultural land.

Ground water supplies are adequate for the domestic, livestock, municipal, and industrial needs in this area. A number of unconsolidated and bedrock aquifers occur in the area. Most of the ground water used in the area is pumped from the surficial aquifer (buried channels, glacial drift, and alluvium) or the Ordovician and Cambrian sandstone and dolomite in the Jordan, or Prairie du Chien-Jordan, aquifer. The water from both of the aquifers generally meets Federal and State drinking water standards. It is hard or very hard. The level of total dissolved solids in the water from the surficial aquifer is about 500 parts per million (milligrams per liter).

Soils

The dominant soil orders in this MLRA are Mollisols and, to a lesser extent, Alfisols and Inceptisols. The soils in the area dominantly have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. They generally are very deep, well drained to very poorly drained, and loamy. Hapludolls formed in loamy till on till plains and moraines (Amiret, Clarion, Nicollet, and Ves series) and in outwash deposits on outwash plains, terraces, and kames (Estherville and Hawick series). Argiudolls (Le Sueur series) and Argiaquolls (Cordova series) formed in loamy till on till plains and moraines. Endoaquolls (Canisteo, Glencoe, and Webster series) and Calciaquolls (Harps series) formed in loamy till and/or local alluvium on till plains and in swales and depressions. Endoaquolls also formed in alluvium on flood plains (Coland series). Hapludalfs (Hayden and Lester series) and Eutrudepts (Storden series) formed in loamy till on moraines.

Biological Resources

This area supports natural prairie vegetation characterized by little bluestem, Indiangrass, and switchgrass. Little bluestem, Indiangrass, and needlegrass grow on sandy, droughty soils. Little bluestem, sideoats grama, blue grama, and scattered bur oak, juniper, and sumac grow on very shallow soils.

Some of the major wildlife species in this area are white-tailed deer, fox, beaver, muskrat, rabbit, squirrel, mink, Canada goose, pheasant, and gray partridge. The most common species of fish in the area are walleye, northern pike, largemouth bass, bluegill, crappie, yellow perch, and sunfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 80%
Grassland—private, 5%
Forest—private, 3%
Urban development—private, 6%
Water—private, 2%
Other—private, 4%

Nearly all of this area is in farms, and about four-fifths is cropland. The proportion of cropland is highest in the southern part of the area. Corn, soybeans, and other feed grains are the major crops. Some of the cropland is used for hay. Dairy farming is a more common enterprise in the northern part of the MLRA than in the southern part. Forested areas occur as narrow bands on steep slopes bordering stream valleys and as wet areas on bottom land. Less than one-tenth of the area is used for urban development. Many natural lakes occur in this area, and numerous bogs, swales, and circular depressions indicate sites of previously ponded water. Much of the area is currently drained by tile. Extensive drainage ditches provide outlets for the tile drains. Many areas in this MLRA are used for outdoor recreation.

The major resource concerns are water erosion, depletion of organic matter in the soils, excess surface and subsurface water, and poor water quality. Conservation practices on cropland generally include systems of crop residue management (especially no-till, strip-till, and mulch-till systems), cover crops, surface and subsurface drainage systems, nutrient and pest management, grassed waterways, buffer strips, and development of wildlife habitat. ■

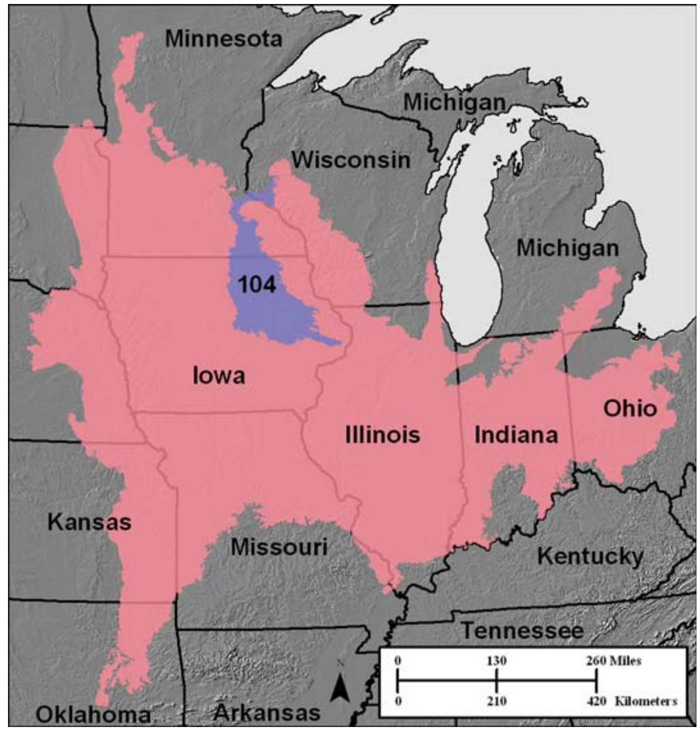

Figure 104-1: Location of MLRA 104 in Land Resource Region M.

104—Eastern Iowa and Minnesota Till Prairies

This area (shown in fig. 104-1) is in Iowa (74 percent), Minnesota (22 percent), and Wisconsin (4 percent). It makes up about 9,660 square miles (about 25,040 square kilometers). The larger cities and towns in this area are Mason City, Cedar Falls, Waterloo, and Cedar Rapids, Iowa, and Austin, Minnesota. Interstate 90 passes through Austin, Minnesota, in the northern end of the area. The small part of this area that crosses into Wisconsin from Minnesota does so at Red Wing, Minnesota. A few State parks are in the area.

Physiography

This area is in the Central Lowland Province of the Interior Plains. Almost all of the area is in the Dissected Till Plains Section of the province, but parts of the western edge are in the Western Lake Plain Section, and the small part of the area in Wisconsin is in the Wisconsin Driftless Section. The landscape is a nearly level to gently rolling glaciated plain with long slopes. The natural drainage network is well established and commonly described as dendritic, resulting in few lakes and ponds. Subsurface tile drainage lines are commonly used to lower water tables and increase crop production. Karst topography is common in this area. Elevation ranges from 985 to 1,310 feet (300 to 400 meters). Local relief is 10 to 20 feet (3 to 6 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Mississippi-Iowa-Skunk-Wapsipinicon (0708), 62 percent; Upper Mississippi-Maquoketa-Plum (0706), 19 percent; Upper Mississippi-Black-Root (0704), 17 percent; and Chippewa (0705), 2 percent. The major rivers that drain the area include the Cannon, Zumbro, Root, and Cedar Rivers in Minnesota and the Beaver, Cedar, Winnebago, Shell Rock, and Wapsipinicon Rivers in Iowa.

Geology

This area is covered with glacial till and outwash deposits. Recent alluvium consisting of clay, silt, sand, and gravel fills the major river valleys. Paleozoic bedrock sediments, primarily shale and limestone, underlie most of the area. A shallow depth to limestone results in karst topography in much of the area. Some limestone units containing fossils are exposed in road cuts in the northeast corner of the area and along the major rivers in the part of the area in Iowa. Bedrock units also are exposed on the Mississippi River bluffs near Red Wing, Minnesota.

Climate

The average annual precipitation in most of this area is 29 to 37 inches (735 to 940 millimeters). Most of the rainfall occurs as high-intensity, convective thunderstorms during the summer. More than two-thirds of the precipitation falls during the growing season. Precipitation in winter occurs mainly as snow. The average annual temperature is 44 to 50 degrees F (7 to 10 degrees C). The freeze-free period averages about 180 days and ranges from 160 to 195 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 6.5%; ground water, 27.6%
Livestock—surface water, 1.6%; ground water, 4.2%
Irrigation—surface water, 0.0%; ground water, 0.3%
Other—surface water, 36.3%; ground water, 23.4%

The total withdrawals average 365 million gallons per day (1,380 million liters per day). About 56 percent is from ground water sources, and 44 percent is from surface water sources. Precipitation is generally adequate for crops, but in years when the precipitation is below normal, yields can be reduced. Water is generally abundant in the many rivers in the area. It is of good quality and is suitable for all uses. It is used mainly for public supplies and industry.

The supply of ground water is adequate for the livestock, domestic, municipal, and industrial needs in this area. A number of unconsolidated and bedrock aquifers are in the area. Most of the ground water used in this area is pumped from either the surficial aquifer (buried channels, glacial drift, and alluvium) or the Ordovician and Cambrian sandstone and dolomite in the Jordan, or Prairie du Chien-Jordan, aquifer. The water from both aquifers generally meets Federal and State drinking water standards. The median level of 850 parts per million (milligrams per liter) total dissolved solids in the Jordan aquifer does exceed the secondary (esthetic) standard for drinking water in Iowa. The level of total dissolved solids is much lower in the Prairie du Chien-Jordan aquifer in Minnesota. Water in both aquifers is hard or very hard, and the level of total dissolved solids in the water from the surficial aquifer is about 500 parts per million (milligrams per liter).

Soils

The dominant soil orders in this MLRA are Mollisols and Alfisols. The soils in the area dominantly have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. They generally are very deep, well drained to very poorly drained, and loamy. Hapludolls (Floyd, Kenyon, Marquis, Ostrander, and Readlyn series) and Hapludalfs (Bassett, Kasson, and Racine series) formed in loamy sediments over till on uplands. Argiudolls (Dinsdale series) formed in loess over till on uplands. Endoaquolls (Maxfield and Tripoli series) formed in loamy and silty sediments over till on uplands.

Biological Resources

This area supports prairie vegetation. Big bluestem and Indiangrass are dominant on the well drained soils in rolling areas. Switchgrass, prairie cordgrass, and prairie dropseed are better adapted to the somewhat poorly drained soils. Switchgrass, sedges, and rushes grow on poorly drained soils in draws or valleys. Common cattails grow on swampy sites. Little bluestem, porcupinegrass, and sand lovegrass grow on sandy, rocky, dry sites. Forbs, such as clovers, phlox, sunflower, gayfeather, and goldenrod, grow on the more productive soils. Roundhead lespedeza, spiderwort, and flowering spurge grow on droughty soils. Loosestrife, bedstraw, milkweed, and tickclover are water-tolerant species that grow on wet soils.

Some of the major wildlife species in this area are white-tailed deer, beaver, otter, muskrat, squirrel, mink, pheasant, gray partridge, great blue heron, American egret, mallard, and teal. The species of fish in the area include smallmouth bass, catfish, northern pike, black bullhead, bluegill, sunfish, and rough fish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 80%
Grassland—private, 5%
Forest—private, 6%
Urban development—private, 5%
Water—private, 1%
Other—private, 3%

Nearly all of this area is in farms, and about four-fifths is cropland. Much of the area is drained by tile. Extensive drainage ditches provide outlets for the tile drains. Corn, soybeans, other feed grains, and hay are the major crops. Raising and feeding hogs and beef cattle and dairying are important enterprises. The forestland in the area is mainly on wet bottom land and on steep slopes bordering stream valleys.

The major resource concerns are water erosion, depletion of organic matter in the soils, excess surface and subsurface water, and poor water quality. Many of the wet soils require artificial drainage for good growth of the field crops commonly grown in the area. Conservation practices on cropland generally include systems of crop residue management (especially no-till, strip-till, and mulch-till systems), cover crops, surface and subsurface drainage systems, nutrient and pest management, grassed waterways, terraces, manure management, pasture and hayland planting, and grade-stabilization structures. ■

105—Northern Mississippi Valley Loess Hills

This area (shown in fig. 105-1) is in Wisconsin (52 percent), Iowa (23 percent), Minnesota (20 percent), and Illinois (5 percent). It makes up about 17,950 square miles (about 46,515 square kilometers). The major cities or towns in the area are Decorah, Dubuque, Maquoketa, and Clinton, Iowa; Rochester and Winona, Minnesota; and Eau Claire, Menomonie, Prairie du Chien, Platteville, and Richland Center, Wisconsin. Interstate 90 crosses parts of this MLRA. The Savanna Army Depot Military Reservation, along the part of the Mississippi River in Illinois, and the Fort McCoy Military Reservation, in Wisconsin, are in the MLRA. The Richard J. Dorer Memorial State Forest makes up almost the entire northeast one-quarter of the part of this area in Minnesota. Numerous State parks are throughout the area. Much of the Upper Mississippi National Wildlife Refuge is in this MLRA.

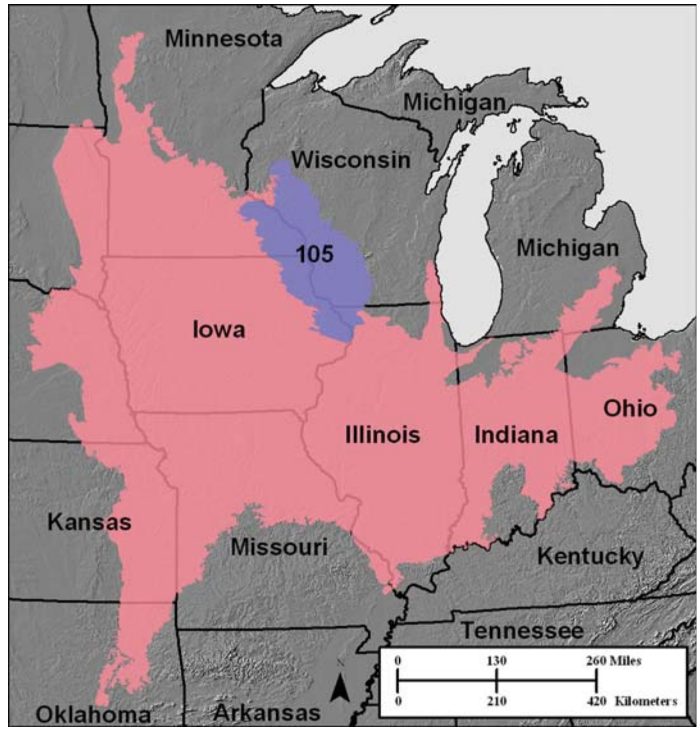

Figure 105-1: Location of MLRA 105 in Land Resource Region M.

Physiography

This area is in the Wisconsin Driftless Section of the Central Lowland Province of the Interior Plains. In Wisconsin, this area is often referred to as the “Driftless Area” because it has undergone only limited landscape formation by glacial ice. The area consists mostly of gently sloping to rolling summits with steeper valley walls that join small to very large flood plains. Scenic landscapes are characteristic of the area. They include deep valleys, abundant rock outcrops, high bluffs, caves, crevices, and sinkholes. Stream valleys are deep, narrow, and V-shaped and have irregular slopes and steep cliffs. The valleys commonly take abrupt, sharp-angled turns, indicating that the local drainage network is controlled by joint patterns in the underlying bedrock. Elevation ranges from 660 feet (200 meters) on the valley floors to 1,310 feet (400 meters) on the highest ridges. Local relief is mainly 10 to 20 feet (3 to 6 meters), but it is as much as 50 to 100 feet (15 to 30 meters) on valley walls along the major streams and is as much as 250 feet (75 meters) on the Mississippi River bluffs above the river valley floor.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows:

Upper Mississippi-Maquoketa-Plum (0706), 38 percent; Upper Mississippi-Black-Root (0704), 33 percent; Wisconsin (0707), 19 percent; Rock (0709), 7 percent; Chippewa (0705), 2 percent; and Upper Mississippi-Iowa-Skunk-Wapsipinicon (0708), 1 percent. The Mississippi River flows through much of this area, forming the boundaries between Minnesota and Wisconsin and between Iowa and Illinois. The Kickapoo, Wisconsin, and Pecatonica Rivers are in the part of this area in Wisconsin. The Zumbro, Whitewater, and Root Rivers flow into the Mississippi River from the part in Minnesota. The Upper Iowa, Turkey, Yellow, Volga, and Maquoketa Rivers all flow into the Mississippi River from the part in Iowa. The Apple, Plum, and Rock Rivers are in the southeast corner of the area, in Illinois.

Geology

This area is in the "Driftless Area" of southwestern Wisconsin, but it shows some evidence of glaciation, especially in the western part. Cambrian sandstone, with some shale and dolomite layers, is exposed in the northern part of the area. The sandstone also underlies Ordovician sediments in the more deeply eroded river valleys. Sandstone, shale, dolomite, and limestone units of the St. Peter Formation and Prairie du Chien Group are at the surface, in road cuts, and in valley walls along the major rivers in the part of the area in Wisconsin and Minnesota. In the southern part of the area, younger Ordovician shale and dolomite units occur at the surface. Some karst areas have formed where the carbonate rocks are near the surface. Loess deposits cover many of the bedrock units in this area.

Climate

The average annual precipitation in most of this area is 30 to 38 inches (760 to 965 millimeters). Two-thirds or more of the precipitation falls during the freeze-free period. Most of the rainfall occurs as high-intensity, convective thunderstorms during the summer. Snowfall is common in winter. The average annual temperature is 42 to 50 degrees F (6 to 10 degrees C). The freeze-free period averages about 175 days and ranges from 145 to 205 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 2.1%; ground water, 4.0%
Livestock—surface water, 0.2%; ground water, 1.2%
Irrigation—surface water, 0.0%; ground water, 0.2%
Other—surface water, 88.2%; ground water, 3.9%

The total withdrawals average 2,650 million gallons per day (10,030 million liters per day). About 9 percent is from ground water sources, and 91 percent is from surface water sources. In most years the moderate precipitation is adequate for crops and forage, but in years of little or no precipitation, yields are reduced on soils that are shallow over bedrock. The many springs, streams, and farm ponds are additional sources of surface water in the area. The surface water is abundant and generally is of good quality. Poor water quality in stream reaches is primarily the result of nonpoint sources of sediment, nutrients, and pesticides from agricultural land or wastewater discharges downstream from the larger cities.

Ground water is abundant in glacial outwash deposits in most of the river valleys in this area. This water is moderately hard or hard but is generally of very good quality. The level of total dissolved solids is typically less than 250 parts per million (milligrams per liter). The supply of ground water varies in the uplands. The sandstone and dolomite layers in the Jordan and Prairie du Chien aquifers usually provide adequate yields to wells. The water from these aquifers is suitable for all uses, although the level of total dissolved solids approaches 1,000 parts per million (milligrams per liter) in some areas.

Soils

The dominant soil orders in this MLRA are Alfisols and Entisols and, to a lesser extent, Mollisols. The soils in the area dominantly have a mesic soil temperature regime, a udic soil moisture regime, and mixed mineralogy. They generally are moderately deep to very deep, well drained or moderately well drained, and loamy. Hapludalfs formed in loess (Downs, Fayette, Mt. Carroll, and Seaton series) or loess over residuum (Dubuque, La Farge, Norden, and Nordness series) on uplands and benches. Paleudalfs (Valton series) formed in loess over residuum on uplands. Argiudolls (Tama series) formed in loess on uplands and terraces. Udifluvents (Chaseburg series) formed in alluvium on flood plains and alluvial fans. Udipsamments (Plainfield series) formed in glaciofluvial deposits on outwash plains, terraces, and valley trains.

Biological Resources

The soils on uplands support native hardwoods. Oak, hickory, and sugar maple are the dominant species. Big bluestem, little bluestem, and scattered oak trees grow on some sites. The soils on lowlands support mixed hardwoods, mainly elm, cottonwood, river birch, ash, silver maple, and willow. Sedge and grass meadows and scattered trees grow on some of the wetter lowlands.

Some of the major wildlife species in this area are white-tailed deer, coyote, gray fox, red fox, beaver, raccoon, skunk, muskrat, opossum, fisher, otter, mink, cottontail, fox squirrel, gray squirrel, red squirrel, Canada goose, sandhill crane, bald eagle, red-shouldered hawk, goshawk, peregrine falcon, osprey, Cooper's hawk, turkey vulture, turkey, ruffed grouse, woodcock, great horned owl, wood duck, hooded merganser, pileated woodpecker, and red-bellied woodpecker.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 49%
Grassland—private, 14%; Federal, 1%
Forest—private, 27%
Urban development—private, 4%
Water—private, 2%
Other—private, 2%; Federal, 1%

Nearly all of this area is farmed. About one-half of the area is cropland, and 15 percent is permanent pasture. Cash crops, such as corn and soybeans, and feed grains and forage crops for dairy cattle and other livestock are the principal crops. About one-fourth of the area, mainly the more sloping parts, consists of farm woodlots used for commercial timber production or for farm products. The Mississippi River and its major tributaries provide opportunities for recreation.

The major resource concerns are water erosion, depletion of organic matter in the soils, and poor water quality. Conservation practices on cropland generally include systems of crop residue management (especially no-till, strip-till, and mulch-till systems), cover crops, nutrient and pest management, contour stripcropping, grassed waterways, terraces, manure management, pasture and hayland planting, tree planting, and grade-stabilization structures. ■

106—Nebraska and Kansas Loess-Drift Hills

This area (shown in fig. 106-1) is in Nebraska (52 percent) and Kansas (48 percent). It makes up about 10,920 square miles (28,295 square kilometers). It includes the town of Beatrice, Nebraska; the city of Lincoln, Nebraska; and the cities of Topeka and Lawrence, Kansas. Interstate 80 crosses the northern part this MLRA, passing through an area just north of Lincoln, and Interstates 70 and 470 pass through Topeka and Lawrence, Kansas, in the southern part of the MLRA. The Iowa Sac and Fox, Kickapoo, and Potawatomi Indian Reservations are in the part of this area in Kansas. Part of the Iowa Sac and Fox Reservation is in Nebraska. The Homestead National Monument, commemorating pioneer life on the prairie, is just west of Beatrice, Nebraska.

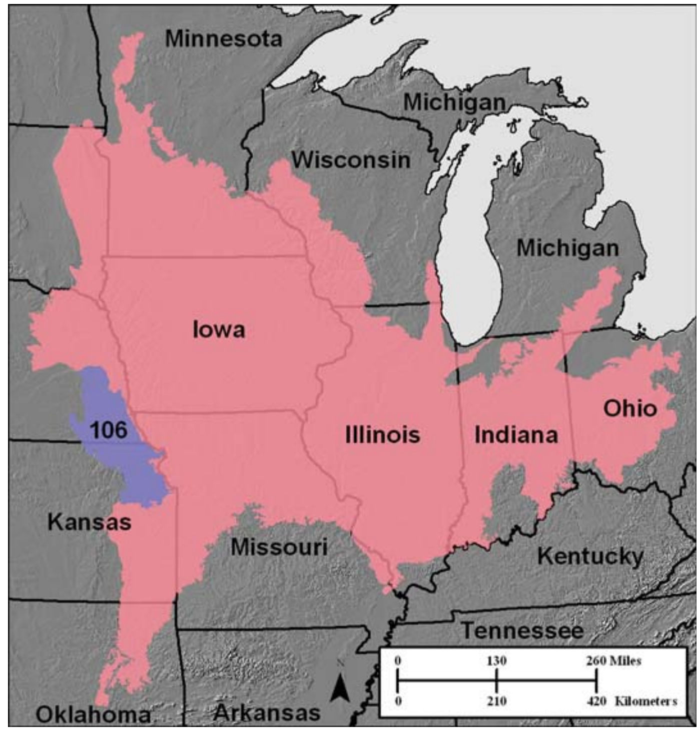

Figure 106-1: Location of MLRA 106 in Land Resource Region M.

Physiography

This area is almost entirely in the Dissected Till Plains Section of the Central Lowland Province of the Interior Plains. The southern tip is in the Osage Plains Section of the same province and division. Interstate 70 is close to the boundary between these two sections in this MLRA. This area is a dissected glacial drift plain. Ridgetops are broad and smooth, and slopes are nearly level to strongly sloping. Stream valleys are bordered by relatively narrow bands of hilly and steep slopes. Valley floors are typically narrow, except along the larger rivers and their primary tributaries. Elevation ranges from 980 to 1,650 feet (300 to 505 meters), increasing from east to west. Local relief is mainly 10 to 20 feet (3 to 6 meters), but some of the larger valley floors are 80 to 160 feet (25 to 50 meters) or more below the level of the adjacent uplands.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Kansas (1027), 51 percent; Missouri-Nishnabotna (1024), 32 percent; and Platte (1020), 17 percent. The Little Nemaha River and the North Fork of the Big Nemaha River flow into the Missouri River, which is just east of the part of this area in Nebraska. The Big Blue River flows through Beatrice, Nebraska, and on into the part of this area in Kansas. Salt-Wahoo Creeks flow through Lincoln and Wahoo and on into the Platte River in the northern part of the area. The Big Blue joins the Black Vermillion River at Tuttle Creek Lake in the southern end of the MLRA, in Kansas. The Soldier and Delaware Rivers also are in the part of the MLRA in Kansas.

Geology

Loess covers the surface of almost all of the uplands in this MLRA. Glacial drift underlies the loess. Alluvial clay, silt, sand, and gravel are deposited in all of the stream and river valleys. The alluvial deposits can be extensive in the major river valleys. Paleozoic sandstone, shale, and limestone units are exposed in a few road cuts and in the walls of valleys along the major streams on the east side of the area, near the bluffs along the Missouri River. Limestone and shale (clay) quarries are in this MLRA.

Climate

The average annual precipitation in most of this area is 28 to 40 inches (710 to 1,015 millimeters), increasing from northwest to southeast. About three-fourths of the precipitation falls as high-intensity, convective thunderstorms from late in spring through early in autumn. The scant precipitation in winter occurs mainly as snow. The average annual temperature is 50 to 55 degrees F (10 to 13 degrees C). The freeze-free period averages about 195 days and ranges from 175 to 215 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 6.5%; ground water, 18.7%
Livestock—surface water, 1.3%; ground water, 2.5%
Irrigation—surface water, 11.4%; ground water, 31.9%
Other—surface water, 13.6%; ground water, 14.1%

The total withdrawals average 485 million gallons per day (1,835 million liters per day). About 67 percent is from ground water sources, and 33 percent is from surface water sources. Precipitation is generally adequate for crops, but in years of little or no precipitation, yields are reduced. The supply of both surface and ground water is limited in this area. Small areas along some of the perennial streams are irrigated. Small ponds and reservoirs are important sources of water for livestock. The surface water in this area is generally of good quality, but it typically is not used for drinking because of the variability of the supply. Many streams flow only in direct response to rainfall.

Shallow wells in glacial drift and in alluvium in stream valleys supply water for domestic and livestock needs on most farms. This water primarily contains calcium, magnesium, and bicarbonate and is very hard. The level of total dissolved solids varies considerably in the water in the glacial drift. The water in the alluvial deposits has a median level of 390 parts per million (milligrams per liter) total dissolved solids. In some areas deep wells in glacial drift provide very hard water that contains more than 700 parts per million (milligrams per liter) total dissolved solids. Many communities and households obtain water from the Dakota Formation. This water is very hard and has a median level of 840 parts per million (milligrams per liter) total dissolved solids. The public water supply for Lincoln, Nebraska, is pumped from alluvium along the Platte River, almost 30 miles east of the city.

Soils

The dominant soil orders in this MLRA are Mollisols, Alfisols, and Entisols. The soils in the area dominantly have a mesic soil temperature regime, a udic soil moisture regime, and mixed or smectitic mineralogy. They generally are very deep, well drained or moderately well drained, and loamy or clayey. Hapludolls formed in alluvium on flood plains (Kennebec series), in colluvium on footslopes and alluvial fans (Judson series), and in loess on uplands (Marshall series). Argiudolls formed in loess (Aksarben and Wymore series), till (Burchard, Morrill, Pawnee, and Shelby series), and colluvium and/or residuum (Martin series) on uplands. Udifluvents (Nodaway series) formed in alluvium on flood plains. Udorthents (Steinauer series) formed in till on uplands. Hapludalfs formed in loess on uplands and stream terraces (Yutan and Otoe series) and in till on uplands (Malmo series).

Biological Resources

This area supports grassland vegetation characterized by mid and tall grasses. Big bluestem, little bluestem, switchgrass, Indiangrass, porcupinegrass, and sideoats grama are the dominant species on silty soils in the uplands. Clayey soils in the uplands support a similar plant community but have a higher percentage of switchgrass and have some wildrye. Green ash, hackberry, oak, boxelder, black walnut, and maple trees grow along streams and intermittent drainageways.

Some of the major wildlife species in this area are white-tailed deer, raccoon, opossum, tree squirrel, pheasant, bobwhite quail, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 62%
Grassland—private, 22%; Federal, 1%
Forest—private, 6%
Urban development—private, 5%
Water—private, 2%
Other—private, 2%

Nearly all of this area is farmland, and about two-thirds is cropland. The cropland is more extensive on the less sloping soils that formed in loess than on other soils. Wheat and corn are important cash crops, but grain sorghum, soybeans, and alfalfa and other hay crops are grown on a large percentage of the area. Most of the grain and hay is fed to livestock on the farms where it is grown. About one-fourth of the area is used as pasture or range. Pastures of native grasses are more extensive on the strongly sloping to steep soils that formed in glacial till than on other soils. Pastures of introduced grasses and legumes are on the more productive soils, and native grasses are common on the more sloping, shallow soils. Native woodland is confined to narrow bands bordering drainageways and streams and to some nearly level, wet soils on bottom land.

The major soil resource concerns are water erosion and maintenance of the content of organic matter in the soils. The resource concerns on pasture and rangeland are plant productivity, health, and vigor; noxious and invasive plants; and inadequate wildlife habitat. Conservation practices on cropland generally include high-residue crops in the cropping system, systems of crop residue management (such as no-till, strip-till, and mulch-till systems), gradient terraces and grassed waterways, underground outlets, contour farming, conservation crop rotations, and nutrient and pest management. Conservation practices on rangeland and pasture generally include prescribed grazing, brush management, management of upland wildlife habitat, and proper distribution of watering facilities. ■

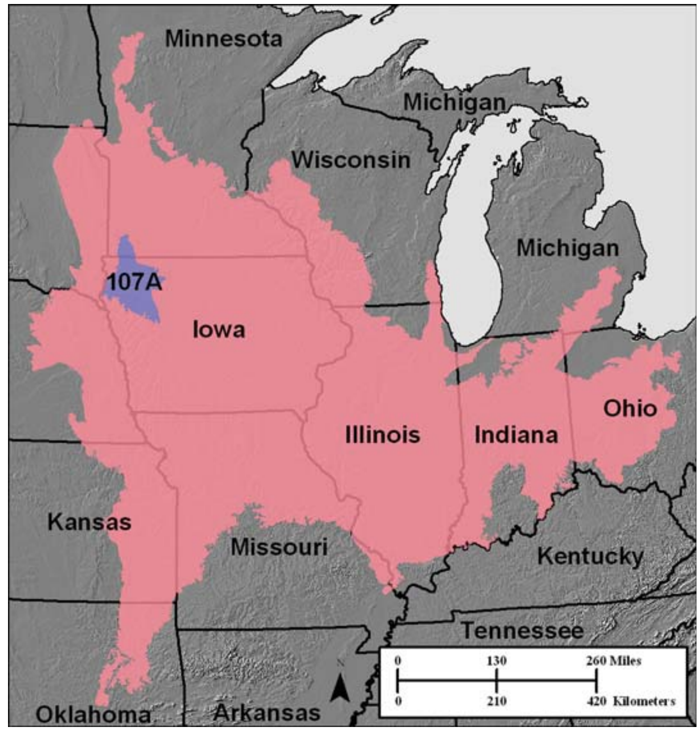

Figure 107A-1: Location of MLRA 107A in Land Resource Region M.

107A—Iowa and Minnesota Loess Hills

This area (shown in fig. 107A-1) is in Iowa (89 percent) and Minnesota (11 percent). It makes up about 4,470 square miles (11,590 square kilometers). The towns of Le Mars, Sioux Center, Cherokee, and Spencer, Iowa, and Adrian and Lismore, Minnesota, are in this MLRA. Interstate 90 passes through the northern part of the MLRA. The area has only a few State parks.

Physiography

This area is in the Central Lowland Province of the Interior Plains. The western half of the area is in the Dissected Till Plains Section of the province, and the eastern half is in the Western Lake Section. This MLRA is mostly an undulating to rolling glaciated plain with some nearly level, broad ridgetops and some steep slopes bordering the major stream valleys. Nearly level, broad valley floors are along a few large rivers. The natural drainage network is well established and commonly is described as dendritic, resulting in few lakes and ponds. Elevation ranges from 1,115 feet (340 meters) in the lowest valleys to 1,700 feet (520 meters) on the highest ridges. Local relief is mainly 10 to 100 feet (3 to 30 meters), but valley floors can be 80 to 200 feet (25 to 60 meters) below the adjacent uplands. Also, some upland flats and valley floors have local relief of only 3 to 6 feet (1 to 2 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Missouri-Little Sioux (1023), 74 percent; Missouri-Big Sioux (1017), 25 percent; and Des Moines (0710), 1 percent. The Rock River, a tributary of the Big Sioux River, and the Little Sioux and Floyd Rivers, tributaries of the Missouri River, drain this MLRA.

Geology

The western half of this MLRA is underlain by pre-Illinoian glacial till, which was deposited more than 500,000 years ago and has since undergone extensive erosion and dissection. The eastern half is underlain by the much younger Wisconsin-age till layer that was deposited between 20,000 and 30,000 years ago. Both till surfaces are covered by about 4 to 20 feet (1 to 6 meters) of loess on the hillslopes and by Holocene alluvium in the drainageways. The Quaternary deposits range from 150 to 450 feet (45 to 135 meters) in thickness and are underlain by Cretaceous bedrock consisting of sandstone and shale.

Climate

The average annual precipitation in this area is 26 to 31 inches (660 to 790 millimeters). Most of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. About 10 percent of the precipitation occurs as snow in the winter. The average annual temperature is 44 to 48 degrees F (7 to 9 degrees C). The freeze-free period averages about 165 days and ranges from 155 to 175 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 8.2%; ground water, 31.2%
Livestock—surface water, 3.6%; ground water, 57.0%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average 12 million gallons per day (45 million liters per day). About 88 percent is from ground water sources, and 12 percent is from surface water sources. Precipitation is the principal source of moisture for crops. Sediment, nutrients, and pesticides from agricultural activities impair the major streams and rivers in this area. The surface water, however, is still used for livestock and public supplies in some parts of the area.

Ground water is obtained from buried channel aquifers, glacial drift aquifers, and alluvial deposits of unconsolidated sand and gravel throughout most of this area. The glacial till is a poor source of ground water; yields to wells are small or negligible, and the water commonly is highly mineralized. The buried channels are sources of moderate or moderately large supplies of generally good-quality water. The mineral content of the water may be high if this aquifer is hydraulically connected to bedrock aquifers beneath it. Alluvial deposits are extensive along the Rock River in the part of this area in Minnesota. This aquifer can be a source of large supplies of generally good-quality water. It has water with a median level of 350 parts per million (milligrams per liter) total dissolved solids. The water in the shallow aquifers in Iowa has a median level of total dissolved solids of about 500 parts per million (milligrams per liter). The ground water in this MLRA is very hard and is used for domestic purposes, livestock, and public supply.

The Cretaceous-age Dakota Sandstone Formation is at a shallow or moderate depth in this area. It is tapped by many domestic and livestock wells. Not very many irrigation wells tap this aquifer. In areas where more shallow aquifers do not occur, a number of communities in northwestern Iowa obtain their public supplies from this aquifer. Locally, the base of the Dakota Formation contains beds of gravel from which moderately large yields of water can be obtained. The water in the aquifer in Iowa has a median level of total dissolved solids of 824 parts per million (milligrams per liter) and is very hard. Other bedrock formations in Iowa are very deep, and wells in these formations generally are not economical. Precambrian Sioux Quartzite is near the surface in the part of this area in Minnesota, and it contains good-quality water where it is not in contact with the Cretaceous sediments. Well yields vary dramatically, depending on how many interconnected joints and fractures are penetrated by the well.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. Hapludolls (Annieville, Everly, Galva, McCreath, Primghar, and Sac series) and Endoaquolls (Gillett Grove, Letri, and Marcus series) formed in loess or loess over till on uplands. Hapludolls (Moneta series) also formed in till on steeply sloping valley slopes, and Endoaquolls (Havelock series) also formed in alluvium on flood plains.

Biological Resources

Prairies in this area support tall grasses on moist soils and xeric short grasses on uplands. Grama, muhly, lovegrass, and wheatgrass commonly grow beside the more familiar little bluestem, big bluestem, Indiangrass, and wildrye. The prairie forbs in the area include fragrant false indigo, showy milkweed, woolly milkweed, western prairie fringed orchid, dotted blazing star, Maximilian sunflower, ground plum, and wild prairie onion. Wooded areas have become more extensive in this area, making up 1 percent of the current landscape as compared to 0.2 percent in the mid-1800s. Wooded areas on uplands commonly support bur oak, red oak, and hackberry. Those on bottom land support slippery elm, cottonwood, willow, and plum.

The wildlife species in this MLRA include Great Plains toad, bobcat, prairie rattlesnake, prairie skink, smooth green snake, pygmy shrew, and northern grasshopper mouse on the prairies and blue grosbeak, pine siskin, redbelly snake, and Woodhouse's toad in the wooded areas.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 84%
Grassland—private, 7%
Forest—private, 1%
Urban development—private, 4%
Water—private, 1%
Other—private, 3%

Nearly all of this area is farmland, and more than four-fifths is cropland, which is used mainly for corn, soybeans, other feed grains, and hay. Much of this area is drained by tile. Extensive drainage ditches provide outlets for the tile drains. The small acreage of woodland in the area is mainly on wet bottom land and on steep slopes bordering stream valleys.

The major resource concerns are water erosion, depletion of organic matter in the soils, and poor water quality. Many of the wet soils require artificial drainage for good growth of field crops. Conservation practices on cropland generally include systems of crop residue management (especially no-till, strip-till, and mulch-till systems), cover crops, subsurface drainage systems, nutrient and pest management, grassed waterways, terraces, manure management, pasture and hayland planting, and grade-stabilization structures. ■

107B—Iowa and Missouri Deep Loess Hills

This area (shown in fig. 107B-1) is in Iowa (53 percent), Missouri (32 percent), Nebraska (12 percent), and Kansas (3 percent). It makes up about 14,410 square miles (37,335 square kilometers). It includes the cities or towns of Atlantic, Council Bluffs, and Sioux City, Iowa; St. Joseph, Kansas City, Independence, and Marshall, Missouri; Atchison, Leavenworth, and Kansas City, Kansas; and Omaha, Nebraska. Interstates 29, 35, 70, and 80 cross different parts of this area. Fort Leavenworth Military Reservation and parts of the Winnebago and Omaha Indian Reservations are in this MLRA. A number of State parks are throughout the area, and a number of national wildlife refuges are in the area, especially along the Missouri River.

Physiography

This area is almost entirely in the Dissected Till Plains Section of the Central Lowland Province of the Interior Plains. The farthest southern part of the area in Missouri is in the Osage Plains Section of the same province and division. Slopes are mostly rolling to hilly, but some broad ridgetops are nearly level to undulating. Slopes bordering the major stream valleys are steep. Nearly level, broad valley floors are along a few large rivers. Elevation ranges from 600 feet (185 meters) where the Missouri River exits the area to 1,565 feet (475 meters) on the highest ridges. Local relief is mainly 10 to 100 feet (3 to 30 meters), but valley floors can be 80 to 300 feet (25 to 90 meters) below the adjacent uplands. Also, some upland flats and valley floors have local relief of only 3 to 6 feet (1 to 2 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Missouri-Nishnabotna (1024), 45 percent; Missouri-Little Sioux (1023), 33 percent; Lower Missouri (1030), 15 percent; Des Moines (0710), 2 percent; Platte (1020), 2 percent; Chariton-

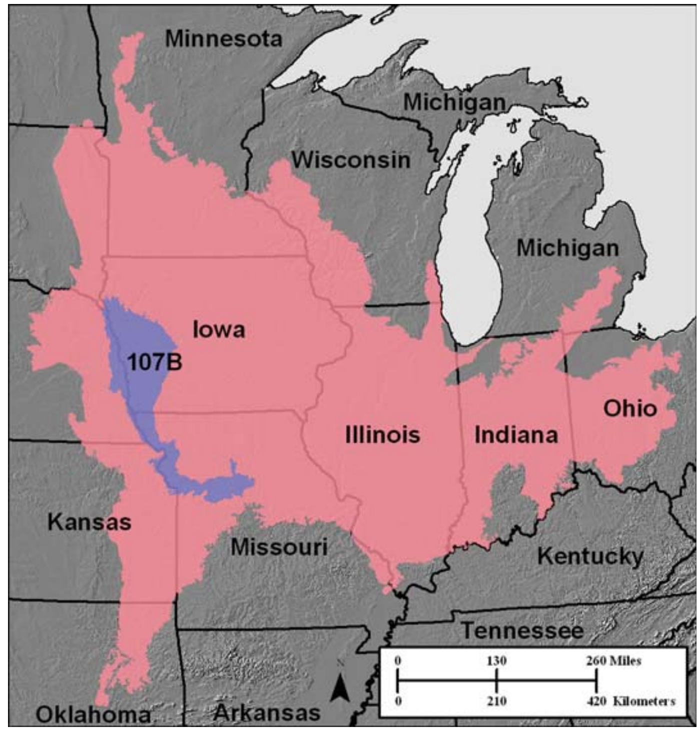

Figure 107B-1: Location of MLRA 107B in Land Resource Region M.

Grand (1028), 2 percent; and Missouri-Big Sioux (1017), 1 percent. A small part of the Kansas (1027) and Elkhorn (1022) Hydrologic Unit Areas also occur in this MLRA. The Missouri River forms the “centerline” of this MLRA. The major tributaries that join the Missouri River in this area include, from north to south, the Floyd, Little Sioux, Soldier, Boyer, Platte (Nebraska), Nishnabotna, Little Nemaha, Tarkio, Big Nemaha, Nodaway, Platte and Little Platte (Missouri), Kansas, Grand, and Thompson Rivers.

Geology

This area includes the Missouri Alluvial Plain, the Loess Hills, and part of the Southern Iowa Drift Plain landform regions of Iowa. Most of the area is overlain by loess deposits that reach a thickness of 65 to 200 feet (20 to 60 meters) in the Loess Hills and thin to about 20 feet (6 meters) in the eastern part of the area. The loess is underlain by pre-Illinoian till, which was deposited more than 500,000 years ago and has since undergone extensive erosion and dissection. In the Loess Hills, Holocene cycles of erosion and deposition, or “cut and fill,” have produced deeply incised gullies and fine grained alluvial deposits. The Quaternary overburden ranges from 150 to 450 feet (45 to 135 meters) in thickness throughout most of the area, but it is generally less than 150 feet (45 meters) thick in the southeastern part of the area. The glacial materials are underlain by Pennsylvanian and Cretaceous bedrock, which consists of shale, mudstones, and sandstones.

Climate

The average annual precipitation in this area is 26 to 41 inches (660 to 1,040 millimeters). Most of the rainfall occurs as convective thunderstorms during the growing season. About 10 percent of the precipitation occurs as snow in the winter. The average annual temperature is 46 to 56 degrees F (8 to 13 degrees C). The freeze-free period averages about 190 days and ranges from 155 to 220 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 5.1%; ground water, 1.8%
Livestock—surface water, 0.2%; ground water, 0.4%
Irrigation—surface water, 0.4%; ground water, 1.7%
Other—surface water, 89.1%; ground water, 1.3%

The total withdrawals average 4,210 million gallons per day (15,935 million liters per day). About 5 percent is from ground water sources, and 95 percent is from surface water sources. Sediment, nutrients, and pesticides from agricultural activities impair many of the major streams and rivers in this area (not including the Missouri River). The surface water is used mainly for cooling thermoelectric power plants along the Missouri River. The Missouri River also provides most of the municipal and industrial water for the major cities in the area. Other streams and rivers provide some surface water for livestock, irrigation, and public supplies in parts of the area.

The principal sources of ground water in the area are glacial drift, alluvial aquifers along the major streams, buried valley aquifers, the Dakota Sandstone, and Paleozoic rocks. Glacial drift aquifers supply many rural homeowners with domestic water. The buried channels are sources of moderate or moderately large supplies of generally good-quality water. The mineral content of the water may be high if this aquifer is hydraulically connected to bedrock aquifers beneath it. Alluvial deposits are extensive across the broad flood plain along the Missouri River. This aquifer is used for public supplies in Missouri. It has very hard water that contains a median level of 467 parts per million (milligrams per liter) total dissolved solids. The other shallow aquifers in Iowa have water very similar in quality to that in the Missouri River alluvium. They provide water for domestic use, livestock, some irrigation, and public supply.

The Cretaceous-age Dakota Sandstone is at a shallow or moderate depth in the northern half of this area. It is tapped by many domestic and livestock wells. A few irrigation wells tap this aquifer. In areas where more shallow aquifers do not occur, a number of communities obtain their public supplies from this aquifer. Locally, the base of the Dakota Sandstone has beds of gravel from which moderately large yields can be obtained. The median level of total dissolved solids in the aquifer in Iowa and Nebraska is 824 and 840 parts per million (milligrams per liter), respectively, and the water is very hard.

The Jordan aquifer is the most extensively used aquifer in Iowa. It consists of Ordovician-Cambrian sandstone and dolomite beds. Its water has a median level of total dissolved solids that exceeds 800 parts per million (milligrams per liter) and may contain levels of radium that exceed the national standards for drinking water. Some communities in the part of this area in Iowa depend on this aquifer for public supplies, even though the wells are very deep. Paleozoic units serve as aquifers in the parts of this area in southeastern Nebraska and northwestern Missouri. Water from these aquifers has a median level of total dissolved solids of 1,300 parts per million (milligrams per liter) in Nebraska. Many farmers and communities in Missouri have abandoned wells in these units because of high levels of dissolved salts.

Soils

The dominant soil orders in this MLRA are Mollisols and, to a lesser extent, Alfisols and Entisols. The soils in the area dominantly have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. They generally are very deep, well drained or moderately well drained, and silty or loamy. Well drained and moderately well drained, gently sloping to strongly sloping Hapludolls (Marshall and Monona series) formed on loess-mantled uplands. Well drained, strongly sloping Alfisols (Knox series) formed in loess. Well drained, strongly sloping Udorthents on side slopes (Steinauer series) and Argiudolls (Shelby series) formed in clay loam glacial till. Somewhat excessively drained and well drained, strongly sloping to very steep Udorthents (Hamburg and Ida series) on uplands formed in thick layers of loess bordering the Missouri River. Well drained and moderately well drained Udifluvents (Haynie and McPaul series) and Hapludolls (Keg, Kennebec, Napier, and Salix series), somewhat poorly drained or poorly drained Fluvaquents (Onawa and Albaton series), and poorly drained or very poorly drained Haplaquolls (Colo, Luton, and Wabash series) formed in alluvium on bottom land.

Biological Resources

Prairies in this area support tall grasses on moist soils and xeric short grasses on uplands. Within the prairies, grama, muhly, lovegrass, and wheatgrass commonly grow beside the more familiar little bluestem, big bluestem, Indiangrass, and wildrye. The most common forbs are eared milkweed, Missouri milkvetch, prairie tea, western prairie fringed orchid, yucca, Baldwin ironweed, painted cup, pale gentian, silky aster, and skeletonweed (in the loess hills).

The wooded areas on uplands commonly support red oak, white oak, hackberry, shagbark hickory, and bitternut hickory. The wooded areas on bottom land commonly support mulberry, sycamore, cottonwood, willow, elms, green ash, silver maple, and American elder.

The wildlife species in the prairies include barn and long-eared owls; broad-winged hawk; Leonard's, Pawnee, Ottoe, and dusted skippers; wild indigo and sleepy dusky wings; and zebra swallowtail, Great Plains toad, plains leopard frog, plains spadefoot, massasauga rattlesnake, prairie skink, ornate box turtle, six lined racerunner, bobcat, black-tailed jackrabbit, plains pocket mouse, and least shrew. The wildlife species in the wooded areas include blue grosbeak, great crested flycatcher, western meadowlark, western fox snake, western worm snake, and Woodhouse's toad. This area has 47 threatened or endangered species or species of special concern, including piping plover, blacknose and Topeka shiners, pallid sturgeon, least tern, small white lady's slipper, bog buckbean, yellow monkey flower, and spring ladies-tresses.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 69%
Grassland—private, 11%; Federal, 1%
Forest—private, 7%
Urban development—private, 8%
Water—private, 2%
Other—private, 2%

Historically, 92 percent of this MLRA was prairie. Forests made up 4 percent of the area; savannas, 2 percent; rivers and streams, 1 percent; wetlands, 1 percent; ponds and lakes, 0.2 percent; and shrub land, 0.2 percent. The increase in the forested acreage from 4 percent of the historic landscape to 7 percent of the current landscape occurred mainly on the loess hills, where the forested acreage increased significantly because of fire suppression.

Farms currently make up nearly all of this area. They produce cash and grain crops and livestock.

The major resource concerns are water erosion, depletion of organic matter in the soils, and poor water quality. Conservation practices on cropland generally include systems of crop residue management (especially no-till, strip-till, and mulch-till systems), cover crops, pest and nutrient management, grassed waterways, terraces, manure management, pasture and hayland planting, and grade-stabilization structures. ■

108A—Illinois and Iowa Deep Loess and Drift, Eastern Part

This area (shown in fig. 108A-1) is in Illinois (97 percent) and Indiana (3 percent). It makes up about 11,145 square miles (28,875 square kilometers). The cities of Decatur, Champaign,

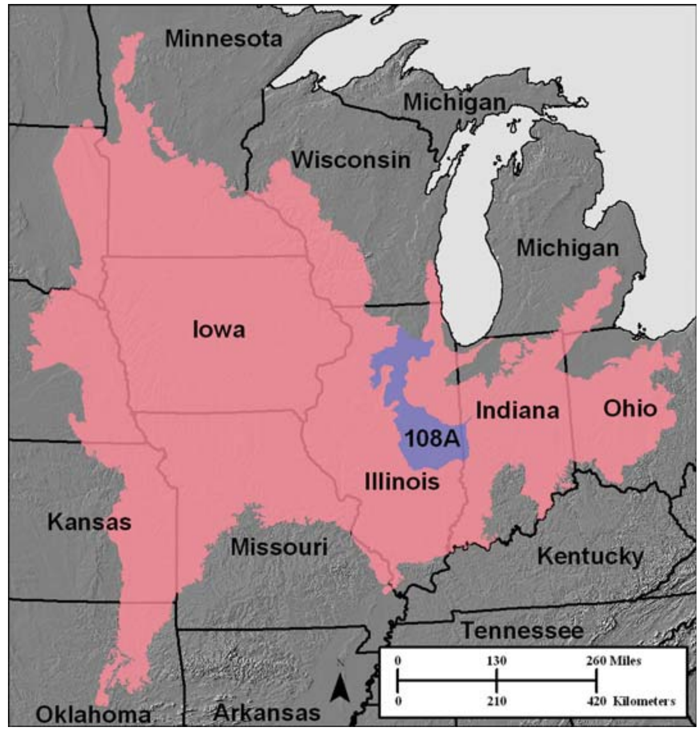

Figure 108A-1: Location of MLRA 108A in Land Resource Region M.

Urbana, Bloomington, and De Kalb, Illinois, are in this MLRA. Interstates 39, 55, and 57 cross the area, running north and south. Interstate 72 crosses the area from Champaign, through Decatur, and on to Springfield, Illinois. Interstate 74 connects Champaign-Urbana and Bloomington, and Interstate 80 crosses the northern end of the area. The numerous State parks in the MLRA include Moraine Hills in the northern part of the area and Moraine View in the southern part. The National Accelerator Laboratory and Chanute Air Force Base are Federal installations in the MLRA.

Physiography

Almost all of this area is on the glaciated Bloomington Ridged Plain in the Till Plains Section of the Central Lowland Province of the Interior Plains. The northern tip is in the Eastern Lake Section of the same province and division. The area is a relatively young, moderately dissected, rolling plain with stream terraces adjacent to the broad flood plains along the major streams and rivers. Glacial moraines are numerous in the area and tend to form elongated ridges tending from northwest to southeast. Slopes are generally less than 5 percent but are significantly steeper on the moraines and along the major streams. Elevation ranges from 660 feet (200 meters) in the southern part of the area to about 985 feet (300 meters) in the northern part. The maximum local relief is about 160 feet (50 meters) along the major streams. Relief is considerably lower, however, in most of the area. It typically is only 3 to 10 feet (1 to 3 meters) on the broad, flat uplands.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Illinois (0713), 46 percent; Wabash (0512), 26 percent; Upper Illinois (0712), 13 percent; Upper Mississippi-Kaskaskia-Meramec (0714), 10 percent; and Rock (0709), 5 percent. The Illinois, Rock, and Wabash Rivers drain this MLRA.

Geology

This area is underlain by Pennsylvanian shale, siltstone, and limestone in the southern part and Ordovician and Silurian limestone in the extreme northern part. Glacial drift covers all of the MLRA, except for some areas along the major streams where the underlying bedrock is exposed. The glacial drift is Wisconsin in age and consists of distinct till units as well as sorted, stratified outwash. The entire area has been covered by a moderately thin or thick layer of loess. In a few areas the loess directly overlies the bedrock.

Climate

The average annual precipitation in this area is 35 to 43 inches (890 to 1,090 millimeters). Two-thirds or more of the precipitation falls as convective thunderstorms during the freeze-free period. In winter, precipitation is low and occurs mostly as snow. The average annual temperature is 47 to 54 degrees F (8 to 12 degrees C). The freeze-free period averages about 195 days and ranges from 175 to 210 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 50.0%; ground water, 15.9%
Livestock—surface water, 0.1%; ground water, 6.8%
Irrigation—surface water, 0.0%; ground water, 3.9%
Other—surface water, 19.3%; ground water, 3.9%

The total withdrawals average 260 million gallons per day (985 million liters per day). About 31 percent is from ground water sources, and 69 percent is from surface water sources. In most years lack of moisture is not a problem for agricultural production. Numerous large rivers provide surface water for livestock, irrigation, industry, and public supplies in the area. Some water for livestock is stored in small ponds and reservoirs. The surface water is of fair or good quality and is suitable for most uses. Sediment, nutrients, and pesticides from agricultural activities and wastewater discharges from cities can contaminate the surface water in the area.

The principal sources of ground water in the area are glacial drift, the Sand-and-Gravel aquifer, alluvial aquifers along the major streams, and Paleozoic bedrock. Glacial drift aquifers supply many rural homeowners with domestic water, but this water typically has high levels of iron. The iron is not dangerous to public health, but it causes esthetic problems of iron stains and scale. Alluvial deposits provide water for domestic use and livestock. The water in these deposits is similar in quality to the surface water and is suitable for most uses. The shallow Sand-and-Gravel aquifer is extensive throughout Illinois. It typically consists of glacial outwash deposits within the drift. The water in this aquifer is very hard and may have very high levels of iron. The median level of total dissolved solids is very near the national secondary drinking water standard of 500 parts per million (milligrams per liter). This aquifer provides water for domestic use, livestock, irrigation, and public and municipal supply.

Paleozoic bedrock aquifers are not utilized very much in this area. The Pennsylvanian-Mississippian aquifer underlies the lower three-fourths of the area. Well yields from this aquifer are generally low, so the aquifer is not used extensively. The water is extremely variable in quality. It is generally more heavily mineralized than the water in the surficial aquifers, and it has high levels of iron. The Shallow Dolomite aquifer occurs only in the extreme northern part of this area. The water in this aquifer is similar in quality to the water in the Pennsylvanian-Mississippian aquifer and is not used unless no other aquifer is available. The Cambrian-Ordovician aquifer underlies the northern quarter of this MLRA. This aquifer is used extensively in the northern third of Illinois. Its water is of good quality and is suitable for almost all uses. Wells can penetrate the St. Peter Sandstone in the upper part of this unit or the deeper Ironton-Galesville layer. The median level of total dissolved solids is typically less than the national secondary drinking water standard of 500 parts per million (milligrams per liter), and iron levels are much lower than those in the water from the other bedrock aquifers.

Soils

The dominant soil orders in this MLRA are Mollisols and Alfisols. Most of the soils are Udolls or Aquolls. The soils in the area have a mesic soil temperature regime, an aquic or udic soil moisture regime, and dominantly mixed mineralogy. They generally are moderately deep to very deep, poorly drained to moderately well drained, and silty or clayey. Nearly level Endoaquolls (Drummer series) and gently sloping to sloping Argiudolls (Saybrook and Catlin series) formed in loess over loamy till on uplands. Hapludalfs commonly occur along the major stream valleys. They are on the gently sloping to moderately sloping uplands (Birkbeck and Mayville series) or on the steep or very steep valley bluffs (Strawn series).

Argiudolls (Plano and Warsaw series) and Hapludalfs (St. Charles and Fox series) are on gently sloping to sloping stream terraces along the major streams and on broad outwash plains. Cumulic Endoaquolls (Sawmill series) and Cumulic Hapludolls (Lawson and Huntsville series) formed in alluvium on nearly level, broad flood plains and in the smaller upland drainageways.

Biological Resources

This area originally supported prairie vegetation with hardwood forests on scattered upland sites. The areas of tall prairie grasses are characterized by big bluestem, Indiangrass, prairie dropseed, and switchgrass. White oak, shingle oak, black oak, hickory, white ash, basswood, sugar maple, and walnut grow on the better drained soils. Silver maple, black willow, cottonwood, and sycamore grow on flood plains.

Some of the major wildlife species in this area are white-tailed deer, coyote, turkey, red fox, beaver, raccoon, skunk, muskrat, opossum, cottontail rabbit, fox squirrel, Canada goose, red-tailed hawk, great horned owl, blue heron, wood duck, mallard duck, redheaded woodpecker, and ring-necked pheasant. Fishing is limited mostly to constructed impoundments and rivers. The species of fish in the area include largemouth bass, carp, catfish, bluegill, crappie, and sunfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 80%
Grassland—private, 3%; Federal, 1%
Forest—private, 5%
Urban development—private, 8%
Water—private, 1%
Other—private, 2%

Most of this area is in privately owned farms, which produce mainly cash-grain crops and livestock. About 80 percent of the area is cropland, and nearly 5 percent supports introduced and native grasses. The less sloping soils are used for dry-farmed corn for grain and silage and for soybeans. Some small grains, such as winter wheat, also are grown in the area. A few areas on broad outwash plains are irrigated and are used primarily for high-value specialty crops. The forested areas in this MLRA are mainly along the major streams.

The major resource concerns are wind erosion, water erosion, and maintenance of the content of organic matter and productivity of the soils. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems), cover crops, windbreaks, vegetative wind barriers, and nutrient management. ■

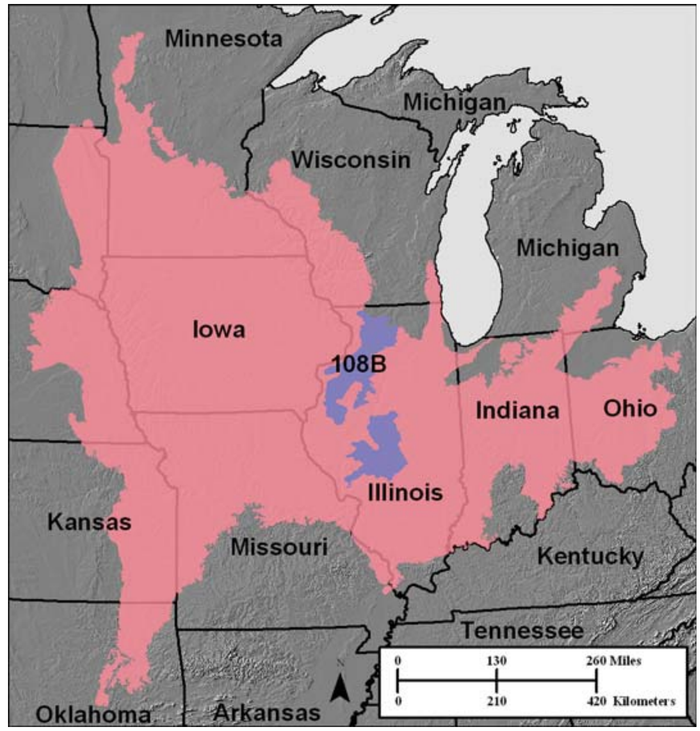

Figure 108B-1: Location of MLRA 108B in Land Resource Region M.

108B—Illinois and Iowa Deep Loess and Drift, East-Central Part

This area is entirely in Illinois (fig. 108B-1). It makes up about 7,450 square miles (19,300 square kilometers). It is in two parts separated by MLRA 115C (Central Mississippi Valley Wooded Slopes, Northern Part). Two-thirds of the area is in northwestern Illinois, and one-third is in central Illinois. The towns of Kewanee and Galesburg are in the western part of the area, and the towns of Macomb, Jacksonville, and Springfield are in the eastern part. Interstates 74, 80, and 88 cross the northern part of the area.

Physiography

This area is in the Till Plains Section of the Central Lowland Province of the Interior Plains. The eastern part of the area, on the east side of the Illinois River, is on the glaciated Springfield Plain. The western part is dominantly on the Galesburg Plain. The northern part of this western area also encompasses the Green River Lowland and the Rock River Hill Country. The entire MLRA was glaciated and has deposits of loess of various thickness. The area is on a relatively young, moderately dissected to strongly dissected, rolling plain where stream terraces are adjacent to broad flood plains along the major streams and rivers. Slopes are generally less than 15 percent but are significantly steeper in some areas along the major streams. Elevation ranges from 660 feet (200 meters) in the eastern and southern parts of the area to about 985 feet (300 meters) in the western and northern parts. The maximum local relief is about 160 feet (50 meters) along the major streams and along the dissected drainageways fingering into the uplands. Relief is considerably lower in much of the area. It typically is only 3 to 10 feet (1 to 3 meters) on the broad, flat uplands.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Illinois (0713), 42 percent; Rock (0709), 35 percent; Upper Mississippi-Iowa-Skunk-Wapsipinicon (0708), 22 percent; and Upper Mississippi-Maquoketa-Plum (0706), 1 percent. The Illinois, Rock, and Mississippi Rivers drain the MLRA.

Geology

This area is underlain by Pennsylvanian shales, siltstones, and limestones in the southern and western parts and Ordovician and Silurian limestone in the extreme northern part. Coal beds occur in the northern part and east of the Illinois River. Glacial drift covers the entire area, except for the bluffs along the major streams, where the underlying bedrock can be exposed. The glacial till is Illinoian in age and consists of distinct till units as well as sorted, stratified outwash of Wisconsin age. The entire area has been covered by a thick or moderately thin layer of Wisconsin loess. In a few areas the loess directly overlies the bedrock.

Climate

The average annual precipitation in this area is 33 to 39 inches (840 to 990 millimeters). Two-thirds or more of the precipitation occurs as convective thunderstorms during the growing season. In winter, precipitation is low and occurs mostly as snow. The average annual temperature is 47 to 54 degrees F (8 to 12 degrees C). The freeze-free period averages about 185 days and ranges from 165 to 210 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 46.8%; ground water, 16.5%
Livestock—surface water, 0.1%; ground water, 4.1%
Irrigation—surface water, 0.5%; ground water, 7.2%
Other—surface water, 20.6%; ground water, 4.2%

The total withdrawals average 240 million gallons per day (910 million liters per day). About 32 percent is from ground water sources, and 68 percent is from surface water sources. In most years lack of moisture is not a problem for agricultural production. Numerous large rivers provide surface water for livestock, irrigation, industry, and public supplies in this area. Water-supply reservoirs are common in the eastern part of the area. Some water for livestock is stored in small ponds and reservoirs. The surface water is of fair or good quality and is suitable for most uses. Sediment, nutrients, and pesticides from agricultural activities and wastewater discharges from cities can contaminate the water.

The principal sources of ground water in this area are glacial drift, the Sand-and-Gravel aquifer, alluvial aquifers along the major streams, and Paleozoic bedrock. Glacial drift aquifers supply many rural homeowners with domestic water that has high levels of iron. The iron is not dangerous to public health, but it causes esthetic problems of iron stains and scale. Alluvial deposits provide water for domestic use and livestock. The water in these deposits is similar in quality to the surface water and is suitable for most uses. The shallow Sand-and-Gravel aquifer is extensive throughout the State. It typically consists of glacial outwash deposits within the drift. Water in this aquifer is very hard and may have very high levels of iron. The median level of total dissolved solids is very near the national secondary drinking water standard of 500 parts per million (milligrams per liter). This aquifer provides water for domestic use, livestock, irrigation, and public and municipal supply.

Paleozoic bedrock aquifers are not utilized very much in this area. The Pennsylvanian-Mississippian aquifer underlies all of the eastern part of the area and the southern two-thirds of the western part. Well yields from this aquifer are generally low, so the aquifer is not used extensively. The water in this aquifer is extremely variable in quality. It is generally more heavily mineralized than the water in the surficial aquifers, and it has high levels of iron. The Shallow Dolomite aquifer occurs only in the northern one-third of the western part of this area. Its water is similar in quality to the water in the Pennsylvanian-Mississippian aquifer, and it is not used unless no other aquifer is available. The Cambrian-Ordovician aquifer occurs only north of the Shallow Dolomite aquifer in the western part of this MLRA. This aquifer is used extensively in the northern third of Illinois. Its water is of good quality and is suitable for almost all uses. Wells can penetrate the St. Peter Sandstone in the upper part of this unit or the deeper Ironton-Galesville layer. The median level of total dissolved solids is typically less than the national secondary drinking water standard of 500 parts per million (milligrams per liter), and iron levels are much lower than those in the water from the other bedrock aquifers.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Inceptisols, and Mollisols. Most of the soils are Udolls or Udalfs. Aquolls are in the flatter interfluve areas. The soils in the area have a mesic soil temperature regime, an aquic or udic soil moisture regime, and dominantly mixed mineralogy. They generally are moderately deep to very deep, somewhat poorly drained to well drained, and silty or clayey. Nearly level Endoaquolls (Sable series) and depressional to nearly level Albaqualfs (Rushville and Denny series) occur on broad interfluves. Gently sloping to sloping Argiudolls (Tama and Ipava series) formed in thick deposits of loess on uplands. Some Hapludalfs (Fayette, Elco, and Hickory series) formed in loess that is deep to loamy till or a paleosol. They are along the major streams and in dissected upland drainageways. Other Hapludalfs (Marseilles series) formed in loess and bedrock residuum in major stream valleys. Argiudolls (Plano and Warsaw series) and Hapludalfs (St. Charles and Fox series) are on gently sloping to sloping terraces along the major streams. Endoaquolls (Sawmill and Otter series) and Hapludolls (Lawson, Huntsville, and Ross series) formed in alluvium on nearly level, broad flood plains. Fluvaquents (Wakeland series) and Udifluvents (Orion series) are along the much smaller upland drainageways.

Biological Resources

This area originally supported prairie vegetation with hardwood forests on scattered upland sites. The areas of tall prairie grasses are characterized by big bluestem, Indiangrass, prairie dropseed, and switchgrass. White oak, shingle oak, black oak, hickory, white ash, basswood, sugar maple, and walnut grow on the better drained soils. Silver maple, black willow, cottonwood, and sycamore grow on flood plains.

Some of the major wildlife species in this area are white-tailed deer, coyote, turkey, red fox, beaver, raccoon, skunk, muskrat, opossum, cottontail rabbit, fox squirrel, Canada goose, red-tailed hawk, great horned owl, blue heron, wood duck, mallard duck, redheaded woodpecker, and quail. Fishing is limited mostly to constructed impoundments and rivers. The species of fish in the area include largemouth bass, carp, catfish, bluegill, crappie, and sunfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 79%
Grassland—private, 7%
Forest—private, 5%
Urban development—private, 6%
Water—private, 1%
Other—private, 2%

Most of this area is in privately owned farms. Almost 80 percent of the area is cropland. Cash-grain crops are dominant, but hay and pasture crops also are grown for the livestock produced in the area. The less sloping soils are used for dry-farmed corn for grain and silage and for soybeans. Some small grains, such as winter wheat and oats, are also grown in the area. A few areas on broad stream terraces and outwash plains are irrigated. About 7 percent of the area supports introduced and native grasses. Although not occupying an overall large acreage, surface-mined areas that have been or are being reclaimed occur in the northern part of the MLRA and active underground coal-mining areas occur in the part of the MLRA on the east side of the Illinois River.

The major resource concerns are wind erosion, water erosion, and maintenance of the content of organic matter and productivity of the soils. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems), cover crops, windbreaks, vegetative wind barriers, and nutrient management. ■

108C—Illinois and Iowa Deep Loess and Drift, West-Central Part

This area is entirely in Iowa (fig. 108C-1). It makes up about 9,805 square miles (25,405 square kilometers). The towns of Newton, Oskaloosa, Pella, Marshalltown, Iowa City, and Washington are in this MLRA. Interstate 80 crosses the center of the MLRA from east to west. This area includes many State parks and the Sac and Fox and Mesquakie Indian Reservations.

Physiography

This area is in the Dissected Till Plains Section of the Central Lowland Province of the Interior Plains. Locally, it is within a landform region called the Southern Iowa Drift Plain. As the section name implies, this area is a dissected till plain. Slopes are mostly rolling to hilly, but some broad ridgetops are nearly level to undulating and areas bordering the major stream valleys are steep. A few large rivers have nearly level, broad valley floors. Elevation ranges from 505 feet (155 meters) in the lowest valleys to 1,110 feet (340 meters) on the highest ridges. Local relief is mainly 10 to 20 feet (3 to 6 meters), but valley floors can be 80 to 200 feet (25 to 60 meters) below the adjacent uplands. Also, some upland flats and valley floors have local relief of only 3 to 6 feet (1 to 2 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Mississippi-Iowa-Skunk-Wapsipinicon (0708), 95 percent, and Des Moines (0710), 5 percent. The Des Moines, Skunk, Iowa, and Cedar Rivers cross this area. These watersheds have more than 10,600 miles of streams and associated wetlands that drain to the Mississippi River.

Geology

This area is underlain by dense pre-Illinoian till, which was deposited more than 500,000 years ago and has since undergone extensive erosion and dissection. The till surface is covered by a mantle of Peoria Loess on the hillslopes and by

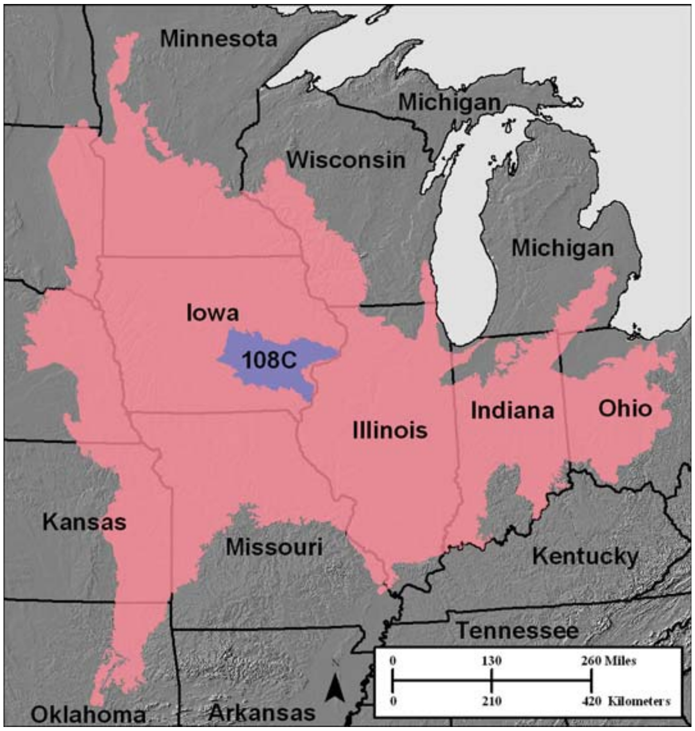

Figure 108C-1: Location of MLRA 108C in Land Resource Region M.

Holocene alluvium (DeForest Formation) in the drainageways. The till is generally less than 150 feet (45 meters) thick in the southern half of the area but ranges from 150 to 350 feet (45 to 105 meters) in thickness in the northern half. It is underlain by Paleozoic bedrock consisting dominantly of limestone, shale, and mudstones. The bedrock includes dolomite in the northeastern part of the area.

Climate

The average annual precipitation in this area is 33 to 38 inches (840 to 965 millimeters). Most of the rainfall occurs as convective thunderstorms during the growing season. About 10 inches (25 centimeters) of the precipitation occurs as snow in the winter. The average annual temperature is 46 to 51 degrees F (8 to 11 degrees C). The freeze-free period averages about 185 days and ranges from 170 to 205 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 4.8%; ground water, 45.3%
Livestock—surface water, 4.2%; ground water, 17.1%
Irrigation—surface water, 0.0%; ground water, 0.5%
Other—surface water, 1.1%; ground water, 27.0%

The total withdrawals average 90 million gallons per day (340 million liters per day). About 90 percent is from ground water sources, and 10 percent is from surface water sources. In most years lack of water is not a problem for agricultural production. Large rivers provide some surface water for livestock, irrigation, industry, and public supplies. The Coralville Reservoir provides municipal and industrial water to areas along the Iowa River. Some water for livestock is stored in small ponds and reservoirs. The surface water is of fair quality and is suitable for most uses with treatment. Contamination from sediment, nutrients, and pesticides from agricultural activities and wastewater discharges from cities cause some water-quality problems.

Good-quality ground water is abundant in this area. The principal sources of ground water in the area are glacial drift aquifers, buried channel aquifers, alluvial aquifers, and Paleozoic bedrock. Glacial drift aquifers supply many rural homeowners with small quantities of domestic water and some livestock water. Alluvial deposits provide much greater quantities of water for domestic use, livestock, public supply, and some limited irrigation. Buried channels typically consist of glacial outwash deposits that filled preglacial valleys and then were covered by glacial drift. Large quantities of water can be obtained from this aquifer in the limited areas where it occurs. This aquifer can provide water for domestic use, livestock, irrigation, and some public and municipal supply. All of these surficial aquifers have good-quality water. The water is very hard, but the median level of total dissolved solids is very near the national secondary drinking water standard of 500 parts per million (milligrams per liter).

Paleozoic bedrock aquifers are heavily utilized in this area. The Silurian-Devonian aquifer underlies the northern half of the area, the Mississippian aquifer underlies the southern half, and the Jordan aquifer underlies all of the area. The Jordan aquifer is the most extensively used aquifer in Iowa. It consists of sandstone and dolomite of Ordovician and Cambrian age. Well yields from this aquifer are very high. The water from this aquifer is suitable for most uses, but the median level of total dissolved solids typically exceeds 800 parts per million (milligrams per liter) and radium-226 levels can exceed the national standard for drinking water. The Silurian-Devonian aquifer consists of limestone and dolomite. It is close to the surface in this area, and it has the best water quality of all the principal aquifers in Iowa. Where this aquifer is buried by younger bedrock deposits, its use is limited by the level of total dissolved solids and naturally high levels of sulfate. The Mississippian aquifer consists of limestone and dolomite that is very close to the surface in this area. Its water quality is between that of the other two bedrock aquifers. In some areas it has very high levels of total dissolved solids and thus cannot be used. Wells in this aquifer produce low yields, so the aquifer is not used unless no other water sources are available. Water from the Jordan and Silurian-Devonian aquifers is used for domestic purposes, livestock, irrigation, public and municipal supply, and industry.

Soils

The dominant soil orders in this MLRA are Mollisols and, to a lesser extent, Alfisols, Entisols, and Inceptisols. Most of the soils are Udolls or Udalfs. Some Aquolls are on the flatter interfluves and on nearly level, broad valley floors. The soils in the area dominantly have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. They generally are very deep, well drained to poorly drained, and silty, loamy, or clayey. The soils on uplands include somewhat poorly drained, nearly level Argiudolls (Mahaska series) and Hapludolls (Muscatine series); moderately well drained, gently sloping to strongly sloping Argiudolls (Otley series); well drained or moderately well drained, moderately sloping to strongly sloping Eutrudepts (Killduff series); poorly drained, nearly level Endoaquolls (Garwin series) and Argiaquolls (Taintor series); well drained or moderately well drained, gently sloping to strongly sloping Argiudolls (Tama and Dinsdale series); and well drained, strongly sloping to steep Hapludalfs (Fayette, Downs, Ladoga, Armstrong, and Clinton series). Somewhat poorly drained Hapludolls (Lawson series) and moderately well drained Udifluvents (Nodaway series) formed in silty alluvium on flood plains. Poorly drained Endoaquolls (Colo and Zook series) formed in clayey alluvium on flood plains.

Biological Resources

Prairies in this area are dominated by tall grasses. Xeric mid and short grasses occur on steep slopes, ridges, and sandy soils. Grama, muhly, lovegrass, dropseed, wild rice, threeawn, and wheatgrass may occur in the prairies, along with the dominant bluestems, Indiangrass, switchgrass, prairie cordgrass, and wildrye. The forbs in the area include pale and round-stemmed false foxgloves, Virginia snakeroot, golden corydalis, kittentails, shooting star, foxglove penstemon, cleft phlox, eastern and western prairie fringed orchid, blackeyed Susan, sneezeweed, puccoon, wild geranium, slender mountain mint, and bottle gentian. Wooded areas on uplands commonly support red oak, white oak, hackberry, and shagbark, mockernut, butternut, and bitternut hickories. Wooded areas on bottom land commonly support swamp white oak, pin oak, river birch, sycamore, cottonwood, willow, redbud, white ash, green ash, silver maple, and American elder.

The wildlife species on the prairies in this area include plains leopard frog, tiger salamander, ornate box turtle, six-lined racerunner, slender glass lizard, smooth green snake, bull snake, western hognose, prairie king snake, massasauga rattlesnake, long-eared owl, northern harrier, wild indigo dusky wing, Baltimore checkerspot, regal fritillary, plains pocket mouse, spotted skunk, and bald eagle. The wildlife species in the wooded areas include the great-crested flycatcher, prothonitary warbler, ovenbird, Acadian flycatcher, scarlet tanager, Indiana bat, western fox snake, western worm snake, and Fowler's toad. This MLRA has 91 threatened or endangered species or species of special concern. The watersheds in the area provide habitat for many rare and declining species, such as the least tern, piping plover, lake sturgeon, pirate perch, blacknose and Topeka shiners, pallid sturgeon, grass pickerel, bluntnose darter, pugnose minnow, freckled madtom, sheepnose, round pigtoe, spectacle case, yellow sandshell, strange floater, pistol grip, central newt, Blanding's turtle, yellow mud turtle, and common musk turtle.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 76%
Grassland—private, 9%; Federal, 1%
Forest—private, 6%
Urban development—private, 5%
Water—private, 1%
Other—private, 2%

In the mid-1800s, about 75 percent of this area was prairie. Forests made up 18.5 percent of the area; savannas, 5 percent; shrub lands, 1 percent; wetlands, 0.4 percent; and streams, 0.1 percent.

Farms currently make up nearly all of this area. They produce cash crops, grain crops, and livestock.

The major resource concerns are water erosion, depletion of organic matter in the soils, and poor water quality. Conservation practices on cropland generally include systems of crop residue management (especially no-till, strip-till, and mulch-till systems), cover crops, pest and nutrient management, grassed waterways, terraces, manure management, pasture and hayland planting, and grade-stabilization structures. ■

108D—Illinois and Iowa Deep Loess and Drift, Western Part

This area (shown in fig. 108D-1) is in Iowa (82 percent) and Missouri (18 percent). It makes up about 5,480 square miles (14,195 square kilometers). It includes the towns of Clarinda, Creston, and Indianola, Iowa; the southern part of the city of Des Moines, Iowa; and the town of Maryville, Missouri. Interstate 35 crosses the eastern part of the area from north to south, and Interstate 80 crosses the northern end of the area.

Physiography

This area is in the Dissected Till Plains Section of the Central Lowland Province of the Interior Plains. The area is in a

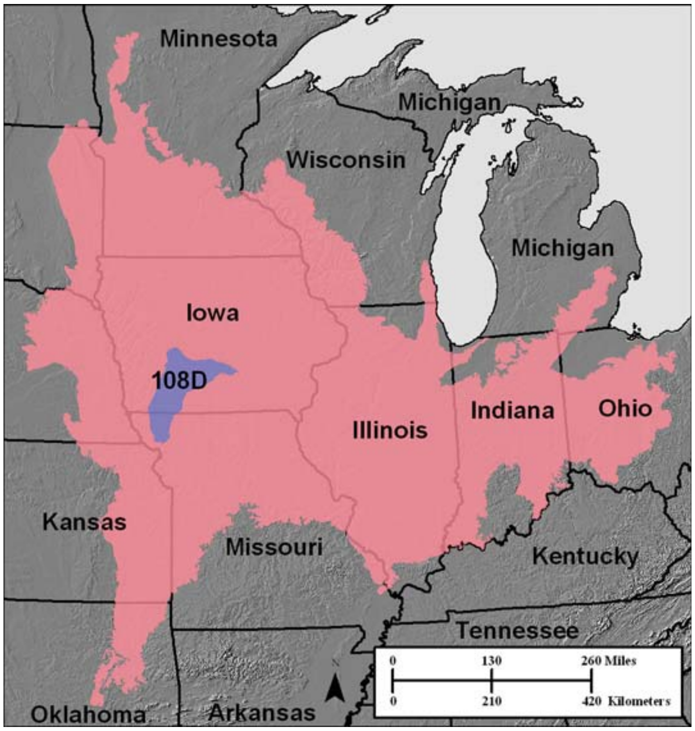

Figure 108D-1: Location of MLRA 108D in Land Resource Region M.

landform region locally called the Southern Iowa Drift Plain. Slopes are mostly rolling to hilly, but some broad ridgetops are nearly level to undulating and areas bordering the major stream valleys are steep. Nearly level, broad valley floors are along a few large rivers. Elevation ranges from 690 feet (210 meters) in the lowest valleys to 1,510 feet (460 meters) on the highest ridges. Local relief is mainly 10 to 20 feet (3 to 6 meters), but valley floors can be 80 to 200 feet (25 to 60 meters) below the adjacent uplands. Also, some upland flats and valley floors have local relief of only 3 to 6 feet (1 to 2 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Missouri-Nishnabotna (1024), 54 percent; Des Moines (0710), 37 percent; and Chariton-Grand (1028), 9 percent. The Raccoon and Des Moines Rivers empty into the Mississippi River to the southeast of this area, and the Platte and Nodaway Rivers empty into the Missouri River to the southwest of the area. The Tarkio-Wolf, West Nodaway, Nodaway, One-Hundred and Two, and Platte watersheds and parts of the Lake Red Rock and Thompson watersheds have more than 6,700 miles of streams and associated wetlands in this area.

Geology

This MLRA is underlain by dense pre-Illinoian till, which was deposited more than 500,000 years ago and has since undergone extensive erosion and dissection. A mantle of silt (Peoria Loess) covers the till surface on the hillslopes, and Holocene alluvium (DeForest Formation) is typically in stream valleys. The till is generally less than 150 feet (45 meters) thick in the northern and southwestern parts of the area and ranges from 150 to 350 feet (45 to 105 meters) in thickness in the rest of the area. It is underlain mainly by Pennsylvanian bedrock consisting dominantly of shale and mudstones.

Climate

The average annual precipitation in this area is 33 to 37 inches (840 to 940 millimeters). Most of the rainfall occurs as convective thunderstorms during the growing season. About 10 inches (25 centimeters) of the precipitation occurs as snow in the winter. The average annual temperature is 48 to 52 degrees F (9 to 11 degrees C). The freeze-free period averages about 185 days and ranges from 175 to 200 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 13.1%; ground water, 15.6%
Livestock—surface water, 2.4%; ground water, 10.3%
Irrigation—surface water, 0.1%; ground water, 0.0%
Other—surface water, 53.0%; ground water, 5.5%

The total withdrawals average 71 million gallons per day (270 million liters per day). About 31 percent is from ground water sources, and 69 percent is from surface water sources. In most years lack of moisture is not a problem for agricultural production. Large rivers provide surface water for livestock, industry, and public supplies in the area. Some water for livestock is stored in small ponds and reservoirs. The surface water is of fair quality and is suitable for most uses with treatment. Contamination from sediment, nutrients, and pesticides from agricultural activities and wastewater discharges from cities cause some water-quality problems.

The principal sources of ground water in the area are glacial drift aquifers, buried channel aquifers, and alluvial aquifers. Glacial drift aquifers supply many rural homeowners with small quantities of domestic water and some livestock water. Alluvial deposits provide much greater quantities of water for domestic use, livestock, and some public supply. Buried channels typically consist of glacial outwash deposits that filled preglacial valleys and then were covered by glacial drift. Large quantities of water can be obtained from this aquifer in the limited areas where the aquifer occurs. This aquifer can provide water for domestic use, livestock, and some public and municipal supply. All of these surficial aquifers have good-quality water. The water is very hard, but the median level of total dissolved solids is very near the national secondary drinking water standard of 500 parts per million (milligrams per liter).

Paleozoic bedrock aquifers are not utilized very much in this area. The Dakota aquifer underlies the northwestern part of the area, and the Jordan aquifer underlies all of the area. The Jordan aquifer is the most extensively used aquifer in Iowa. It consists of sandstone and dolomite of Ordovician and Cambrian age. Well yields from this aquifer are very high, and the water is suitable for most uses. The median level of total dissolved solids, however, typically exceeds 800 parts per million (milligrams per liter), and radium-226 levels can exceed the national standard for drinking water. The Dakota aquifer consists of Cretaceous-age sandstone. It is close to the surface in this area, and its water is very similar in quality to the water in the Jordan aquifer. Some communities and rural homeowners utilize these bedrock aquifers for drinking water where no other aquifers are available. The water from the Jordan and Dakota aquifers is used for domestic purposes, livestock, and some public and municipal supply and industry.

Soils

The dominant soil orders in this MLRA are Mollisols and Alfisols and, to a lesser extent, Entisols. Most of the soils are Udolls or Udalfs. Aquolls are on the flatter interfluves. The soils in the area dominantly have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. They generally are very deep, well drained to poorly drained, and silty, loamy, or clayey. The soils on uplands include somewhat poorly drained, nearly level Argiudolls (Macksburg series); moderately well drained, gently sloping to strongly sloping Argiudolls (Sharpsburg and Exira series); poorly drained, nearly level Argiaquolls (Winterset and Taintor series); and well drained, strongly sloping to steep Hapludalfs (Gara, Lindley, Ladoga, Armstrong, Keswick, and Clinton series). Somewhat poorly drained Hapludolls (Lawson series) and moderately well drained Udifluvents (Nodaway series) formed in silty alluvium on flood plains. Poorly drained Endoaquolls (Colo and Zook series) formed in clayey alluvium on flood plains.

Biological Resources

Prairies in this area support tall grasses on moist soils and xeric short grasses on uplands. In the prairies, grama, muhly, lovegrass, and bentgrasses commonly grow beside the more familiar grasses, such as little bluestem, big bluestem, Indiangrass, and wildrye. The forbs growing in the area include Mead’s milkweed, fragrant false indigo, showy lady’s slipper, western prairie fringed orchid, Virginia spiderwort, scaly blazing star, Baldwin ironweed, and slender mountain mint.

Forests on uplands commonly support red oak, white oak, bur oak, chinkapin oak, black oak, hackberry, shagbark hickory, and bitternut hickory and may support some pawpaw. Forests on bottom land support mulberry, sycamore, cottonwood, willow, elm, white ash, silver maple, buttonbush, and American elder.

The plains leopard frog, Henslow’s sparrow, northern harrier, smooth green snake, spotted skunk, and massasauga rattlesnake inhabit the prairies in this area. Brown snake, smallmouth salamander, western worm snake, speckled king snake, and the Indiana bat inhabit the forested areas. The area has 29 threatened or endangered species or species of special concern. The watersheds are inhabited by many rare and declining species, such as the Blanding’s turtle, Topeka shiner, small white lady’s slipper, showy lady’s slipper, and glomerate sedge.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 66%
Grassland—private, 20%
Forest—private, 6%
Urban development—private, 4%
Water—private, 2%
Other—private, 2%

Historically, 86.75 percent of this area was prairie. Forest made up 9 percent of the area; savannas, 4 percent; shrub lands, 0.2 percent; wetlands, 0.04 percent; and ponds and lakes, 0.01 percent.

Currently, about 86 percent of this area is agricultural land. Cash-grain crops dominate the area, although hay and pasture crops also are grown in support of local livestock production.

The major resource concerns are water erosion, depletion of the organic matter in the soils, and poor water quality. Conservation practices on cropland generally include systems of crop residue management (especially no-till, strip-till, and mulch-till systems), cover crops, nutrient and pest management, grassed waterways, terraces, manure management, pasture and hayland planting, and grade-stabilization structures. ■

109—Iowa and Missouri Heavy Till Plain

This area (shown in fig. 109-1) is in Missouri (65 percent) and Iowa (35 percent). It makes up about 15,895 square miles (41,185 square kilometers). It includes the towns of Bethany, Chillicothe, Memphis, and Plattsburg, Missouri, and Ottumwa, Fairfield, Mt. Pleasant, and Centerville, Iowa. Interstate 35 crosses the northwestern part of this area.

Physiography

This area is in the Dissected Till Plains Section of the Central Lowland Province of the Interior Plains. It is an area of rolling hills interspersed with uniformly level upland divides and level alluvial lowlands. Dendritic drainage patterns

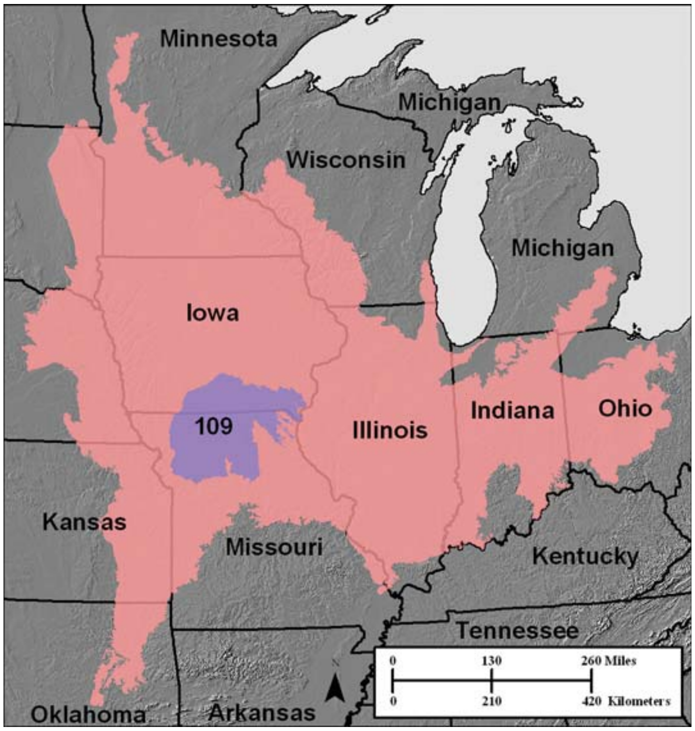

Figure 109-1: Location of MLRA 109 in Land Resource Region M.

characterize the area. The northeastern part of the area consists of flat, tablelike uplands with steep or hilly land occurring only near the margins of stream valleys. Other parts of the area are more dissected, have less extensive upland divides, and consist mostly of hillslopes. Nearly level, broad valley floors are along a few large rivers. Elevation ranges from 660 feet (200 meters) in the lowest valleys to 980 feet (300 meters) on the highest ridges. Local relief is mainly 10 to 20 feet (3 to 6 meters), but valley floors can be 80 to 160 feet (25 to 50 meters) below the adjacent uplands. Also, some upland flats and valley floors have local relief of only 3 to 6 feet (1 to 2 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Chariton-Grand (1028), 65 percent; Des Moines (0710), 14 percent; Upper Mississippi-Salt (0711), 9 percent; Lower Missouri (1030), 5 percent; Upper Mississippi-Iowa-Skunk-Wapsipinicon (0708), 4 percent; and Missouri-Nishnabotna (1024), 3 percent. The Grand, Thompson, and Chariton Rivers, which are tributaries of the Missouri River, begin in the part of this area in Iowa and flow south into Missouri. The Whitebreast and Des Moines Rivers also occur in the northern part of the area. The Locust River, in the southern part of the area, is another major tributary of the Missouri River.

Geology

Loess covers the surface of almost all of the uplands in this MLRA. Glacial drift that is high in content of clay underlies the loess. Alluvial clay, silt, sand, and gravel deposits are in all of the stream and river valleys. They can be extensive in the major river valleys. Mississippian shale and limestone bedrock lies beneath the glacial and alluvial deposits.

Climate

The average annual precipitation in most of this area is 34 to 41 inches (865 to 1,040 millimeters). About two-thirds of the precipitation falls as high-intensity, convective thunderstorms during the freeze-free period. The low amount of precipitation in winter occurs as snow. The average annual temperature is 49 to 54 degrees F (9 to 12 degrees C). The freeze-free period averages 190 days and ranges from 175 to 210 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 10.8%; ground water, 5.9%
Livestock—surface water, 3.9%; ground water, 4.3%
Irrigation—surface water, 0.0%; ground water, 1.5%
Other—surface water, 71.0%; ground water, 2.7%

The total withdrawals average 220 million gallons per day (835 million liters per day). About 14 percent is from ground water sources, and 86 percent is from surface water sources. In most years the favorably distributed, moderate precipitation provides enough water for crops. The many small perennial streams and a few large streams are additional sources of water. Since the ground water is highly mineralized, many communities in the area rely on surface water for their supply of drinking water. The streamflow fluctuates widely and frequently, so storage is required to maintain any public supplies.

Ground water supplies from glacial drift are small, undependable, and of poor quality. This water is naturally high in total dissolved solids, commonly exceeding the national drinking water standard of 1,000 parts per million (milligrams per liter). Some ground water is pumped for irrigation from alluvial deposits along the larger rivers in the area.

Soils

The dominant soil orders in this MLRA are Alfisols and Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed or smectitic mineralogy. They generally are very deep, well drained to poorly drained, and loamy or clayey. Hapludalfs formed in loess and/or pedisediment over till (Armster, Armstrong, and Keswick series), loess (Weller series), and till (Gara and Lindley series) on uplands. Epiaqualfs (Pershing series) and Argialbolls (Edina series) formed in loess on uplands and benches. Argiaquolls (Clarinda series) formed in till on uplands. Argiudolls formed in loess (Grundy series), till (Lamoni and Shelby series), and loess and/or pedisediment over till (Lagonda series) on uplands. Endoaquolls (Zook series) formed in alluvium on flood plains and stream terraces.

Biological Resources

This area supports grassland vegetation. Big bluestem, Indiangrass, little bluestem, and switchgrass are the major species. The natural drainageways and the lowlands interspersed throughout the area support forest vegetation, mainly oaks and hickories. Most of the native grasses have been removed by cultivation and overgrazing. Naturalized bluegrass is prevalent in uncultivated areas.

Some of the major wildlife species in this area are white-tailed deer, raccoon, skunk, opossum, muskrat, cottontail, mink, squirrel, and quail. The species of fish in the area include bullhead, carp, bass, bluegill, and catfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 53%
Grassland—private, 26%
Forest—private, 14%
Urban development—private, 3%
Water—private, 2%
Other—private, 2%

Nearly all of this area is in farms, and more than one-half is cropland. Corn, soybeans, other feed grains, and hay are the principal crops. About one-fourth of the area supports introduced and native grasses. Beef cattle and swine are important sources of income on many farms.

The major resource concerns are water erosion, depletion of the organic matter in the soils, and poor water quality. Conservation practices on cropland generally include systems of crop residue management (especially no-till, strip-till, and mulch-till systems), cover crops, pest management, nutrient management, grassed waterways, terraces, manure management, pasture and hayland planting, and grade-stabilization structures. These practices help to control erosion, flooding, and sedimentation. ■

110—Northern Illinois and Indiana Heavy Till Plain

This area (shown in fig. 110-1) is in Illinois (79 percent), Wisconsin (11 percent), and Indiana (10 percent). It makes up about 7,535 square miles (19,525 square kilometers). The entire northern part of this MLRA is an urban-suburban complex

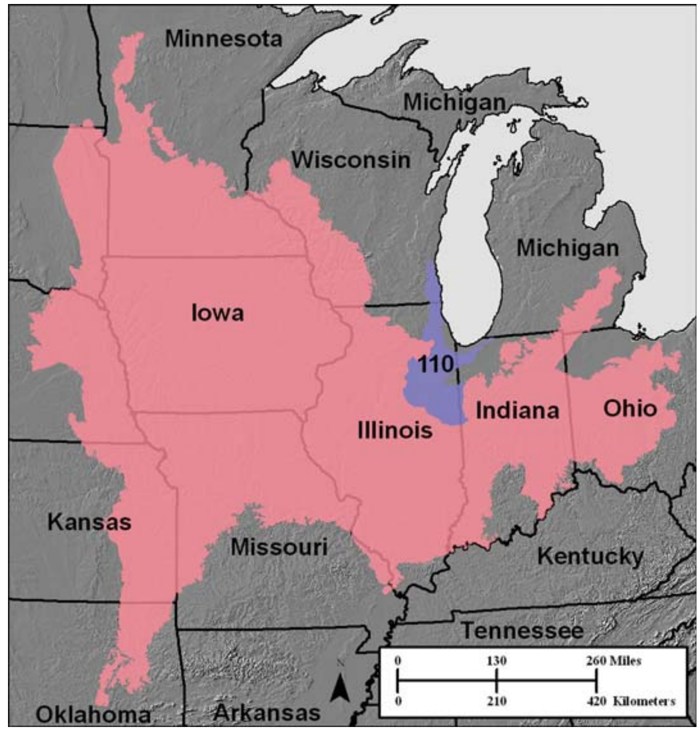

Figure 110-1: Location of MLRA 110 in Land Resource Region M.

including Milwaukee, Wisconsin, all of the western and southern suburbs of Chicago, Illinois, and Merrillville, Indiana. Pontiac and Kankakee, Illinois, are in the southern part of this area. Danville, Illinois, is just outside the southeast corner of the area. Interstates 55, 57, 65, 80, 90, 94, and 294 as well as numerous State and Federal highways cross the area. The Great Lakes Naval Training Center, O'Hare International Airport, Midway Airport, and General Mitchell International Airport are in the area. The Argonne National Laboratory and numerous forest preserves are in the part of the area in Illinois.

Physiography

The northern half of this area is in the Eastern Lake Section of the Central Lowland Province of the Interior Plains. The southern half is in the Till Plains Section of the same province and division. The area is a nearly level to gently sloping glaciated plain. It has relatively low relief on the glacial lake plains and more rolling topography along the major stream valleys and on glacial moraines. The numerous glacial moraines in the area tend to form elongated ridges tending from northwest to southeast. Elevation is about 650 feet (200 meters), increasing gradually from Lake Michigan south. Streams have cut shallow valleys on much of the plain. Local relief is typically 10 to 25 feet (3 to 8 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows:

Upper Illinois (0712), 69 percent; Lower Illinois (0713), 13 percent; Southwestern Lake Michigan (0404), 10 percent; and Wabash (0512), 8 percent. Five major tributaries to the Illinois River are in this area. They are the Des Plaines, Fox, Vermilion, Iroquois, and Kankakee Rivers.

Geology

The surface of this area is covered by glacial drift. Till, outwash, lacustrine deposits, loess or other silty material, and organic deposits are common. Fractured dolomite and limestone bedrock of Silurian age lies beneath the glacial drift.

Climate

The average annual precipitation in this area is 31 to 40 inches (785 to 1,015 millimeters). About two-thirds of the precipitation falls during the freeze-free period. Most of the rainfall occurs during high-intensity, convective thunderstorms in summer. Precipitation in winter occurs as snow. The average annual temperature is 45 to 52 degrees F (7 to 11 degrees C). The freeze-free period averages about 185 days and ranges from 165 to 205 days. It is longest in a narrow belt along Lake Michigan.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 3.4%; ground water, 2.1%
Livestock—surface water, 0.0%; ground water, 0.2%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 92.5%; ground water, 1.7%

The total withdrawals average 11,815 million gallons per day (44,720 million liters per day). This is the fourth highest amount of water used among all of the MLRAs. About 4 percent is from ground water sources, and 96 percent is from surface water sources. In most years the favorably distributed, moderate precipitation is adequate for crops. Ground water is the primary source of the municipal water supply, except in the Chicago, Gary, and Milwaukee areas, where water is taken directly from Lake Michigan. A few large perennial streams are potential sources of water but are not extensively used for this purpose. The surface water generally is suitable for almost all uses. The water in the Des Plaines River, however, is contaminated by municipal and industrial wastewater discharges from the heavily urbanized area around Chicago.

Abundant ground water in shallow glacial outwash deposits (unconsolidated sand and gravel) meets the domestic and municipal needs in much of the area. Some irrigation water is pumped from areas underlain by extensive outwash deposits. Isolated lenses of sand and gravel buried in the glacial till also provide some ground water throughout the area. Average values of total dissolved solids are between 350 and 450 parts per million (milligrams per liter). The water in these aquifers is very hard, and the iron concentrations commonly exceed the national standard for drinking water of 1,000 parts per billion (micrograms per liter). Some of the deeper wells in the fractured limestone and dolomite bedrock beneath the glacial drift have water that is very similar in quality to the water in the glacial deposits.

Soils

The dominant soil orders in this MLRA are Alfisols, Histosols, Inceptisols, and Mollisols. The soils in the area have a mesic soil temperature regime, a udic or aquic soil moisture regime, and dominantly mixed or illitic mineralogy. They generally are moderately deep to very deep, poorly drained to moderately well drained, and silty or clayey in the subsoil.

Nearly level Endoaquolls (Ashkum, Bryce, and Drummer series) are on broad flats and in shallow depressions. Moderately well drained Argiudolls (Graymont and Varna series) formed in loess and loamy till on gently sloping to sloping uplands. In areas of the more clayey till, somewhat poorly drained Argiudolls (Clarence, Elliott, and Swygert series) are more prevalent. Hapludalfs (Kidami and Ozaukee series) commonly occur on gently sloping to moderately sloping uplands along the major stream valleys. They also occur on many of the more sloping glacial moraines. Moderately well drained Eutrudepts (Chatsworth series) generally are in the steeper areas. Haplosaprists (Houghton and Lena series) are common in wet, closed depressions. Loamy, moderately well drained and well drained Argiudolls (Proctor and Warsaw series) and Hapludalfs (Camden and Fox series) are on outwash plains or broad stream terraces underlain by sand and gravel. Somewhat poorly drained Argiudolls (Martinton series) and poorly drained Endoaquolls (Milford series) commonly are on broad glacial lake plains. Cumulic Endoaquolls (Sawmill series) and Cumulic Hapludolls (Lawson and Huntsville series) formed in alluvium on nearly level, broad flood plains and in the smaller upland drainageways.

Biological Resources

When this area was settled, about 60 percent of the total acreage supported prairie vegetation. The present potential for natural vegetation on the prairies in the area is unknown. Cattails, bulrushes, and common reed grow on organic soils in marshes. A few bogs support tamarack, pitcherplant, sundew, cranberry, leatherleaf, winterberry, and dwarf birch. Some of the major wildlife species in this area are white-tailed deer, coyote, beaver, raccoon, and Canada goose.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 65%
Grassland—private, 4%
Forest—private, 5%
Urban development—private, 22%
Water—private, 2%
Other—private, 2%

Most of this area is in farms, but more than 20 percent is used for urban development. Some land formerly used for crops is rapidly becoming urbanized. Farmed areas are used mainly for cash-grain crops. Corn and other feed grain crops dominate the area. Hay and pasture crops are grown in support of the local livestock industry. The forestland in the area is mainly on wet flood plains, on steeply sloping valley sides, and on ridges formed by moraines.

The major resource concerns on cropland and construction sites are water erosion, excessive soil wetness, flooding, sedimentation, surface water quality, storm-water management, and protection and restoration of wetland habitat. Conservation practices on cropland generally include systems of crop residue management (such as mulch-till, no-till, and strip-till systems), cover crops, conservation cropping systems, crop rotations, and maintenance of tile drainage systems, which improve soil aeration and increase the rooting depth. Grassed waterways, grade-stabilization structures, and filter strips help to control concentrated runoff and protect water quality. Nutrient management and pest management also are important conservation practices in the area. Urban storm-water management helps to control flooding and improves water quality in this heavily urbanized area. ■

111A—Indiana and Ohio Till Plain, Central Part

This area (shown in fig. 111A-1) is in the central part of Indiana (54 percent) and the southwestern part of Ohio (46 percent). It makes up about 10,980 square miles (28,445 square kilometers). It includes the towns or cities of Anderson, Columbus, Indianapolis, Kokomo, Muncie, Plainfield, and Richmond, Indiana, and Dayton, Eaton, Greenville, Springfield, and Washington Court House, Ohio. Columbus, the capital of Ohio, is just outside the eastern edge of the area. Interstates 65, 69, 70, 71, 74, and 75 cross the area. Numerous State parks occur in this area. The Fort Harrison, Mounds, Summit Lake, and White River State Parks are in the part of the area in Indiana, and Buck Creek, Deer Creek, John Bryan, Kiser Lake, Little Miami, Madison Lake, and Sycamore State Parks are in the part in Ohio.

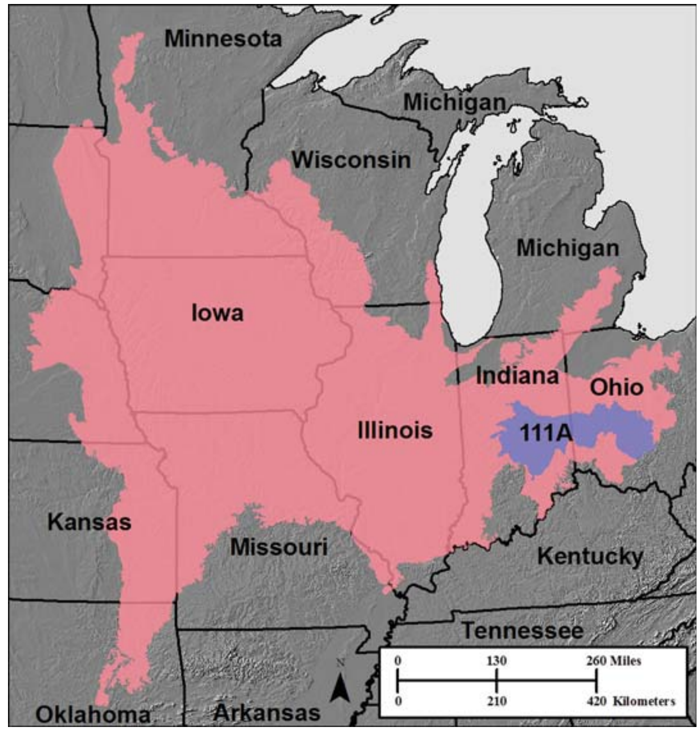

Figure 111A-1: Location of MLRA 111A in Land Resource Region M.

Physiography

This area is in the Till Plains Section of the Central Lowland Province of the Interior Plains. It is dominated by broad, nearly level ground moraines that are broken in some areas by kames, outwash plains, and stream valleys along the leading edge of the moraines. Narrow, shallow valleys commonly are along the few large streams in the area. Elevation ranges from 680 to 1,250 feet (205 to 380 meters), increasing gradually from west to east. Relief is mainly a few meters, but in some areas hills rise as much as 100 feet (30 meters) above the adjoining plains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Wabash (0512), 46 percent; Great Miami (0508), 30 percent; Scioto (0506), 22 percent; and the Middle Ohio (0509), 2 percent. The major rivers in the area include the East and West Forks of the White River and the Whitewater River in Indiana and the Great Miami, Stillwater, Big Darby, Scioto, and Big Walnut Rivers in Ohio.

Geology

Surface deposits in this area include glacial deposits of till, lacustrine sediments, and outwash from Wisconsin and older glacial periods. A moderately thick mantle of loess covers much of the area. Most of this MLRA is underlain by Silurian and

Devonian limestone and dolostone. Also, some areas of Late Ordovician shale and limestone are in the western part of the MLRA.

Climate

The average annual precipitation in this area is 36 to 43 inches (915 to 1,090 millimeters). Most of the rainfall occurs as convective thunderstorms during the growing season. About half or more of the precipitation occurs during the freeze-free period. Snowfall is common in winter. The average annual temperature is 49 to 53 degrees F (9 to 12 degrees C). The freeze-free period averages about 195 days and ranges from 175 to 215 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 6.6%; ground water, 11.0%
Livestock—surface water, 0.3%; ground water, 0.4%
Irrigation—surface water, 0.2%; ground water, 0.1%
Other—surface water, 62.0%; ground water, 19.4%

The total withdrawals average 1,985 million gallons per day (7,515 million liters per day). About 31 percent is from ground water sources, and 69 percent is from surface water sources. In most years the moderate precipitation provides enough water for crops, but in some years yields are reduced by drought. Many of the soils require artificial drainage before they can be used for crops. Reservoirs on the East Fork of the White River and on the Great Miami and Scioto Rivers and their tributaries provide water for public, municipal, and industrial supplies and for cooling thermoelectric power plants. Recreation is the most significant use of some of the reservoirs. Since an advanced wastewater treatment facility has been in use in Indianapolis, the water in the East Fork is now suitable for almost all uses. Rivers receiving wastewater effluent from the larger urban centers in Ohio have poor-quality water during periods of low flow. The water in the other streams and rivers in this area is of good or fair quality and is suitable for most uses.

Abundant ground water in shallow glaciofluvial deposits (unconsolidated sand and gravel along streams and in glacial channels) meets some of the domestic, livestock, municipal, and industrial needs in the part of this area in Indiana. Also, some irrigation water is pumped from this aquifer. The extensive sand and gravel deposits in the valleys along the Great Miami and Scioto Rivers are heavily used in Ohio. Average values of total dissolved solids are 416 and 546 parts per million (milligrams per liter) in Ohio and Indiana, respectively, and the water is very hard. The water is very low in iron in Indiana, but it exceeds the secondary (esthetic) standard for drinking water in Ohio. Isolated lenses of sand and gravel buried in the glacial till provide some very hard ground water throughout the area. Average values of total dissolved solids are 358 parts per million (milligrams per liter), but this water has the highest levels of iron of all the aquifers in the area. The water is used primarily for domestic purposes and for watering livestock. Where the higher yield wells occur, this aquifer provides some water for irrigation or for municipal and industrial needs. Some deeper wells in the fractured limestone and dolomite bedrock beneath the glacial drift have water that is very similar in quality to the water in the glacial deposits.

Soils

The dominant soil orders in this MLRA are Alfisols, Inceptisols, and Mollisols. The MLRA also has small areas of Histosols. The soils in the area have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. They are very deep, generally are very poorly drained to somewhat poorly drained, and are loamy or clayey. The dominant kinds of parent material are till, outwash, and loess. Others include alluvium, glaciolacustrine sediments, residuum, and organic deposits. Hapludalfs (Cardington, Celina, Lewisburg, Losantville, Miami, Miamian, Milton, Russell, Strawn, Wawaka, Williamstown, and Xenia series) and Epiaqualfs (Crosby and Fincastle series) are on moraines. Some Argiaquolls (Brookston, Cyclone, Kokomo, and Treaty series) are in depressions on ground moraines. Other Argiaquolls (Lippincott and Westland series) and Endoaquolls (Patton and Pella series) are in depressions on outwash plains and terraces. Hapludalfs (Eldean, Fox, Martinsville, and Ockley series) and Endoaqualfs (Sleeth and Whitaker series) are on terraces and outwash plains. Haplosaprists (Linwood and Palms series) and Humaquepts (Martisco series) are in deep depressions or potholes. Eutrudepts (Eel and Genesee series), Hapludolls (Ross series), Endoaquepts (Shoals series), and Endoaquolls (Sloan series) are on flood plains.

Biological Resources

This area supports hardwoods. Pin oak, swamp white oak, blackgum, American sycamore, green ash, silver maple, and cottonwood grow on the wetter soils. White oak, northern red oak, black walnut, tuliptree, shagbark hickory, sugar maple, and white ash are major species on the better drained soils.

Some of the major wildlife species in this area are white-tailed deer, red fox, gray squirrel, raccoon, opossum, cottontail rabbit, quail, ducks, turkey, dove, and geese. Fishing is limited mostly to constructed impoundments, rivers, and streams. The species of fish in the area include largemouth bass, smallmouth bass, flathead catfish, bullhead catfish, bluegill, and crappie.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 65%
Grassland—private, 6%
Forest—private, 8%
Urban development—private, 17%
Water—private, 1%
Other—private, 3%

Most of this area is farmed. Corn, soybeans, other feed grains, and hay for livestock are the principal crops. Dairying is an important enterprise near the cities in the area, and truck and canning crops are grown extensively in areas where the soils and markets are favorable. Some small areas along Big Walnut Creek, Little Walnut Creek, Eagle Creek, and the White River are irrigated. This MLRA has small acreages of permanent pasture and farm woodlots. The pressure of urban expansion is high around the major towns and cities in this populous area.

The major resource concerns are seasonal wetness; water erosion; maintenance of the content of organic matter and productivity of the soils; excessive sediments, nutrients, and pesticides in surface water; nutrients and pesticides in ground water; and loss of wildlife habitat. Conservation practices on cropland generally include surface and subsurface drainage systems, conservation crop rotations, crop residue management, filter strips, nutrient and pest management, protection of streambanks, agrichemical containment facilities, and management of wildlife habitat. ■

111B—Indiana and Ohio Till Plain, Northeastern Part

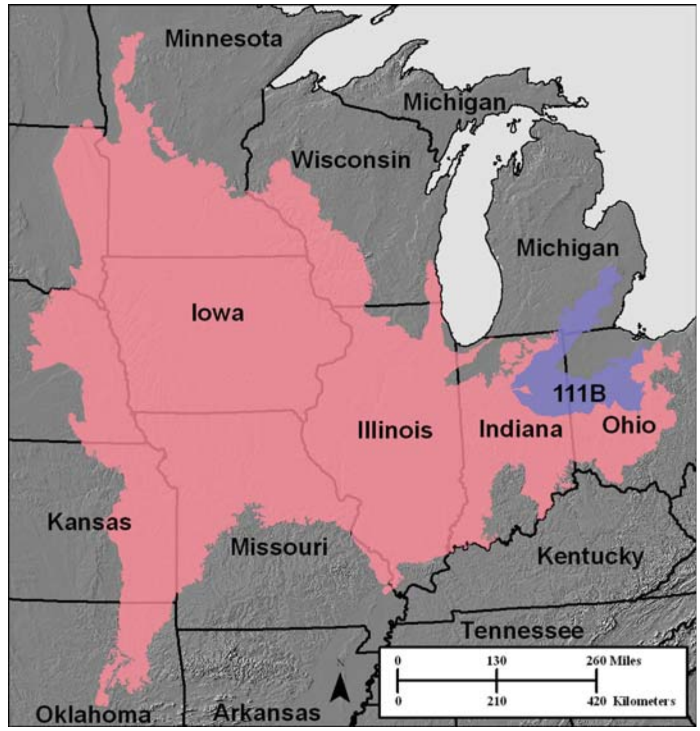

Figure 111B-1: Location of MLRA 111B in Land Resource Region M.

This area (shown in fig. 111B-1) is in the northwestern part of Ohio (42 percent), the northeastern part of Indiana (35 percent), and the south-central part of Michigan (23 percent). It makes up about 13,460 square miles (34,880 square kilometers). It includes the towns of Fort Wayne, Huntington, and Marion, Indiana; Pontiac, Adrian, and Ann Arbor, Michigan; and Bellefontaine, Celina, Delaware, Lima, Marion, Sidney, and Upper Sandusky, Ohio. Interstates 69, 75, 80, and 90 cross this area. A number of State parks are in the part of the area in Michigan; the Delaware Lake, Grand Lake St. Marys, Indian Lake, and Lake Loramie State Parks are in the part in Ohio; and the Chain O'Lakes and Ouabache State Parks are in the part in Indiana.

Physiography

This area is in the Eastern Lake and Till Plains Sections of the Central Lowland Province of the Interior Plains. The entire MLRA is glaciated, and most areas are dominated by ground moraines that are broken in places by lake plains, outwash plains, flood plains, and many recessional moraines. The ground moraines and lake plains in front of the recessional moraines are flat to undulating. In many places stream valleys occur at the leading edge of the recessional moraines. Narrow, shallow valleys commonly are along the large streams in this MLRA, and some areas along the major rivers and streams have deposits of sand. Elevation ranges from 630 to 1,550 feet (190 to 470 meters), increasing gradually from west to east. Relief is mainly a few meters, but in some areas hills rise as much as 100 feet (30 meters) above the adjoining plains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Western Lake Erie (0410), 41 percent; Wabash (0512), 28 percent; Scioto (0506), 10 percent; St. Clair-Detroit (0409), 9 percent; Great Miami (0508), 6 percent; Southeastern Lake Michigan (0405), 5 percent; and Southwestern Lake Huron-Lake Huron (0408), 1 percent. The Huron River in Michigan, Cedar Creek in Indiana, and the Sandusky River in Ohio have been designated as National Wild and Scenic Rivers in this MLRA.

Geology

The surficial materials in this area include glacial deposits of till, outwash, and lacustrine sediments from Wisconsin and older glacial periods. A thin mantle of loess occurs in some areas. Most of this MLRA is underlain by Silurian and Devonian limestone and dolostone. Middle Devonian to Early Mississippian black shale and Early to Middle Mississippian siltstone and shale are in some areas of the northern part of the MLRA.

Climate

The average annual precipitation in this area is 30 to 39 inches (760 to 990 millimeters). Most of the rainfall occurs as convective thunderstorms during the growing season. About half or more of the annual precipitation occurs during the freeze-free period. Snowfall is common in winter. The average annual temperature is 47 to 52 degrees F (8 to 11 degrees C). The freeze-free period averages about 180 days and ranges from 165 to 195 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 10.2%; ground water, 7.7%
Livestock—surface water, 0.3%; ground water, 0.4%
Irrigation—surface water, 0.4%; ground water, 0.4%
Other—surface water, 70.0%; ground water, 10.5%

The total withdrawals average 1,715 million gallons per day (6,490 million liters per day). About 19 percent is from ground water sources, and 81 percent is from surface water sources. In most years the moderate precipitation provides enough water for crops, but in some years yields are reduced by drought. Many of the soils require artificial drainage before they can be used for crops. Reservoirs in the part of the area in Indiana, the rivers in the part in Ohio, and the rivers and lakes in the part in Michigan provide water for public, municipal, and industrial supplies and for cooling thermoelectric power plants. Recreation is the most important use of some of the reservoirs. The surface water is suitable for almost all uses.

Abundant ground water in shallow glaciofluvial deposits (unconsolidated sand and gravel along streams and in glacial channels) meets some of the domestic, livestock, municipal, and industrial needs in this area. Also, some irrigation water is pumped from this aquifer. Deposits along the Great Miami and Scioto Rivers are pumped heavily. Average values of total dissolved solids are 185, 413, and 546 parts per million (milligrams per liter) in Michigan, Ohio, and Indiana, respectively. The water generally is very hard, but in Michigan it typically is moderately hard or hard. It is very low in iron in Indiana, but it typically exceeds the secondary (esthetic) national standard for drinking water in Michigan and Ohio.

A glacial outwash aquifer consisting of a deposit of sand and gravel in northern Indiana and in Michigan is more extensive than the glaciofluvial deposits. The water from this aquifer has less than 500 parts per million (milligrams per liter) total dissolved solids, and it is very hard. Iron levels are very high. Isolated lenses of sand and gravel buried in the glacial till provide some very hard ground water throughout the area. Average values of total dissolved solids are 358 parts per million (milligrams per liter), but this water has the highest levels of iron of all the aquifers in the area. The two glacial aquifers provide water primarily for domestic use and livestock. Where the higher yield wells occur, the outwash aquifer provides some water for irrigation or for municipal and industrial needs. Some deeper wells in the fractured limestone and dolomite bedrock beneath the glacial drift have water that is very similar in quality to the water in the glacial deposits. This bedrock provides most of the industrial, agricultural, and domestic water in west-central Ohio.

Soils

The dominant soil orders in this MLRA are Alfisols, Inceptisols, and Mollisols. The soils in the area have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed or illitic mineralogy. They are very deep, generally are very poorly drained to somewhat poorly drained, and are loamy or clayey. The dominant kinds of parent material are clayey till and lacustrine sediments. Others include outwash, alluvium, loess, and organic deposits. Hapludalfs (Glynwood and Morley series), Epiaqualfs (Blount, Nappanee, and Pandora series), Endoaqualfs (Wetzel series), and Argiaquolls (Pewamo series) are on till plains. Endoaquolls (Milford and Montgomery series) and Epiaqualfs (Del Rey series) are on lake plains. Haplosaprists (Houghton and Linwood series), Humaquepts (Roundhead and Wallkill series), and Endoaquepts (Wunabuna series) are in deep depressions or potholes. Hapludalfs (Belmore, Eldean, and Fox series), Endoaqualfs (Sleeth series), and Argiaquolls (Millgrove, Rensselaer, and Westland series) are on terraces and outwash plains. Eutrudepts (Genesee series), Endoaquepts (Shoals series), and Endoaquolls (Saranac and Sloan series) are on flood plains.

Biological Resources

This area supports hardwoods. Pin oak, swamp white oak, blackgum, American sycamore, green ash, silver maple, and cottonwood grow on the wetter soils. White oak, northern red oak, black walnut, tuliptree, shagbark hickory, sugar maple, and white ash are major species on the better drained soils.

Some of the major wildlife species in this area are white-tailed deer, red fox, gray squirrel, raccoon, opossum, cottontail rabbit, quail, ducks, turkey, dove, and geese. Fishing is limited mostly to constructed impoundments and to rivers and streams. The species of fish in the area include largemouth bass, smallmouth bass, flathead catfish, bullhead catfish, bluegill, and crappie.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 76%
Grassland—private, 3%
Forest—private, 7%; Federal, 1%
Urban development—private, 8%
Water—private, 1%
Other—private, 4%

More than 80 percent of this area is farmed. Corn, soybeans, other feed grains, and hay for livestock are the principal crops. Dairying is an important enterprise near cities, and truck and canning crops are grown extensively in areas where the soils and markets are favorable. Some small areas along the major rivers are irrigated. This MLRA has small acreages of permanent pasture and farm woodlots.

The major resource concerns are seasonal wetness; water erosion; maintenance of the content of organic matter and productivity of the soils; excessive sediments, nutrients, and pesticides in surface water; nutrients and pesticides in ground water; and loss of wildlife habitat. Conservation practices on cropland generally include surface and subsurface drainage systems, conservation crop rotations, crop residue management, filter strips, nutrient and pest management, protection of streambanks, agrichemical containment facilities, and management of wildlife habitat. ■

111C—Indiana and Ohio Till Plain, Northwestern Part

This area is almost entirely in Indiana (fig. 111C-1). A very small part is in Michigan. The area makes up about 3,500 square miles (9,065 square kilometers). The towns of Logansport, Plymouth, Syracuse, and Rensselaer, Indiana, are in this MLRA. Interstate 65 crosses the southwestern part of the area, and Interstate 69 crosses the northeast tip.

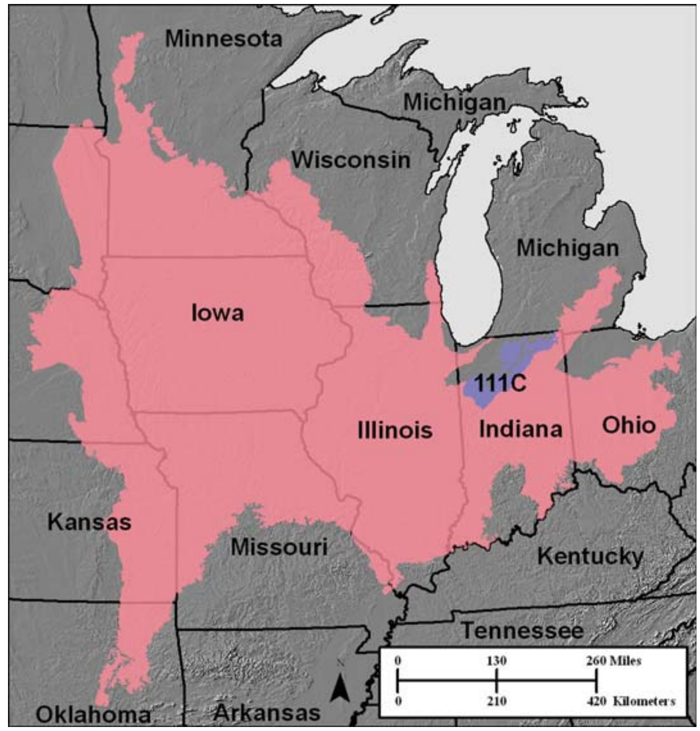

Figure 111C-1: Location of MLRA 111C in Land Resource Region M.

Physiography

Almost all of this area is in the Eastern Lake Section of the Central Lowland Province of the Interior Plains. The southern end of the area is in the Till Plains Section of the same province and division. This MLRA is in the glaciated part of north-central Indiana. It has a series of end moraines throughout. Areas that parallel most of the major rivers and streams have deposits of sand. Most of the MLRA is dominated by glacial till plains broken in places by lake plains, outwash plains, and flood plains. Narrow, shallow valleys commonly are along the large streams in the MLRA. In many places stream valleys occur at the edge of moraines that represent different episodes of glacial advancement and retreat. Elevation ranges from 630 to 940 feet (190 to 285 meters), increasing gradually from west to east. Relief is mainly a few meters, but in some areas hills rise as much as 100 feet (30 meters) above the adjoining plains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Wabash (0512), 53 percent; Upper Illinois (0712), 24 percent; Southeastern Lake Michigan (0405), 22 percent; and Western Lake Erie (0410), 1 percent. The Eel, Wabash, Pigeon, Tippecanoe, and St. Joseph Rivers cross this area.

Geology

The surficial materials in this area include glacial deposits of till, outwash, and lacustrine sediments from Wisconsin and older glacial periods. A thin or moderately thick mantle of loess covers much of the area. This MLRA is underlain by Late Ordovician shale and limestone. The western part is underlain by shale, siltstone, sandstone, limestone, and dolostone ranging in age from Middle Pennsylvanian to Silurian.

Climate

The average annual precipitation in this area is 35 to 39 inches (890 to 990 millimeters). About half or more of the annual precipitation occurs during the freeze-free period. Most of the rainfall occurs as convective thunderstorms during the summer. The low amount of precipitation in winter occurs mostly as snow. The average annual temperature is 47 to 51 degrees F (9 to 11 degrees C). The freeze-free period averages about 185 days and ranges from 170 to 195 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 15.9%; ground water, 13.0%
Livestock—surface water, 16.9%; ground water, 14.0%
Irrigation—surface water, 20.8%; ground water, 19.3%
Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average 21 million gallons per day (80 million liters per day). About 46 percent is from ground water sources, and 54 percent is from surface water sources. In normal years the favorably distributed, moderate precipitation is adequate for crops, but in some years yields are reduced by drought. A few large streams, mainly tributaries of the Wabash and St. Joseph Rivers, are potential sources of surface water. Some surface water is used for public, municipal, and industrial supplies and for irrigation. A few lakes in the northern part of the area are widely used for recreation. The surface water is suitable for almost all uses.

A glacial outwash aquifer consisting of a deposit of sand and gravel in northern Indiana and in Michigan has water with about 440 parts per million (milligrams per liter) total dissolved solids. The water is very hard. Iron levels are very high. Isolated lenses of sand and gravel buried in the glacial till provide some very hard ground water throughout the area. Average values of total dissolved solids are 358 parts per million (milligrams per liter), but this water has the highest levels of iron of all the aquifers in the area. The two glacial aquifers provide water primarily for domestic use and livestock. Where the higher yield wells occur, the outwash aquifer provides some water for irrigation and for public, municipal, and industrial needs. Some deeper wells in the fractured Silurian-Devonian limestone beneath the glacial drift have water that is very similar in quality to the water in the glacial deposits.

Soils

The soils in this area are mostly Alfisols, Mollisols, Entisols, Inceptisols, or Histosols. They generally are deep and medium textured to fine textured and have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed or illitic mineralogy. They formed in calcareous, loamy glacial till. Gently sloping or moderately sloping, moderately well drained or well drained Hapludalfs (Miami, Riddles, Williamstown, and Oshtemo series) are on summits. Level or nearly level, somewhat poorly drained, clayey Epiaqualfs (Conover, Baugo, and Crosier series) are on flat uplands; in broad, flat depressions; and in drainageways. Poorly drained or very poorly drained Argiaquolls (Brookston, Treaty, and Rennselaer series), Endoaquolls (Milford, Patton, and Pella series), and Haplosaprists (Adrian, Edwards, Houghton, Muskego, and Madaus series) are on narrow flats and in deep depressions or potholes.

Biological Resources

This area supports hardwoods. Pin oak, swamp white oak, blackgum, American sycamore, green ash, silver maple, and cottonwood grow on the wetter soils. White oak, northern red oak, black walnut, tuliptree, shagbark hickory, sugar maple, and white ash are major species on the better drained soils.

Some of the major wildlife species in this area are white-tailed deer, red fox, gray squirrel, raccoon, opossum, cottontail rabbit, quail, ducks, turkey, dove, and geese. Fishing is limited mostly to constructed impoundments and to rivers and streams. The species of fish in the area include largemouth bass, smallmouth bass, flathead catfish, bullhead catfish, bluegill, and crappie.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 58%
Grassland—private, 5%
Forest—private, 13%
Urban development—private, 14%
Water—private, 3%
Other—private, 7%

Most of this area is farmed. Corn, soybeans, other feed grains, and hay for livestock are the principal crops. Dairying is an important enterprise near cities, and truck and canning crops are grown extensively in areas where the soils and markets are favorable. Some small areas along the Eel, Wabash, Pigeon, Tippecanoe, and St. Joseph Rivers are irrigated. This MLRA has small acreages of permanent pasture and small farm woodlots.

The major resource concerns are water erosion, maintenance of the fertility and productivity of the soils, and soil moisture management. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems that eliminate the need for fall and spring fallow tillage), cover crops, nutrient management, terraces, water- and sediment-control basins, grassed waterways, and diversions. ■

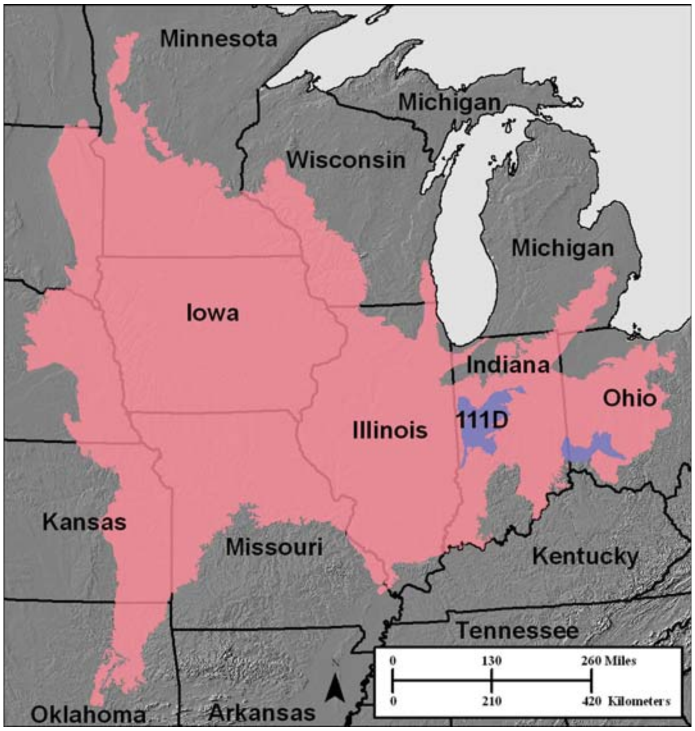

Figure 111D-1: Location of MLRA 111D in Land Resource Region M.

111D—Indiana and Ohio Till Plain, Western Part

This MLRA occurs in two separate areas (fig. 111D-1). One area is in the west-central part of Indiana (73 percent), and the other is in southwestern Ohio (27 percent). The MLRA makes up 5,355 square miles (13,880 square kilometers). It includes the towns of Crawfordville, Delphi, Frankfort, Lafayette, and Liberty, Indiana, and Hamilton, Lebanon, Middletown, and Wilmington, Ohio. Interstates 65 and 74 cross the part of this area in Indiana, and Interstates 71 and 75 cross the part in Ohio. Shades and Turkey Run State Parks are in the part in Indiana, and Caesar Creek and Hueston Woods State Parks are in the part in Ohio. A small portion of the Wright-Patterson Air Force Base, in Ohio, is in the northern part of the area.

Physiography

This area is in the Till Plains Section of the Central Lowland Province of the Interior Plains. It is dominated by loess hills and flats that are broken in places by moraines, kames, outwash plains, and stream terraces. Narrow, shallow valleys commonly are along the few large streams in the area. Elevation ranges from 530 to 1,050 feet (160 to 320 meters), increasing gradually from southwest to northeast. Relief is mainly a few meters, but in some areas hills rise as much as 100 feet (30 meters) above the adjoining plains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Wabash (0512), 68 percent; Great Miami (0508), 15 percent; Middle Ohio (0509), 14 percent; Scioto (0506,) 2 percent; and Upper Illinois (0712), 1 percent. Wildcat Creek in Indiana and the Little Miami River in Ohio have been designated as National Wild and Scenic Rivers. Sugar Creek and Walnut Creek occur in the part of the area in northern Indiana, and the Whitewater River is in the part in southeastern Indiana. The Sevenmile, Fourmile, and Great Miami Rivers cross the part of the area in Ohio.

Geology

Most of the eastern part of this MLRA is underlain by Late Ordovician shale and limestone. The western part is underlain by shale, siltstone, sandstone, limestone, and dolostone ranging in age from Middle Pennsylvanian to Silurian. Surficial materials include glacial deposits of till, outwash, and lacustrine sediments from Wisconsin and older glacial periods. A thin or moderately thick mantle of loess overlies much of the area.

Climate

The average annual precipitation in this area is 36 to 43 inches (915 to 1,090 millimeters). Most of the rainfall occurs as convective thunderstorms during the growing season. About half or more of the precipitation occurs during the freeze-free period. Snowfall is common in winter. The average annual temperature is 49 to 54 degrees F (10 to 12 degrees C). The freeze-free period averages about 200 days and ranges from 180 to 215 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 10.6%; ground water, 35.3%
Livestock—surface water, 1.4%; ground water, 1.5%
Irrigation—surface water, 1.3%; ground water, 0.2%
Other—surface water, 26.9%; ground water, 22.8%

The total withdrawals average 240 million gallons per day (910 million liters per day). About 60 percent is from ground water sources, and 40 percent is from surface water sources. In most years the moderate precipitation provides enough water for crops, but in some years yields are reduced by drought. A few large streams, mainly tributaries of the Ohio River, are potential sources of surface water. Some surface water is used for public, municipal, and industrial supplies and for irrigation. A few lakes in the area are used mostly for recreation. The surface water in the area is suitable for almost all uses.

A glacial outwash aquifer in northern Indiana is one source of ground water in this area. It is a sand and gravel deposit that has water with about 440 parts per million (milligrams per liter) total dissolved solids. The water is very hard. Iron levels are very high. Isolated lenses of sand and gravel buried in the glacial till provide some very hard ground water throughout the area. Average values of total dissolved solids are 358 parts per million (milligrams per liter), but this water has the highest levels of iron of all the aquifers in the area. The two glacial aquifers provide water primarily for domestic use and for livestock. Where the higher yield wells occur, the outwash aquifer provides some water for irrigation and for public, municipal, and industrial needs. Some deeper wells in the fractured Silurian-Devonian limestone beneath the glacial drift have water that is very similar in quality to the water in the glacial deposits.

Glaciofluvial deposits of sand and gravel in the valleys along the Whitewater and Great Miami Rivers are primary sources of ground water in the parts of this area in southeastern Indiana and southwestern Ohio, respectively. The median level of total dissolved solids in the ground water beneath these two river valleys is 546 and 413 parts per million (milligrams per liter), respectively, and the water in both aquifers is very hard. There has been no contamination of these shallow aquifers to date. The Shaly Carbonate bedrock aquifer beneath this area is not used because abundant good-quality water is available in the river valley deposits.

Soils

The dominant soil orders in this MLRA are Alfisols, Inceptisols, and Mollisols. The MLRA also has small areas of Histosols. The soils in the area have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. They are dominantly very deep, very poorly drained to well drained, and loamy or silty. The dominant kinds of parent material are till, outwash, loess, and alluvium. Hapludalfs (Celina, Miami, Miamian, Reesville, Russell, Wynn, and Xenia series) and Epiaqualfs (Crosby and Fincastle series) are on till plains. Endoaquolls (Drummer series), Argiaquolls (Cyclone, Kokomo, Mahalasville, Ragsdale, and Treaty series), and Endoaqualfs (Starks series) are on till plains or outwash plains. Haplosaprists (Houghton and Palms series) are in deep depressions and potholes. Hapludalfs (Camden, Eldean, Fox, Martinsville, and Ockley series) and Endoaqualfs (Sleeth series) are on terraces and outwash plains. Argiaquolls (Westland series) are in depressions on terraces and outwash plains. Eutrudepts (Beckville, Eel, and Genesee series), Endoaquepts (Shoals series), and Endoaquolls (Sloan series) are on flood plains.

Biological Resources

When this area was settled, the broad, nearly level uplands in the northwestern part of the MLRA supported prairie vegetation. The rest of the MLRA supported hardwoods. Pin oak, swamp white oak, blackgum, American sycamore, green ash, silver maple, and cottonwood grow on the wetter soils. White oak, northern red oak, black walnut, tuliptree, shagbark hickory, sugar maple, and white ash are the major species on the better drained soils.

Some of the major wildlife species in this area are white-tailed deer, red fox, gray squirrel, raccoon, opossum, cottontail rabbit, quail, ducks, turkey, dove, and geese. Fishing is limited mostly to constructed impoundments and to rivers and streams. The species of fish in the area include largemouth bass, smallmouth bass, flathead catfish, bullhead catfish, bluegill, and crappie.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 74%
Grassland—private, 5%
Forest—private, 11%
Urban development—private, 6%
Water—private, 1%
Other—private, 3%

Almost all of this area is in farms. Corn, soybeans, other feed grains, and hay for livestock are the principal crops. Dairying is an important enterprise on some farms near cities, and truck and canning crops are grown in areas where the soils and markets are favorable. The MLRA has small acreages of permanent pasture and farm woodlots. The pressure of urban expansion is high around the major towns and cities in the area.

The major resource concerns are seasonal wetness; water erosion; maintenance of the content of organic matter and productivity of the soils; excessive sediments, nutrients, and pesticides in surface water; nutrients and pesticides in ground water; and loss of wildlife habitat. Conservation practices on cropland generally include surface and subsurface drainage systems, conservation crop rotations, crop residue management, filter strips, nutrient and pest management, protection of streambanks, agrichemical containment facilities, and management of wildlife habitat. ■

111E—Indiana and Ohio Till Plain, Eastern Part

This area is entirely in the north-central part of Ohio (fig. 111E-1). It makes up 2,980 square miles (7,720 square kilometers). The towns of Bucyrus, Ashland, Lancaster, Mount Gilead, Shelby, Sunbury, and Columbus are in this MLRA. Interstate 71 crosses the central and northeastern parts of the area, and Interstate 70 crosses the south-central part. Mount Gilead State Park is in this MLRA.

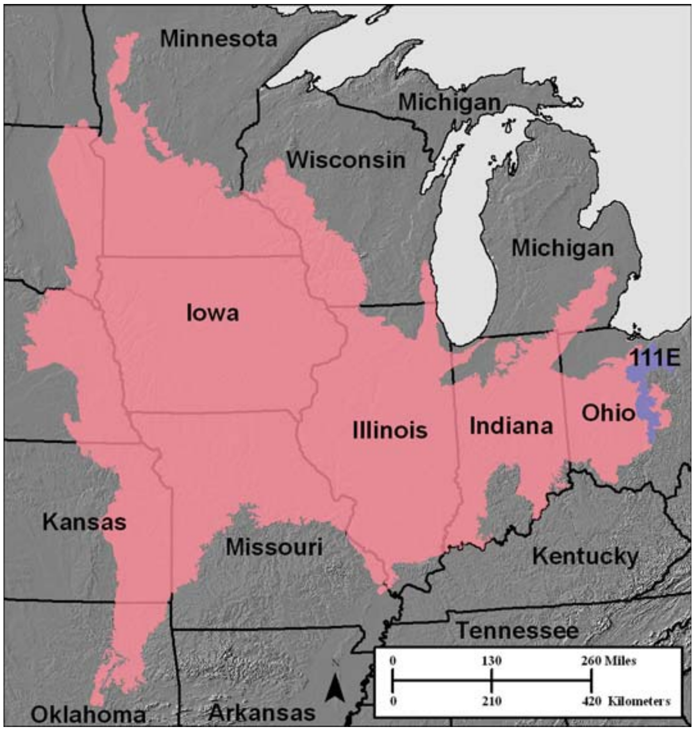

Figure 111E-1: Location of MLRA 111E in Land Resource Region M.

Physiography

Most of this area is in the Till Plains Section of the Central Lowland Province of the Interior Plains. The northeast tip of the area is in the Southern New York Section of the Appalachian Plateaus Province of the Appalachian Highlands. The entire area has been glaciated. It is dominated by ground moraines that are broken in places by kames, lake plains, outwash plains, terraces, and stream valleys. Narrow, shallow valleys commonly are along the few large streams in the area. Elevation ranges from 580 to 1,400 feet (175 to 425 meters), increasing gradually from west to east. Relief is mainly a few meters, but in some areas hills rise as much as 100 feet (30 meters) above the adjoining plains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Scioto (0506), 33 percent; Muskingum (0504), 31 percent; Western Lake Erie (0410), 28 percent; Upper Ohio (0503), 5 percent; and Southern Lake Erie (0411), 3 percent. The headwaters of many rivers in central Ohio, including the Vermilion, Black Fork, Sandusky, Little Scioto, and Olentangy Rivers, are in this MLRA.

Geology

This MLRA is underlain by late Devonian shale and sandstone. Surficial materials include glacial deposits of till, glaciolacustrine sediments, and outwash from Wisconsin and older glacial periods.

Climate

The average annual precipitation in this area is 35 to 41 inches (890 to 1,040 millimeters). Most of the rainfall occurs as convective thunderstorms during the growing season. About half or more of the precipitation occurs during the freeze-free period. Snowfall is common in winter. The average annual temperature is 48 to 52 degrees F (9 to 11 degrees C). The freeze-free period averages about 185 days and ranges from 165 to 205 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 21.6%; ground water, 37.7%
Livestock—surface water, 0.9%; ground water, 1.3%
Irrigation—surface water, 2.1%; ground water, 0.6%
Other—surface water, 29.8%; ground water, 6.0%

The total withdrawals average 84 million gallons per day (320 million liters per day). About 46 percent is from ground water sources, and 54 percent is from surface water sources. In most years the moderate precipitation provides enough water for crops, but in some years yields are reduced by drought. Reservoirs are one of the principal sources of water for industrial and municipal uses. A few large streams are potential sources of water but are little used. A small quantity of surface water is diverted for irrigation. A few lakes in the area are used mostly for recreation. The surface water in the area is suitable for almost all uses.

Ground water in layers of sand and gravel in ancestral valleys is a major source of water for industrial and municipal uses and some limited irrigation. The median level of total dissolved solids in this aquifer is 413 parts per million (milligrams per liter), and the water is very hard. There has been no contamination of this shallow aquifer to date. In areas away from the deposits of sand and gravel, many communities and rural landowners rely on wells in the Shaly Sandstone and Sandstone aquifers that lie beneath the glacial drift. These aquifers have water that is very similar in quality to the water in the glacial deposits. Well yields from the Shaly Sandstone are very low, so some landowners use cisterns.

Soils

The dominant soil orders in this MLRA are Alfisols, Inceptisols, and Mollisols. The MLRA also has small areas of Histosols. The soils in the area have a mesic soil temperature regime, an aquic or udic soil moisture regime, and dominantly mixed mineralogy. They are dominantly very deep, very poorly drained to well drained, and loamy or silty. The dominant kinds of parent material are till, glaciolacustrine sediments, outwash, loess, and alluvium. Hapludalfs (Amanda, Cardington, and Centerburg series), Epiaqualfs (Bennington and Condit series), and Endoaquolls (Marengo series) are on till plains. Argiaquolls (Luray and Pewamo series) and Epiaqualfs (Haskins and Tiro series) are on till plains and lake plains. Hapludalfs (Chili, Gallman, and Ockley series) and Endoaqualfs (Sleeth series) are on terraces and outwash plains. Hapludalfs (Glenford and Mentor series) and Endoaqualfs (Fitchville and Sebring series) are on lake plains and terraces. Endoaquolls (Patton series) are in depressions on terraces and outwash plains. Haplosaprists (Carlisle series) are in deep depressions and potholes. Eutrudepts (Eel series), Endoaquepts (Shoals series), and Endoaquolls (Sloan series) are on flood plains.

Biological Resources

This area supports hardwoods. Pin oak, swamp white oak, blackgum, American sycamore, green ash, silver maple, and cottonwood grow on the wetter soils. White oak, northern red oak, black walnut, tuliptree, shagbark hickory, sugar maple, and white ash are major species on the better drained soils.

Some of the major wildlife species in this area are white-tailed deer, red fox, gray squirrel, raccoon, opossum, cottontail rabbit, quail, ducks, turkey, dove, and geese. Fishing is limited mostly to constructed impoundments and to rivers and streams. The species of fish in the area include largemouth bass, smallmouth bass, flathead catfish, bullhead catfish, bluegill, and crappie.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 58%
Grassland—private, 5%
Forest—private, 18%
Urban development—private, 14%
Water—private, 1%
Other—private, 4%

Most of this area is farmed. Corn, soybeans, other feed grains, and hay for livestock are the principal crops. Dairying is an important enterprise on some farms near cities. Some truck and canning crops are grown in areas where the soils and markets are favorable. The MLRA has small acreages of permanent pasture and farm woodlots. Urban development and recreational development are important land uses in the area.

The major resource concerns are seasonal wetness; water erosion; maintenance of the content of organic matter and productivity of the soils; excessive sediments, nutrients, and pesticides in surface water; nutrients and pesticides in ground water; and loss of wildlife habitat. Conservation practices on cropland generally include surface and subsurface drainage systems, conservation crop rotations, crop residue management, filter strips, nutrient and pest management, protection of streambanks, agrichemical containment facilities, and management of wildlife habitat. ■

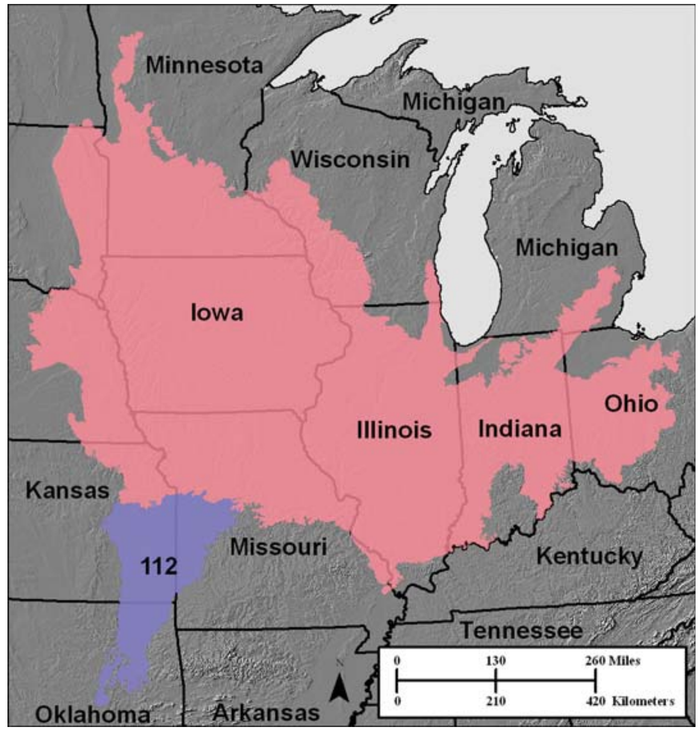

Figure 112-1: Location of MLRA 112 in Land Resource Region M.

112—Cherokee Prairies

This area (shown in fig. 112-1) is in Kansas (49 percent), Missouri (26 percent), and Oklahoma (25 percent). It makes up about 23,840 square miles (61,775 square kilometers). The southern and western suburbs of Kansas City are in the northeast corner of this MLRA. The city of Emporia, Kansas, is along Interstate 35 in the northwest corner of the area. The area includes the towns of Iola, Chanute, Pittsburg, Parsons, Independence, and Coffeyville, Kansas; Miami, Claremore, and Broken Arrow, Oklahoma; and Harrisonville, Warrensburg, Sedalia, and Clinton, Missouri. It also includes the cities of Bartlesville and Tulsa, Oklahoma. A short stretch of Interstate 70 is in this area, and Interstates 35 and 44 cross the area.

Physiography

This area is in the Osage Plains Section of the Central Lowland Province of the Interior Plains. It is an area of gently sloping to rolling, dissected plains. Elevation ranges from 330 to 1,310 feet (100 to 400 meters). Even though the area is thoroughly dissected, local relief typically is only 3 to 10 feet (1 to 3 meters), and major valleys generally are less than 8 feet (25 meters) below the adjacent uplands.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Neosho-Verdigris (1107), 47 percent; Gasconade-Osage (1029), 35 percent; Lower Missouri (1030), 8 percent; North Canadian (1110), 5 percent; Lower Arkansas (1111), 4 percent; and Kansas (1027), 1 percent. The Neosho, Marais des Cygnes, and Verdigris Rivers are the larger rivers in the part of this area in Kansas. Major reservoirs used for water supply and recreation are on the Verdigris and Grand (Neosho) Rivers in the part of the area in Oklahoma. The Harry Truman Reservoir, the westernmost lake in the popular recreational area called Lake of the Ozarks, is on the Little Osage and Grand Rivers in the part of the area in western Missouri.

Geology

Almost all of this area is underlain by Permian, Pennsylvanian, and Mississippian sandstone, shale, and limestone bedrock. The northern part of the area has a thin mantle of loess.

Climate

The average annual precipitation in most of this area is 34 to 45 inches (865 to 1,145 millimeters). Most of the rainfall occurs as high-intensity, convective thunderstorms from late in spring through autumn. Snow falls in winter, but it does not usually remain on the ground. The annual snowfall ranges from about 5 inches (12 centimeters) in the southern part of the area to 18 inches (45 centimeters) in the northern part. The average annual temperature is 53 to 62 degrees F (11 to 17 degrees C). The freeze-free period averages 220 days and ranges from 185 to 255 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 17.3%; ground water, 1.5%
Livestock—surface water, 2.3%; ground water, 1.0%
Irrigation—surface water, 0.2%; ground water, 4.3%
Other—surface water, 72.5%; ground water, 0.9%

The total withdrawals average 1,270 million gallons per day (4,805 million liters per day). About 8 percent is from ground water sources, and 92 percent is from surface water sources. In many years the moderate precipitation is adequate for crops and pasture, but in some years summer droughts reduce crop yields. Small ponds and reservoirs on individual farms are increasingly important sources of water for livestock. Surface water is abundant and of good quality in this area. Low flows during dry periods are a major limitation affecting use of the water. Large reservoirs have been constructed to augment riverflows. These reservoirs provide water for industrial use and public supplies. Water from the John Redmond Reservoir on the upper Neosho River is piped to a nuclear power plant for use in evaporative cooling.

In much of the area, shallow wells are the principal sources of water for domestic use and for livestock. The Douglas aquifer is utilized in the part of the area in Kansas. Water in this aquifer is hard but typically has less than 500 parts per million (milligrams per liter) total dissolved solids. The Keokuk-Reeds Spring and Roubidoux aquifers in the northeast corner of Oklahoma also are used. Water from the Roubidoux aquifer is low in total dissolved solids, having a median level of 280 parts per million (milligrams per liter), and it is used for public supply. This water is hard. There is no information available about the Keokuk-Reeds Spring aquifer. Water for irrigation and domestic use is pumped from alluvial aquifers in the southern end of this area, in Oklahoma. Deep wells, especially in the dolomite and minor sandstone layers in the Ozark aquifer in western Missouri, provide water for all uses. The Ozark water has a median concentration of 322 parts per million (milligrams per liter) total dissolved solids.

Soils

The dominant soil orders in this MLRA are Mollisols and Alfisols. The MLRA also has small areas of Vertisols. The soils in the area dominantly have a thermic soil temperature regime, an aquic or udic soil moisture regime, and mixed or smectitic mineralogy. They generally are moderately deep to very deep, well drained to poorly drained, and loamy or clayey. Hapludolls formed in alluvium on flood plains (Verdigris series) and in residuum on uplands (Zaar series). Argiudolls formed in residuum (Bates, Catoosa, Clareson, and Eram series) and colluvium mixed with residuum (Dennis, Martin, and Summit series) on uplands. Argiudolls (Kenoma series), Albaqualfs (Parsons series), and Argiaquolls (Woodson series) formed in old alluvium on plains. Hapludalfs formed in residuum (Barco and Barden series). Epiaquerts (Osage series) formed in alluvium on flood plains and stream terraces.

Biological Resources

The western part of this area generally supports tall prairie grasses. Big bluestem, little bluestem, Indiangrass, and switchgrass are the main species. The eastern part of the area and the valleys in the western part support natural vegetation characterized by trees, mainly red oak, white oak, and shagbark hickory. Islands of tall prairie grasses are common.

Some of the major wildlife species in this area are white-tailed deer, cottontail rabbit, fox squirrel, bobwhite quail, and mourning dove. The species of fish in the area include bass, bluegill, crappie, carp, channel catfish, black bullhead, and flathead catfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 35%
Grassland—private, 43%; Federal, 1%
Forest—private, 11%
Urban development—private, 6%
Water—private, 2%
Other—private, 2%

Nearly all of this area is farmed. Winter wheat, soybeans, corn, grain sorghum, other feed grains, and hay are the major crops. Some cotton is grown in a few counties in Oklahoma. More than two-fifths of the area supports pasture grasses and legumes. Native grasses grow in the more sloping areas. Forested areas are on the steeper valley slopes and on some of the wet bottom land. The forested acreage is considerably less in Kansas than in Missouri and Oklahoma.

The major resource concerns on cropland are water erosion, maintenance of the content of organic matter in the soils, surface compaction, and low pH in the soils. The major resource concerns on pasture and rangeland are plant productivity, health, and vigor and noxious and invasive plants. Conservation practices on cropland generally include high-residue crops in the cropping system, systems of crop residue management (such as no-till, strip-till, and mulch-till systems), a combination of gradient terraces and grassed waterways, contour farming, conservation crop rotations, and nutrient and pest management. Conservation practices on rangeland generally include prescribed grazing, brush management, and proper distribution of watering facilities. ■

113—Central Claypan Areas

This MLRA is in two separate areas (fig. 113-1). One area is in Illinois (69 percent), and the other is in Missouri (31 percent). The MLRA makes up about 12,790 square miles (33,150 square kilometers). It includes the towns of Moberly and Mexico, Missouri, and Effingham, Mount Vernon, Centralia, Herrin, Marion, and Carbondale, Illinois. Interstates 57 and 64 cross near the center of the area in Illinois. Interstate 70 crosses the extreme northern part of the area in Missouri. Parts of the Shawnee National Forest, Crab Orchard National Wildlife Refuge, and a Federal prison near the refuge are in the southern end of the area in Illinois.

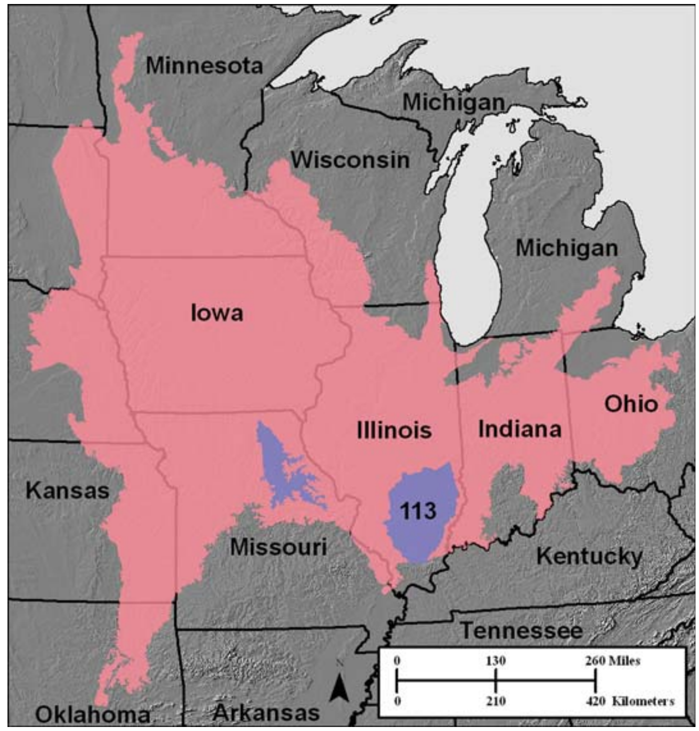

Figure 113-1: Location of MLRA 113 in Land Resource Region M.

Physiography

The part of this area in Illinois is in the Till Plains Section of the Central Lowland Province of the Interior Plains. The part in Missouri is in the Dissected Till Plains Section of the same province and division. This MLRA consists of nearly level to gently sloping, old till plains. Stream valleys are shallow and generally are narrow. Elevation is 660 to 980 feet (200 to 300 meters) in Missouri and about 660 feet (200 meters) in Illinois, increasing gradually from south to north in both States. Local relief is generally low on the broad, flat till plains and flood plains and high on the dissected hills bordering rivers or drainage systems. It is mainly 5 to 10 feet (1.5 to 3 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Wabash (0512), 36 percent; Upper Mississippi-Kaskaskia-Meramec (0714), 28 percent; Upper Mississippi-Salt (0711), 26 percent; Lower Ohio (0514), 6 percent; and Lower Missouri (1030), 4 percent. The Kaskaskia, Little Muddy, Little Wabash, Embarras, and Saline Rivers are in the part of this area in Illinois. Mark Twain Lake, a major reservoir on the Salt River, and the North and West Forks of the Cuivre River are in the part of the area in Missouri.

Geology

This MLRA is covered with loess, which overlies old (pre-Wisconsin) glacial drift that has a high content of clay. Pennsylvanian limestone and shale bedrock underlies the glacial till in both Missouri and Illinois.

Climate

The average annual precipitation in most of this area is 36 to 46 inches (915 to 1,170 millimeters). About 60 percent of the precipitation falls as high-intensity, convective thunderstorms during the freeze-free period. Snow may fall occasionally in winter, but it does not remain on the ground for very long periods. The average annual temperature is 51 to 57 degrees F (11 to 14 degrees C). The freeze-free period averages about 205 days and ranges from 190 to 225 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 26.5%; ground water, 4.1%
Livestock—surface water, 0.2%; ground water, 0.2%
Irrigation—surface water, 0.0%; ground water, 2.1%
Other—surface water, 62.5%; ground water, 4.3%

The total withdrawals average 450 million gallons per day (1,705 million liters per day). About 11 percent is from ground water sources, and 89 percent is from surface water sources. In most years the moderate precipitation is adequate for crops. Most of the soils are somewhat poorly drained or poorly drained, however, and claypans prevent effective artificial drainage of most of them. Reservoirs have been built on the larger rivers in this area to provide drinking water and water for industries. The surface water in the area also is used for cooling thermoelectric plants and in mineral extraction. It generally is of good quality.

Small to moderate quantities of ground water are available in this area. The supply of ground water from glacial drift in Missouri is small, undependable, and of poor quality (because of high concentrations of naturally occurring salts). Wells in the Pennsylvanian-Mississippian sediments in the part of this area in Illinois produce low yields. Little is known about the quality of the water in this aquifer.

Soils

The dominant soil order in this MLRA is Alfisols. The soils in the area dominantly have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed or smectitic mineralogy. They generally are very deep, well drained to poorly drained, and loamy or clayey. Hapludalfs formed in loess and/or pedisediment over till on uplands (Armstrong, Hoyleton, and Keswick series) and in till on till plains (Hickory series). Fragiudalfs (Ava series) formed in loess and/or pedisediment over till on uplands. Epiaqualfs formed in loess over pedisediment (Bluford and Mexico series) and loess over till (Leonard series) on uplands. Albaqualfs formed in loess (Putnam series), loess over pedisediment (Cisne series), and loess and/or pedisediment over till (Wynoose series) on uplands.

Biological Resources

When this MLRA was settled, most of the level soils on uplands supported tall prairie grasses, mainly big bluestem, Indiangrass, prairie dropseed, and switchgrass. The present potential for natural vegetation on these soils is unknown. Forests of post oak, swamp white oak, blackjack oak, and pin oak grow on poorly drained soils. White oak, shingle oak, black oak, hickory, white ash, basswood, sugar maple, elm, and walnut grow on the better drained soils. Silver maple, willows, cottonwood, sycamore, elm, pin oak, white oak, hickory, and ash grow on flood plains.

Some of the major wildlife species in this area are white-tailed deer, coyote, turkey, and bobwhite quail. The species of fish in the area include carp, catfish, largemouth bass, bluegill, crappie, and sunfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 67%
Grassland—private, 10%; Federal, 1%
Forest—private, 13%
Urban development—private, 5%
Water—private, 2%
Other—private, 2%

Nearly all of this MLRA is farmed. Corn, soybeans, other feed grains, and hay for cattle and other livestock are the main crops. The grassland in the area supports introduced and native grasses. The forested areas are mainly on the steeper slopes and on wet bottom land.

The major soil resource concerns are wetness, water erosion, flooding, a limited available water capacity, and maintenance of the content of organic matter and productivity of the soils, particularly the soils with a high content of sodium. Conservation practices on cropland generally include surface and subsurface drainage systems, crop residue management, filter strips, cover crops, and nutrient and pest management. ■

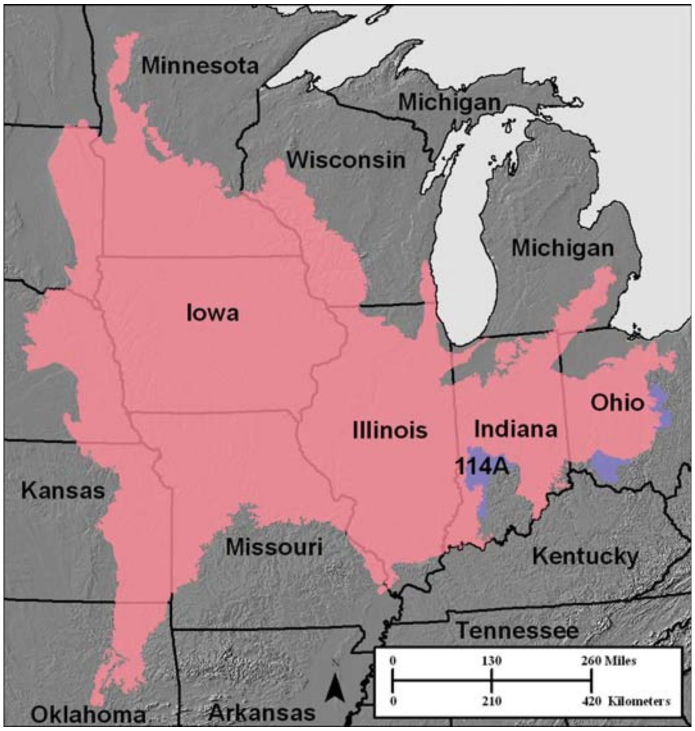

Figure 114A-1: Location of MLRA 114A in Land Resource Region M.

114A—Southern Illinois and Indiana Thin Loess and Till Plain, Eastern Part

This area (shown in fig. 114A-1) is in three separate areas, one in Indiana (55 percent) and two in Ohio (45 percent). The MLRA makes up about 4,550 square miles (11,795 square kilometers). It includes the towns of North Vernon, Seymour, Versailles, Madison, and New Albany, Indiana, and Fayetteville, Batavia, and Hillsboro, Ohio. Cincinnati, Ohio, is just west of this area, and Louisville, Kentucky, is just outside the extreme southwest corner of the area. Interstate 74 crosses the northern part of the area, and Interstate 65 crosses the central part from north to south in Indiana. The Clark and Clifty Falls State Parks, James F.D. Lanier Historical Site, Jackson-Washington State Forest, Starve Hollow State Beach, Hardy Lake State Recreational Area, Muscatatuck and Big Oaks National Wildlife Refuges, and Versailles State Park are in the part of this area in Indiana, and Stonelick, East Fork, and Cowan State Parks and Fort Hill State Memorial are in the part in Ohio. The Jefferson Proving Ground Military Reservation is in the part in Indiana.

Physiography

The three parts of this area are mostly in the Till Plains Section of the Central Lowland Province of the Interior Plains. The western third of the western part is in the Highland Rim Section of the Interior Low Plateaus Province of the Interior Plains. The eastern half of the eastern part is in the Kanawha Section of the Appalachian Plateaus Province of the Appalachian Highlands. Both large and small tributaries of the Ohio River dissect the nearly level to very steep glaciated uplands in this area. The major streams and rivers have well defined valleys with broad flood plains and numerous stream terraces. The flood plains along the smaller streams are narrow. Broad summits are nearly level to gently sloping. Elevation ranges from 320 feet (100 meters) on the southernmost flood plain along the Ohio River to 1,250 feet (380 meters) on the highest ridges. Local relief is mainly 10 to 50 feet (3 to 15 meters), but it can be 50 to 100 feet (15 to 30 meters) along drainageways and streams. Also, the Ohio River bluffs are as much as 300 feet (90 meters) above the river valley floor.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Middle Ohio (0509), 33 percent; Wabash (0512), 33 percent; Muskingum (0504), 16 percent; Lower Ohio (0514), 9 percent; Great Miami (0508), 4 percent; Scioto (0506), 3 percent; and Upper Ohio (0503), 2 percent. The Ohio River flows along the southernmost boundary of this area, forming the State boundary between Indiana and Kentucky and between Ohio and Kentucky. The Ohio River flows southwest and empties into the Mississippi River to the west of this area, in southern Illinois. The Muscatatuck, East Fork White, and Laughery Rivers are the major drainage systems in the part of this MLRA in Indiana. The White Oak River is the primary drainage in the part in Ohio. The Little Miami River, a National Wild and Scenic River, flows along the west edge of this area in Ohio.

Geology

This area is covered with Illinoian-age loess and glacial till or outwash. The loess ranges from about 3 to 7 feet (1 to 2 meters) in thickness on stable summits and does not occur on some of the steeper slopes. Acid outwash and alluvial deposits are on some of the stream terraces along the major tributaries. The loess and glacial drift deposits are underlain by several bedrock systems. Middle Devonian to Early and Middle Mississippian bedrock occurs in the western part of the area; Ordovician, Silurian, and Devonian bedrock occurs in the southeastern part; and Middle to Late Mississippian bedrock occurs in the northeastern part. Bedrock outcrops are common on the bluffs along rivers and the major tributaries. They also are evident at the base of steep slopes along minor streams and drainageways.

Climate

The average annual precipitation in most of this area is 37 to 46 inches (940 to 1,170 millimeters). About 60 percent of the precipitation falls during the freeze-free period. Most of the rainfall occurs as high-intensity, convective thunderstorms during summer. Snowfall is common in winter. The average annual temperature is 48 to 57 degrees F (9 to 14 degrees C). The freeze-free period averages about 190 days and ranges from 155 to 225 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 1.9%; ground water, 2.8%
Livestock—surface water, 0.1%; ground water, 0.2%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 94.0%; ground water, 0.8%

The total withdrawals average 1,180 million gallons per day (4,465 million liters per day). About 4 percent is from ground water sources, and 96 percent is from surface water sources. In most years the supply of moisture is adequate for crop production, but in some years yields are reduced by drought. The many springs and streams are sources of surface water in this area. Some water for livestock is stored in small ponds and reservoirs. The larger rivers and reservoirs provide water for industrial and municipal uses and for cooling thermoelectric power plants. A few large streams are used mostly for recreation. The surface water in the area is suitable for almost all uses.

Ground water is used mostly for domestic purposes in this area, but some communities away from surface water sources use ground water for public, municipal, and industrial supplies. The primary source of ground water in the part of this area in Indiana is the fractured limestone in the Silurian-Devonian aquifer. The median level of total dissolved solids in the water in this aquifer is 513 parts per million (milligrams per liter), and the water is very hard. Also, its median level of iron is about 1,100 parts per billion (micrograms per liter), which is over three times the national secondary (esthetic) standard for drinking water. Many communities and rural landowners in Ohio rely on wells in the Shaly Carbonate aquifer, which lies beneath the glacial drift. This aquifer has water that is very similar in quality to the water in the bedrock aquifer in Indiana, but iron is not a problem.

Soils

The dominant soil orders in this MLRA are Alfisols and Inceptisols. The MLRA also has small areas of Entisols. The soils in the area have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. They formed in loess, Illinoian glacial till or outwash, and alluvium derived from these deposits. The soils are deep or very deep, poorly drained to well drained, and loamy, silty, or clayey. Glossaqualfs (Avonburg, Clermont, and Cobbsfork series) are on broad, flat till plains. Fragiudalfs (Cincinnati, Homewood, Nabb, and Rossmoyne series) are on gently sloping to strongly sloping side slopes on till plains. Hapludalfs (Blocher, Bonnell, and Hickory series) are on moderately sloping to very steep side slopes on till plains. Hapludalfs (Cana, Grayford, and Jessup series), Paleudalfs (Ryker series), and Fragiudalfs (Weisburg series) are on gently sloping to steep side slopes that are underlain by bedrock residuum. Paleudalfs (Negley series), Hapludalfs (Parke and Pike series), and Fragiudalfs (Medora series) formed in outwash deposits on high stream terraces, kames, and moraines. Fragiudalfs (Otwell and Haubstadt series) and Fragiaqualfs (Dubois series) formed in a thin layer of loess and the underlying weathered outwash, lacustrine sediments, or old alluvium on high stream terraces or lake plains. Eutrudepts (Haymond, Oldenburg, Wilbur, and Wirt series), Endoaquepts (Holton and Stendal series), and Fluvaquents (Birds, Bonnie, and Wakeland series) formed in alluvium on flood plains.

Biological Resources

The soils on uplands support natural hardwoods. Oak, hickory, beech, and sugar maple are the dominant species. Some native grasses grow between the oak trees on some sites. The lowland soils support mixed forest vegetation. Pin oak, shingle oak, sweetgum, and black oak are the dominant species on the wetter sites. White oak, black oak, red oak, hickory, yellow-poplar, ash, sugar maple, and black walnut grow on the better drained sites. Honeylocust is dominant on soils that formed in shaly limestone residuum. Silver maple, cottonwood, sycamore, pin oak, elm, and sweetgum grow along rivers and streams. Black walnut is abundant on deep, well drained soils on some small flood plains. Sedge and grass meadows and scattered trees are on some lowland sites.

Some of the major wildlife species in this area are white-tailed deer, coyote, gray fox, red fox, beaver, raccoon, skunk, muskrat, opossum, mink, rabbit, fox squirrel, gray squirrel, Canada goose, turkey vulture, turkey, woodcock, great horned owl, wood duck, pileated woodpecker, red-bellied woodpecker, and bobwhite quail.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 61%
Grassland—private, 9%
Forest—private, 17%
Urban development—private, 8%
Water—private, 2%
Other—private, 3%

Most of this area is in privately owned farms. The farms produce both cash-grain crops and livestock. The less sloping soils are used for dry-farmed corn for grain and for soybeans. Some small grains, including winter wheat, oats, and grain sorghum, also are grown. Specialty crops, such as tobacco and apple orchards, make up a small acreage in the area. The grassland in the area supports introduced and native grasses.

The major soil resource concerns are water erosion, flooding, wetness, a limited available water capacity, and maintenance of the content of organic matter and productivity of the soils. Conservation practices on cropland generally include surface and subsurface drainage systems, crop residue management, filter strips, cover crops, and nutrient and pest management. Woodland management practices, such as exclusion of grazing and timber stand improvement, are important for timber production. ■

114B—Southern Illinois and Indiana Thin Loess and Till Plain, Western Part

This area (shown in fig. 114B-1) is in two separate areas in Illinois (66 percent) and Indiana (34 percent). It makes up about 7,005 square miles (18,150 square kilometers). It includes the towns of Brazil, Bloomfield, Cloverdale, and Spencer, Indiana, and Carlyle, Nashville, Hillsboro, Greenville, Vandalia, and Pinckneyville, Illinois. Interstates 55, 64, and 70 cross the part of the MLRA in Illinois. They converge in St. Louis, which is just west of this MLRA. The east edge of the Scott Air Force Base is on the western edge of the area in Illinois. The numerous State parks in the MLRA include Eldon Hazlet, South Shore, and Pyramid State Parks in Illinois and Cagles Mill and McCormick's Creek State Parks in Indiana.

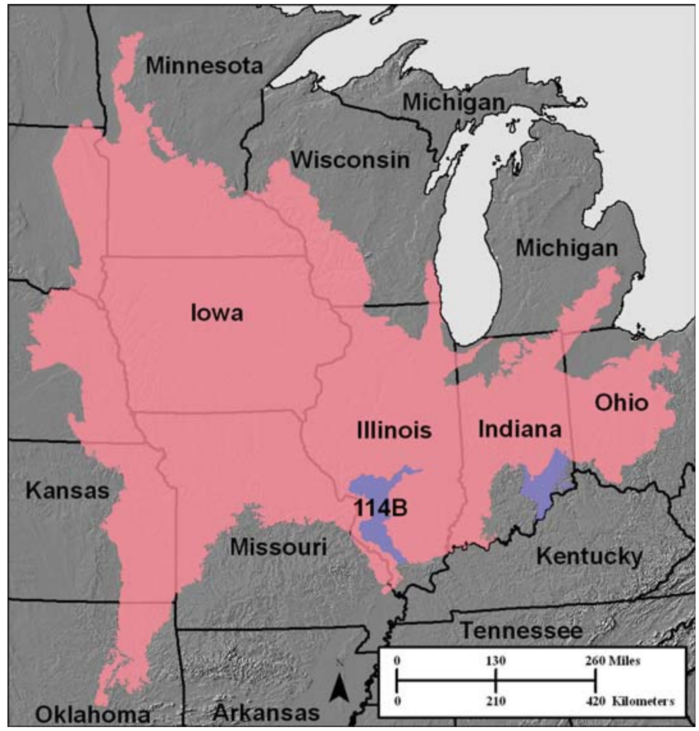

Figure 114B-1: Location of MLRA 114B in Land Resource Region M.

Physiography

This area is in the Till Plains Section of the Central Lowland Province of the Interior Plains. Both large and small tributaries of the West Fork of the White River, the Eel River, the Kaskaskia River, and the Little Muddy River dissect the nearly level to very steep uplands. Well defined valleys with broad flood plains and numerous stream terraces are along the major streams and rivers. The flood plains along the smaller streams are narrow. Broad summits are nearly level to gently sloping. Elevation ranges from 350 feet (105 meters) on the southernmost flood plains along the Ohio and Wabash Rivers to 1,190 feet (365 meters) on the highest ridges. Local relief is mainly 10 to 50 feet (3 to 15 meters), but it can be 50 to 100 feet (15 to 30 meters) along drainageways and streams. It generally is low on broad, flat till plains and flood plains and high on the dissected hills bordering rivers or drainage systems.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Mississippi-Kaskaskia-Meramec (0714), 45 percent; Wabash (0512), 34 percent; Lower Illinois (0713), 18 percent; and Upper Mississippi-Salt (0711), 3 percent. The Macoupin, Shoal, and Kaskaskia Rivers drain the part of the area in Illinois. The West Fork of the White River and the Eel River flow westward through the central part of the area in Indiana and empty into the Wabash River south of Vincennes, which is west of this MLRA.

Geology

This area is covered dominantly with loess and Illinoian till. The loess ranges from about 4 to 7 feet (1 to 2 meters) in thickness on stable summits. On the steeper slopes, it is 1 foot or less (0.1 to 0.3 meter) thick or does not occur. Meltwater outwash and lacustrine and alluvial deposits are along some of the streams and on terraces along the major tributaries. The glacial till and loess deposits are underlain by several bedrock systems. Middle and Late Mississippian bedrock occurs in the eastern part of the area, and Early and Middle Pennsylvanian bedrock occurs in the western part. Bedrock outcrops are common on the bluffs along the large rivers and their major tributaries. They also occur at the base of some steep slopes along minor streams and drainageways.

Climate

The average annual precipitation in most of this area is 37 to 46 inches (940 to 1,170 millimeters). About 60 percent of the precipitation falls during the freeze-free period. Most of the rainfall occurs as high-intensity, convective thunderstorms during summer. Snowfall is common in winter. The average annual temperature is 52 to 56 degrees F (11 to 14 degrees C).

The freeze-free period averages about 210 days and ranges from 190 to 225 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 91.9%; ground water, 1.8%
Livestock—surface water, 0.4%; ground water, 1.8%
Irrigation—surface water, 0.6%; ground water, 3.4%
Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average 79 million gallons per day (300 million liters per day). About 7 percent is from ground water sources, and 93 percent is from surface water sources. In most years the supply of moisture is adequate for maximum crop production, except on sandy soils. The many springs, streams, and farm ponds are additional sources of surface water in this area. Some water for livestock is stored in small ponds and reservoirs. The larger rivers and reservoirs provide water for industrial and municipal uses and some limited irrigation. A few large streams are used mostly for recreation. The surface water in the area is suitable for almost all uses. Water quality is a concern in sandy areas of the MLRA.

Abundant ground water occurs only in deposits of unconsolidated sand and gravel along the East and West Forks of the White River in Indiana and along the Kaskaskia River in Illinois. These aquifers provide water for the domestic, livestock, municipal, and industrial needs in the area. Some irrigation water is pumped. The average values of total dissolved solids are 546 and 500 parts per million (milligrams per liter) in Indiana and Illinois, respectively, and the water is very hard. The water is very low in iron in Indiana, but it exceeds the secondary (esthetic) standard for drinking water in Illinois.

Away from the river valley deposits, the only source of ground water in Illinois is the Pennsylvanian-Mississippian aquifer. Water from this aquifer is very hard and has high amounts of iron. The level of total dissolved solids is 500 to 3,000 parts per million (milligrams per liter). In Indiana, the only other source of ground water is in isolated lenses of sand and gravel buried in older glacial till outside the river valleys. This water is very hard and high in iron, but it has lower levels of total dissolved solids than the water in the other aquifers. The low quantities of ground water from the other aquifers are used primarily for domestic purposes and for watering livestock.

Soils

The dominant soil orders in this MLRA are Alfisols and Inceptisols. The MLRA also has small areas of Mollisols, Ultisols, and Entisols. The soils in the area have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed or smectitic mineralogy. Most are medium textured or fine textured.

Somewhat poorly drained or poorly drained Albaqualfs (Cowden and Marine series), Endoaqualfs (Iva and Oconee series), Epiaqualfs (Hoosierville series), Glossaqualfs (Vigo series), and Argiudolls (Herrick series) are on broad, loess-covered till plains. Moderately well drained, gently sloping to strongly sloping Fragiudalfs are on side slopes on loess-covered till plains (Ava, Cincinnati, Hosmer, and Shakamak series) and on side slopes that are underlain by bedrock residuum (Grantsburg series). Somewhat poorly drained and moderately well drained, gently sloping to strongly sloping Hapludalfs (Blair, Bunkum, Fishhook, and Homen series) and Epiaqualfs (Atlas series) are on side slopes that are underlain by paleosols or pedisediments. Well drained, strongly sloping to very steep Hapludalfs (Hickory series) are on side slopes on till plains. Well drained Paleudalfs (Negley series), Hapludults (Chetwynd series), and Hapludalfs (Parke and Pike series) formed in outwash deposits on high stream terraces, kames, and moraines. Moderately well drained Fragiudalfs (Otwell and Haubstadt series) and somewhat poorly drained Fragiaqualfs (Dubois series) formed in a thin layer of loess and in the underlying weathered outwash, lacustrine sediments, or old alluvium. They are on high stream terraces and lake plains. Somewhat poorly drained to well drained, nearly level to strongly sloping Epiaqualfs (Hurst and McGary series) and Hapludalfs (Colp, Shircliff, and Markland series) formed in lacustrine sediments on lacustrine terraces and lake plains. Well drained to poorly drained Eutrudepts (Haymond and Wilbur series), Endoaquepts (Belknap, Piopolis, and Stendal series), and Fluvaquents (Birds, Bonnie, and Wakeland series) formed in alluvium on flood plains. Udorthents (Bethesda, Fairpoint, and Morristown series) and Udarents (Lenzburg, Minnehaha, Schuline, and Swanwick series) formed in regolith from surface-mining operations.

Biological Resources

The soils on uplands in this area support natural hardwoods. Oak, hickory, beech, and sugar maple are the dominant species. Native grasses grow in some scattered areas between the trees. The soils on lowlands support mixed forest vegetation. Pin oak, shingle oak, hickory, sweetgum, and black oak are the dominant species on the wetter sites. White oak, black oak, red oak, hickory, yellow-poplar, ash, sugar maple, and black walnut grow on the better drained sites. Honeylocust is dominant on soils that formed in shaly limestone residuum. Silver maple, cottonwood, sycamore, pin oak, elm, and sweetgum grow along rivers and streams. Black walnut is abundant on deep, well drained soils on some small flood plains. Sedge and grass meadows and scattered trees are on some lowland sites.

Some of the major wildlife species in this area are white-tailed deer, coyote, gray fox, red fox, beaver, raccoon, skunk, muskrat, opossum, mink, rabbit, fox squirrel, gray squirrel, Canada goose, turkey vulture, turkey, woodcock, great horned owl, wood duck, pileated woodpecker, red-bellied woodpecker, and bobwhite quail.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 47%
Grassland—private, 11%; Federal, 1%
Forest—private, 27%; Federal, 2%
Urban development—private, 7%; Federal, 1%
Water—private, 2%
Other—private, 2%

Most of this area is in privately owned farms, which produce both cash-grain crops and livestock. The less sloping soils are used for dry-farmed corn for grain and for soybeans. Some small grains, dominantly winter wheat and grain sorghum, also are grown in the area. A small acreage is used for specialty crops, such as popcorn and apple orchards. The grassland in the area supports introduced and native grasses. Nearly 30 percent of the area is forested. Surface coal mines make up a small acreage of this MLRA.

The major soil resource concerns are wind erosion, water erosion, flooding, wetness, a limited available water capacity, and maintenance of the content of organic matter and productivity of the soils. Conservation practices on cropland generally include surface and subsurface drainage systems, crop residue management, filter strips, cover crops, and nutrient and pest management. Woodland management practices, such as exclusion of grazing and timber stand improvement, are important for timber production. ■

115A—Central Mississippi Valley Wooded Slopes, Eastern Part

This area (shown in fig. 115A-1) is primarily in Indiana (63 percent) and Illinois (37 percent). It makes up about 3,690 square miles (9,565 square kilometers). It includes the towns of Evansville, Sullivan, Vincennes, and Princeton, Indiana; parts of Terre Haute, Indiana; and Marshall, Newton, Robinson, Lawrenceville, Olney, Mt. Carmel, Carmi, and Shawneetown, Illinois. Interstate 64 crosses the southern part of this area, and Interstate 70 crosses the northern part. U.S. Highway 41 parallels the Illinois-Indiana State border in the part of this area in Indiana. The George Rogers Clark National Historic Park, Harmonie State Park, New Harmony State Memorial, and Hovey Lake State Game Reserve are in the part of the area in Indiana.

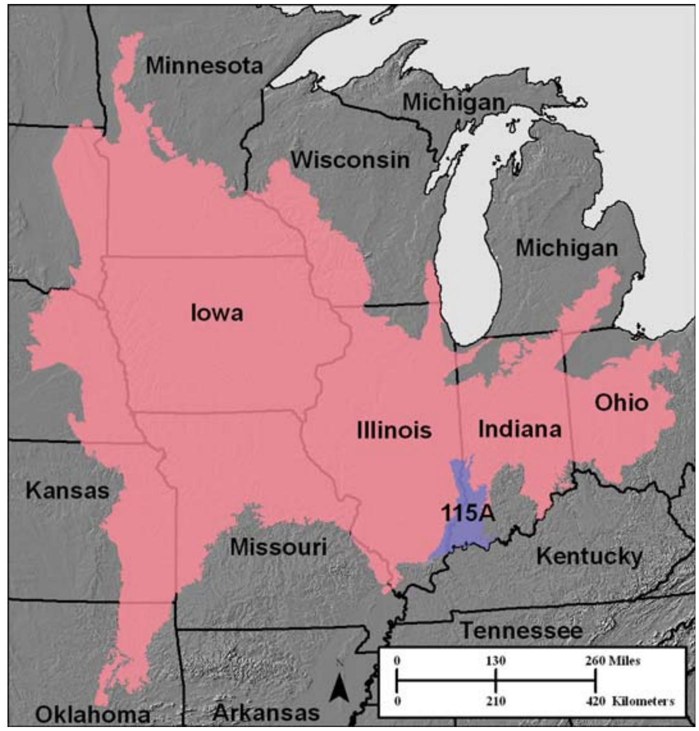

Figure 115A-1: Location of MLRA 115A in Land Resource Region M.

Lincoln Trail State Park is in the part in Illinois. The Shawnee National Forest is just outside the southern end of the part in Illinois.

Physiography

Most of this area is in the glaciated Till Plains Section of the Central Lowland Province of the Interior Plains. The southeast corner is in the Highland Rim Section (locally known as the Shawnee Hills Section) of the Interior Low Plateaus Province of the Interior Plains. The nearly level to very steep uplands in this MLRA are dissected by both large and small tributaries of the Wabash and Ohio Rivers. Well defined valleys with broad flood plains and numerous stream terraces are along the major streams and rivers. The flood plains along the smaller streams are narrow. Broad summits are nearly level to gently sloping. Elevation ranges from 320 feet (100 meters) on the southernmost flood plains along the Ohio and Wabash Rivers to 1,020 feet (310 meters) on the highest ridges. Relief is generally 10 to 50 feet (3 to 15 meters) in the undulating or rolling loess hills. It can be 50 to 150 feet (15 to 45 meters) in the steep, deeply dissected hills bordering rivers or drainage systems. The nearly level flood plains have very little relief.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Wabash (0512), 82 percent, and Lower Ohio (0514), 18 percent. The Wabash River flows southward through this area, forming the boundaries between Indiana and Illinois. The Ohio River flows along the southern border of the area, forming the boundaries between Indiana and Kentucky and between Illinois and Kentucky. From north to south, the major rivers in the part of the area in Illinois are the Mill, Embarras, Bonpas, and Little Wabash Rivers. The White River flows westward through the central part of the area and empties into the Wabash River south of Vincennes, Indiana.

Geology

This area is covered almost entirely with Wisconsin loess. The loess can be more than 7 feet (2 meters) thick on stable summits. On the steeper slopes, it is thin or does not occur. The loess throughout the area is underlain dominantly by glacial till. Wisconsin outwash, alluvial deposits, and sandy eolian material are on some of the stream terraces and on dunes along the major tributaries in the area. The loess and glacial drift are underlain by Pennsylvanian-age bedrock. Bedrock outcrops are common in the walls of the valleys along the Wabash and Ohio Rivers and at the base of some steep slopes along minor streams and drainageways.

Climate

The average annual precipitation in most of this area is 40 to 47 inches (1,015 to 1,195 millimeters). About 60 percent of the precipitation falls during the freeze-free period. Most of the rainfall occurs as high-intensity, convective thunderstorms in summer. Snowfall is common in winter. The average annual temperature is 53 to 57 degrees F (11 to 14 degrees C). The freeze-free period averages 210 days and ranges from 200 to 225 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 3.1%; ground water, 0.6%
Livestock—surface water, 0.1%; ground water, 0.2%
Irrigation—surface water, 0.2%; ground water, 0.2%
Other—surface water, 93.1%; ground water, 2.6%

The total withdrawals average 855 million gallons per day (3,235 million liters per day). About 4 percent is from ground water sources, and 96 percent is from surface water sources. In most years the supply of moisture is adequate for crop production, but in some years yields are reduced by drought, especially on the sandy soils. The many springs, streams, and farm ponds in the area are additional sources of surface water. Some water for livestock is stored in small ponds and reservoirs. The larger rivers provide water for industrial and municipal uses and for some limited irrigation. Also, water from the Ohio River is used for cooling thermoelectric power plants in Illinois. The Ohio River is a major transportation artery, and the Ohio and Wabash Rivers are used for recreation. The surface water in the area is suitable for almost all uses. Water quality is a concern in sandy areas.

Abundant ground water occurs only in deposits of unconsolidated sand and gravel along the Ohio River, the lower White River, and the Wabash River. These aquifers provide water for domestic use, livestock, municipal and industrial needs, and some limited irrigation. The average values of total dissolved solids are close to 500 parts per million (milligrams per liter), and the water is very hard. The water in Indiana is much lower in iron than the water in Illinois.

Away from the river valley deposits, the only source of ground water in Illinois is the Pennsylvanian-Mississippian aquifer. Water from this aquifer is very hard and has high amounts of iron. The level of total dissolved solids is 500 to 3,000 parts per million (milligrams per liter). In Indiana, the only source of ground water outside the river valleys is in isolated lenses of sand and gravel buried in older glacial till. This water is very hard and high in content of iron, but it has lower levels of total dissolved solids than the water in the other aquifers. The low quantities of ground water from these aquifers are used primarily for domestic purposes and for watering livestock.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Inceptisols, and Mollisols. The soils in the area have a mesic soil temperature regime, a udic or aquic soil moisture regime, and dominantly mixed or smectitic mineralogy. The soils are very deep, poorly drained to excessively drained, and loamy, silty, or clayey.

Nearly level Endoaqualfs (Iva series) and Argiaquolls (Ragsdale series) formed in loess on broad upland summits and flats. Nearly level to steep Hapludalfs (Alford, Iona, Muren, Stoy, and Sylvan series) and Fragiudalfs (Hosmer series) formed in loess on uplands. Hapludalfs (Alvin, Bloomfield, and Princeton series) and Argiudolls (Ade series) formed in sandy eolian material in areas of dunes on uplands and stream terraces. Steep and very steep Hapludalfs (Hickory series) formed in Illinoian till along the major streams and dissected upland drainageways. Hapludalfs (Wellston series) formed in siltstone or sandstone residuum on strongly sloping to steep side slopes underlain by bedrock. The soils in the major stream valleys include Hapludolls (Carmi series), Argiudolls (Elston series), and Hapludalfs (Skelton series), all of which formed in outwash on nearly level to moderately sloping stream terraces and outwash plains. Endoaquolls (Montgomery series), Endoaquepts (Zipp series), Epiaqualfs (McGary series), and Hapludalfs (Shircliff and Markland series) formed in clayey lacustrine sediments on nearly level to strongly sloping lacustrine terraces or lake plains. Endoaquepts (Evansville series), Endoaquolls (Patton series), and Hapludalfs (Henshaw and Uniontown series) formed in silty sediments on terraces and lake plains.

Endoaquolls (Beaucoup and Wabash series), Hapludolls (Armiesburg, Landes, and Tice series), Eutrudepts (Nolin series), and Endoaquepts (Petrolia series) formed in alluvium on nearly level, broad flood plains. Fluvaquents (Birds and Wakeland series) and Eutrudepts (Haymond and Wilbur series) are along the smaller upland drainageways. Udorthents (Bethesda, Fairpoint, Nawakwa, and Tapawingo series) and Udarents (Hollybrook, Minnehaha, and Swanwick series) formed in regolith from surface-mining operations.

Biological Resources

The uplands in this area support natural hardwoods. Oak, hickory, and sugar maple are the dominant species. Big bluestem, little bluestem, and scattered oak trees grow on some sites. The lowlands support mixed forest vegetation, mainly elm, cottonwood, river birch, ash, silver maple, sweetgum, sycamore, pin oak, pecan, and willow. Sedge and grass meadows and scattered trees are on some lowlands.

Some of the major wildlife species in this area are white-tailed deer, coyote, gray fox, red fox, beaver, raccoon, skunk, muskrat, opossum, mink, rabbit, fox and gray squirrels, Canada goose, bald eagle, turkey vulture, turkey, ruffed grouse, woodcock, great horned owl, wood duck, pileated and red-bellied woodpeckers, ring-necked pheasant, and bobwhite quail.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 69%
Grassland—private, 6%
Forest—private, 13%
Urban development—private, 6%
Water—private, 3%
Other—private, 3%

Most of this area is in privately owned farms, which produce both cash-grain crops and livestock. The less sloping soils are used for dry-farmed corn for grain and for soybeans. Some small grains, such as winter wheat and grain sorghum, also are grown in the area. A small acreage is used for specialty crops, such as vegetables, melons, potatoes, and apple and peach orchards. The grassland in the area supports introduced and native grasses. About 13 percent of the area is forested. Surface coal mines make up a small acreage of this MLRA.

The major soil resource concerns are wind erosion, water erosion, flooding, wetness, a limited available water capacity, and maintenance of the content of organic matter and productivity of the soils. Conservation practices on cropland generally include surface and subsurface drainage systems, crop residue management, filter strips, cover crops, and nutrient and pest management. Woodland management practices, such as exclusion of grazing and timber stand improvement, are important for timber production. ■

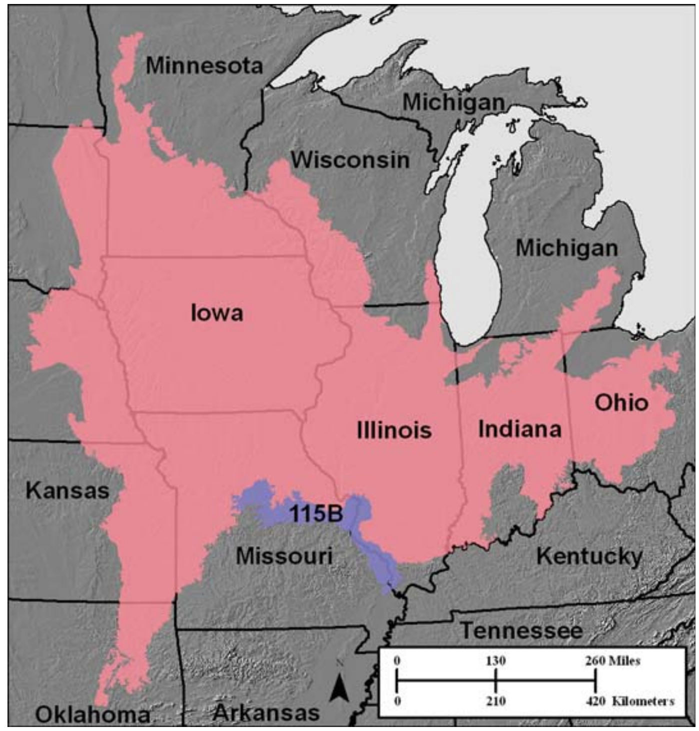

Figure 115B-1: Location of MLRA 115B in Land Resource Region M.

115B—Central Mississippi Valley Wooded Slopes, Western Part

This area (shown in fig. 115B-1) is in Missouri (78 percent) and Illinois (22 percent). It makes up about 8,085 square miles (20,955 square kilometers). It includes the towns or cities of Cape Girardeau, Columbia, Fayette, Fulton, Jackson, Jefferson City (the capital of Missouri), Ste. Genevieve, St. Louis, and Washington, Missouri, and East St. Louis, Edwardsville, and Chester, Illinois. Interstates 44, 55, 64, and 70 cross parts of this area. The Gateway Arch National Memorial in St. Louis and the Cahokia Mounds historical site are along the banks of the part of the Mississippi River in this MLRA. The Daniel Boone Memorial State Forest is in the part of the MLRA in Missouri. The Shawnee National Forest is in the part in Illinois.

Physiography

This area straddles the borders of five different physiographic regions. The northern one-fifth of the area in Missouri is in the glaciated Dissected Till Plains Section (locally known as the Springfield Plain) of the Central Lowland Province of the Interior Plains. The western end in Missouri is in the Osage Plains Section of the same province and division. The southern four-fifths of the area in Missouri is in the Springfield-Salem Plateaus Section of the Ozark Plateaus

Province of the Interior Highlands. The northeast part of the area in Illinois is in the Till Plains Section of the Central Lowland Province of the Interior Plains. The southeast corner of the MLRA is in the Highland Rim Section (locally known as the Shawnee Hills Section) of the Interior Low Plateaus Province of the Interior Plains.

This area consists mainly of the deeply dissected, loess-covered hills bordering the Missouri and Mississippi Rivers, their adjacent flood plains, and several relatively smooth, loess-mantled karst plains. It wraps around the northeast corner of the Ozark Uplift. The nearly level to very steep uplands are dissected by both large and small tributaries of the Mississippi River. Well defined valleys with broad flood plains and numerous stream terraces are along the major streams and rivers. The flood plains along the smaller streams are narrow. Broad summits are nearly level to gently sloping. Karst topography is common in this MLRA. The well developed karst areas have hundreds of sinkholes, caves, springs, and losing streams. In the St. Louis area, many of the karst features have been obliterated by urban development. Elevation ranges from 320 feet (100 meters) on the southernmost flood plain along the Mississippi River to 1,020 feet (310 meters) on the highest ridges. Local relief is mainly 10 to 50 feet (3 to 15 meters), but it is as much as 50 to 100 feet (15 to 30 meters) along drainageways and streams. Also, the bluffs along the Mississippi River are generally 200 to 350 feet (60 to 105 meters) above the floor of the river valley.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Missouri (1030), 49 percent; Upper Mississippi-Kaskaskia-Meramec (0714), 41 percent; Upper Mississippi-Salt (0711), 7 percent; and Gasconade-Osage (1029), 3 percent. The Mississippi River flows through this area, forming the boundary between Illinois and Missouri. The Kaskaskia, Muddy, and Meramec Rivers empty into the Mississippi River in the area. The Missouri River flows eastward through the northern part of the area and empties into the Mississippi River north of St. Louis. The Osage, Loutre, and Gasconade Rivers empty into the Missouri River in this MLRA.

Geology

The uplands in this area are covered almost entirely with Wisconsin loess. The loess is thick on stable summits. On the steeper slopes, it is thin or does not occur. The loess in the northeastern part of the MLRA is underlain by Illinoian glacial drift, the dominant drift in Illinois. Wisconsin outwash deposits, alluvium, and sandy eolian material are on some of the stream terraces along the major tributaries in the area. The glacial deposits are underlain by several bedrock systems. The Mississippian System is the most extensive. Cherty dolostone and limestone are the most common rock types in this system. The Ordovician System is most common in more dissected areas and consists mostly of sandstone, dolostone, and limestone. Shale, sandstone, limestone, and coal in the Pennsylvanian System occur in the northeastern part of the MLRA, in both Illinois and Missouri. Bedrock outcrops are common on the bluffs along the Mississippi River and its major tributaries and at the base of steep slopes along minor streams and valleys. Karst areas have formed where Mississippian or Ordovician limestone is near the surface. Many limestone and dolomite quarries are throughout the MLRA, and silica sand for industrial uses in glass and abrasives is mined from the Ordovician St. Peter Sandstone Formation in Missouri.

Climate

The average annual precipitation in most of this area is 38 to 48 inches (965 to 1,220 millimeters). About 60 percent of the precipitation falls during the freeze-free period. Most of the rainfall occurs as high-intensity, convective thunderstorms in summer. Snowfall is common in winter. The average annual temperature is 53 to 57 degrees F (12 to 14 degrees C). The freeze-free period averages 205 days and ranges from 185 to 230 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 18.4%; ground water, 1.8%
Livestock—surface water, 0.4%; ground water, 0.1%
Irrigation—surface water, 0.0%; ground water, 0.2%
Other—surface water, 77.3%; ground water, 1.8%

The total withdrawals average 1,685 million gallons per day (6,380 million liters per day). About 4 percent is from ground water sources, and 96 percent is from surface water sources. In most years the supply of moisture is adequate for crop production, but in some years yields are reduced by drought. Surface water is abundant in this MLRA. Water for livestock is stored in small ponds and reservoirs. The larger rivers provide water for public supply, industrial and municipal use, and some limited irrigation. Water from the two large rivers also is used for cooling thermoelectric power plants in Missouri. A growing number of lakes are being constructed in areas of urban development, especially in the St. Louis and Columbia, Missouri, areas. The Mississippi and Missouri Rivers are major transportation arteries and are used for recreation. Both rivers carry large sediment loads and have low-quality water. The waterflow is regulated by dams in the upper reaches of both rivers. Generally, the flow is highest in May and June and lowest in winter. Although most areas along the Missouri and Mississippi Rivers are protected by a levee system, flooding remains a major concern. The quality of surface water and ground water is a concern in karst areas and in urban areas. The quality is degraded by pesticides and nutrients in agricultural runoff.

This area has abundant ground water in deposits of unconsolidated sand and gravel along the Mississippi River, the lower reaches of the Meramac River, and the Missouri River. These aquifers provide water for domestic use, livestock, municipal and industrial needs, and some limited irrigation. The average values of total dissolved solids are close to 500 parts per million (milligrams per liter), but the water is very hard and may have high levels of iron. Away from the river valley deposits in Illinois, ground water can be obtained from the Pennsylvanian-Mississippian and Shallow Dolomite aquifers. The water from these aquifers is similar in quality to that in the river valley deposits, but the water in the Shallow Dolomite aquifer has lower levels of iron. Away from the river valley deposits in Missouri, ground water can be obtained from the Ozark aquifer, which is south of the Missouri River, and the Kimmswick-Potosi aquifer, which is north of the river. Both of these aquifers consist of dolomite with some sandstone beds. Their water has median levels of total dissolved solids that are less than 500 parts per million (milligrams per liter). The water is hard but is not typically high in iron. Because of the karst topography, contaminated water from surface activities has created some local water-quality problems in these bedrock aquifers.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Inceptisols, and Mollisols. The soils in the area have a mesic soil temperature regime, a udic or aquic soil moisture regime, and dominantly mixed or smectitic mineralogy. The soils are very shallow to very deep, poorly drained to excessively drained, and loamy, silty, or clayey.

Gently sloping to depressional Albaqualfs (Marine, Mariosa, and Pierron series), Hapludalfs (Marion series), and Endoaqualfs (Caseyville series) formed in loess on broad upland summits and flats. Gently sloping to steep Hapludalfs (Winfield, Menfro, Hatton, Wrengart, and Stookey series) formed in loess on uplands. Steep and very steep Hapludalfs (Hickory series) formed in Illinoian till along the major streams and dissected upland drainageways in the eastern part of this MLRA. Hapludalfs (Freeburg series) and Endoaqualfs (Moniteau series) formed in silty alluvium on terraces. The major stream valleys also have soils that formed in bedrock residuum and colluvium in steep or very steep areas on uplands. Hapludalfs (Minnith, Neotoma, Pevely, and Wellston series) and Paleudalfs (Holstein series) formed in siltstone or sandstone residuum. Paleudalfs (Goss series) and Lithic Hapludolls (Gasconade and Moko series) formed in limestone and dolostone residuum. Endoaquolls (Booker, Fults, Ambraw, Beaucoup, and Darwin series), Hapludolls (Landes, Tice, and Medway series), and Endoaquepts (Karnak series) formed in alluvium on nearly level, broad flood plains. The major soils on the flood plain along the Missouri River are Udifluvents (Blake and Haynie series), Fluvaquents (Waldron series), and Udipsamments (Hodge and Sarpy series). Fluvaquents (Wakeland series), Eutrudepts (Haymond and Wilbur series), and Hapludolls (Dameron and Cedargap series) are along the smaller upland drainageways. Udorthents (Harvester series) are the major soils in urban areas.

Biological Resources

The soils on uplands support natural hardwoods. Oak, hickory, and sugar maple are the dominant species. Big bluestem, little bluestem, and scattered oak and eastern redcedar trees grow on some sites. The soils on lowlands support mixed forest vegetation, mainly elm, cottonwood, river birch, ash, silver maple, sweetgum, sycamore, pin oak, pecan, and willow. Sedge and grass meadows and scattered trees are on some lowland sites.

Some of the major wildlife species in this area are white-tailed deer, coyote, gray fox, red fox, beaver, raccoon, skunk, muskrat, opossum, mink, rabbit, fox squirrel, gray squirrel, Canada goose, bald eagle, turkey vulture, turkey, ruffed grouse, woodcock, great horned owl, wood duck, pileated woodpecker, red-bellied woodpecker, ring-necked pheasant, and bobwhite quail.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 32%
Grassland—private, 18%; Federal, 1%
Forest—private, 28%; Federal, 1%
Urban development—private, 15%
Water—private, 3%
Other—private, 2%

Most of this area is in privately owned farms, which produce both cash-grain crops and livestock. The less sloping soils are used for dry-farmed corn for grain and for soybeans. Some small grains, such as winter wheat and grain sorghum, also are grown in the area. A small acreage is used for specialty crops, such as vegetables, Christmas trees, grape vineyards, and apple and peach orchards. The grassland in the area supports introduced and native grasses. Almost one-third of the area is forested.

The major resource concerns are water erosion, flooding, wetness, a limited available water capacity, maintenance of the content of organic matter and productivity of the soils, and surface water quality. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems), cover crops, terraces and grassed waterways, windbreaks, vegetative wind barriers, and pest and nutrient management. Woodland management practices, such as exclusion of grazing and timber stand improvement, are important for timber production. ■

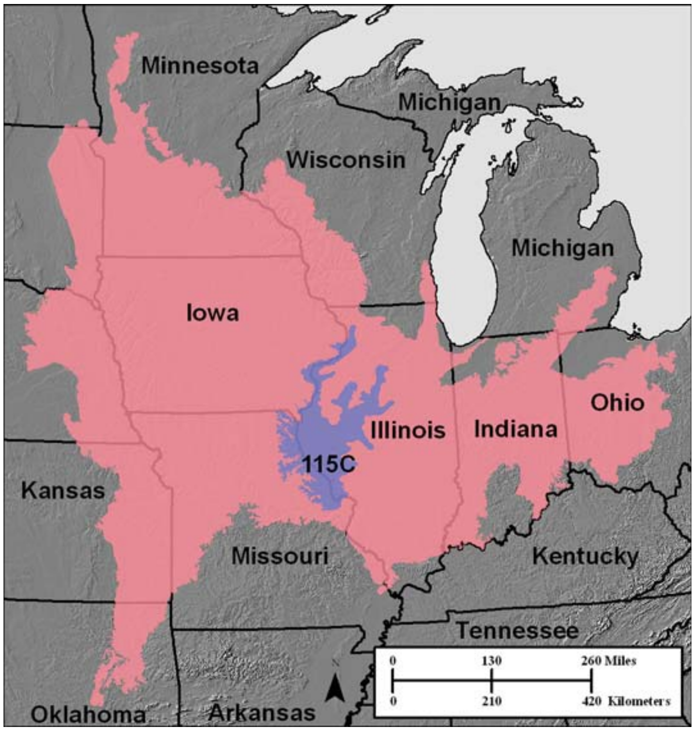

Figure 115C-1: Location of MLRA 115C in Land Resource Region M.

115C—Central Mississippi Valley Wooded Slopes, Northern Part

This area (shown in fig. 115C-1) is in Illinois (73 percent), Missouri (21 percent), and Iowa (6 percent). It makes up about 13,650 square miles (35,375 square kilometers). The "Quad Cities" of Moline and Rock Island, Illinois, and Bettendorf and Davenport, Iowa, are in the northwest tip of this area. The area also includes Muscatine, Burlington, and Fort Madison, Iowa; Hannibal, Missouri; and Peoria, Canton, Macomb, and Quincy, Illinois. Interstates 74 and 88 end in the Quad Cities, and Interstate 80 cuts across the northern end of the area. Interstate 72 crosses the central part of the area from Jacksonville, Illinois, to Hannibal, Missouri. The area has a number of State parks and national wildlife refuges, especially along the Mississippi River. Small parcels of State forests are in the part of the MLRA in Illinois.

Physiography

Most of this area is in the Till Plains Section of the Central Lowland Province of the Interior Plains. The western part of the area in Missouri is in the Dissected Till Plains Section of the same province and division. The southern edge is in the Springfield-Salem Plateaus Section of the Ozark Plateaus Province of the Interior Highlands. Locally, most of this area is known as the glaciated Galesburg Plain and Springfield Plain, and the southern edge is in an area known as the Lincoln Hills and Salem Plateau. The nearly level to very steep uplands in this MLRA are dissected by both large and small tributaries of the Mississippi River. Well defined valleys with broad flood plains and numerous stream terraces are along the major streams and rivers. The flood plains along the smaller streams are narrow. Broad summits are nearly level to gently sloping. Elevation ranges from 420 feet (130 meters) on the southernmost flood plain along the Mississippi River to 885 feet (270 meters) on the highest ridges. Local relief is mainly 10 to 20 feet (3 to 6 meters), but it can be 50 to 100 feet (15 to 30 meters) along drainageways and streams. Also, the bluffs along the Illinois and Mississippi Rivers are as much as 250 feet (75 meters) above the valley floors.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Illinois (0713), 54 percent; Upper Mississippi-Salt (0711), 32 percent; Upper Mississippi-Iowa-Skunk-Wapsipinicon (0708), 10 percent; and Rock (0709), 4 percent. The Mississippi River flows through this area, forming the boundaries between Iowa and Illinois and between Missouri and Illinois. Lock and Dam Numbers 14 through 25 form lakes on the Mississippi River from Clinton, Iowa, to Hannibal, Missouri. The Illinois River flows through the eastern part of this area. The La Moine, Spoon, Mackinaw, and Sangamon Rivers are major tributaries to the Illinois River in the area. The Rock, Henderson, Edwards, and Bear Rivers empty into the Mississippi from the Illinois side in this area. The Wapsipinicon, Iowa, Skunk, and Des Moines Rivers from the Iowa side and the Fox, Wyaconda, North and South Fabius, Salt, and Cuivre Rivers from the Missouri side also empty into the Mississippi River.

Geology

The uplands in this area are covered almost entirely with Wisconsin loess. The loess is thick on stable summits. On the steeper slopes, it is thin or does not occur. The loess is underlain dominantly by glacial drift consisting of distinct till units. Illinoian glacial drift is the dominant drift in Illinois and is of minor extent in Iowa. Pre-Illinoian drift is in the parts of this MLRA in Iowa and Missouri and to a minor extent in the western part of Illinois, in Hancock, Adams, and Pike Counties. Unglaciated areas are in the southwestern portion of the part of the MLRA in Illinois. Wisconsin outwash deposits and sandy eolian material are on some of the stream terraces along the major tributaries. The glacial drift and loess deposits are underlain by several bedrock systems. The Cretaceous System is of minor extent, occurring only in Pike and Adams Counties, Illinois. The Pennsylvanian System occurs in the eastern part of the MLRA. The Mississippian System occurs along the Mississippi and Illinois Rivers. The Silurian System occurs in the northern and southern parts of the area. The Devonian System occurs only in the northern part of the area, and the

Ordovician System occurs only in the southern part. Bedrock outcrops are common on the bluffs along the Mississippi River and its major tributaries and at the base of steep slopes along minor streams and drainageways.

Climate

The average annual precipitation in most of this area is 34 to 40 inches (865 to 1,015 millimeters). Two-thirds or more of the precipitation falls during the freeze-free period. Most of the rainfall occurs as high-intensity, convective thunderstorms in summer. Snowfall is common in winter. The average annual temperature is 48 to 55 degrees F (9 to 13 degrees C). The freeze-free period averages 200 days and ranges from 180 to 215 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 3.8%; ground water, 0.6%
Livestock—surface water, 0.1%; ground water, 0.1%
Irrigation—surface water, 0.1%; ground water, 1.1%
Other—surface water, 92.9%; ground water, 1.4%

The total withdrawals average 3,555 million gallons per day (13,455 million liters per day). About 3 percent is from ground water sources, and 97 percent is from surface water sources. In most years the supply of moisture is adequate for crop production, but in some years yields are reduced by drought. Surface water is abundant in this MLRA. Water for livestock is stored in small ponds and reservoirs. The larger rivers provide water for public supply, industrial and municipal use, and some limited irrigation. Water from the Mississippi River also is used for cooling thermoelectric power plants in the three States in this area. The Mississippi River is a major transportation artery and is used for recreation. Most of the large rivers in the area carry heavy sediment loads and have low-quality water. The waterflow is regulated by dams in the upper reaches of most rivers. Generally, the flow is highest in May and June and lowest in winter. Although most areas along the Mississippi River are protected by a levee system, flooding remains a major concern. Water quality is a concern in karst areas and in urban areas. Also, it is degraded by agricultural runoff.

Abundant ground water occurs in deposits of unconsolidated sand and gravel along the Mississippi River, the Illinois River, and other large rivers throughout this area. These aquifers provide water for domestic use, livestock, municipal and industrial needs, and some limited irrigation. The average values of total dissolved solids are close to 500 parts per million (milligrams per liter), and the water is very hard and may have high levels of iron. Away from the river valley deposits in Illinois, ground water can be obtained from the Pennsylvanian-Mississippian and Shallow Dolomite aquifers. The water from these aquifers is similar in quality to the water in the river valleys, but the Shallow Dolomite aquifer has lower levels of iron. Areas away from the river valley deposits in Missouri have two sources of ground water. A glacial drift aquifer lies over the Pennsylvanian-Mississippian aquifer in these areas. Well yields are generally low from both these aquifers, but rural landowners rely on them for domestic and livestock water. The water quality varies considerably. The level of total dissolved solids can be 500 to 3,000 parts per million (milligrams per liter). The water is hard and is typically high in iron. Because of karst topography in the southern end of this area, contaminated water from surface activities has created some local water-quality problems in the Pennsylvanian-Mississippian aquifer.

In the part of this MLRA in Iowa, rural landowners and some farmers and small communities rely on ground water from the Silurian-Devonian and Jordan aquifers. The Silurian-Devonian aquifer is most accessible just north of the middle of the part of this MLRA in Iowa, whereas the Jordan aquifer underlies all of this part of the MLRA. The Jordan aquifer is the most extensively used aquifer in Iowa. It consists of sandstone and dolomite of Ordovician and Cambrian age. Well yields from this aquifer are very high, and the water from the aquifer is suitable for most uses. The median level of total dissolved solids, however, typically exceeds 800 parts per million (milligrams per liter), and radium-226 levels can exceed the national standard for drinking water. The Silurian-Devonian aquifer consists of limestone and dolomite. It is close to the surface in the part of the MLRA in Iowa, and it has the best water quality of all the principal aquifers in Iowa. Where this aquifer is buried by younger bedrock deposits, the level of total dissolved solids and naturally high levels of sulfate limit use of the water. The Jordan and Silurian-Devonian aquifers provide water for domestic use, livestock, irrigation, public and municipal supply, and industry.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Inceptisols, and Mollisols. The soils in the area have a mesic soil temperature regime, a udic or aquic soil moisture regime, and dominantly mixed or smectitic mineralogy. The mesic soil temperature regime occurs in two regions in this MLRA—cool mesic areas and warm mesic areas. The soils in the MLRA are very shallow to very deep, poorly drained to excessively drained, and loamy, silty, or clayey.

Nearly level Endoaquolls (Sable and Virden series), nearly level to depressional Albaqualfs (Rushville and Denny series), and nearly level Argiudolls (Ipava series) and Endoaqualfs (Keomah series) formed in loess on broad upland summits and flats. Gently sloping to sloping Argiudolls (Osco and Tama series) and gently sloping to steep Hapludalfs (Fayette, Rozetta, Seaton, Winfield, and Menfro series) formed in thick deposits of loess on uplands. Sloping to steep Hapludalfs (Elco and

Hickory series) formed in Illinoian till or paleosols along the major streams and dissected upland drainageways. Sloping to steep Hapludalfs (Lindley and Keswick series) formed in pre-Illinoian till along the major streams and dissected upland drainageways. Hapludolls (Sparta series), Argiudolls (Onarga and Plano series), and Udipsamments (Plainfield series) are on gently sloping to strongly sloping stream terraces along the major streams. The major stream valleys also have soils that formed in bedrock residuum and colluvium in strongly sloping to very steep areas on uplands. Hapludalfs (Marseilles series) and Dystrudepts (Gosport series) formed in shale residuum, Paleudalfs (Baylis and Goss series) and Hapludolls (Elizabeth series) formed in limestone residuum, and Dystrudepts (Judyville series) formed in sandstone residuum. Hapludolls (Lacrescent series) formed in limestone colluvium. Moderately sloping to very steep Hapludalfs (El Dara series) formed in Cretaceous deposits.

Endoaquolls (Beaucoup, Otter, and Sawmill series) and Hapludolls (Huntsville, Ross, and Tice series) formed in alluvium on nearly level, broad flood plains. Fluvaquents (Wakeland series), Udifluvents (Orion series), and Hapludolls (Lawson and Radford series) are along the smaller upland drainageways.

Biological Resources

The soils on uplands in this area support natural hardwoods. Oak, hickory, and sugar maple are the dominant species. Big bluestem, little bluestem, and scattered oak trees grow on some sites. The soils on lowlands support mixed forest vegetation, mainly elm, cottonwood, river birch, ash, silver maple, and willow. Sedge and grass meadows and scattered trees are on some lowland sites.

Some of the major wildlife species in this area are white-tailed deer, coyote, gray fox, red fox, beaver, raccoon, skunk, muskrat, opossum, mink, cottontail, fox squirrel, gray squirrel, Canada goose, bald eagle, turkey vulture, turkey, ruffed grouse, woodcock, great horned owl, wood duck, pileated woodpecker, red-bellied woodpecker, ring-necked pheasant, and bobwhite quail.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 59%
Grassland—private, 11%
Forest—private, 17%; Federal, 1%
Urban development—private, 6%
Water—private, 4%
Other—private, 2%

Most of this area is in privately owned farms, which produce both cash-grain crops and livestock. The less sloping soils are used for dry-farmed corn for grain and for soybeans. Some small grains, such as winter wheat and oats, also are grown in the area. Some areas on broad stream terraces and outwash plains are irrigated. A small acreage is used for specialty crops, such as watermelons, pumpkins, and orchards. The grassland in the area supports introduced and native grasses. About 18 percent of the area is forested. Although not occupying a large acreage, surface-mined areas that have been or are currently being reclaimed occur in the northeastern part of the MLRA.

The major soil resource concerns are wind erosion, water erosion, flooding, wetness, a limited available water capacity, and maintenance of the content of organic matter and productivity of the soils. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems), cover crops, windbreaks, vegetative wind barriers, and pest and nutrient management. Woodland management practices, such as grazing exclusion and timber stand improvement, are important for timber production. ■

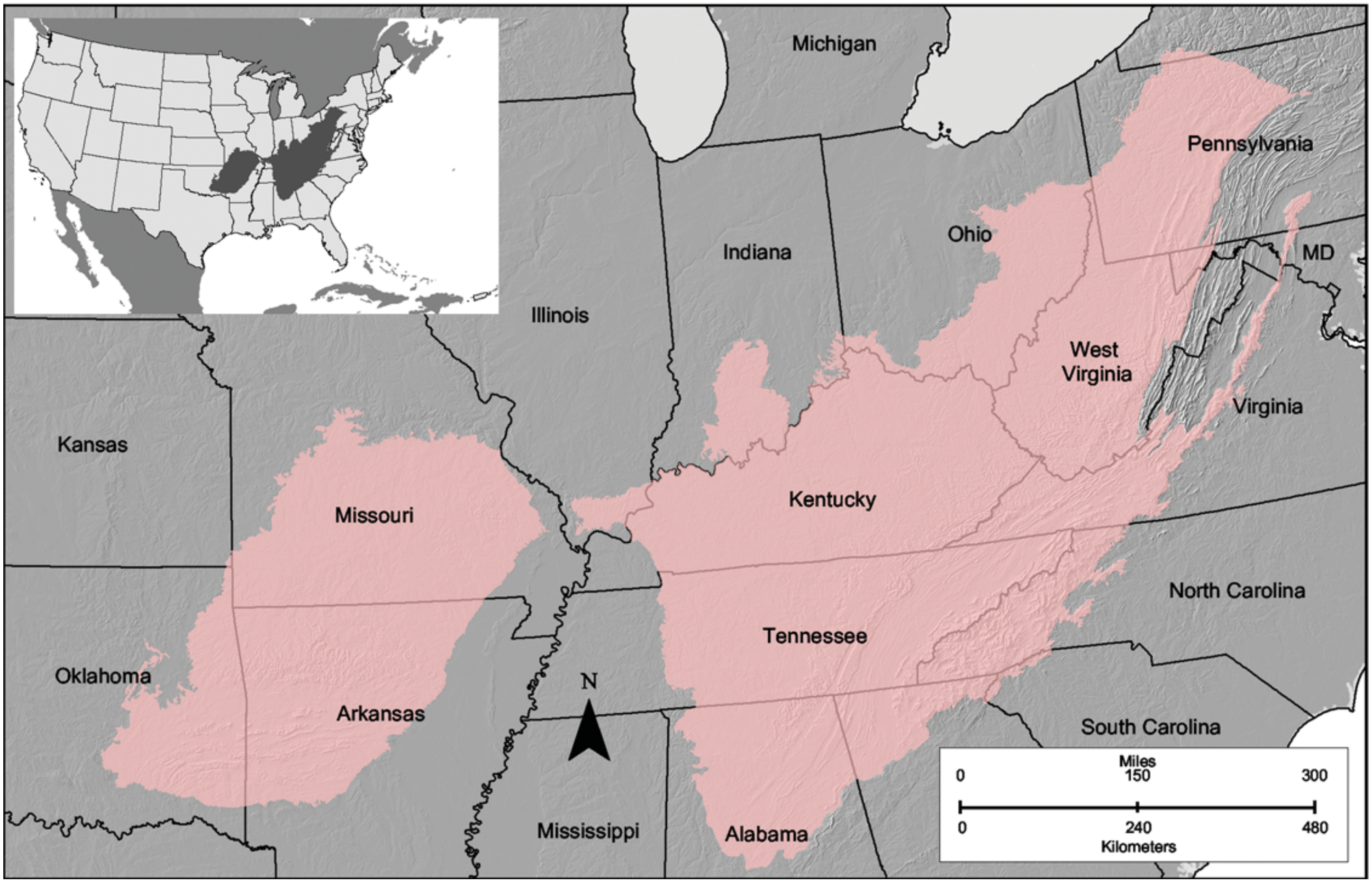

Figure N-1: Location of Land Resource Region N.

N—East and Central Farming and Forest Region

This region (shown in fig. N-1) is in Kentucky (16 percent), Missouri (13 percent), Tennessee (13 percent), Arkansas (11 percent), West Virginia (9 percent), Pennsylvania (8 percent), Alabama (6 percent), Ohio (6 percent), Oklahoma (5 percent), Virginia (4 percent), North Carolina (3 percent), Indiana (3 percent), Georgia (2 percent), and Illinois (1 percent) and in very small areas in Kansas, Maryland, New York, and South Carolina. It makes up 236,415 square miles (612,645 square kilometers).

Diversity of topography and climate gives rise to a wide range of natural ecosystems and limits the amount of land available for production agriculture. The topography ranges from undulating hills in the Kentucky Bluegrass region to steep, mountainous terrain in the Appalachians (fig. N-2). The climate ranges from hot and humid with modest snowfall in the western part of the region to more than 100 inches (2,540 millimeters) of annual snowfall in spruce forests in the eastern part. The mean annual precipitation in most of the region is 40 to 59 inches (1,015 to 1,500 millimeters), but the southern, high-elevation parts of the Blue Ridge may receive as much as 119 inches (3,025 millimeters). The mean annual air temperature in most of the region is 52 to 59 degrees F (11 to 15 degrees C). The freeze-free period generally ranges from 180 to 235 days, but it is considerably shorter in the high-elevation areas in North Carolina, Virginia, and West Virginia. The mean annual air temperature and the length of the freeze-free period increase from north to south and with decreasing elevation.

The physiography in the part of this region east of the Mississippi River is varied and consists of gently rolling terrain on level-bedded limestone in the Kentucky Bluegrass and Highland Rim areas. Moving eastward, the topography becomes progressively more dissected and hilly. The Appalachian Plateau, stretching from central Pennsylvania to northern Georgia, grades from a dissected plateau to a rugged band of mainly forested mountains and high hills underlain by shale, sandstone, coal, and some limestone. The Valley and Ridge features long, linear forested ridges and cropland in the valleys. The bedrock geology is faulted and folded shale, sandstone, and limestone. The Blue Ridge makes up the eastern edge of the region. It consists mainly of rugged mountains

Figure N-2: An area of Land Resource Region N.

formed from igneous and metamorphic rocks. West of the Mississippi River, the Ozarks are a slightly dissected to deeply dissected plateau typically underlain by limestone, sandstone, and shale bedrock. Igneous rocks are exposed in a small area in southeast Missouri. Elevation ranges from 300 to 6,600 feet (90 to 2,010 meters) overall. West of the Mississippi River, elevation ranges from 300 to 2,750 feet (90 to 840 meters) and local relief ranges from 100 feet (30 meters) in the St. Francois Knobs and Basins to 800 feet (245 meters) in the Ozark Highland. East of the Mississippi River, elevation ranges from 330 to 6,600 feet (100 to 2,010 meters) and is highest in the Southern Blue Ridge. Local relief ranges from 10 to 50 feet (3 to 15 meters) in southern Indiana to 1,000 to 3,000 feet (305 to 915 meters) in western North Carolina.

The total withdrawals of freshwater in this region average about 30,935 million gallons per day (119,720 million liters per day). About 93 percent is from surface water sources, and 7 percent is from ground water sources. This region is one of six land resource regions that use more than 30,000 million gallons (113,550 million liters) of water daily. About 89 percent of the total water used is for cooling thermoelectric power plants or for mining or industry.

The soils in this region are dominantly Alfisols, Entisols, Inceptisols, or Ultisols. In the Ozarks, Hapludalfs and Paleudults formed in material weathered dominantly from limestone and cherty limestone. Hapludults and Dystrudepts formed in shale and sandstone residuum. Paleudults and Hapludults typically formed in colluvium. Most of the soils in the middle third of the region are Hapludalfs that formed in limestone residuum or loess. The soils in the eastern third of the region are dominantly Hapludults and Dystrudepts that formed in shale and sandstone residuum. Some Hapludalfs formed in calcareous material. In the high mountains, the soils are dominantly Dystrudepts and Hapludults that formed in material weathered from igneous and metamorphic rocks. The soils in the region have a thermic, mesic, or frigid soil temperature regime, depending on latitude and elevation, and have a udic soil moisture regime.

About 93 percent of the land in this region is privately owned. The native vegetation generally consists of deciduous forests. At the highest elevations, however, coniferous forests and glades are evident. Forestry is an important industry. Oak, yellow-poplar, and pine are the dominant trees harvested. The array of crops grown is diverse and includes cotton, soybeans, corn, and wheat. The major management concerns in areas of forestland are the erosion resulting from harvest practices and maintenance of forest productivity. The concerns on cropland include maintenance of the productivity of the soils, erosion control, and prevention of ground-water contamination. ■

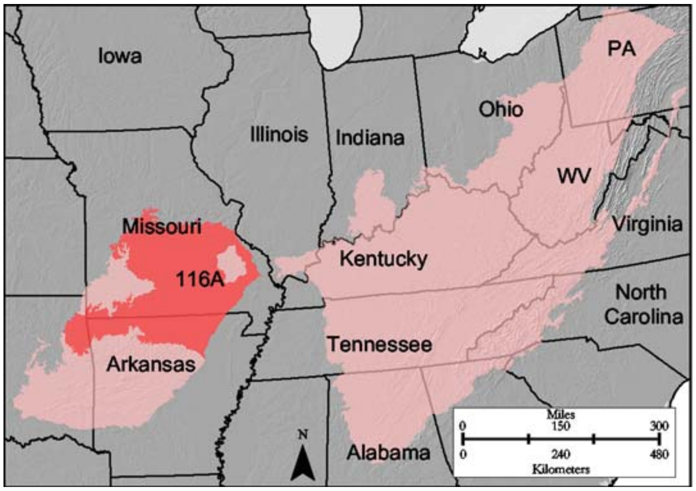

Figure 116A-1: Location of MLRA 116A in Land Resource Region N.

116A—Ozark Highland

This area (shown in fig. 116A-1) is in southern Missouri (72 percent), northern Arkansas (23 percent), and northeastern Oklahoma (5 percent). It makes up about 32,845 square miles (85,110 square kilometers). West Plains, Branson, and Poplar Bluff, Missouri, and Bentonville, Mountain Home, and Springdale, Arkansas, are the major towns in the area. Interstate 44 cuts across the area diagonally from St. Louis to Springfield, Missouri. The area has several large reservoirs. The major ones are the Lake of the Ozarks, Truman Lake, Table Rock Lake, Norfolk Lake, Bull Shoals Lake, and Beaver Lake. The Mark Twain National Forest manages the largest part of the public lands in Missouri, and parts of the Ozark National Forest are in Arkansas. These forests occur in this MLRA. The Ozark National Scenic Riverways is the largest national park in the area. The Pea Ridge National Military Park in Arkansas and Fort Leonard Wood, a major military base in Missouri, are in this area.

Physiography

This area is in the Springfield-Salem Plateaus Section of the Ozark Plateaus Province of the Interior Highlands. The landscape ranges from highly dissected, steeply sloping wooded hills and narrow, gravelly valleys in the central and southern parts of the area to gently rolling prairie-like uplands in the northern part. Soluble carbonate rocks are responsible for a well developed karst topography in the southern part of the area. This topography includes sinkholes, caves, dry valleys, box valleys, and large springs. Elevation ranges from about 300 feet (90 meters) on the southeast edge of the Ozark escarpment to about 1,600 feet (490 meters) on the western side of the area. Relief is generally 200 to 800 feet (60 to 245 meters). It is highest in the southwestern part of the area. The geologic strata generally are horizontally bedded, but with a slight dip to the west and south away from the apex of the Ozark Uplift in southeast Missouri.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper White (1101), 47 percent; Gasconade-Osage (1029), 25 percent; Upper Mississippi-Kaskaskia-Meramec (0714), 14 percent; Neosho-Verdigris (1107), 6 percent; Lower Arkansas (1111), 4 percent; Lower Missouri (1030), 3 percent; and Lower Mississippi-St. Francis (0802), 1 percent. The major rivers in this area are the Osage, Gasconade, Current, Black, James, White, and Buffalo Rivers. The Ozark and Eleven Point Rivers in Missouri have been designated as National Scenic Rivers. The Buffalo River is a National Scenic River in Arkansas, and the Strawberry and Illinois Rivers are National Wild and Scenic Rivers in Arkansas and Oklahoma, respectively. Streamflow is highest in winter and spring.

Geology

This area has a variety of geologic formations. Most of the bedrock consists of sedimentary rocks, including Ordovician-age dolostone and sandstone, Lower Mississippian-age limestone and dolostone, and Pennsylvanian-age sandstone and shale. Remnants of an ancient loess deposit ranging from a few inches to several feet in thickness are on the nearly level upland divides. The loess is thickest in the northern and eastern parts of the area. Most of the exposed bedrock consists of limestone and dolostone formations that have thick layers of chert bedrock or chert fragments. The chert generally occurs in long, wavy beds less than 1 foot thick. In some areas, however, it occurs in massive layers more than 6 feet (2 meters) thick. Several old and inactive geologic faults are in the area.

Climate

The average annual precipitation in almost all of this area is 38 to 45 inches (965 to 1,145 millimeters). It is as high as 49 inches (1,245 millimeters) in some small areas along the extreme southeast and south edges of the area. About 57 percent of the annual precipitation falls during the 6 warmest months of the year. Snow falls nearly every winter, but the snow cover lasts for only a few days. The annual snowfall averages about 12 inches (305 millimeters). The average annual temperature is about 53 to 60 degrees F (12 to 16 degrees C). The lower temperatures occur at the higher elevations in the western part of the MLRA. The freeze-free period averages 210 days and ranges from 175 to 245 days. It is shortest at the higher elevations along the western edge of the MLRA. The longer freeze-free periods occur at the lower elevations.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 12.0%; ground water, 8.4%
Livestock—surface water, 3.1%; ground water, 2.9%
Irrigation—surface water, 1.6%; ground water, 5.9%
Other—surface water, 59.2%; ground water, 6.8%

The total withdrawals average 675 million gallons per day (2,555 million liters per day). About 24 percent is from ground water sources, and 76 percent is from surface water sources. In most years precipitation is adequate for most agricultural uses, but summer droughts of sufficient severity and duration to reduce production are common. Streams, ponds, springs, and lakes provide surface water for livestock. Karst areas are common in much of the southern part of the MLRA, and many stretches of headwater streams in this part of the MLRA are dry or losing streams. This water flows to underground systems and returns elsewhere as springs. Springs are numerous, and spring flow is a major contributor to the base flow of many streams. The major springs are Big, Blanchard, Greer, Alley, Mammoth, and Round Springs. Large reservoirs in the area provide hydroelectric power, flood control, and opportunities for recreation.

Ground water is abundant in this area. The primary source is the Ozark aquifer in Missouri and Arkansas. This aquifer consists of consolidated dolomite with some minor beds of sandstone. It is about 1,000 feet below the ground surface in western Missouri. It has good-quality water, and it provides water for public supply, irrigation, municipal and industrial uses, and domestic use. Water in the Ozark aquifer has median levels of total dissolved solids of 275 and 322 parts per million (milligrams per liter) in Arkansas and Missouri, respectively. It is hard or very hard but is not high in iron. Because of the karst topography, contaminated water from surface activities has created some local water-quality problems in this bedrock aquifer. Hazardous waste, landfills, municipal and industrial wastewater, and agricultural activities have caused some bacteria and nitrate contamination.

The Roubidoux and Keokuk-Reeds Spring aquifers are in this area. They occur only in a few counties in the northeast corner of Oklahoma. These aquifers are the only source of water for rural landowners and the small communities in this part of the MLRA. The water is generally of good quality and is suitable for most uses. The median level of total dissolved solids is only 280 parts per million (milligrams per liter). Chloride, sulfate, and fluoride levels, however, exceed the national drinking water standards in some areas.

Soils

Most of the soils in this area are Alfisols or Ultisols. They formed in material weathered from cherty limestone. Most areas in the northern and eastern parts of the MLRA are partly covered with a thin mantle of loess. Physical and chemical weathering has caused the cherty limestone to disintegrate into its least soluble components, which are chert and clay. The chert remains in the form of angular fragments or wavy horizon beds interstratified with layers of clay. Downslope movement by gravitational creep and overland waterflow has altered the cherty material in the upper part of some soils. In general, the soils are shallow to very deep, moderately well drained to excessively drained, and medium textured to fine textured. The soil temperature regime is mesic bordering on thermic, the soil moisture regime is udic, and mineralogy is mixed or siliceous.

Many of the soils on nearly level to moderately sloping upland divides are Paleudalfs (Gravois, Gepp, and Peridge series), Fragiudalfs (Union, Viraton, and Wilderness series), or Fragiudults (Captina, Scholten, and Tonti series). Many of the soils on moderately sloping to steep side slopes in the uplands are Hapludalfs (Gatewood, Mano, Ocie, and Wrengart series), Hapludults (Bendavis, Bender, and Lily series), Paleudalfs (Alred, Goss, and Rueter series), or Paleudults (Clarksville, Coulstone, Noark, and Poynor series). Many of the soils in glades are Mollisols (Gasconade, Knobby, and Moko series). Many of the soils on terraces and the adjacent flood plains are Hapludalfs (Razort, Secesh, and Waben series), Hapludolls (Cedargap, Dameron, and Sturkie series), Paleudalfs (Britwater and Pomme series), Eutrudepts (Gladden and Jamesfin series), or Udifluvents (Midco and Relfe) series.

Biological Resources

Oak, hickory, and shortleaf pine are the major tree species in the forested areas of this MLRA. Eastern redcedar is a common invader in abandoned fields and in glades. Most of the less sloping areas have been cleared and planted to cool-season grasses. Fescue is the dominant introduced grass species. Glade openings support warm-season grasses, primarily big bluestem, Indiangrass, little bluestem, and dropseeds. Savanna restoration projects are underway in the national and State forests and parks.

Some of the major game species of wildlife are white-tailed deer, eastern cottontail, raccoon, wood duck, wild turkey, smallmouth bass, and largemouth bass.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 5%
Grassland—private, 32%; Federal, 1%
Forest—private, 48%; Federal, 6%
Urban development—private, 4%
Water—private, 2%; Federal, 1%
Other—private, 1%

The public lands in this area are used for timber production and for recreational activities. Most of the private lands are in farms and ranches. Forage and grain are grown for beef, dairy cattle, and other livestock. Raising cattle, both beef and dairy, is one of the major industries in the area. Poultry production is important in the southwestern part of the area. Specialized farming includes vineyards and small orchards. The areas along the Interstate 44 corridor and near the large lakes have a growing service industry oriented to recreation and tourism. Commercial and residential growth occurs mainly around the large lakes, the major highways, and the Branson area.

The major resource concerns are the quality of both surface and subsurface water; forest and grassland productivity, health, and vigor; and streambank erosion. The important conservation practices are forest stand improvement, prescribed grazing, development of springs, riparian forest buffers, nutrient management, and exclusion from use as needed. ■

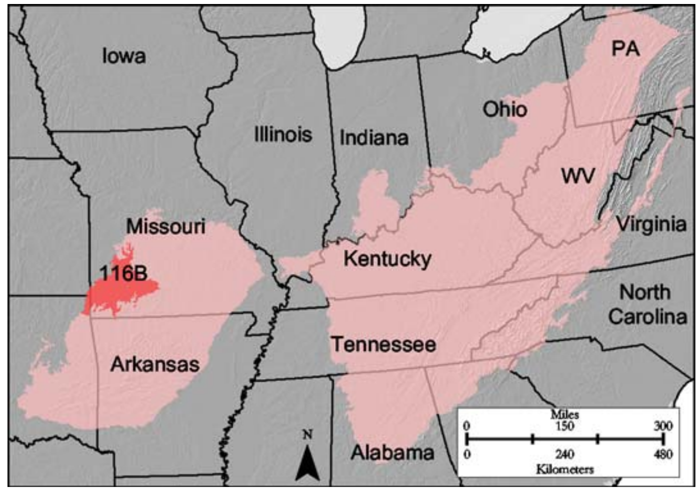

Figure 116B-1: Location of MLRA 116B in Land Resource Region N.

116B—Springfield Plain

This area (shown in fig. 116B-1) is dominantly in southwest Missouri (95 percent) and extends for a short distance into the northeast corner of Oklahoma (4 percent) and southeast Kansas (1 percent). It makes up about 5,130 square miles (13,300 square kilometers). This is one of the fastest growing areas in Missouri. The towns of Springfield, Carthage, and Joplin, Missouri, are the major urban areas in the MLRA. They are connected by Interstate 44, which runs in an east-west direction through the center of the area. The birthplace of a famous agricultural scientist is marked by the George Washington Carver National Monument, in the western part of the area, near Diamond, Missouri. The Wilson's Creek National Battlefield, near Springfield, is the site of a Civil War battle.

Physiography

This area is in the Springfield-Salem Plateaus Section of the Ozark Plateaus Province of the Interior Highlands. It is in the western part of the Ozark Uplift, which is commonly referred to as the Springfield Plateau. It is primarily a smooth plain that is slightly dissected along streams. The plain is underlain by carbonate rocks. These formations are responsible for well developed karst features in several places and also numerous caves and springs. Elevation is about 1,000 feet (305 meters) in the northern part of the area and increases to more than 1,700 feet (520 meters) on the eastern escarpment. Relief is generally less than 150 feet (45 meters) but is as much as 250 feet (75 meters) along the eastern boundary of the area, where the prominent Burlington Escarpment rises above the adjacent Ozark Highlands.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Neosho-Verdigris (1107), 42 percent; Gasconade-Osage (1029), 36 percent; and Upper White (1101), 22 percent. Because it is at a relatively high elevation, this area includes the headwaters and upper reaches of streams that drain into adjacent regions. These include the Sac River, which flows north into the Osage River; the James River and Finley Creek, which flow south into the White River; and Shoal Creek and the Spring River, which drain most of the western part of the area westward into the Neosho River. Stockton Lake is a large multipurpose reservoir on the Sac River. Lake McDaniel and Lake Springfield provide water for the city of Springfield.

Geology

Sedimentary rocks ranging from Mississippian-age limestone to Pennsylvanian-age sandstone and shale underlie this area. A layer of loess that is generally about 6 inches or less thick covers most of the area. Erosion has removed much of the original loess. On the nearly level upland divides, however, remnants of the loess are 1 to 2 feet (0.3 to 0.7 meter) thick. Most of the exposed bedrock consists of limestone formations that have thick layers of chert bedrock or chert fragments. The chert generally occurs in long, wavy beds less than 1 foot thick. In some areas, however, it occurs in massive layers more than 6 feet (2 meters) thick. Although the bedrock strata appear to lie horizontally, there is a regional dip to the west. The direction of the dip is influenced mainly by the Ozark Uplift. The apex of the uplift is in southeast Missouri, and the bedrock dips away from the uplift. Historic lead and zinc mines in the southwestern part of the MLRA have scarified large areas. Tripoli, a chert powder used for polishing and for manufacturing paint and paper, is mined in Newton County, Missouri. High-calcium limestone is quarried, mostly near Springfield and Joplin.

Climate

The average annual precipitation in this area is 41 to 45 inches (1,040 to 1,145 millimeters). About 57 percent of the annual precipitation falls during the 6 warmest months of the year. Snow falls nearly every winter, but the snow cover lasts for only a few days. The annual snowfall averages about 12 inches (305 millimeters). The average annual temperature is about 55 to 58 degrees F (13 to 15 degrees C). The lower temperatures occur at the higher elevations. The freeze-free period averages 210 days and ranges from 195 to 225 days. It is shortest at the higher elevations.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 10.0%; ground water, 5.9%
Livestock—surface water, 0.5%; ground water, 0.2%
Irrigation—surface water, 0.3%; ground water, 0.9%
Other—surface water, 76.3%; ground water, 5.9%

The total withdrawals average 685 million gallons per day (2,595 million liters per day). About 13 percent is from ground water sources, and 87 percent is from surface water sources. In most years the precipitation is adequate for crops and pasture, but summer droughts of sufficient severity and duration to reduce crop yields are common. Streams, ponds, springs, and lakes provide surface water for most livestock. Springs are numerous, and spring flow is a major contributor to the base flow of many streams. The few large reservoirs in the area provide flood control, opportunities for recreation, and part of the water supply for large cities, such as Springfield. The surface water is generally of good quality and is suitable for most uses.

Ground water is very abundant in this area. The primary source is the Ozark aquifer in Missouri. This aquifer consists of consolidated dolomite with some minor beds of sandstone. It is about 1,000 feet below the ground surface in western Missouri. It has good-quality water, and it provides water for public supply, irrigation, municipal and industrial uses, and domestic use. Water in the Ozark aquifer has median levels of total dissolved solids of 322 parts per million (milligrams per liter). The water is hard or very hard but is not high in iron. Because of the karst topography, contaminated water from surface activities has created some local water-quality problems in this bedrock aquifer. Hazardous waste from abandoned lead and zinc mines, landfills, municipal and industrial wastewater, and agricultural activities have caused some contamination by heavy metals, bacteria, and nitrates.

The Roubidoux and Keokuk-Reeds Spring aquifers are in this area. They occur only in a few counties in the northeast corner of Oklahoma. They are the only sources of water for rural landowners and the small communities in this part of the MLRA. The water generally is of good quality and is suitable for most uses. The median level of total dissolved solids is only 280 parts per million (milligrams per liter). Chloride, sulfate, and fluoride levels, however, exceed the national drinking water standards in some areas.

Soils

Most of the soils in this area are Alfisols, Ultisols, or Mollisols. They formed in material weathered from cherty limestone. This material is partly covered with a thin mantle of loess. Physical and chemical weathering has caused the cherty limestone to disintegrate into its least soluble components, which are chert and clay. The chert remains in the form of angular fragments or wavy horizon beds interstratified between layers of clay. Downslope movement by gravitational creep and overland waterflow has altered the cherty material in the upper part of some soils. In general, the soils are moderately deep to very deep, moderately well drained to well drained, and medium textured to fine textured. The soil temperature regime is typically mesic and extends slightly into thermic. The soil moisture regime is udic. Mineralogy generally is mixed or siliceous, but some soils are high in kaolinite.

Many of the soils on nearly level to moderately sloping upland divides are Paleudolls (Newtonia and Wanda series), Paleudalfs (Peridge series), Fragiudalfs (Creldon, Hoberg, Keeno, and Viraton series), Fragiaqualfs (Bado and Gerald series), Fragiudults (Captina, Needleye, Nixa, and Tonti series), or Hapludalfs (Barden and Bolivar series). Many of the soils on moderately sloping to steep side slopes in the uplands are Paleudalfs (Bona, Goss, and Rueter series) or Paleudults (Clarksville series). Many of the soils on terraces and the adjacent flood plains are Hapludalfs (Razort, Secesh, and Waben series), Hapludolls (Cedargap and Dapue series), Paleudalfs (Pomme and Pembroke series), or Eutrudepts (Jamesfin series).

Biological Resources

This is a transitional area between the oak-hickory forests to the east and south and the bluestem prairie to the west and north. The vegetation prior to settlement consisted mostly of prairie grasses with timber along streams. The major native grass species are big bluestem, little bluestem, Indiangrass, and switchgrass. Most of the area is cleared and used for pasture or cropland, but forests remain in the steepest areas. Fescue is the dominant introduced grass species.

Some of the major wildlife species in the area are white-tailed deer, eastern cottontail, raccoon, wood duck, wild turkey, smallmouth bass, and largemouth bass. Several prairie species, such as black-tailed jackrabbits and prairie chickens, inhabit small areas of the original tall grass prairie.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 20%
Grassland—private, 45%; Federal, 1%
Forest—private, 22%
Urban development—private, 8%
Water—private, 2%
Other—private, 2%

Farms and ranches make up most of this area. Forage and grain are grown for beef, dairy cattle, and other livestock. Raising cattle is one of the major industries in the area. The area around Springfield is the leading dairy area in Missouri. From the practice of keeping a few chickens on each farm, the poultry business has developed into a very specialized multimillion-dollar industry. Soybeans, winter wheat, and hay are the major cash crops grown in the area. The loss of prime farmland and farmland of statewide importance to urban development is a concern, especially in the Springfield and Joplin areas.

The major resource concerns are excessive nutrients and organic material in surface water; conversion of farmland to urban uses; ground-water pollution in areas of karst topography; forest and pasture productivity, health, and vigor; inadequate water sources for domestic animals; and the structure failure of dams in areas of ponds and small lakes. The structure failure of dams results from a high amount of kaolinitic clay in the soils.

The conservation practices that are important in this area are management of phosphorus from chicken litter applied to cropland and pasture, forest stand improvement, prescribed grazing, development of springs, riparian forest buffers, and construction of ponds. ■

116C—St. Francois Knobs and Basins

This area is entirely in southeast Missouri (fig. 116C-1). It makes up about 1,600 square miles (4,150 square kilometers). The towns of Farmington, Fredericktown, Ironton, and Park Hills are the largest municipalities in this area. U.S. Highway 67 crosses this area from north to south. The largest area of public land in the MLRA is the Mark Twain National Forest. Unique rock formations are in Elephant Rocks State Park, Johnson's Shut-Ins State Park, and the Mudlick Mountain Natural Areas.

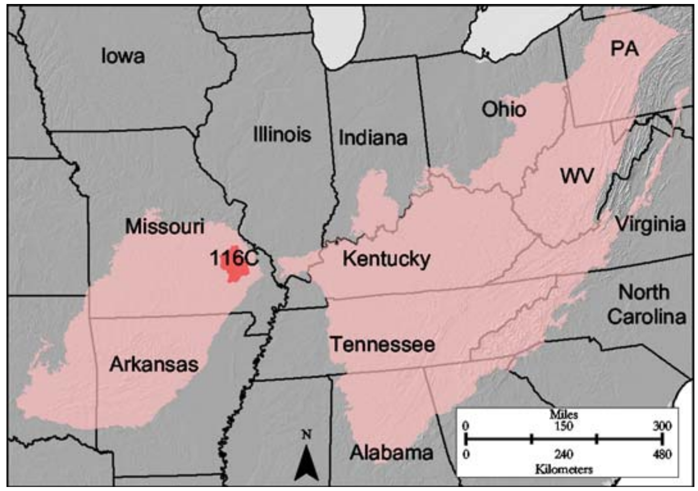

Figure 116C-1: Location of MLRA 116C in Land Resource Region N.

Physiography

This area is in the Springfield-Salem Plateaus Section of the Ozark Plateaus Province of the Interior Highlands. It is the structural center of the Ozark dome. Three different topographic expressions are in this MLRA. One is the prominent Precambrian igneous knobs and hills that rise conspicuously to various elevations. Another is the intervening smooth-floored basins and valleys overlying dolostone and sandstone. The third consists of tracts of deeply dissected, cherty, sedimentary hills of the Ozarks Highlands that are intermixed with the other two kinds of topography. The boundary of the area is drawn to encompass all of the major Precambrian surfaces in the area. Since the Precambrian surfaces are intermixed with younger Paleozoic surfaces, a large area of cherty, sedimentary rock normally found in the adjacent Ozark Highland (MLRA 116A) is included in this area. Elevation ranges from about 450 feet (135 meters) along the rivers in the southern part of the area to 1,772 feet (540 meters) on the summit of Taum Sauk Mountain, the highest point in Missouri. Local relief is generally about 300 to 1,000 feet (90 to 305 meters) among the igneous knobs, 100 to 200 feet (30 to 60 meters) in the basins, and 200 to 300 feet (60 to 90 meters) in the sedimentary hills.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Mississippi-St. Francis (0802), 60 percent; Upper Mississippi-Kaskaskia-Meramec (0714), 29 percent; and Upper White (1101), 11 percent. Because it is at the highest elevation in the Ozark Uplift, this area includes the headwaters of streams that radiate outward in several directions. The St. Francis River, which has the largest river basin in this MLRA, drains the south-central part of the area. The Castor River flows southward on the eastern boundary of the area. The south-flowing Black River has its headwaters in the western part of the area. The Big River, the largest tributary of the Meramec River, drains to the north.

Geology

The distinctive geologic features of this area are the Precambrian igneous rocks that have been uplifted and exposed by geologic erosion. These exhumed igneous rocks consist primarily of granites with intruded rhyolites and other volcanics. The rocks are resistant to erosion and stand out at high elevations on the landscape. The igneous knobs are broad and rounded. Slopes in areas of rhyolites are noticeably steeper than those in areas of granite. The igneous knobs are interconnected by Early Cambrian sedimentary rocks. The Cambrian strata consist of the LaMotte sandstone, Derby-Doe Run dolostone, Bonne Terre dolostone, and Potosi and Eminence cherty dolostones. The sandstone and the cherty dolostones are associated with hilly landscapes, whereas the chert-free dolostones are on the smooth floors of the basins. This area has valuable mineral deposits, including lead, iron, manganese, silver, cobalt, and dimension stone (granite). The area has one of the largest historic lead-mining districts in the world. Lead mining has left numerous scars on the landscape.

Climate

The average annual precipitation in this area is 40 to 46 inches (1,015 to 1,170 millimeters). The rainfall is fairly evenly distributed throughout the year. Snow falls nearly every winter, but the snow cover lasts for only a few days. The annual snowfall averages about 14 inches (355 millimeters). The average annual temperature is about 54 to 56 degrees F (12 to 14 degrees C). The lower temperatures occur at the higher elevations. The freeze-free period averages 200 days and ranges from 185 to 215 days. The shorter freeze-free periods occur at the higher elevations.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 10.7%; ground water, 3.9%
Livestock—surface water, 1.1%; ground water, 0.7%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 79.6%; ground water, 4.1%

The total withdrawals average 46 million gallons per day (175 million liters per day). About 9 percent is from ground water sources, and 91 percent is from surface water sources. In most years the precipitation is adequate for crops and pasture, although summer droughts of sufficient severity and duration to reduce yields are common. Springs, ponds, and streams provide water for livestock. Springs are common, although not so large as elsewhere in the Ozarks. Ponds for livestock water are mainly in the cleared basins. Stream gradients are generally steep, and water velocities are high. Stream discharges reach their peak in spring and decline rapidly in summer. They are lowest in fall. Several small lakes have been built for residential developments and water supplies. One unique lake, Taum Sauk Reservoir, was built for pumped-storage hydroelectricity generation on the top of Proffit Mountain. Lakes have also been built to impound and settle out tailings from lead mines. Most of the surface water used in this area is for the mining industry. The water is generally of high quality, although in some areas it is affected by lead mining and pollution from urbanization. There are no natural lakes and no large reservoirs in this MLRA.

Ground water is adequate in the areas with sedimentary bedrock. It is not abundant in the igneous areas. Ground water sources include the Cambrian sediments and the Ozark dolomite that occur between the igneous knobs. The water is of good quality. Limited amounts of the water are used for public supply, municipal and industrial supply, and domestic purposes. Data on water quality from this particular area are not available. The Ozark aquifer has a median level of total dissolved solids of 322 parts per million (milligrams per liter) in other parts of Missouri. The water is hard or very hard but is not high in iron. Because of the karst topography where the carbonate sediments are at or very near the ground surface, contaminated water from surface activities has created some local water-quality problems in this bedrock aquifer. Hazardous waste, landfills, municipal and industrial wastewater, and agricultural activities have caused some contamination by heavy metals, bacteria, and nitrates.

Soils

Most of the soils in this area are Alfisols or Ultisols. They formed in material weathered from igneous and sedimentary rocks. The less sloping areas have a thin mantle of loess. The soils have a mesic soil temperature regime and a udic soil moisture regime and typically have mixed mineralogy. Downslope movement by gravitational creep and overland waterflow has altered the upper part of the soils. In general, the soils are shallow to very deep, moderately well drained to excessively drained, and moderately coarse textured to fine textured.

Many of the soils on igneous knobs are Hapludults (Irondale, Knobtop, Taumsauk, and Trackler series), Paleudults (Frenchmill series), or Fragiudults (Delassus and Killarney series). Many of the soils in basins are Hapludalfs (Bucklick and Caneyville series) or Paleudalfs (Courtois, Crider, and Fourche series). Many of the soils on moderately sloping to steep side slopes in the uplands are Paleudults (Firebaugh and Clarksville series), Paleudalfs (Alred and Goss series), or Fragiudults (Captina and Scholten series). Many of the soils on terraces and the adjacent flood plains are Hapludalfs (Bearthicket, Secesh, and Tilk series), Udifluvents (Midco and Relfe series), or Eutrudepts (Gladden and Jamesfin series).

Biological Resources

Most of this area is in oak or oak-pine forest. White oak, northern red oak, and hickories are the dominant tree species on the most productive sites. Post oak, black oak, shortleaf pine, and hickories dominate the drier sites. Warm-season grasses, shrubs, and eastern redcedar are dominant in glades. Fescue and orchardgrass are the dominant introduced grass species.

The major wildlife species are those that prefer woodland habitat, such as white-tailed deer, gray squirrel, raccoon, and wild turkey. Small fur animals, such as red fox, gray fox, opossum, and skunk, are fairly abundant. Wetland habitat is almost nonexistent, and the waterfowl population is low.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 8%
Grassland—private, 19%; Federal, 1%
Forest—private, 59%; Federal, 6%
Urban development—private, 4%; Federal, 1%
Water—private, 1%
Other—private, 1%

Timber production, outdoor recreation and tourism, and livestock production are the major land uses in this area. Urban growth is limited to the U.S. Highway 67 corridor and the Ironton area. Corn and soybeans are the major cash crops grown in the area. A few mines are still active in the area.

The major natural resource concerns in this area are forest and pasture health and productivity, excessive runoff, excessive nutrients and organic material in the surface water, head-cut erosion in drainageways in pastured areas, fragmentation of the wildlife plant community, and inadequate water supplies for livestock. The important conservation practices are improvement of forest stands and wildlife habitat, erosion-control structures that include hydrants to supplement livestock water and to control head-cut erosion, prescribed grazing, development of springs, construction of ponds for livestock water, pasture and hayland planting, nutrient management, riparian forest buffers, and exclusion from use as needed. ■

117—Boston Mountains

This area (shown in fig. 117-1) is in Arkansas (82 percent) and Oklahoma (18 percent). It makes up about 6,850 square miles (17,755 square kilometers). The town of Batesville, Arkansas, is at the east end of this area, and Fayetteville, Arkansas, is just outside the northern boundary in the western part of the area. There are no interstate highways in this area. The Ozark National Forest makes up a significant portion of the area.

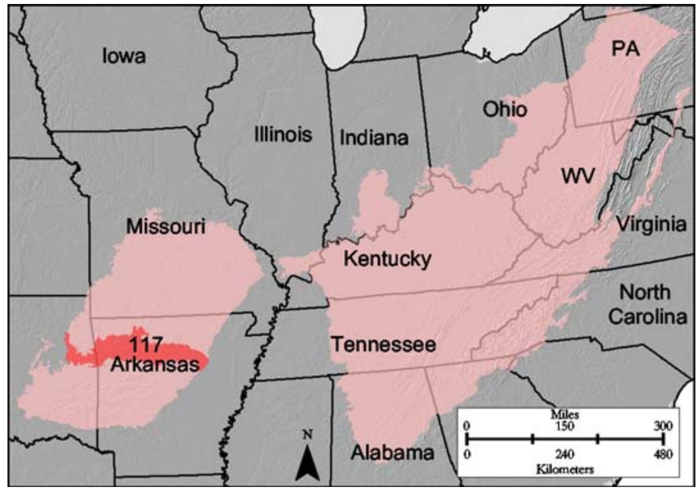

Figure 117-1: Location of MLRA 117 in Land Resource Region N.

Physiography

This area is mostly in the Boston “Mountains” Section of the Ozark Plateaus Province of the Interior Highlands. The northern half of the western tip of the area is in the Springfield-Salem Plateaus Section of the same province and division. The southern half of the western tip is in the Arkansas Valley Section of the Ouachita Province of the Interior Highlands. This MLRA marks the southern extent of the Ozarks. It is an old plateau that has been deeply eroded. Ridgetops are narrow and rolling. Valley walls are steep. Elevation ranges from 660 feet (200 meters) on the lowest valley floors to 2,625 feet (800 meters) on the highest ridge crests. Local relief commonly exceeds 100 feet (30 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper White (1101), 53 percent; Lower Arkansas (1111), 45 percent; and Neosho-Verdigris (1107), 2 percent. The Mulberry, King, Buffalo, and Middle Fork Little Red Rivers are in the part of this area in Arkansas, and the Illinois River is in the part in Oklahoma. The Buffalo River is a National River, and Lee Creek, in the southwest corner of the area, in Arkansas, has been designated a National Wild and Scenic River.

Geology

Most of this area is underlain by level to slightly tilted shale, sandstone, and siltstone strata in the Pennsylvanian-age Atoka Formation and the Cane, Boyd Shale, and Prairie Grove members of the Hale Formation. Parts of the northern edge are underlain by the Mississippian-age Pitkin Limestone, Fayetteville Shale, and Batesville Sandstone. Alluvium consisting of an unconsolidated mixture of clay, silt, sand, and gravel is deposited in river valleys.

Climate

The average annual precipitation in this area is 42 to 55 inches (1,065 to 1,395 millimeters). The maximum precipitation occurs in spring and fall, and the minimum occurs in midsummer. Most of the rainfall occurs as high-intensity, convective thunderstorms. Snowfall is uncommon in winter. The average annual temperature is 55 to 61 degrees F (13 to 16 degrees C). The freeze-free period averages 225 days and ranges from 200 to 245 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 24.4%; ground water, 5.1%
Livestock—surface water, 8.1%; ground water, 0.6%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 61.8%; ground water, 0.0%

The total withdrawals average 95 million gallons per day (360 million liters per day). About 6 percent is from ground water sources, and 94 percent is from surface water sources. The moderately high precipitation is adequate for crops and pasture. Small ponds on individual farms provide water for livestock, and springs are numerous on the mountainsides and in the valleys. Large reservoirs on a few of the major streams are sources of municipal water and provide flood control and opportunities for recreation. The surface water is generally of good quality and is suitable for most uses. Municipal and industrial wastewater discharges and nonpoint pollution have caused some local degradation of the water quality.

Shallow wells are the principal sources of water for domestic use. Deep wells are needed to obtain moderate to large quantities of ground water. Water from the Ozark aquifer system in the northern half of this area is suitable for drinking. It is hard or very hard, so treatment to remove calcium and/or magnesium may be needed. The average concentration of total dissolved solids is about 270 parts per million (milligrams per liter). The shallow aquifers within this system have the highest average level of nitrate of all aquifers in Arkansas. The average concentration, however, is still less than 1 part per million (milligram per liter).

Soils

The dominant soil orders in this MLRA are Ultisols and Inceptisols. The soils in the area dominantly have a thermic soil temperature regime, a udic soil moisture regime, and mixed or siliceous mineralogy. They are shallow to very deep, generally well drained, and loamy. Hapludults (Enders, Linker, Mountainburg, and Steprock series) and Dystrudepts (Hector series) formed in residuum on hills, plateaus, and mountains. Paleudults formed in alluvium or colluvium over residuum (Allen and Nella series) and alluvium or colluvium (Leesburg series) on hills and terraces.

Biological Resources

This area supports hardwood forests. The primary overstory species are red oak, white oak, and hickory. Shortleaf pine and eastern redcedar are important on disturbed sites, on shallow soils, and on south or west aspects. Big bluestem, switchgrass, Indiangrass, and little bluestem are important understory species under medium to open forest canopy. Broadleaf uniola, longleaf uniola, wildrye, and low panicums are important species under heavy canopy.

Some of the major wildlife species in this area are white-tailed deer, coyote, red fox, gray fox, bobcat, beaver, raccoon, opossum, skunk, muskrat, mink, cottontail, fox squirrel, gray squirrel, bobwhite quail, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 1%
Grassland—private, 22%; Federal, 3%
Forest—private, 48%; Federal, 18%
Urban development—private, 3%
Water—private, 2%; Federal, 2%
Other—private, 1%

About two-thirds of this area is forested. The forested areas are mainly in farm woodlots, but large tracts in Arkansas are national forests. About one-fourth of the area is grazing land, and a small percentage is cropland. Small grains and hay for livestock are the main crops. Peach and apple orchards are important locally. Most of the pastures support cultivated grasses and legumes, but native grasses grow on the prairie outliers in the western part of the area.

The major resource concerns in this area are gully and streambank erosion; plant productivity, health, and vigor; soil contaminants from applications of animal waste; and water for livestock. Conservation practices on cropland generally include critical area planting, protection of streambanks and shorelines, fencing, riparian forest buffers, forage harvest management, nutrient management, waste utilization, brush management, pest management, grade-stabilization structures, construction of ponds, and prescribed grazing. ■

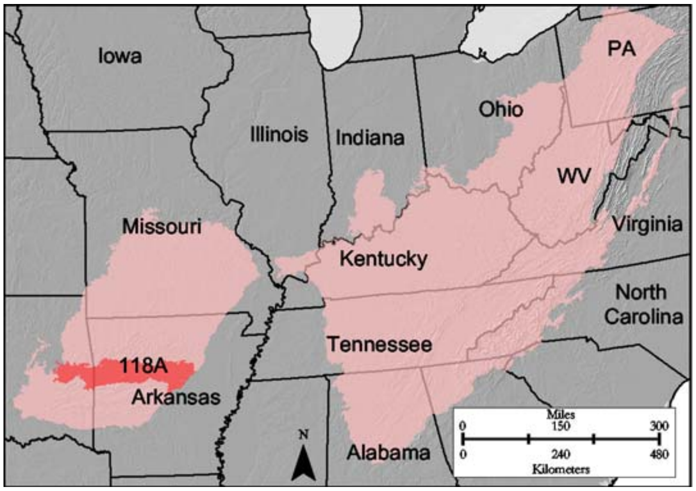

Figure 118A-1: Location of MLRA 118A in Land Resource Region N.

118A—Arkansas Valley and Ridges, Eastern Part

This area (shown in fig. 118A-1) is in Arkansas (75 percent) and Oklahoma (25 percent). It makes up about 6,755 square miles (17,510 square kilometers). The towns of Poteau and Sallisaw, Oklahoma, and Booneville, Clarksville, Fort Smith, Greenwood, and Ozark, Arkansas, are in the western part of this area. The towns of Conway, Morrilton, Russellville, and Searcy, Arkansas, are in the eastern part. Part of Little Rock, Arkansas, is in the southeast corner of the area. Interstate 40 passes through this MLRA from east to west and parallels the northern side of the Arkansas River. The Ozark National Forest and the northern fringe of the Ouachita National Forest occur in this area. Fort Chaffee, Camp Joseph T. Robinson, and Little Rock Air Force Base are in the area.

Physiography

Most of this area is in the Arkansas Valley Section of the Ouachita Province of the Interior Highlands. Small areas in the southeast corner and the south-central part of the MLRA are in the Ouachita Mountains Section of the same province and division. This MLRA consists of long, narrow ridges and high flat-topped mountains capped with sandstone that trend northeastward. Crests are narrow and rolling on ridges and broad and flat on mountaintops. The intervening valleys are broad and smooth. Elevation ranges from 300 feet (90 meters) on the lowest valley floors to 2,750 feet (840 meters) on the mountaintops.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Arkansas (1111), 85 percent; Lower Mississippi-St. Francis (802), 6 percent; Upper White (1101), 5 percent; and Lower Canadian (1109), 4 percent. The Arkansas River, which is regulated by numerous locks, dams, and reservoirs, is a major inland navigational river. It flows from the northwestern part of the MLRA, at Robert S. Kerr Lake, in Oklahoma, through the MLRA to the southeastern part of the area, at Little Rock, Arkansas.

Geology

The ridges and valleys in this area are underlain by slightly folded to level beds of sandstone and shale, respectively. The area principally consists of the Savanna group, McAlester group, Hartshorne sandstone group, and the upper and lower Atoka group. These are all of Pennsylvanian age. The terrace deposits along the Arkansas River include a complex sequence of unconsolidated gravel, sandy gravel, sands, silty sands, silts, clayey silts, and clays. The individual deposits commonly are lenticular and discontinuous. At least three terrace levels are recognized. The lowest is the youngest.

Climate

The average annual precipitation is 41 to 45 inches (1,040 to 1,145 millimeters) in the western one-third of this area. It is 45 to 61 inches (1,145 to 1,550 millimeters) in the eastern two-thirds of the area. Most of the rainfall occurs as frontal storms in spring and early summer. Some high-intensity, convective thunderstorms occur in summer. Precipitation occurs as rain and snow in January and February. The average seasonal snowfall is 5 inches (125 millimeters). The average annual temperature is 58 to 62 degrees F (14 to 17 degrees C). The freeze-free period averages 240 days and ranges from 220 to 260 days. It is shortest at the higher elevations on ridges.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 8.4%; ground water, 0.9%
Livestock—surface water, 3.5%; ground water, 0.2%
Irrigation—surface water, 26.7%; ground water, 1.0%
Other—surface water, 59.3%; ground water, 0.0%

The total withdrawals average 340 million gallons per day (1,285 million liters per day). About 2 percent is from ground water sources, and 98 percent is from surface water sources. The moderate precipitation generally is adequate for crops and pasture. In the uplands, water for livestock is obtained from small ponds on individual farms. In the valleys, springs, small ponds, and perennial streams provide water for most uses. Several large reservoirs are used for flood control and for recreation. Surface water for irrigation is obtained primarily from the Arkansas River. This river is being considered as a source of public supply water. Naturally occurring saline seeps impact the salinity of the Arkansas River, and industrial and municipal waste discharges also cause some degradation in water quality. One of the major uses of water from the Arkansas River is for cooling the nuclear power plant at Russellville. The surface water in the other streams in the area is generally of good quality and is suitable for most uses.

This area has very little ground water. It has no bedrock aquifers. Isolated alluvial deposits along the Arkansas River in both States provide high yields to irrigation wells. Water from this aquifer has median levels of total dissolved solids of less than 500 parts per million (milligrams per liter). As a result, it is suitable as irrigation water. It is very hard, however, and has high levels of iron. Extensive treatment is needed to make this water suitable for public supply. Rural landowners in valleys away from the Arkansas River obtain some water for domestic use and livestock from shallow wells in alluvium.

Soils

The dominant soil orders in this MLRA are Ultisols. The soils in the area dominantly have a thermic soil temperature regime, a udic soil moisture regime, and mixed or siliceous mineralogy. They are stony or nonstony and are medium textured. Well drained, shallow and moderately deep Hapludults (Mountainburg and Linker series) formed on ridgetops, benches, and the upper slopes. Well drained, deep Hapludults (Enders series) and Paleudults (Nella series) formed on the middle and lower slopes and in concave areas between ledges. Fragiudults (Leadvale, Taft, and Cane series) formed in valleys. Udifluvents (Roxana series), Udipsamments (Crevasse series), Haplaquolls (Roellen series), and Hapludalfs (Gallion series) are minor soils along the Arkansas River, and Dystrochrepts (Barling series) and Hapludults (Spadra and Pickwick series) are minor soils on terraces along the smaller streams.

Biological Resources

The pristine vegetation of this area was oak savanna and oak-hickory-pine forest. The primary overstory species are red oak, white oak, and hickory. Shortleaf pine is important on disturbed sites, on shallow soils, and on south and west aspects. Big bluestem, switchgrass, Indiangrass, and little bluestem are important understory species under medium to open forest canopy. Broadleaf uniola, longleaf uniola, wildrye, and low panicums are important species under heavy canopy.

Some of the major wildlife species in this area are white-tailed deer, coyote, armadillo, beaver, raccoon, skunk, opossum, muskrat, cottontail, mourning dove, turkey, fox squirrel, and gray squirrel.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 6%
Grassland—private, 44%; Federal, 4%
Forest—private, 32%; Federal, 2%
Urban development—private, 6%
Water—private, 4%
Other—private, 2%

Most of this MLRA is pasture, hayland, or forestland. Most of the privately owned land consists of farm woodlots and pasture. The poultry business has grown into a major industry in this area. Most of the cropland in the area is in the less sloping valleys, but some is on flat mountaintops. Small grains and hay are the major crops. Soybeans are an important crop on the bottom land along the Arkansas River. Orchards, vineyards, and vegetable crops are important locally. Pastures are on the bottom land along small streams and throughout the cleared parts of uplands. They support a mixture of tame and native grasses and legumes.

The major resource concerns are excessive nutrients and organic material in surface water; forest and pasture productivity, health, and vigor; and inadequate water sources for domestic animals. The important conservation practices in the area are management of phosphorus from chicken litter applied to cropland and pasture, forest stand improvement, prescribed grazing, development of springs, riparian forest buffers, and construction of ponds. ■

118B—Arkansas Valley and Ridges, Western Part

This area is entirely in Oklahoma (fig. 118B-1). It makes up about 3,070 square miles (7,960 square kilometers). It has no major cities. The towns of Henryetta and McAlester are in the area. Interstate 40 passes through the northern part of the area from east to west. The McAlester Army Ammunition Plant is in this area.

Physiography

Most of this area is in the Osage Plains Section of the Central Lowland Province of the Interior Plains. Parts of the east side of the area are in the Arkansas Valley and Ouachita Mountains Sections of the Ouachita Province of the Interior Highlands. The topography of the area is characterized by long, narrow sandstone-capped ridges that trend northeastward. The ridges are dissected by valleys cut by streams at right angles to the ridges. The valleys and scarp areas generally are cut into

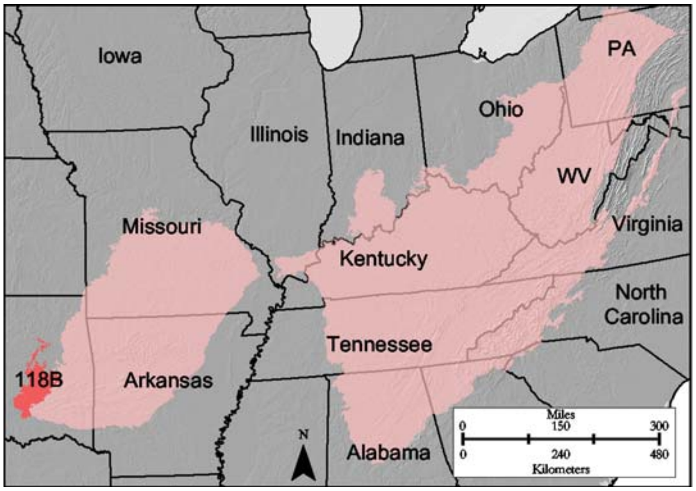

Figure 118B-1: Location of MLRA 118B in Land Resource Region N.

less resistant shale units. Elevation ranges from 550 feet (170 meters) to 1,500 feet (455 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Canadian (1109), 44 percent; Red-Sulphur (1114), 29 percent; North Canadian (1110), 18 percent; and Lower Arkansas (1111), 9 percent. The North and South Canadian Rivers flow from the western part of this area and merge at Eufaula Lake on the east side of the area. A narrow extension of this area catches part of the Arkansas and Verdigris Rivers southeast of Tulsa. The Arkansas River is heavily regulated by locks, dams, and reservoirs. It allows Mississippi River barge traffic to reach land-locked Tulsa, which is northwest of this area.

Geology

This area principally consists of hard and soft sandstone, shale, siltstone, limestone, and some conglomerates of the Cabaniss, Krebs, and Marmaton groups. These are all of Pennsylvanian age. They may include economically viable coal deposits. The bedrock geology of the area is tilted 2 to 15 degrees from the horizontal and is gently folded in some areas. Unconsolidated clay, silt, sand, and gravel are deposited in the river valleys.

Climate

The average annual precipitation in this area is 39 to 46 inches (990 to 1,170 millimeters). Most of the precipitation falls from April through September. The average annual temperature is 59 to 62 degrees F (15 to 17 degrees C). The freeze-free period averages 235 days and ranges from 220 to 255 days. The shorter freeze-free periods occur at the higher elevations on top of the major ridges.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 65.9%; ground water, 6.1%
Livestock—surface water, 28.0%; ground water, 0.0%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average 26 million gallons per day (100 million liters per day). About 6 percent is from ground water sources, and 94 percent is from surface water sources. The moderate precipitation generally is adequate for crops and pasture. In the uplands, water for livestock is obtained from small ponds on individual farms. Springs, small ponds, and perennial streams provide water for most uses in the valleys. Several large reservoirs are used for flood control, recreation, and some drinking water. The surface water is generally of good quality and is suitable for most uses.

This area has very little ground water. It has no bedrock aquifers. Isolated alluvial deposits along the Canadian, Arkansas, and Verdigris Rivers provide some public supply water. The water in this alluvial aquifer has a median level of total dissolved solids of 485 parts per million (milligrams per liter). It is very hard, so treatment is required to make the water suitable for public supply. Rural landowners away from the major river valleys obtain small quantities of water for domestic use from shallow wells in alluvium and fractures in the bedrock.

Soils

Most of the soils in this MLRA are Udalfs or Udepts. They have a thermic soil temperature regime, a udic soil moisture regime, and mixed or siliceous mineralogy. Moderately deep, gently sloping to steep Hapludalfs (Clearview series) formed on ridgetops, shoulder slopes, and side slopes. Very deep, gently sloping to sloping Paleudalfs (Stigler series) formed on the side slopes of valleys. Deep, gently sloping to steep Hapludalfs (Endsaw series) formed on side slopes and footslopes. Shallow, sloping to steep Dystrudepts (Clebit and Hector series) formed on narrow ridgetops and the upper shoulder slopes. Very deep, gently sloping to steep Paleudalfs (Larton and Porum series) and Hapludalfs (Karma series) are minor soils on terraces along streams. Nearly level to sloping Hapludolls (Verdigris series) and Udifluvents (Severn series) are minor soils along flood plains throughout the area.

Biological Resources

The pristine vegetation of this area was oak savanna. The primary trees that make up the overstory are red oak, white oak, and hickory. Pine grows in some isolated areas, but it is of minor importance. Big bluestem, switchgrass, Indiangrass, and little bluestem are important understory species under medium to open canopy. Broadleaf uniola, longleaf uniola, wildrye, and low panicums are important species under heavy canopy.

Some of the major wildlife species in this area are white-tailed deer, bobwhite quail, coyote, eastern turkey, fox squirrel, and gray squirrel.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 3%
Grassland—private, 48%; Federal, 2%
Forest—private, 33%; Federal, 2%
Urban development—private, 6%
Water—private, 5%
Other—private, 1%

About 32 percent of this area is pasture or hayland, and 18 percent is rangeland. Most of the pasture and rangeland is grazed by beef cattle. The pasture and hayland mainly support introduced grasses and legumes. Wheat, soybeans, and grain sorghum are the major crops grown on the small acreage of cropland in the area. The forested areas are covered with low-grade mixed hardwoods, and forest products are of very minor importance. Some areas are used for urban development.

Strip-mining of coal is common throughout the area. Stabilizing strip-mine spoil and reclaiming mined areas are major management concerns. Maintaining pasture and forest productivity also is important.

The important conservation practices in this area are forest stand improvement, prescribed grazing, development of springs, riparian forest buffers, and construction of ponds. ■

119—Ouachita Mountains

This area (shown in fig. 119-1) is in Arkansas (57 percent) and Oklahoma (43 percent). It makes up about 11,885 square miles (30,800 square kilometers). The towns of Mena and Murfreesboro, Arkansas, and Poteau, Oklahoma, are in this area. The cities of Benton and Hot Springs, Arkansas, are at the east end of the area. Little Rock, Arkansas, is just east of the area. Interstate 30 crosses the southeastern part of the area. Hot Springs National Park, the Ouachita National Forest, and a number of State parks are in the part of this MLRA in Arkansas.

Physiography

This area is in the Ouachita Mountains Section of the Ouachita Province of the Interior Highlands. The steep mountains are underlain by folded and faulted sedimentary and metamorphic rocks. Most of the stream valleys are narrow and have steep gradients, but wide terraces and flood plains border the Ouachita River in western Arkansas. Elevation ranges from 330 feet (100 meters) on the lowest valley floors to 2,625 feet (800 meters) on the highest mountain peaks. Local relief is generally 100 to 200 feet (30 to 60 meters), but it can exceed 980 feet (300 meters).

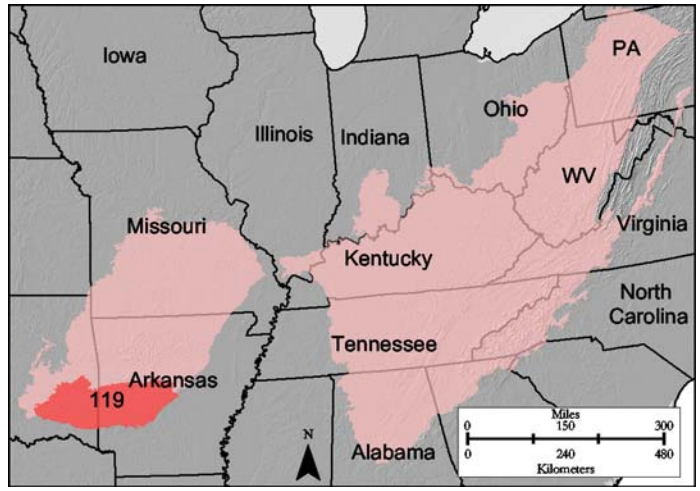

Figure 119-1: Location of MLRA 119 in Land Resource Region N.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Red-Sulphur (1114), 38 percent; Lower Arkansas (1111), 29 percent; Lower Red-Ouachita (0804), 29 percent; and Lower Canadian (1109), 4 percent. The Muddy Boggy, Kiamichi, Little, Fourche Maline, and Poteau Rivers are in the part of this MLRA in Oklahoma. The Petit Jean, Fourche LaFaye, Ouachita, and Caddo Rivers are in the part in Arkansas. The Cossatot, Little Missouri, and Mountain Fork Rivers, in the southern part of this area, have been designated as National Wild and Scenic Rivers.

Geology

These steep mountains are underlain by folded and faulted formations, dominantly of shale and sandstone. Ordovician-age shale and sandstone are included in the Collier Shale, Crystal Mountain Sandstone, and Womble Shale. Mississippian-age shale, sandstone, novaculite, and chert are included in the Arkansas Novaculite and the Stanley Shale. Pennsylvanian-age shale, slate, quartzite, and sandstone are included in the Jackfork Sandstone, Johns Valley Shale, and upper Atoka Formations. Alluvial deposits of silt, sand, and gravel are on the wide terraces and flood plains that border the Ouachita River in this area.

Climate

The average annual precipitation in most of this area is 50 to 66 inches (1,270 to 1,675 millimeters). It decreases to 41 to 49 inches (1,040 to 1,245 millimeters) along the western edge of the area. The precipitation is fairly evenly distributed throughout the year. The maximum occurs in spring and early in autumn. Most of the rainfall occurs as high-intensity, convective thunderstorms. Snowfall is not common in winter. The average annual temperature is 57 to 63 degrees F (14 to 17 degrees C). The freeze-free period averages 230 days and ranges from 205 to 255 days. The shorter freeze-free periods occur at the higher elevations on the major ridges.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 26.5%; ground water, 0.3%
Livestock—surface water, 9.6%; ground water, 0.3%
Irrigation—surface water, 0.6%; ground water, 0.0%
Other—surface water, 62.6%; ground water, 0.0%

The total withdrawals average 155 million gallons per day (585 million liters per day). About 1 percent is from ground water sources, and 99 percent is from surface water sources. The high precipitation, perennial streams, and reservoirs provide abundant water. Several large reservoirs are used for water storage, flood control, and recreation. In the valleys, small ponds and springs are the main sources of water for domestic use and for livestock. The surface water is typically of very good quality in this mountainous area. The area has few municipal or industrial wastewater discharges, and the lack of major agricultural enterprises has resulted in very little nonpoint source pollution.

In the valleys, shallow wells in alluvium are the main sources of water for domestic use and for livestock. None of the bedrock aquifers in Arkansas or Oklahoma occur in this area. The quality of the shallow ground water is very similar to the quality of the water in the streams and rivers. The ground water is suitable for drinking.

Soils

The dominant soil orders in this MLRA are Ultisols and Inceptisols. The soils in the area dominantly have a thermic soil temperature regime, a udic soil moisture regime, and mixed or siliceous mineralogy. They are shallow to very deep, generally somewhat excessively drained to somewhat poorly drained, and loamy. Dystrudepts (Bismarck and Clebit series) and Hapludalfs (Clearview series) formed in residuum on hills and mountains. Hapludults formed in colluvium (Zafra series), colluvium over residuum (Bengal series), and residuum (Carnasaw, Pirum, Sherless, Sherwood, Stapp, and Townley series) on hills, mountains, and plateaus. Udifluvents (Ceda series) formed in alluvium on flood plains.

Biological Resources

This area supports hardwood-pine forests. The primary overstory species are southern red oak, black oak, white oak, and hickories. Pine constitutes as much as 40 percent of the cover. It consists of shortleaf pine in the uplands and loblolly pine on the lower alluvial soils. Switchgrass, little bluestem, and Indiangrass are the primary grass species in the understory. Prairie cordgrass, plumegrass, low panicums, sedges, and rushes occur in smaller amounts.

Some of the major wildlife species in this area are coyote, bobcat, beaver, raccoon, otter, skunk, opossum, muskrat, mink, cottontail, armadillo, gray squirrel, and turkey. The species of fish in the area include largemouth bass, bluegill, redear sunfish, channel catfish, spotted bass, white bass, crappie, flathead catfish, sucker, bullhead, bowfin, and gar.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 1%
Grassland—private, 16%; Federal, 2%
Forest—private, 54%; Federal, 18%
Urban development—private, 3%
Water—private, 3%; Federal, 2%
Other—private, 1%

More than 70 percent of this MLRA is forested. About one-fourth of the forested acreage, mainly in Arkansas, is federally owned. Some of the forestland is in large holdings, but much of it is in farm woodlots. Timber production, wood-using industries, and recreation are important throughout the area. Nearly one-fifth of the MRLA is grazing land. Most of the pastures support a mixture of tame grasses and legumes, but some small prairie outliers in the western part of the area support native grasses. Forage and small grains are the major crops on the small acreage of cropland in the area.

The major soil resource concerns are gully and streambank erosion and the erosion caused by road construction; offsite soil deposition; plant productivity, health, and vigor; and livestock water.

Conservation practices on cropland generally include critical area planting, protection of streambanks and shorelines, riparian forest buffers, fencing, forest site preparation, pruning of trees and shrubs, forest harvest trails and landings, forest stand improvement, pest management, prescribed burning, forage harvest management, construction of ponds, and nutrient management. ■

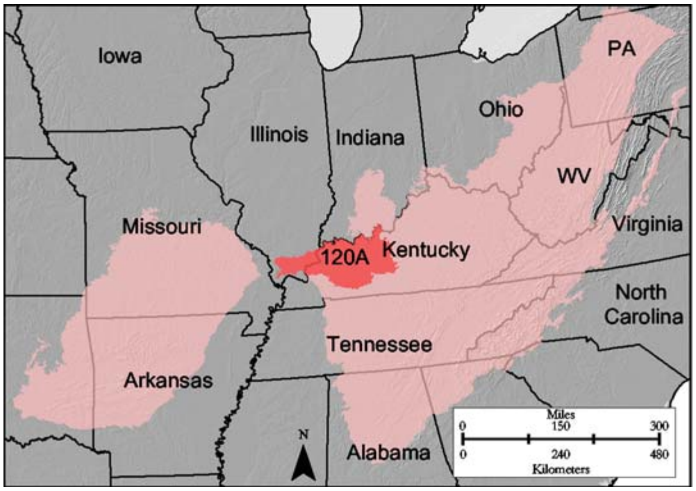

Figure 120A-1: Location of MLRA 120A in Land Resource Region N.

120A—Kentucky and Indiana Sandstone and Shale Hills and Valleys, Southern Part

This area (shown in fig. 120A-1) is primarily in Kentucky (83 percent) and Illinois (17 percent). A very small part is in Indiana. The area makes up about 8,905 square miles (23,080 square kilometers). The towns of Henderson, Owensboro, and Madisonville, Kentucky, and the small communities of Gibsonia, Pulley's Mill, Bloomfield, and Vienna, Illinois, are in this MLRA. Interstates 24 and 57 cross the part of the MLRA in Illinois. The Western Kentucky and Pennyrile Parkways cross the part in Kentucky. Mammoth Cave National Park (and World Heritage Site) is in the part in Kentucky, and the Shawnee National Forest is in the part in Illinois. A number of State parks are in the area.

Physiography

This area is in the Highland Rim Section of the Interior Low Plateaus Province of the Interior Plains. Both large and small tributaries of the Ohio River dissect the nearly level to very steep uplands in the area. The major streams and rivers have well defined valleys with broad flood plains and numerous stream terraces. The flood plains along the smaller streams are narrow. The western part of the area is dominated by gently sloping to steep slopes. The eastern part is dominated by sloping to very steep slopes with several levels of benches, a result of alternating beds of soft shale and hard sandstone bedrock. The steep and very steep slopes have many bedrock escarpments. Narrow, nearly level to gently sloping ridgetops are throughout the area. Elevation ranges from 345 feet (105 meters) on the flood plain along the Ohio River to about 950 feet (290 meters) on the highest ridges. Local relief varies widely within the area. The bluffs along the Ohio River are as much as 250 feet (75 meters) above the river valley floor.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Green (0511), 50 percent; Lower Ohio (0514), 43 percent; Upper Mississippi-Kaskaskia-Meramec (0714), 4 percent; and Cumberland (0513), 3 percent. The Ohio River flows through this area, forming the boundary between Indiana and Kentucky and between Illinois and Kentucky. It is a major transportation artery, and it provides opportunities for recreation in this area. The Saline River, in Illinois, joins the Ohio in this area. The Green River and its many tributaries drain the part of this area in Kentucky. The Green River, in Mammoth Cave National Park, has been designated a National Wild and Scenic River.

Geology

The geologic materials in this area are of Early and Middle Pennsylvanian and Late Mississippian age. The rocks consist mainly of flat-lying, interbedded sandstone, shale, coal, and siltstone with minor areas of limestone. Bedrock outcrops are common on the bluffs along the Ohio River and its major tributaries. There is some coal mining in this area. A layer of loess, typically less than 3.5 feet (1 meter) thick, covers the less eroded parts of the landscape, and the only other surficial geologic materials are stratified Pleistocene-age sediments along the Ohio River and its tributaries. Unconsolidated alluvium is deposited in the river valleys.

Climate

The average annual precipitation in most of this area is 45 to 54 inches (1,145 to 1,370 millimeters). About 60 percent of the precipitation falls during the freeze-free period. Most of the rainfall occurs as high-intensity, convective thunderstorms in summer. Snowfall is common in winter. The average annual temperature is 55 to 58 degrees F (13 to 14 degrees C). The freeze-free period averages 210 days and ranges from 190 to 230 days. The longer freeze-free periods occur along the Ohio River.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 3.7%; ground water, 0.8%
Livestock—surface water, 0.7%; ground water, 0.1%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 91.7%; ground water, 3.0%

The total withdrawals average 1,200 million gallons per day (4,540 million liters per day). About 4 percent is from ground water sources, and 96 percent is from surface water sources. In most years the supply of moisture is adequate for crop production, but in some years yields are reduced by drought. Surface water is abundant in the area. The Ohio River, the many tributary streams of the Ohio River, springs, and farm ponds are sources of surface water in the area. The water is used for recreation, public supply, and coal mining and for cooling thermoelectric power plants in the area. Water for livestock is commonly stored in small ponds and reservoirs. The surface water is generally of good quality and is suitable for almost all uses.

Good-quality ground water is not abundant in all parts of this area. Water for domestic use, livestock, and coal mining is available from underlying hard rock aquifers and from more shallow sand and gravel deposits in the valleys of the Ohio River and tributary streams.

The Pennsylvanian-Mississippian aquifer underlies almost all of this area. Low-yield wells are common in this aquifer in Illinois. The water in Illinois is typically high in total dissolved solids, very hard, and very high in iron content. The Pennsylvanian aquifer is in the coal-mining regions of Kentucky in this area. It has water that is less saline and not so hard as the water in the aquifer in Illinois and has about one-third the iron content. Ground water from these two aquifers requires extensive treatment to reduce the hardness and to prevent iron staining of appliances before the water is used for domestic or industrial purposes. The Mississippian aquifer in Kentucky is mostly limestone and has much fresher water. It is used for public supply in some communities in the area. Water from the alluvial deposits is similar in quality to that from the Pennsylvanian aquifer in Kentucky. The median level of total dissolved solids is just under 500 parts per million (milligrams per liter), but the water is very hard and the median level of iron is just under 1,000 parts per billion (micrograms per liter). Before it can be used for most purposes, it requires treatment to reduce hardness and prevent iron staining.

Soils

Most of the soils in this MLRA are Udalfs. Most are medium textured or moderately fine textured, but some on the lower hillsides and footslopes are fine textured. Most of the soils have a mesic soil temperature regime, a udic soil moisture regime, and mixed mineralogy. Some soils along the major rivers have a thermic soil temperature regime. The soils in the area formed in loess or in sandstone, shale, siltstone, or limestone residuum.

Fragiudalfs (Hosmer, Loring, and Zanesville series) and Fraglossudalfs (Sadler and Grenada series), which have a fragipan, and Hapludalfs (Wellston and Frondorf series) are the dominant soils on ridgetops and side slopes. Fragiudults (Tilsit series) and Hapludults (Gilpin and Shelocta series) are in the northern part of the area. Hapludolls (Huntington series), Eutrudepts (Nolin, Lindside, and Chagrin series), and Endoaquepts (Melvin and Newark series) are loamy soils on flood plains along the major streams. Endoaquepts and Epiaqualfs (Karnak and McGary series) are clayey soils in slackwater areas along the major rivers. Dystrudepts (Cuba and Steff series), Eutrudepts (Haymond and Wilbur series), Fluvaquents (Wakeland series), and Endoaquepts (Stendal series) are loamy soils on flood plains of local origin. Hapludalfs (Wheeling and Elk series) and Fragiudalfs (Otwood and Lawrence series) are loamy soils on terraces along the major streams.

Biological Resources

The soils on uplands in this area support native hardwoods. Oak and hickory are the dominant tree species. Coves and the cooler slopes support mixed beech, sugar maple, yellow-poplar, white ash, red oak, and white oak. Eastern redcedar commonly grows on the shallower soils overlying limestone. Such bottom-land hardwoods as cottonwood, cherrybark oak, pin oak, Shumard oak, sweetgum, and swamp white oak are on flood plains. Sedge and grass meadows and scattered trees are on some lowland sites.

Some of the major wildlife species in this area are white-tailed deer, coyote, gray fox, red fox, beaver, raccoon, skunk, muskrat, opossum, mink, rabbit, fox squirrel, gray squirrel, Canada goose, bald eagle, turkey vulture, turkey, ruffed grouse, woodcock, great horned owl, wood duck, pileated woodpecker, red-bellied woodpecker, and bobwhite quail.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 36%
Grassland—private, 18%
Forest—private, 23%; Federal, 10%
Urban development—private, 2%
Water—private, 4%
Other—private, 7%

Most of this area consists of privately owned farms. The farms produce both cash-grain crops and livestock. The less sloping soils are used for dry-farmed corn for grain and for soybeans. Some small grains, such as winter wheat and grain sorghum, also are grown in the area. About one-third of the area is wooded. Surface coal mines make up a small acreage.

The major soil resource concerns are water erosion, flooding, wetness, a limited available water capacity, and maintenance of the content of organic matter and productivity of the soils. Conservation practices on cropland generally include systems of crop residue management, especially no-till systems; cover crops; and nutrient management. Woodland management practices, such as exclusion of grazing and timber stand improvement, are important in areas used for timber production. ■

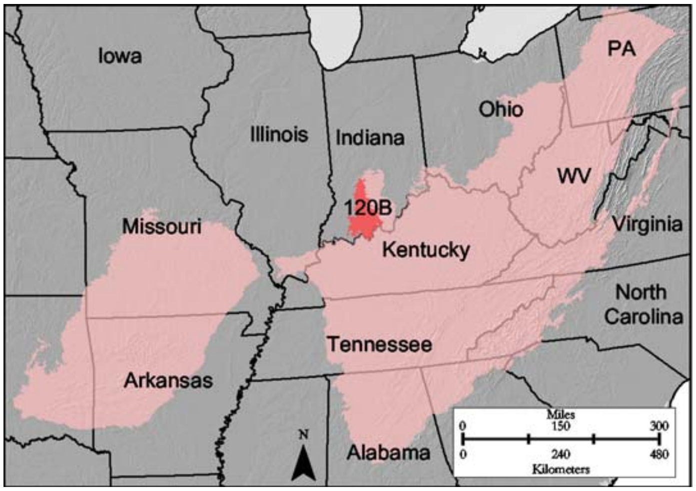

Figure 120B-1: Location of MLRA 120B in Land Resource Region N.

120B—Kentucky and Indiana Sandstone and Shale Hills and Valleys, Northwestern Part

This area is entirely in Indiana (fig. 120B-1). It makes up about 3,040 square miles (7,875 square kilometers). The towns of Boonville, Jasper, Tell City, English, Shoals, and French Lick are in this MLRA. Interstate 64 crosses the southern part of the MLRA and connects Evansville, Indiana, and Louisville, Kentucky. Numerous public lands are in this area. The Crane Naval Weapons Support Center, Scales Lake State Forest, Lincoln State Park, Lincoln Boyhood National Memorial, Martin County State Forest, Jackson State and Tillery Hill Recreation Areas, and Hoosier National Forest are in the MLRA.

Physiography

This area is in the Highland Rim Section of the Interior Low Plateaus Province of the Interior Plains. Both large and small tributaries of the Ohio River dissect the nearly level to very steep uplands in the area. The major streams and rivers have well defined valleys with broad flood plains and numerous stream terraces. The flood plains along the smaller streams are narrow. Local relief varies widely within the area. The western part of the area is dominated by gently sloping to steep slopes. The eastern part is dominated by sloping to very steep slopes with several levels of benches, a result of alternating beds of soft shale and hard sandstone bedrock. The steep and very steep slopes have many bedrock escarpments. Narrow, nearly level to gently sloping ridgetops are throughout the area. Elevation ranges from 345 feet (105 meters) on the flood plain along the Ohio River to about 950 feet (290 meters) on the highest ridges. The bluffs along the Ohio River are as much as 250 feet (75 meters) above the river valley floor.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Wabash (0512), 54 percent, and Lower Ohio (0514), 46 percent. The Ohio River flows through this area, forming the boundary between Indiana and Kentucky. The Anderson River empties into the Ohio River at Troy, Indiana, which is in the south-central part of the MLRA. The East Fork of the White River crosses the northern end of the area. A short reach of the Blue River, a National Wild and Scenic River, is in the southeastern part of the area. Patoka Lake, in the southern part of the area, is a major reservoir on the Patoka River.

Geology

The geologic materials in this area are of Early and Middle Pennsylvanian and Late Mississippian age. The rocks consist mainly of flat-lying, interbedded sandstone, shale, coal, and siltstone with minor areas of limestone. Bedrock outcrops are common on the bluffs along the Ohio River and its major tributaries. The surficial geologic materials consist mainly of a layer of loess, typically less than 3.5 feet (1 meter) thick, on the less eroded parts of the landscape and stratified sediments of Pleistocene age along the Ohio River and its tributaries. Unconsolidated alluvium is deposited in the river valleys.

Climate

The average annual precipitation in most of this area is 43 to 48 inches (1,090 to 1,220 millimeters). About 60 percent of the precipitation falls during the freeze-free period. Most of the rainfall occurs as high-intensity, convective thunderstorms in summer. Snowfall is common in winter. The average annual temperature is 53 to 56 degrees F (11 to 13 degrees C). The freeze-free period averages 205 days and ranges from 185 to 225 days. The longer freeze-free periods occur along the Ohio River.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 2.3%; ground water, 2.0%
Livestock—surface water, 2.0%; ground water, 0.8%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 91.6%; ground water, 1.4%

The total withdrawals average 71 million gallons per day (270 million liters per day). About 4 percent is from ground water sources, and 96 percent is from surface water sources. In most years the supply of moisture is adequate for crop production, but in some years yields are reduced by drought. Surface water is abundant in this area. The East Fork of the White River, the Ohio River and its many tributary streams, springs, and farm ponds are sources of surface water in the area.

This water is used for recreation, public supply, and coal mining and for cooling thermoelectric power plants in this area. Water for livestock is commonly stored in small ponds and reservoirs. The surface water in this area generally is of good quality and is suitable for almost all uses.

Good-quality ground water is not abundant in all parts of this area. Water for domestic use, livestock, and coal mining is available from underlying hard rock aquifers and from more shallow sand and gravel deposits in the valleys along the East Fork of the White River, the Ohio River, and tributary streams. The primary aquifer underlying almost all of this area consists of coal-bearing rocks of Pennsylvanian age. The water from this aquifer typically has about 500 parts per million (milligrams per liter) total dissolved solids, is very hard, and has a median level of iron that approaches 1,200 parts per billion (micrograms per liter). It requires extensive treatment to reduce the hardness and to prevent iron staining of appliances before the water is used for domestic or industrial purposes. Water from the alluvial deposits in the area is similar in quality to that from the Pennsylvanian aquifer. The median level of total dissolved solids is just under 500 parts per million (milligrams per liter), but the water is very hard and the median level of iron is just under 1,000 parts per billion (micrograms per liter). Before it can be used for most purposes, the water requires treatment to reduce hardness and prevent iron staining.

Soils

The dominant soil orders in this MLRA are Alfisols, Ultisols, and Inceptisols. The soils in the area have a mesic soil temperature regime, a udic or aquic soil moisture regime, and dominantly mixed mineralogy. They formed dominantly in less than 40 inches of loess and in residuum or colluvium derived from sandstone, shale, and siltstone. The soils range from moderately deep to very deep and from poorly drained to somewhat excessively drained and are loamy, silty, or clayey.

Fragiudalfs (Apalona and Zanesville series) and Hapludalfs (Wellston series) are the dominant soils on ridgetops and the upper part of side slopes. Hapludults (Adyeville series) and Dystrudepts (Tipsaw series) are on strongly sloping to very steep side slopes, and Hapludults (Tulip series) are on strongly sloping and steep footslopes. Hapludalfs (Deuchars, Ebal, and Kitterman series) are on moderately sloping to steep structural benches and scarps. Endoaquepts (Zipp series), Epiaqualfs (McGary series), and Hapludalfs (Shircliff and Markland series) formed in lacustrine sediments on nearly level to strongly sloping lacustrine terraces or lake plains. Hapludults (Millstone series), Hapludalfs (Elkinsville series), Fragiudalfs (Sciotoville series), and Epiaqualfs (Hatfield series) are on terraces along the Ohio River. Hapludolls (Huntington series), Eutrudepts (McAdoo and Lindside series), and Endoaquepts (Newark series) are on flood plains along the major streams. Dystrudepts (Cuba and Steff series), Eutrudepts (Gatchel and Haymond series), Endoaquepts (Belknap and Stendal series), and Fluvaquents (Birds and Bonnie series) are on local flood plains. Udorthents (Bethesda and Fairpoint series) formed in regolith from surface-mining operations.

Biological Resources

The soils on uplands support native hardwoods. Oak and hickory are the dominant tree species. Coves and the cooler slopes support mixed beech, sugar maple, yellow-poplar, white ash, red oak, and white oak. Eastern redcedar commonly grows on the shallower soils overlying limestone. Such bottom-land hardwoods as cottonwood, cherrybark oak, pin oak, Shumard oak, sweetgum, and swamp white oak are on flood plains. Sedge and grass meadows and scattered trees are on some lowland sites.

Some of the major wildlife species in this area are white-tailed deer, coyote, gray fox, red fox, beaver, raccoon, skunk, muskrat, opossum, mink, rabbit, fox squirrel, gray squirrel, Canada goose, bald eagle, turkey vulture, turkey, ruffed grouse, woodcock, great horned owl, wood duck, pileated woodpecker, red-bellied woodpecker, and bobwhite quail.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 36%
Grassland—private, 18%
Forest—private, 23%; Federal, 10%
Urban development—private, 2%
Water—private, 4%
Other—private, 7%

Most of this area consists of privately owned farms. The farms produce both cash-grain crops and livestock. The less sloping soils are used for dry-farmed corn for grain and for soybeans. Some small grains, such as winter wheat and grain sorghum, also are grown in the area. About one-third of the area is wooded. Surface coal mines make up a small acreage.

The major soil resource concerns are water erosion, flooding, wetness, a limited available water capacity, and maintenance of the content of organic matter and productivity of the soils. Conservation practices on cropland generally include systems of crop residue management, especially no-till systems; cover crops; and nutrient management. Woodland management practices, such as exclusion of grazing and timber stand improvement, are important in areas used for timber production. ■

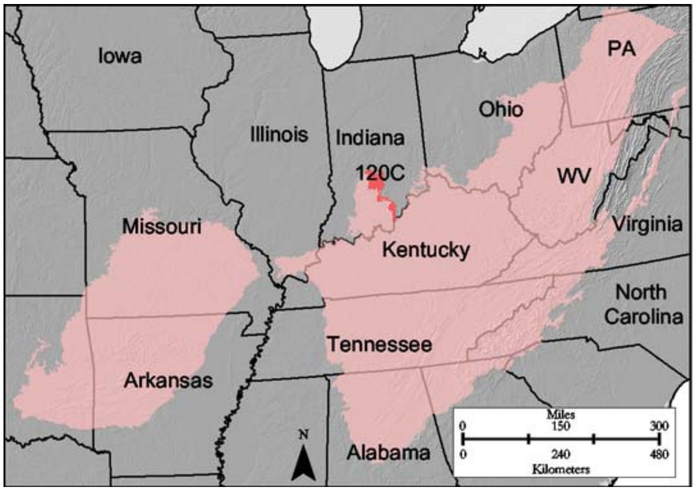

Figure 120C-1: Location of MLRA 120C in Land Resource Region N.

120C—Kentucky and Indiana Sandstone and Shale Hills and Valleys, Northeastern Part

This area is entirely in Indiana (fig. 120C-1). It makes up about 1,050 square miles (2,725 square kilometers). The towns of Freetown, Floyds Knob, and Nashville are in this MLRA. Interstate 64 crosses the lower part of the MLRA and connects Evansville, Indiana, and Louisville, Kentucky. Numerous public lands are in this area. The Yellowwood, Clark, and Jackson-Washington State Forests, Brown County State Park, Hardin Ridge Recreation Area, Paynetown State Recreation Area, part of the Camp Atterbury Maneuver Training Center, and Hoosier National Forest are in the MLRA.

Physiography

This area is in the Highland Rim Section of the Interior Low Plateaus Province of the Interior Plains. Both large and small tributaries of the Ohio River and the East Fork of the White River dissect the nearly level to very steep uplands in the area. The major streams and rivers have well defined valleys with broad flood plains and numerous stream terraces. The flood plains along the smaller streams are narrow. Summits are narrow and are nearly level to gently sloping. Elevation ranges from 380 feet (115 meters) on the northernmost flood plain along the Ohio River to about 1,060 feet (325 meters) on the highest ridges. Local relief is mainly 10 to 50 feet (3 to 15 meters), but it is 50 to 100 feet (15 to 30 meters) along drainageways and streams and the Knobstone Escarpment is as much as 250 feet (75 meters) above the valley floor of the rivers.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Wabash (0512), 79 percent, and Lower Ohio (0514), 21 percent. The Ohio River marks the southern boundary of this area and forms the State line between Indiana and Kentucky. The White River skirts the northern end of the area. The East Fork of the White River and the Muscatatuck and Blue Rivers cross the area. Monroe Lake, on the Salt River, is in the area.

Geology

The geologic materials in this area are of Early and Middle Pennsylvanian and Late Mississippian age. The rocks consist mainly of flat-lying, interbedded sandstone, shale, coal, and siltstone with minor areas of limestone. Bedrock outcrops are common on the bluffs along the Ohio River and its major tributaries. The surficial geologic materials consist mainly of a layer of loess, typically less than 3.5 feet (1 meter) thick, on the less eroded parts of the landscape and stratified sediments of Pleistocene age along the Ohio River and its tributaries. Unconsolidated alluvium is deposited in the river valleys.

Climate

The average annual precipitation in most of this area is 41 to 47 inches (1,040 to 1,195 millimeters). About 60 percent of the precipitation falls during the freeze-free period. Most of the rainfall occurs as high-intensity, convective thunderstorms in summer. Snowfall is common in winter. The average annual temperature is 52 to 56 degrees F (11 to 14 degrees C). The freeze-free period averages 205 days and ranges from 190 to 220 days. The longer freeze-free periods occur along the Ohio River.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 48.7%; ground water, 37.3%
Livestock—surface water, 8.6%; ground water, 5.4%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average 3.5 million gallons per day (13 million liters per day). About 43 percent is from ground water sources, and 57 percent is from surface water sources. In most years the supply of moisture is adequate for crop production, but in some years yields are reduced by drought. Monroe Lake, rivers and streams, springs, and farm ponds are sources of surface water in the area. This water is used for recreation, public supply, domestic use, and livestock. Water for livestock is commonly stored in small ponds and reservoirs. The surface water is generally of good quality and is suitable for almost all uses.

Good-quality ground water is not abundant in all parts of this area. Water for public supply, domestic use, and livestock is available from underlying hard rock aquifers and from more shallow sand and gravel deposits in valleys along the East Fork of the White River, the Ohio River, and tributary streams. The primary aquifer underlying almost all of this area consists of coal-bearing rocks of Pennsylvanian age. The ground water typically has about 500 parts per million (milligrams per liter) total dissolved solids, is very hard, and has a median level of iron that approaches 1,200 parts per billion (micrograms per liter). It requires extensive treatment to reduce the hardness and to prevent iron staining of appliances before the water is used for domestic or industrial purposes. In areas away from the rivers, the ground water supply is the only source of water for rural landowners and communities. Water from the alluvial deposits is similar in quality to that from the Pennsylvanian aquifer. The median level of total dissolved solids is just under 500 parts per million (milligrams per liter), but the water is very hard and the median level of iron is just under 1,000 parts per billion (micrograms per liter). Before it can be used for most purposes, the water requires treatment to reduce hardness and prevent iron staining.

Soils

The dominant soil orders in this MLRA are Alfisols, Ultisols, and Inceptisols. The soils in the area have a mesic soil temperature regime, a udic or aquic soil moisture regime, and dominantly mixed mineralogy. They formed dominantly in loess and in residuum derived from siltstone and shale. They range from moderately deep to very deep and from somewhat poorly drained to well drained and are loamy, silty, or clayey. Fragiudults (Spickert and Tilsit series) and Hapludults (Wrays series) are the dominant soils on ridgetops and the upper parts of hills and knobs. Halpudalfs (Kurtz series), Hapludults (Gilwood and Gnawbone series), and Dystrudepts (Brownstown series) are on moderately sloping to very steep side slopes. Hapludalfs (Coolville, Rarden, Stonehead, and Wellrock series) are on the gently sloping to moderately steep lower parts of side slopes. Hapludalfs (Elkinsville series), Fragiudalfs (Pekin series), and Fragiaqualfs (Bartle series) are on stream terraces. Dystrudepts (Beanblossom, Cuba, and Steff series) and Endoaquepts (Stendal series) are on flood plains.

Biological Resources

The soils on uplands support native hardwoods. Oak and hickory are the dominant tree species. Coves and the cooler slopes support mixed beech, sugar maple, yellow-poplar, white ash, red oak, and white oak. Such bottom-land hardwoods as cottonwood, cherrybark oak, pin oak, Shumard oak, sweetgum, and swamp white oak are on flood plains. Sedge and grass meadows and scattered trees are on some lowland sites.

Some of the major wildlife species in this area are white-tailed deer, coyote, gray fox, red fox, beaver, raccoon, skunk, muskrat, opossum, mink, rabbit, fox squirrel, gray squirrel, Canada goose, bald eagle, turkey vulture, turkey, ruffed grouse, woodcock, great horned owl, wood duck, pileated woodpecker, red-bellied woodpecker, and bobwhite quail.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 29%
Grassland—private, 13%
Forest—private, 35%; Federal, 9%
Urban development—private, 2%
Water—private, 8%
Other—private, 4%

Most of this area consists of privately owned farms. The farms produce both cash-grain crops and livestock. Specialty crops, such as tobacco and apple orchards, are grown on a small acreage in the area. The less sloping soils are used for dry-farmed corn for grain and for soybeans. Some small grains, such as winter wheat and oats, also are grown in the area. About 13 percent of the area supports introduced and native grasses. About 44 percent is wooded. Monroe Lake makes up almost 8 percent of the area.

The major soil resource concerns are water erosion, flooding, wetness, a limited available water capacity, and maintenance of the content of organic matter and productivity of the soils. Conservation practices on cropland generally include systems of crop residue management, especially no-till systems; cover crops; and nutrient management. Woodland management practices, such as exclusion of grazing and timber stand improvement, are important in areas used for timber production. ■

121—Kentucky Bluegrass

This area (shown in fig. 121-1) is in Kentucky (83 percent), Ohio (11 percent), and Indiana (6 percent). It makes up about 10,680 square miles (27,670 square kilometers). The cities of Cincinnati, Ohio, and Louisville, Frankfort, and Lexington, Kentucky, are in this area. Interstates 64 and 74 cross the southern and northern ends of the area, respectively. Interstates 65, 71, and 75 also are in the area. Many State parks are throughout the area.

Physiography

This area is primarily in the Lexington Plain Section of the Interior Low Plateaus Province of the Interior Plains. The parts of the area in Indiana and Ohio generally are in the Till Plains Section of the Central Lowland Province of the Interior Plains. This MLRA is an area of gently rolling terrain with some

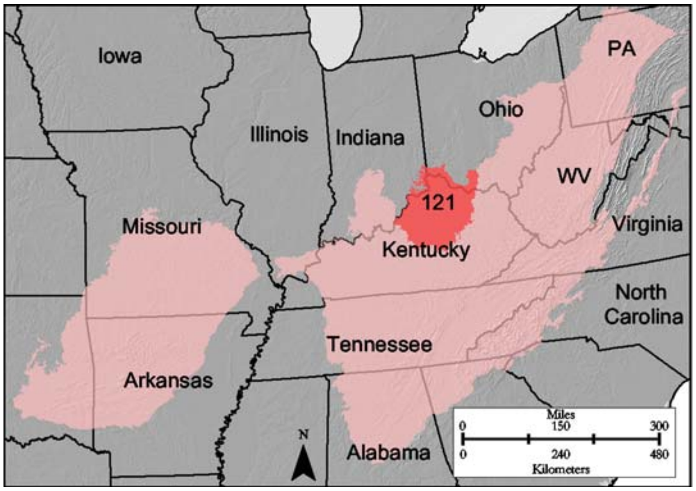

Figure 121-1: Location of MLRA 121 in Land Resource Region N.

isolated hills and ridges. Elevation ranges from about 660 feet (200 meters) on the flood plain along the Ohio River to about 980 feet (300 meters) on the higher ridges near Lexington. Local relief is about 160 to 330 feet (50 to 100 meters) on the highly dissected hills and 80 feet (25 meters) on the undulating, broad upland plains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Kentucky-Licking (0510), 52 percent; Lower Ohio (0514), 24 percent; Middle Ohio (0509), 21 percent; and Great Miami (0508), 3 percent. The Ohio River separates the States of Ohio and Kentucky in the northern part of this MLRA. The Great Miami, White Oak, and Ohio Brush Rivers are all tributaries to the Ohio River. The lower end of the Little Miami National Wild and Scenic River is just west of Cincinnati. The Whitewater River, a major tributary to the Great Miami River, is in southeastern Indiana and southwestern Ohio. The Salt, Kentucky, and Licking Rivers are tributaries to the Ohio River in the part of this area in Kentucky.

Geology

Most of this area has an Ordovician-age limestone that has been brought to the surface in the Jessamine Dome, a high part of a much larger structure called the Cincinnati Arch. The strata of limestone have a propensity to form caves and karst topography. Younger units of thin-bedded shale, siltstone, and limestone occur at the eastern and western edges of the area. The area has no coal-bearing units. Pleistocene-age loess deposits cover most of the bedrock units in this MLRA, and some glacial lake sediments are at the surface in the northwest corner of the area. Unconsolidated alluvium is deposited in the river valleys.

Climate

The average annual precipitation in most of this area is 41 to 45 inches (1,040 to 1,145 millimeters). It is 45 to 52 inches (1,145 to 1,320 millimeters) along the southern edge of the area. About one-half of the precipitation falls during the growing season. Most of the rainfall occurs as high-intensity, convective thunderstorms. The annual snowfall averages about 14 inches (370 millimeters). The average annual temperature is 51 to 57 degrees F (10 to 14 degrees C). The freeze-free period averages 210 days and ranges from 185 to 230 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 8.4%; ground water, 0.6%
Livestock—surface water, 0.4%; ground water, 0.0%
Irrigation—surface water, 0.2%; ground water, 0.0%
Other—surface water, 87.8%; ground water, 2.6%

The total withdrawals average 5,040 million gallons per day (19,075 million liters per day). About 3 percent is from ground water sources, and 97 percent is from surface water sources. Water is abundant in most of this area, and it is suitable for all uses. In most years precipitation is adequate for crops, but in some years yields are reduced by drought. Large streams and constructed lakes supply most of the water in urban areas, and waterlines supply much of the water in nearby rural communities. Farm ponds are one of the major sources of water in other rural communities. Water is diverted from the Great Miami basin to Mill Creek for the city of Cincinnati.

Large quantities of ground water are available in the valleys along the Ohio River and its major tributaries. The unconsolidated sand and gravel aquifer beneath the lower Great Miami River in southwestern Ohio is one of the most heavily used aquifers in Ohio. Water from these alluvial aquifers is of good quality but is very hard. The level of total dissolved solids averages just under the national secondary drinking water standard of 500 parts per million (milligrams per liter). The national secondary drinking water standard for iron, 300 parts per billion (micrograms per liter), was exceeded in 50 to 75 percent of all samples. The high levels of iron and manganese primarily come from runoff from surface mining in the upper part of the watershed. Almost all of the samples in the Louisville area exceeded the drinking water standard of 10 parts per million (milligrams per liter) for nitrates. Leaching from septic tanks appears to be the primary source of this contamination.

Wells and cisterns are the major sources of water in rural communities not served by rural water pipelines from reservoirs. A karst limestone aquifer underlying almost all of this area provides domestic and livestock water. This water is very hard. This aquifer has the highest average levels of nitrates of all the aquifers in this area, but only 10 percent of all samples tested as high as 8 parts per million (milligrams per liter) nitrate.

Soils

The dominant soil orders in this MLRA are Alfisols, Inceptisols, and Mollisols. The soils in the area dominantly have a mesic soil temperature regime, a udic soil moisture regime, and mixed mineralogy. They are shallow to very deep, generally well drained, and loamy or clayey. Hapludalfs formed in residuum on hills and ridges (Beasley, Cynthiana, Eden, Faywood, Lowell, and McAfee series) and in loess over residuum on hills and ridges (Carmel and Shelbyville series). Paleudalfs (Crider and Maury series) formed in loess or other silty sediments over residuum on hills and ridges. Fragiudalfs (Nicholson series) formed in loess over residuum on ridges. Hapludolls formed in residuum on hills and ridges (Fairmount series) and in alluvium on flood plains (Huntington series). Eutrudepts (Nolin series) formed in alluvium on flood plains.

Biological Resources

This area generally supports mixed hardwoods. Chinkapin oak, bur oak, blue ash, Shumard oak, white ash, hackberry, American elm, black walnut, black cherry, black locust, and Kentucky coffeetree are important species. Eastern redcedar is dominant on the drier slopes and on abandoned farmland.

Some of the major wildlife species in this area are white-tailed deer, raccoon, muskrat, mink, cottontail, gray squirrel, fox squirrel, bobwhite quail, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 22%
Grassland—private, 32%
Forest—private, 28%
Urban development—private, 14%
Water—private, 2%
Other—private, 2%

Most of this area consists of small and medium-size farms. Urbanization is of major extent near Louisville, Lexington, and Cincinnati. Nearly one-fourth of the area is cropland. The acreage of cropland varies widely from county to county, depending largely on the topography. Corn, hay, and tobacco are the major crops. About one-third of the area is pasture, which is grazed mostly by beef cattle. Dairying and horse farms are important in some areas. About one-fourth of the area supports mixed hardwoods, but wood products are not commercially important.

The major resource concerns are water erosion, runoff, sedimentation, and water quality, particularly in areas of urban development. Air quality also is a concern near the urban areas. Conservation practices on cropland generally include conservation tillage, nutrient management, pest management, grassed waterways, field borders, and grass buffers. ■

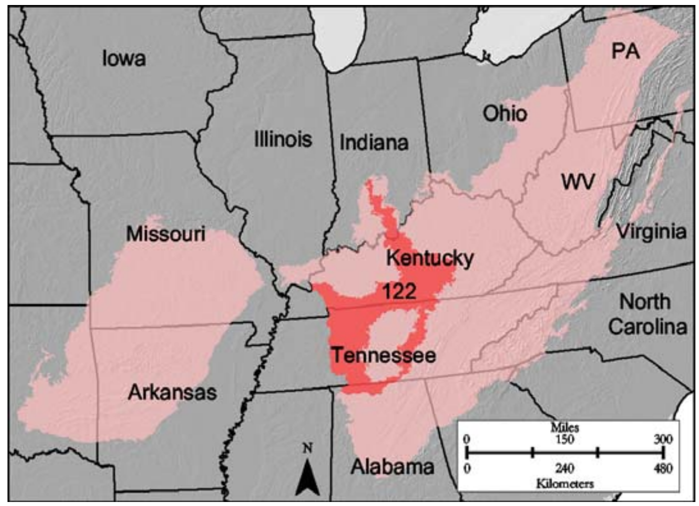

Figure 122-1: Location of MLRA 122 in Land Resource Region N.

122—Highland Rim and Pennyroyal

This area (shown in fig. 122-1) is in Tennessee (47 percent), Kentucky (43 percent), Indiana (7 percent), and Alabama (3 percent). It makes up about 21,530 square miles (55,790 square kilometers). Bloomington, Indiana, is in the small part of this area that juts into southern Indiana. The towns of Bowling Green, Fort Knox, and Hopkinsville, Kentucky, Clarksville, Tennessee, and Athens, Alabama, are in this MLRA. Interstates 24, 40, and 65 cross this area. The historic Natchez Trace (Natchez Trace Parkway) crosses the southeast part of the area. Fort Knox and Fort Campbell Military Reservations are in this MLRA. The Arnold Engineering Development Center, which is a National Natural Landmark, and the Land Between the Lakes, which is a Biosphere Reserve, are in the part of this area in Kentucky. The Biosphere Reserve lies between Kentucky Lake and Lake Barkley, formed on the Tennessee and Cumberland Rivers by dams in Kentucky.

Physiography

This area is in the Highland Rim Section of the Interior Low Plateaus Province of the Interior Plains. It is a plateau consisting of low, rolling hills, upland flats, and narrow valleys. Steep slopes occur where the encircled Nashville Basin cuts into the area and along the western edge bordering the Coastal Plain. Elsewhere, except for steep walls and hillsides along deeply cut stream channels, the topography generally is gently rolling to strongly rolling and is interrupted in a few areas by broad upland flats and shallow basins. In many areas the land surface is pitted by limestone sinks. Elevation generally is 660 to 980 feet (200 to 300 meters). It ranges from about 330 feet (100 meters) along the deepest valley floors to about 1,310 feet (400 meters) on the crest of isolated hills.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Cumberland (0513), 39 percent; Green (0511), 22 percent; Lower Tennessee (0604), 16 percent; Middle Tennessee-Elk (0603), 11 percent; Lower Ohio (0514), 9 percent; and Wabash (0512), 3 percent. The headwaters of the Kentucky, Green, and Cumberland Rivers occur in the part of this area in Kentucky. The Ohio River forms the boundary between Indiana and Kentucky in this MLRA. The Tennessee River follows the western edge of the part of this area in Tennessee. The Cumberland River also is in this area. The Buffalo River, in Tennessee, has been designated a National Wild and Scenic River.

Geology

Most of this area is underlain by Ordovician- to Mississippian-age limestone and dolomite that has been exposed through erosion of the Cincinnati Arch. Parts of these rocks are covered by a layer of clay as much as 80 feet thick. Karst areas are common where the layer of clay does not occur. In the northernmost part of the MLRA, in Indiana, a sizable area is underlain by shale, sandstone, and limestone. Much of the bedrock on uplands and ridges is covered by a loess cap. Significant sand and gravel deposits occur on the valley floor and on terraces along the major rivers.

Climate

The average annual precipitation in this area is 43 to 63 inches (1,090 to 1,600 millimeters), increasing to the south. The maximum precipitation occurs in winter and early in spring, and the minimum occurs in fall. Most of the rainfall occurs as high-intensity, convective thunderstorms. Snowfall may occur in winter. The average annual temperature is 52 to 60 degrees F (11 to 16 degrees C), increasing to the south. The freeze-free period averages 210 days and ranges from 185 to 235 days. The longer freeze-free periods occur in the more southerly parts of the area.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 4.0%; ground water, 1.6%
Livestock—surface water, 0.2%; ground water, 0.2%
Irrigation—surface water, 0.2%; ground water, 0.2%
Other—surface water, 90.2%; ground water, 3.4%

The total withdrawals average 2,055 million gallons per day (7,780 million liters per day). About 5 percent is from ground water sources, and 95 percent is from surface water sources. In most years precipitation is adequate for crops, but in some years yields are reduced by short dry periods early in summer. The numerous perennial streams and lakes supply abundant water to much of the area. The surface water generally is suitable for all uses. Several medium to large lakes constructed by the U.S. Army Corps of Engineers provide flood control, power production, opportunities for recreation, and water for municipalities. Water lines from metropolitan areas commonly extend far into the countryside in areas where surface water is scarce. Farm ponds provide supplemental water in areas where the supply of other surface water is low.

Most of the ground water used in this area is from a Mississippian-age carbonate aquifer system. The water occurs in solution openings and fractures in the limestone and dolomite. It is very hard but is otherwise of excellent quality. The median level of total dissolved solids is about 175 parts per million (milligrams per liter) in Tennessee and about 250 in Kentucky. In some areas high levels of iron, manganese, and sulfate can occur. In Indiana and other areas where the levels of iron are high, they may exceed the national secondary standard for drinking water, which is 300 parts per billion (micrograms per liter). The secondary standard is primarily esthetic, although the iron can stain ceramic and porcelain and precipitate in pipes. In karst areas this aquifer is susceptible to contamination from nonpoint sources of pollution in runoff.

Soils

The dominant soil orders in this MLRA are Alfisols, Inceptisols, and Ultisols. The soils in the area dominantly have a mesic soil temperature regime, a udic soil moisture regime, and mixed or siliceous mineralogy. They are moderately deep to very deep, generally moderately well drained or well drained, and loamy or clayey. Paleudalfs formed in residuum (Baxter and Vertrees series) and loess over residuum or old alluvium (Crider, Hammack, and Pembroke series) on hills and ridges. Hapludalfs (Caneyville series) and Hapludults (Frankstown series) formed in residuum on hills and ridges. Fragiudalfs (Bedford and Nicholson series) and Fragiudults (Dickson series) formed in loess over residuum on hills and ridges. Eutrudepts formed in residuum on hills (Garmon series) and in alluvium on flood plains (Nolin series). Paleudults formed in residuum on uplands (Frederick series) and in loess over residuum on ridges and plateaus (Mountview series). Fluvaquents (Newark series) formed in alluvium on flood plains.

Biological Resources

This area supports oak-hickory forests. Yellow-poplar is common on the deeper soils. Understory plants include a variety of grasses, forbs, vines, and shrubs. Little bluestem and broomsedge are the dominant grass species.

Some of the major wildlife species in this area are red fox, gray fox, raccoon, skunk, opossum, muskrat, mink, cottontail, gray squirrel, fox squirrel, bobwhite quail, and mourning dove. The species of fish in the area include carp, bullhead, largemouth bass, and bluegill.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 23%
Grassland—private, 23%; Federal, 1%
Forest—private, 40%; Federal, 2%
Urban development—private, 6%
Water—private, 3%
Other—private, 2%

Most of this area consists of small and medium-size farms. Extensive forests are on the deeply dissected hills surrounding the Nashville Basin and along the western edge joining the Coastal Plain. Elsewhere, the forests consist mostly of small farm woodlots. Hay and pasture for beef cattle are the principal crops. Corn and soybeans, grown mostly on narrow strips of bottom land and on upland flats, are important locally. Tobacco, especially burley, is an important cash crop. Dark-fired tobacco is a high-value crop grown on the Tennessee-Kentucky line. Some areas are used for urban development.

The major soil resource concern is water erosion. Erosion is a hazard on cropland, streambanks, and construction sites. Minor erosion can occur on overgrazed pastures, and extreme overgrazing can result in gullies in areas of concentrated flow and heavy use. Maintenance of the content of organic matter and productivity of the soils and management of soil moisture are additional resource concerns in areas where long-term erosion has occurred.

Conservation practices on cropland generally include systems of crop residue management, especially no-till systems; cover crops; pest management; and nutrient management. Conservation practices on pasture generally include prescribed grazing, watering systems, protection of heavily used areas, nutrient management, and pest management. Conservation practices on hayland generally include forage harvest management, nutrient management, and pest management. Critical area planting helps to prevent gully erosion in all areas. ■

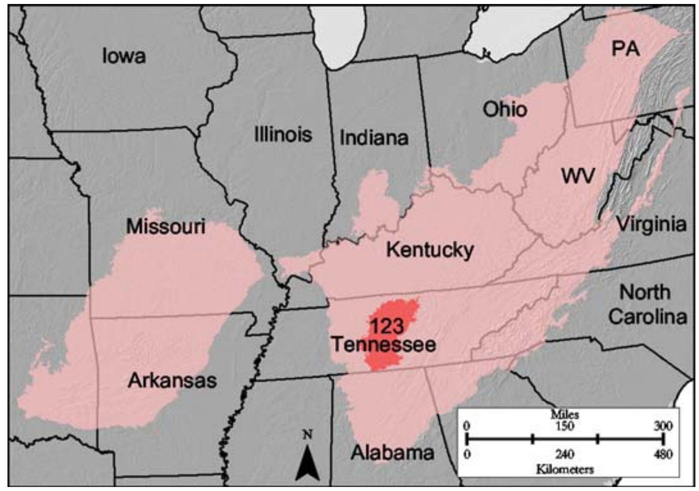

Figure 123-1: Location of MLRA 123 in Land Resource Region N.

123—Nashville Basin

This area is entirely in Tennessee (fig. 123-1). It makes up about 5,625 square miles (14,580 square kilometers). The cities of Nashville, Franklin, Hendersonville, Columbia, Murfreesboro, and Shelbyville are in this area. Interstates 24, 40, and 65 intersect in Nashville. The Cedars of Lebanon State Park and Forest are in the center of this area.

Physiography

Most of this area is in the Nashville Basin Section of the Interior Low Plateaus Province of the Interior Plains. A small part of the northeast corner and the western and southern fourth of the area are in the Highland Rim Section of the same province and division. Most of the outer part of the Nashville Basin is deeply dissected and consists of steep slopes between narrow, rolling ridgetops and narrow valleys. The inner part of the basin is dominantly undulating and rolling. In many areas the land surface is deeply pitted by limestone sinks, and outcrops of limestone are almost everywhere. Elevation generally is about 650 feet (200 meters), but it is 1,000 to 1,325 feet (305 to 405 meters) on isolated hills and is as low as 450 feet (135 meters) in some of the more deeply cut stream channels.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Cumberland (0513), 56 percent; Lower Tennessee (0604), 25 percent; and Middle Tennessee-Elk (0603), 19 percent. The Cumberland River is in the northern part of this area. Two major tributaries of this river, the Harpeth and Stones Rivers, are in this MLRA. A portion of the Harpeth River in the middle of the western part of this area has been designated a National Wild and Scenic River.

Geology

The bedrock geology in this area consists of Ordovician limestone exposed by geologic erosion of the top of the Nashville Dome (a high part of the Cincinnati Arch) throughout this area. Sinkholes are common in the limestone and are either open to the subsurface or are covered by soils and colluvium that have collected in the depressions formed on the land surface above the sinkhole. Younger rocks occur as a rim just outside this area. Surficial deposits include loess on the less eroded landforms and alluvium along the rivers and streams.

Climate

The average annual precipitation in this area is 48 to 57 inches (1,220 to 1,450 millimeters). The maximum precipitation occurs in midwinter and early in spring, and the minimum occurs in autumn. Rainfall primarily occurs during high-intensity, convective thunderstorms. Some snow occurs in winter, but it does not remain on the ground for long periods. The average annual temperature is 56 to 60 degrees F (14 to 16 degrees C). The freeze-free period averages 210 days and ranges from 195 to 230 days. The longer freeze-free periods occur in the southern part of the area.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 8.6%; ground water, 0.3%
Livestock—surface water, 0.1%; ground water, 0.3%
Irrigation—surface water, 0.1%; ground water, 0.1%
Other—surface water, 89.0%; ground water, 1.4%

The total withdrawals average 2,660 million gallons per day (10,070 million liters per day). About 2 percent is from ground water sources, and 98 percent is from surface water sources. The moderately high precipitation generally provides adequate moisture for crops and pasture, but short periods of drought in summer reduce pasture and crop yields in some years. Permanent streams and lakes are important sources of water. The Cumberland River has dams for flood control, power production, navigation, and recreation. Farm ponds provide supplemental water, especially in areas where surface water is scarce because of limestone sinks.

Ground water from wells and springs is an important source of water for domestic use and for livestock. The water is in the Ordovician carbonate aquifer that underlies this area. It is hard and typically has a median level of total dissolved solids of less than 500 parts per million (milligrams per liter). The water is in solution openings in this aquifer and is susceptible to contamination from surface activities in karst areas. For example, septic systems have contaminated the shallow water in the part of this aquifer in the Nashville area.

Soils

Many of the soils in this MLRA are Udalfs. The moderately deep to very deep, well drained, clayey soils formed in limestone residuum. They are dominantly in rolling to steep areas of the “Outer Basin” (Mimosa, Braxton, Gladdice, and Hampshire series) and the undulating to hilly areas of the “Inner Basin” (Talbott and Bradyville series). The most agriculturally productive soils are the very deep, well drained, clayey or loamy soils that formed in alluvium and/or loess over alluvium or limestone residuum in nearly level to undulating areas (Armour, Cumberland, Harpeth, Lomond, and Maury series). The less extensive soils generally are moderately well drained to somewhat poorly drained and formed in loamy or clayey alluvium and/or residuum (Byler, Capshaw, Colbert, and Tupelo series). This MLRA has a significant acreage of Mollisols. Shallow or moderately deep, well drained, clayey Udolls (Ashwood and Barfield series) formed in limestone residuum dominantly in rolling to steep areas. Very shallow, well drained, clayey Rendolls (Gladeville series) formed in limestone residuum dominantly in undulating to rolling areas of the “Inner Basin.” Very deep, well drained or moderately well drained Udolls (Arrington, Egam, Lynnville, and Staser series) and somewhat poorly drained or poorly drained Aquolls (Agee, Godwin, and Lanton series) formed in loamy or clayey alluvium derived from limestone on flood plains. Most of the remaining soils on flood plains are moderately well drained or well drained Udepts (Lindell and Ocana series). Udults are of small extent in this area. Most are very deep, well drained, and loamy and formed in gravelly colluvium or colluvium and the underlying residuum on steep hillsides (Dellrose soils). Rock outcrops are common on uplands.

Biological Resources

This area supports stands of oak and hickory. Yellow-poplar grows on the north aspects, and eastern redcedar and cedar-hardwood stands grow in limestone glades and on rocky, clayey sites. The understory vegetation includes many grasses, forbs, vines, and shrubs. Broomsedge bluestem is the dominant grass species.

Some of the major wildlife species in this area are white-tailed deer, gray fox, red fox, raccoon, muskrat, cottontail, mink, gray squirrel, bobwhite quail, and mourning dove. The species of fish in the area include bass, crappie, and walleye.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 14%
Grassland—private, 31%
Forest—private, 36%; Federal, 1%
Urban development—private, 13%
Water—private, 3%
Other—private, 2%

This densely populated area consists mostly of small and medium-size farms. Much of the farmland has been converted to residential use and to small estate-type farms, particularly around Nashville. Hay, pasture, and some grain for beef cattle and dairy cattle are the principal crops. Small acreages are used for burley tobacco, cotton, or soybeans. Some large rocky sites, commonly called "Glady Land," support redcedar forest or redcedar-deciduous brush.

The major soil resource concerns in this area are water erosion, deposition of sediment, depletion of organic matter in the soils, surface compaction, and soil contaminants. Conservation practices on cropland generally include systems of crop residue management, especially no-till systems; cover crops; and nutrient management. The important conservation practice on pasture is prescribed grazing. ■

124—Western Allegheny Plateau

This area (shown in fig. 124-1) is in Ohio (53 percent), Kentucky (25 percent), and Pennsylvania (22 percent). It makes up about 12,880 square miles (33,375 square kilometers). It includes the towns of Punxsutawney, Kittanning, Butler, and Beaver Falls, Pennsylvania; Dover, Coshocton, Cambridge, Zanesville, Portsmouth, and Ironton, Ohio; and Ashland and Morehead, Kentucky. Interstates 64, 70, 76, 79, and 80 cross this area. The Wayne National Forest covers a significant part of the area in southern Ohio, and the Daniel Boone National Forest is in the part in Kentucky. A number of State forests are in the part in southern Ohio. State parks occur throughout the area.

Physiography

This area is primarily in the Kanawha Section of the Appalachian Plateaus Province of the Appalachian Highlands. The southern edge is in the Cumberland Plateau Section of the same province and division. The southwestern edge is in the Lexington Plain Section of the Interior Low Plateaus Province of the Interior Plains. This MLRA is on a dissected plateau that has narrow, level valley floors, rolling ridgetops, and hilly to steep ridge slopes. Elevation ranges from 660 feet (200 meters) on the lowest valley floors to 1,310 feet (400 meters) on the highest ridgetops. Local relief is about 160 to 330 feet (50 to 100 meters).

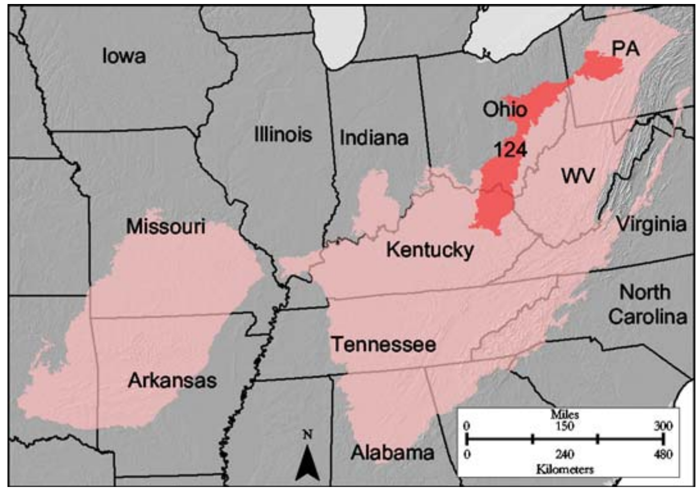

Figure 124-1: Location of MLRA 124 in Land Resource Region N.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Muskingum (0504), 24 percent; Middle Ohio (0509), 22 percent; Allegheny (0501), 15 percent; Upper Ohio (0503), 14 percent; Kentucky-Licking (0510), 11 percent; Scioto (0506), 11 percent; and Big Sandy-Guyandotte (0507), 3 percent. The Allegheny River crosses the part of this area in Pennsylvania. The Muskingum, Raccoon, and Scioto Rivers are in the part in Ohio. The West Fork Little Beaver River is a National Wild and Scenic River in Ohio. It is just across the border from Pennsylvania. The Ohio River forms the boundary between Ohio and Kentucky in the southern part of this area.

Geology

Cyclic beds of sandstone, siltstone, clay, shale, and coal of Pennsylvanian age form the bedrock in this area. Similar rocks of Mississippian age occur along the southwest edge of the area in Kentucky and southern Ohio. This MLRA is on the east side of the Cincinnati Arch, so the bedrock is tilted to the east in Kentucky and Ohio. Old glacial drift deposits are in some of the major river valleys. Wisconsin-age glacial outwash deposits of unconsolidated sand and gravel are near the surface in river valleys in Pennsylvania and Ohio. Wisconsin-age glacial drift covers the surface in areas to the east and north of this MLRA.

Climate

The average annual precipitation in most of this area is 37 to 45 inches (940 to 1,145 millimeters). It is 45 to 50 inches (1,145 to 1,270 millimeters) at the southern tip of the area. The precipitation generally is evenly distributed throughout the year, except for a slight maximum late in spring and a minimum late in autumn. Rainfall occurs as high-intensity, convective thunderstorms in summer. Winter precipitation occurs as snow. The average annual temperature is 46 to 56 degrees F (8 to 13 degrees C). The freeze-free period averages 185 days and ranges from 155 to 220 days. It is longest along the southern edge of the area.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 7.4%; ground water, 7.2%
Livestock—surface water, 0.5%; ground water, 0.5%
Irrigation—surface water, 0.1%; ground water, 0.0%
Other—surface water, 75.5%; ground water, 8.7%

The total withdrawals average 915 million gallons per day (3,465 million liters per day). About 16 percent is from ground water sources, and 84 percent is from surface water sources. The moderate precipitation and many perennial streams supply an abundance of surface water. Springs are among the principal sources of water for domestic use and livestock. Reservoirs on many streams provide water for industrial and municipal uses in most of the cities in this area and also in some cities in adjoining areas. The surface water is suitable for almost all uses with minimal treatment. Municipal and industrial wastewater discharges, nonpoint pollution from agricultural lands, sedimentation from surface mining of coal, and some acid mine drainage are the primary water-quality problems in this area.

Shallow wells are another major source of water for domestic use and livestock in this area. These wells are in the sandstone, shale, and coalbeds or in unconsolidated silt, sand, and gravel deposits along rivers and streams throughout the area. Their water is dominantly moderately hard and, except for high levels of iron, generally meets the national standards for drinking water. Water from fractures in sandstone generally is soft, and water from fractures in the shale generally is hard. The highest iron concentrations are in water from the coal-bearing units. Deep oil and gas exploration wells tap abundant ground water, but this water is briny. For example, water from wells in the Sandstone aquifer in Ohio has a median level of 322 parts per million (milligrams per liter) total dissolved solids, but the water is salty below a depth of 300 feet (90 meters). Contamination from septic systems located too close to domestic wells is one of the most common water-quality problems in this area.

Good-quality ground water can be obtained from the glacial outwash and recent alluvium deposited in the larger stream valleys throughout this area. High-yield wells are common in this aquifer, and many municipalities, industries, and thermoelectric power plants tap this aquifer. The water generally is very hard but typically meets national drinking water standards. In some areas it has high levels of iron that exceed the secondary drinking water standard. Water from most wells tapping the alluvial deposits in the valley of the Ohio River in the southern part of this area exceeds the national secondary standard for total dissolved solids of 500 parts per million (milligrams per liter).

Soils

The dominant soil orders in this MLRA are Ultisols and Inceptisols. The soils in the area have a mesic soil temperature regime, a udic soil moisture regime, and mixed mineralogy. They generally are moderately deep to very deep, excessively drained to somewhat poorly drained, and loamy. Fragiudults and Hapludults (Ernest and Shelocta series) formed in colluvium on footslopes and alluvial fans. Hapludults (Gilpin, Latham, Rayne, and Wharton series) and Dystrudepts (Berks, Steinsburg, and Weikert series) formed in residuum on hills and ridges. Dystrudepts (Pope series), Endoaquepts (Stendal series), Eutrudepts (Chagrin series), and Hapludalfs (Chavies series) formed in alluvium along the major streams. Udorthents (Bethesda, Sewell, Fairpoint, and Kaymine series) formed in material derived from surface mining of coal.

Biological Resources

This area supports mixed oak forest vegetation. White oak, black oak, northern red oak, and some scarlet oak are the dominant tree species. Shagbark hickory, bitternut hickory, pignut hickory, and mockernut hickory also occur. Oak, blackgum, flowering dogwood, sassafras, Virginia pine, pitch pine, and shortleaf pine grow mostly on ridgetops.

Some of the major wildlife species in this area are white-tailed deer, fox, beaver, raccoon, woodchuck, rabbit, squirrel, red-tailed hawk, crow, turkey, pheasant, ruffed grouse, pileated woodpecker, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 13%; Federal, 1%
Grassland—private, 13%; Federal, 1%
Forest—private, 60%; Federal, 3%
Urban development—private, 6%
Water—private, 1%
Other—private, 2%

Most of this area consists of farms, but about one-fourth of the acreage is used for other purposes. Hay and feed grains for livestock are the principal crops grown in the area, and fruits and vegetables are important locally. Less than one-fifth of the area is pasture. Nearly two-thirds of the area is forested. About half of the forested areas consist of farm woodlots, and about half consist of State and national forests and large commercial holdings. Surface mining of coal is an important industry in the northern part of the area and, to a lesser extent, in the southern part, but only a small part of the MLRA has been surface mined.

The major soil resource concerns are sheet and rill erosion on pasture, land slippage, subsidence resulting from mining, streambank erosion, gullying, surface compaction caused by livestock trampling, and a reduced content of organic matter on cropland.

Conservation practices on cropland generally include crop rotations, contour farming, nutrient management, grassed and forested riparian buffers, cover crops, hayland planting, diversions, and grassed waterways. Pasture management includes rotational grazing, watering systems, fencing, managed livestock access to streams, pasture planting, and nutrient management. Forest management includes properly constructed forest harvest trails, critical area planting, and water bars on trails. ■

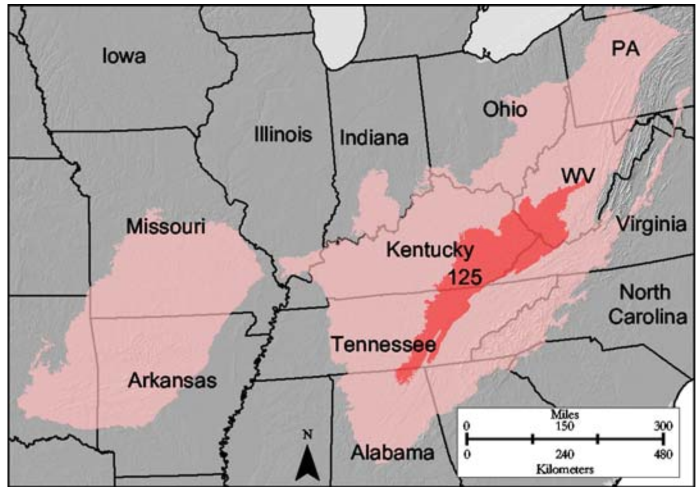

Figure 125-1: Location of MLRA 125 in Land Resource Region N.

125—Cumberland Plateau and Mountains

This area (shown in fig. 125-1) is in Kentucky (43 percent), Tennessee (25 percent), West Virginia (20 percent), Virginia (9 percent), and Alabama (3 percent). It makes up about 20,330 square miles (52,685 square kilometers). The towns of Logan, Madison, Welch, and Williamson, West Virginia, and Norton and Wise, Virginia, are in the northeastern part of this area. The towns of Middlesboro, Williamsburg, Corbin, London, Hazard, and Pikeville, Kentucky, and La Follette and Crossville, Tennessee, are in the area. Chattanooga, Tennessee, and Huntsville, Alabama, are just outside the southeast and southwest corners, respectively. Interstates 24, 64/77, 75, and 40/75 cross this area. The Cumberland Gap National Historic Park is in the part of this area along the Virginia and Kentucky border. The Daniel Boone and Jefferson National Forests occur in this area. Numerous State forests and parks are throughout the area.

Physiography

The northern third of this area is primarily in the Kanawha Section of the Appalachian Plateaus Province of the Appalachian Highlands. The southern two-thirds is primarily in the Cumberland Plateau Section of the same province and division. A strip along the central part of the east edge of the area is in the Cumberland Mountain Section of the same province and division, and small areas of the MLRA along the southwestern edge are in the Highland Rim Section of the Interior Low Plateaus Province of the Interior Plains. This highly dissected MLRA occurs mainly as a series of long, steep side slopes between narrow ridgetops or crests and narrow stream flood plains. Elevation ranges from 650 feet (200 meters) on the flood plain along the Ohio River to about 980 feet (300 meters) on nearby ridgetops. It gradually rises from these areas to areas near the Virginia-Kentucky border, where it is about 1,650 feet (505 meters) on local flood plains and 3,950 feet (1,205 meters) on the higher mountains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Cumberland (0513), 30 percent; Big Sandy-Guyandotte (507), 24 percent; Kentucky-Licking (0510), 19 percent; Upper Tennessee (0601), 10 percent; Kanawha (0505), 8 percent; Middle Tennessee-Elk (0603), 5 percent; Middle Tennessee-Hiwassee (0602), 3 percent; and Middle Ohio (0509), 1 percent. The Kanawha River is the largest river in the part of this area in West Virginia. The Tug Fork and Big Sandy Rivers form the State boundary between West Virginia and Kentucky. The Clinch River forms the southwestern boundary of the part of this area in Virginia. The headwaters of the Licking, Kentucky, and Cumberland Rivers are in the part in Kentucky. The New, Obey, Obed, Caney Fork, and Collins Rivers are in the part in Tennessee. The Tennessee River is in the part in Alabama. A number of National Wild and Scenic Rivers are in the parts of this area in Kentucky and Tennessee.

Geology

Cyclic beds of sandstone, siltstone, clay, shale, and coal of Pennsylvanian age form the bedrock in most of this area. Pennsylvanian limestone and dolomite bedrock is in the part of the area in Virginia and Alabama. Coal mining is the major industry in this MLRA. Unconsolidated deposits of silt, sand, and gravel are in the major river valleys and on terraces along these rivers. The lower parts of many hillslopes have a thin layer of colluvium.

Climate

The average annual precipitation is mostly 37 to 45 inches (940 to 1,145 millimeters) in the northern third of this area and

45 to 60 inches (1,145 to 1,525 millimeters) in the southern two-thirds. It is almost 60 inches (1,525 millimeters) at the higher elevations in the northern third of the area and is as much as 75 inches (1,905 millimeters) in the mountains in the southern two-thirds. Almost half of the annual precipitation falls during the growing season. Rainfall typically occurs during high-intensity, convective thunderstorms in summer. Snow may occur during winter in the northern part of the area and at the higher elevations. The average annual temperature is 50 to 60 degrees F (10 to 15 degrees C). The freeze-free period averages 200 days and ranges from 170 to 225 days. The shorter freeze-free periods are at the higher elevations and in the more northerly parts of the area.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 3.7%; ground water, 0.9%
Livestock—surface water, 0.3%; ground water, 0.3%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 85.2%; ground water, 9.6%

The total withdrawals average 1,685 million gallons per day (6,375 million liters per day). About 11 percent is from ground water sources, and 89 percent is from surface water sources. Water is abundant in most of the area. In most years precipitation is adequate for crops, but in some years yields are reduced by drought. The large streams and constructed lakes supply most of the urban water. Farm ponds can be sources of water in rural communities. The water generally is suitable for all uses, although some sedimentation problems in surface-mined areas and local acid mine drainage cause problems in northern Tennessee and in Kentucky, Virginia, and West Virginia. The carbonate rocks in Virginia buffer the acid mine drainage, so this drainage is not a water-quality issue in Virginia.

Large quantities of generally good-quality ground water are available in some of the larger river valleys in this area, but only small quantities are locally available in the rest of the area. Water in the valley of the Kanawha River has levels of iron and manganese that exceed the national standards for drinking water. The Pennsylvanian Sandstone aquifer is the primary bedrock aquifer in this area. This aquifer is called the Appalachian Plateau aquifer in Virginia and the Middle and Lower Pennsylvanian aquifer in West Virginia. Water is in the bedding planes, joints, and fractures in the sandstone, siltstone, shale, and coalbeds. In Alabama and along the Alabama-Tennessee border, the Paleozoic Carbonate aquifer is a source of ground water. Water is in solution openings and caverns in this limestone and dolomite aquifer.

The ground water in both aquifers is suitable for all uses. High iron concentrations occur in water from the coal-bearing units. The level of total dissolved solids, however, is very low because of the shallow depth of wells and their location near the recharge zones for these aquifers. Wells more than 250 to 300 feet (60 to 90 meters) deep provide salty water. The water from the sandstone is soft, but the water from the carbonate and shale layers is hard. Some communities in Alabama and southern Tennessee use both of these aquifers for their water supply. In the rest of this area, the Pennsylvanian Sandstone aquifer provides domestic and livestock water. Contamination from septic systems located too close to domestic wells is one of the most common water-quality problems in this area.

Soils

Most of the soils in the undulating to rolling areas on the Cumberland Plateau are Hapludults. Moderately deep or deep, well drained, loamy Hapludults (Lily, Lonewood, and Hartsells series) formed in sandstone residuum. Shallow, somewhat excessively drained, loamy Dystrudepts (Ramsey series) also formed in sandstone residuum. They are less extensive than the other soils in the undulating to rolling areas on the Cumberland Plateau. Most of the remaining soils in the undulating to rolling areas are deep or very deep, moderately well drained, loamy Hapludults (Clarkrange and Hendon series), which formed in a loamy mantle and sandstone residuum. The dominant soils in hilly to steep areas are Hapludults (Gilpin and Lily series) and Dystrudepts (Petros and Matewan series). They are shallow to moderately deep, well drained or somewhat excessively drained, and loamy and formed in sandstone or shale residuum. The remaining soils on steep slopes generally are deep or very deep, well drained, loamy Hapludults (Bouldin, Grimsley, Jefferson, Pineville, and Shelocta series) and Dystrudepts (Varilla, Highsplint, and Guyandotte series), which formed in gravelly or stony colluvium derived from sandstone and/or shale.

Soils on flood plains are of small extent on the Cumberland Plateau and are slightly more extensive in the Cumberland Mountains. Most of these soils are well drained or moderately well drained Dystrudepts (Ealy, Pope, Philo, and Sewanee series) or Eutrudepts (Grigsby, Sensabaugh, and Chagrin series) or poorly drained Endoaquepts (Bonair and Atkins series). They are deep or very deep, are loamy, and formed in alluvium derived from sandstone and shale.

Material derived from surface and deep mines is common in this area. Udorthents (Bethesda, Cedarcreek, Fairpoint, and Kaymine series) formed in this material.

Biological Resources

This area supports a variety of woody and herbaceous plant communities. Mixed hardwoods are in coves and on north- and east-facing slopes. Yellow-poplar, beech, black walnut, basswood, red oak, white oak, hemlock, and buckeye are among the 20 or more tree species. Oak-hickory communities, shortleaf pine, pitch pine, and Virginia pine are on ridges and on south- and west-facing slopes. Willows, sycamore, sweetgum, and river birch grow on flood plains.

Some of the major wildlife species in this area are white-tailed deer, red fox, raccoon, cottontail, muskrat, gray squirrel, fox squirrel, mink, ruffed grouse, woodcock, bobwhite quail, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 3%
Grassland—private, 10%; Federal, 1%
Forest—private, 73%; Federal, 5%
Urban development—private, 5%
Water—private, 1%
Other—private, 2%

Most of this area consists of small and medium-size farms. An extensive acreage in Kentucky is in the Daniel Boone National Forest, and some large tracts are owned by coal and timber companies. The forested areas support mostly mixed hardwoods. Lumber is an important product. Corn, hay, and tobacco are the major crops grown on the small acreage of cropland in the area. More than one-tenth of the area is pasture, which is used mostly for grazing by beef cattle. Some areas are used for urban development. Stabilizing surface-mined areas is a major management concern.

The major soil resource concerns are water erosion, deposition of sediment, depletion of organic matter, surface compaction, and soil contaminants. Conservation practices on cropland generally include systems of crop residue management, especially no-till systems; cover crops; and nutrient management. The most important conservation practice on pasture is prescribed grazing. Forest management practices generally include planting and harvesting methods that minimize disturbance of the surface and minimize surface compaction. ■

126—Central Allegheny Plateau

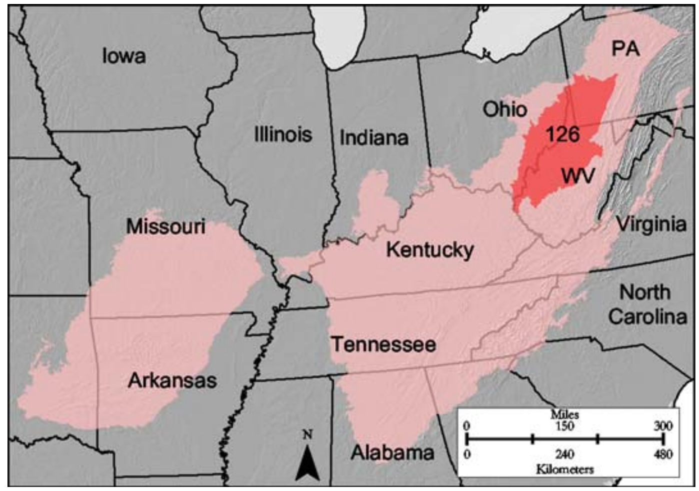

Figure 126-1: Location of MLRA 126 in Land Resource Region N.

This area (shown in fig. 126-1) is in West Virginia (49 percent), Ohio (28 percent), Pennsylvania (22 percent), and Kentucky (1 percent). It makes up about 18,040 square miles (46,750 square kilometers). The cities of Huntington, Charleston, Parkersburg, Clarksburg, Fairmont, Morgantown, and Wheeling, West Virginia, and Pittsburgh, Uniontown, and Indiana, Pennsylvania, are in this area. Steubenville, Marietta, and Athens, Ohio, also are in this area. Interstates 64, 70, 77, and 79 cross the area, and Interstate 68 ends in Morgantown, West Virginia. The Wayne National Forest is in the part of this area in Ohio. A number of State forests and State parks are throughout the area.

Physiography

This area is in the Kanawha Section of the Appalachian Plateaus Province of the Appalachian Highlands. It is on a dissected plateau that is underlain mainly by horizontally bedded sedimentary rocks. The narrow, level valleys and narrow, sloping ridgetops are separated by long, steep and very steep side slopes. Elevation ranges from 650 feet (200 meters) on the lowest valley floors to 1,310 feet (400 meters) or more on the highest ridgetops. Local relief is about 330 feet (100 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Ohio (0503), 48 percent; Monongahela (0502), 19 percent; Kanawha (0505), 10 percent; Muskingum (0504), 9 percent; Middle Ohio (0509), 6 percent; Allegheny (0501), 5 percent; and Big Sandy-Guyandotte (0507), 3 percent. The Allegheny and Monongahela Rivers join in Pittsburgh to form the Ohio River. The Ohio River forms the State boundary between Ohio and West Virginia in this area. The Kanawha and Little Kanawha Rivers in West Virginia join the Ohio River in the southern part of the area. The headwaters of the Monongahela River are in the part of this area in north-central West Virginia. Some of the major tributaries of the Ohio River in the Ohio part of the area are the Muskingum, Little Muskingum, and Hocking Rivers and Duck, Raccoon, and Symmes Creeks..

Geology

This plateau is underlain mostly by horizontal layers of Pennsylvanian-age sandstone, siltstone, shale, coal, and some limestone. The valleys along the Ohio, Muskingum, and Kanawha Rivers have significant deposits of river alluvium (unconsolidated silt, sand, and gravel).

Climate

The average annual precipitation in most of this area is 34 to 45 inches (865 to 1,145 millimeters). It increases to as much as 51 inches (1,295 millimeters) at the higher elevations along the eastern edge of the area. The precipitation is somewhat unevenly distributed throughout the year. The maximum occurs in midsummer, and the minimum occurs in autumn and early in winter. Rainfall occurs during high-intensity, convective thunderstorms in summer. The annual snowfall ranges from less than 35 inches (890 millimeters) to more than 50 inches (1,270 millimeters). The average annual temperature is 48 to 56 degrees F (9 to 13 degrees C). The freeze-free period averages 190 days and ranges from 165 to 215 days. The longer freeze-free periods occur in the southwestern part of the area and at the lower elevations.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 10.9%; ground water, 2.5%
Livestock—surface water, 0.1%; ground water, 0.1%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 78.9%; ground water, 7.4%

The total withdrawals average 5,180 million gallons per day (19,605 million liters per day). About 10 percent is from ground water sources, and 90 percent is from surface water sources. Water from springs, farm ponds, and reservoirs is plentiful. The surface water in this area generally is suitable for most uses. Water quality during periods of low flow commonly is a problem because of contamination. Reservoirs are used to augment low flows in some areas. Sedimentation and acid mine drainage from coal mining and industrial and municipal wastewater discharges cause surface water degradation throughout the area. Improved environmental practices are helping to solve these stream-pollution problems. Demands for surface water for industry, coal mining, and cooling of thermoelectric power plants can create local shortages. Flows for navigation take precedence over most water rights, so some public water suppliers may not obtain all the water they need for their customers during periods of low flow.

Domestic and agricultural water from wells varies, so storage tanks are commonly utilized with wells. The Pennsylvanian-age sandstone, siltstone, shale, coal, and limestone bedrock in this area is the primary source of ground water. The water is in bedding planes, fractures, and joints in most of the rocks in this aquifer, so low-yield wells are typical. Ground water is in solution openings in the limestone. This aquifer is called the Upper Pennsylvanian aquifer in West Virginia, the Shaly Sandstone and Shale aquifer in Ohio, and the Sandstone and Shale aquifer in Pennsylvania. The ground water is typically of good quality and is suitable for all uses. High iron and manganese cause some esthetic problems involving taste and staining. Topographic position impacts the water quality in much of this aquifer. Higher iron and manganese concentrations are common in wells in valleys as opposed to wells in areas on hilltops. Where limestone is more common in the eastern half of this area, the water from valleys is softer than the water from hilltops, but it has higher sodium concentrations. Large quantities of ground water can be obtained from deep wells, but the water generally is highly mineralized.

Some communities and industries obtain ground water from high-yield wells in the alluvium in the major river valleys in this area. This water is generally suitable for all uses. It is very similar in quality to the water in the bedrock, although it is much harder. Very high concentrations of naturally occurring manganese are common in wells in the valley along the Ohio River. Iron and manganese concentrations in the valley along the Kanawha River greatly exceed national standards for drinking water. No other significant contamination problems occur in these sand and gravel aquifers in the area.

Soils

The dominant soil orders in this MLRA are Alfisols, Ultisols, and Inceptisols. The soils in the area have a mesic soil temperature regime, a udic soil moisture regime, and mixed mineralogy. They generally are shallow to very deep, excessively drained to somewhat poorly drained, and skeletal to clayey. Dystrudepts (Dekalb and Hazleton series) formed in sandstone residuum that caps the ridges. Hapludults (Wharton series) formed on the broader summits. Hapludalfs (Culleoka, Dormont, Lowell, Peabody, Upshur, and Westmoreland series), Hapludults (Gilpin series), and Dystrudepts (Weikert series) formed on the hillsides of red shale, limestone, calcareous shale, and acid shale. The Dystrudepts on these hillsides are less extensive than the Hapludalfs and Hapludults. Hapludalfs (Guernsey, Vandalia, and Beech series) formed in colluvium on footslopes. Fragiudults (Monongahela series), Dystrudepts (Philo series), Endoaquepts (Newark series), and Eutrudepts (Chagrin and Sensabaugh series) formed in alluvium along the major streams. Udorthents (Bethesda, Fairpoint, and Morristown series) formed in material derived from the surface mining of coal.

Biological Resources

This area supports deciduous forest vegetation. White oak, red oak, black oak, hickory, and associated upland hardwoods are the major species. Scarlet oak, chestnut oak, and hickory along with scattered Virginia pine, shortleaf pine, and white pine grow on dry ridges and on the shallower soils. Yellow-poplar, black walnut, red oak, red maple, and other species requiring much moisture grow in sheltered coves, on footslopes, and on north-facing slopes.

Some of the major wildlife species in this area are white-tailed deer, black bear, red fox, raccoon, cottontail rabbit, muskrat, gray squirrel, pheasant, grouse, and migratory songbirds.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 12%
Grassland—private, 14%
Forest—private, 58%; Federal, 1%
Urban development—private, 11%
Water—private, 2%
Other—private, 2%

Most of this area consists of farms, but less than one-half of the area consists of income-producing farms. The farm income is dominantly from beef cattle operations and dairy farms associated with hay, grassland, and cultivated crops. More than one-half of the area is forested, and the sale of timber is important in some areas. Urban expansion, including industrial and residential development, is increasing along the Ohio River and its major tributaries. Much of the cropland has been converted to urban uses. Large acreages are owned or leased for surface mining of coal.

The major soil resource concerns are sheet and rill erosion on pasture, land slippage, subsidence resulting from mining, streambank erosion, gullying, surface compaction caused by livestock trampling, and a reduced content of organic matter on cropland. Conservation practices on cropland generally include crop rotations, contour farming, nutrient management, grassed and forested riparian buffers, cover crops, hayland planting, diversions, and grassed waterways. Pasture management includes rotational grazing, watering systems, fencing, managed livestock access to streams, pasture planting, and nutrient management. Forest management includes forest harvest trails, critical area planting, and water bars on trails. ■

127—Eastern Allegheny Plateau and Mountains

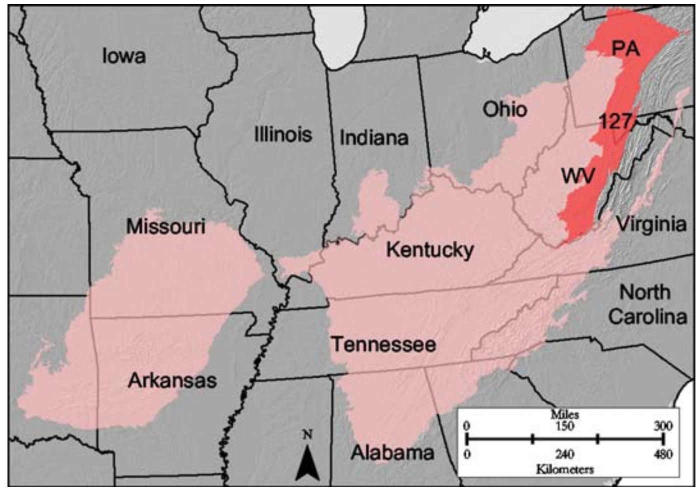

Figure 127-1: Location of MLRA 127 in Land Resource Region N.

This area (shown in fig. 127-1) is in Pennsylvania (57 percent), West Virginia (37 percent), Maryland (4 percent), and New York (2 percent). It makes up about 19,440 square miles (50,370 square kilometers). The towns of Warren, Oil City, and Johnstown, Pennsylvania, and Beckley, West Virginia, are in this area. Titusville, Pennsylvania, is in the northwest corner of the area. It was the site of the first well drilled specifically for oil in the United States in 1859. Cumberland, Maryland, is on the eastern border of this area. From north to south, Interstates 80, 70/76, 68, and 64 cross the area. The Allegheny National Forest covers the northern tip of the area, and the Monongahela National Forest is in the southeast corner. Many State forests and parks are throughout the area, and half of the Allegany Indian Reservation is at the northern end of the area.

Physiography

The southern third and northwest corner of this area are in the Kanawha Section of the Appalachian Plateaus Province of the Appalachian Highlands. The rest of the area is in the Allegheny Mountain Section of the same province and division. The deeply dissected plateau in this area terminates in a high escarpment, the Allegheny Front, in the eastern part of the area. Steep slopes are dominant, but level to gently rolling plateau remnants are conspicuous in the northern part of the area. Elevation ranges from 980 feet (300 meters) in the lowest valleys to 1,970 to 2,620 feet (600 to 800 meters) throughout much of the top of the plateau. It is 3,600 to 4,600 feet (1,100 to 1,400 meters) on the mountains in the southeastern part of the area. Local relief is mainly about 330 feet (100 meters), but some mountain peaks in the southern part of the area rise 980 feet (300 meters) or more above the plateau or adjacent valleys.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Allegheny (0501), 28 percent; Susquehanna (0205), 25 percent; Kanawha (0505), 22 percent; Monongahela (0502), 20 percent; and Potomac (0207), 5 percent. The New, Cranberry, and Greenbrier Rivers in West Virginia have been designated National Wild and Scenic Rivers. The reach of the New River in the New River Gorge has been designated a National River. The Youghiogheny National Wild and Scenic River is in Maryland and continues in Pennsylvania. The Cheat River and the North Branch of the Potomac River are in West Virginia and

Maryland. The headwaters of many tributaries to the Allegheny River to the west and the Susquehanna River to the east are in the part of this area in Pennsylvania. Some tributaries of the Kanawha River occur in this MLRA.

Geology

This area consists of alternating beds of sandstone, limestone, coal, and shale in the uplands. These units are mostly flat-lying. A few distinct folds and faults are along the southeastern edge of the part of this area in West Virginia. These bedrock units are Permian to Mississippian in Pennsylvania and Pennsylvanian to Cambrian in West Virginia. Coal is mined throughout most of this area, and oil and gas wells have been developed. There are no coal mines in the older rocks along the southeastern edge of this area, in West Virginia. The major river valleys are filled with unconsolidated deposits of clay, silt, sand, and gravel, and some outwash and glaciofluvial deposits are in the river valleys in the northwest corner of this area, in Pennsylvania. The lower portions of most hills are mantled with a layer of colluvium.

Climate

The average annual precipitation in this area is 33 to 68 inches (840 to 1,725 millimeters), increasing to the south and with elevation. The maximum precipitation occurs in spring and summer, and the minimum occurs in fall. Most of the rainfall occurs as high-intensity, convective thunderstorms. The average annual snowfall ranges from 35 inches (890 millimeters) in the southern part of the area to more than 90 inches (2,285 millimeters) in the northern part. The average annual temperature is 43 to 54 degrees F (6 to 12 degrees C). The freeze-free period averages 160 days and ranges from 115 to 205 days, decreasing in length to the north and with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 2.5%; ground water, 1.9%
Livestock—surface water, 0.1%; ground water, 0.4%
Irrigation—surface water, 0.1%; ground water, 0.0%
Other—surface water, 83.8%; ground water, 11.2%

The total withdrawals average 2,465 million gallons per day (9,330 million liters per day). About 14 percent is from ground water sources, and 86 percent is from surface water sources. Water from farm ponds, reservoirs, and streams is plentiful. The several large reservoirs in the area include Deep Creek Lake, the Youghiogheny River Reservoir, and the Allegheny Reservoir. Deep Creek Lake, the largest reservoir in Maryland, is a popular summer recreation area. The quality of the surface water is impaired in a few streams because of acid mine drainage or municipal and industrial waste discharges.

Ground water is plentiful, although well yields and water quality are highly variable. Water from alluvium in the major river valleys in West Virginia commonly is used as drinking water. It is of good quality and requires little treatment.

In the rest of the area, alternating beds of sandstone, siltstone, shale, and limestone on uplands of the Appalachian Plateau are the primary sources of ground water. Coalbeds in the Pennsylvanian-age rocks also are considered aquifers. Ground water collected in coal mines commonly is used for industrial supplies. The water in these bedrock units is in fractures, in partings along bedding planes, and in solution openings in limestone. The different rock types and their elevation impact water quality. Hard water occurs in limestone- and shale-dominated layers, and soft water occurs in sandstone-dominated units. The water is freshest on ridgetops where active recharge occurs. Hardness and levels of iron, manganese, and total dissolved solids commonly increase from ridgetops to valley floors. The freshwater in the bedrock is on top of a layer of brine water, which is typically about 300 feet (90 meters) below the valley floors.

Manganese concentrations in the bedrock aquifers exceed the national drinking water standard of 50 parts per billion (micrograms per liter). The ground water is a calcium bicarbonate type where the level of total dissolved solids is less than 300 parts per million (milligrams per liter) and typically is a calcium sulfate type where the level exceeds 300 parts per million (milligrams per liter).

Soils

The dominant soil orders in this area are Ultisols and Inceptisols. The soils dominantly have a mesic or frigid soil temperature regime, a udic soil moisture regime, and mixed or siliceous mineralogy. They generally are moderately deep to very deep, excessively drained to somewhat poorly drained, and loamy. Fragiudults formed in colluvium on footslopes and alluvial fans (Buchanan and Ernest series) and in residuum on ridges (Cookport series). Endoaquults (Cavode series) and Dystrudepts (Dekalb and Hazleton series) formed in residuum on hills and ridges. Hapludults (Gilpin, Hartleton, Leck Kill, Rayne, and Wharton series) formed in residuum and/or till on hills and ridges. Frigid Dystrudepts (Leatherbark and Mandy series) and Fragiudepts (Simoda and Snowdog series) are at high elevations. Udorthents formed in material derived from the surface mining of coal in mesic areas (Cedarcreek and Kaymine series) and frigid areas (Briery series).

Biological Resources

This area supports high-quality hardwoods. Oak, black cherry, yellow-poplar, maple, and other associated hardwoods are the principal species at the lower elevations. White pine, Virginia pine, and black walnut also occur but are of lesser extent. Red spruce, hemlock, birch, and maple species grow on the high mountains. Sugar maple, black cherry, and red oak commonly grow at intermediate elevations.

Some of the major wildlife species in this area are black bear, white-tailed deer, fox, beaver, raccoon, muskrat, mink, cottontail, gray squirrel, pheasant, ruffed grouse, woodcock, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 6%; Federal, 1%
Grassland—private, 6%; Federal, 1%
Forest—private, 68%; Federal, 8%
Urban development—private, 5%; Federal, 1%
Water—private, 1%
Other—private, 3%

Most of this area consists of farms. Corn, small grains, and forage for dairy and beef cattle are the principal crops grown in the area. Other important crops are potatoes and soybeans. Dairy, beef, and poultry farms are important enterprises. About three-fourths of the area is in hardwood forests. Most of the forestland is privately owned, although the area has large blocks of State forest and game lands and national forests. Less than one-tenth of the MLRA consists of urban areas and disturbed land, including surface-mined areas. Stabilizing and revegetating surface-mined areas and controlling acid drainage water from deep mines are major management concerns.

The major soil resource concerns are sheet and rill erosion on pasture, land slippage, subsidence caused by mining, streambank erosion, gullying, surface compaction caused by livestock trampling, and a reduced content of organic matter on cropland. Conservation practices on cropland generally include crop rotations, contour farming, nutrient management, grassed and forested riparian buffers, cover crops, hayland planting, diversions, and grassed waterways. Pasture management includes rotational grazing, watering systems, fencing, managed livestock access to streams, pasture planting, and nutrient management. Forest management includes properly constructed forest harvest trails, critical area planting, and water bars on trails. ■

128—Southern Appalachian Ridges and Valleys

This area (shown in fig. 128-1) is in Tennessee (36 percent), Alabama (27 percent), Virginia (25 percent), and Georgia (12 percent). It makes up about 21,095 square miles (54,660 square kilometers). It is heavily populated. It includes Decatur, Huntsville, and Hartselle in the separate area of the MLRA in northern Alabama; Scottsboro, Gadsden, Anniston, Talladega, and Birmingham in the part of the MLRA in northeastern Alabama; Dalton and Rome, Georgia; Knoxville, Chattanooga, Cleveland, Athens, Maryville, Oak Ridge, Morristown, Greeneville, Johnson City, and Bristol, Tennessee; and Blacksburg and Abingdon, Virginia. Interstates 20, 24, 40, 59, 65, 75, and 81 cross the area. Small areas of the Cherokee National Forest are on the eastern border of the MLRA, the Jefferson National Forest is in the part of the MLRA in Virginia, and the Chattahoochee National Forest is in the part in Georgia. Small parts of the Talladega National Forest are in the southeast corner of the area, in Alabama. The Chickamauga and Chattanooga National Military Park commemorates Civil War battles near the Georgia and Tennessee border. The National Aeronautics and Space Administration’s Marshall Space Flight Center and the Redstone Arsenal and Fort McClellan Military Reservations are in the part of the area in Alabama. The Oak Ridge National Laboratory is in the part in Tennessee.

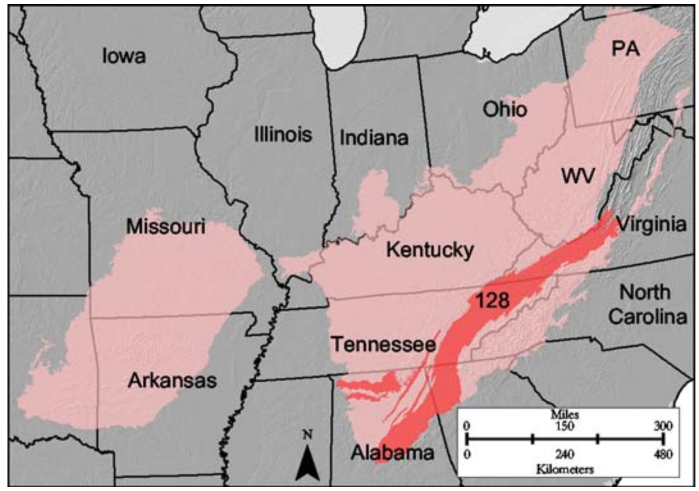

Figure 128-1: Location of MLRA 128 in Land Resource Region N.

Physiography

Most of this area is in the Tennessee Section of the Valley and Ridge Province of the Appalachian Highlands. The thin stringers in the western part of the area are mostly in the Cumberland Plateau Section of the Appalachian Plateaus Province of the Appalachian Highlands. A separate area of the MLRA in northern Alabama is in the Highland Rim Section of the Interior Low Plateaus Province of the Interior Plains. The western side of the area is dominantly hilly to very steep and is rougher and much steeper than the eastern side, much of which is rolling and hilly. Elevation ranges from 660 feet (200 meters) near the southern end of the area to more than 2,400 feet (730 meters) in the part of the area in the western tip of Virginia. Some isolated linear mountain ridges rise to nearly 4,920 feet

(1,500 meters) above sea level. This area is highly diversified. It has many parallel ridges, narrow intervening valleys, and large areas of low, irregular hills. Many ridges and valleys have a difference in elevation of 660 feet (200 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Tennessee (0601), 37 percent; Alabama (0315), 24 percent; Middle Tennessee-Elk (0603), 12 percent; Middle Tennessee-Hiwassee (0602), 11 percent; Kanawha (0505), 9 percent; Lower Chesapeake (0208), 3 percent; Chowan-Roanoke (0301), 2 percent; and Mobile-Tombigbee (0316), 2 percent. The Tennessee River and its main tributaries, the Clinch, Holston, Obed, Hiwassee, and Sequatchie Rivers, are in this area. Two other tributaries in the area, the French Broad and Little Rivers, have been designated National Wild and Scenic Rivers. The Tennessee River is one of the largest rivers in the United States. It is a navigable waterway because of the numerous locks and dams on the river.

Geology

The bedrock in this area consists of alternating beds of limestone, dolomite, shale, and sandstone of early Paleozoic age. Ridgetops are capped with more resistant carbonate and sandstone layers, and valleys have been eroded into the less resistant shale beds. These folded and faulted layers are at the southernmost extent of the Appalachian Mountains. The narrow river valleys are filled with unconsolidated deposits of clay, silt, sand, and gravel.

Climate

The average annual precipitation in most of this area is 41 to 55 inches (1,040 to 1,395 millimeters). It increases to the south and is as much as 66 inches (1,675 millimeters) at the highest elevations in east Tennessee and the northwest corner of Georgia. The maximum precipitation occurs in midwinter and midsummer, and the minimum occurs in autumn. Most of the rainfall occurs as high-intensity, convective thunderstorms. Snowfall may occur in winter. The average annual temperature is 52 to 63 degrees F (11 to 17 degrees C), increasing to the south. The freeze-free period averages 205 days and ranges from 165 to 245 days. It is longest in the southern part of the area and shortest at high elevations and at the northern end.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 6.9%; ground water, 2.4%
Livestock—surface water, 0.3%; ground water, 0.2%
Irrigation—surface water, 0.2%; ground water, 0.3%
Other—surface water, 87.9%; ground water, 1.9%

The total withdrawals average 5,905 million gallons per day (22,350 million liters per day). About 5 percent is from ground water sources, and 95 percent is from surface water sources. In most years precipitation is adequate for crops, but in some years yields are reduced by short dry periods early in summer. Permanent streams, originating on either side of the mountains, carry water to nearly all parts of the area. Several dams, constructed by the Tennessee Valley Authority on the Tennessee River and its major tributaries, provide flood control, facilitate navigation and power production, provide opportunities for recreation, and provide municipal and industrial water. The surface water generally is suitable for all uses. Rivers below reservoirs in this area commonly contain water with low levels of dissolved oxygen because of the release of water from the bottom of the reservoirs. This water is very cold, and the releases can cause water temperature fluctuations, which can cause problems for fish and wildlife and for recreational uses.

The ground water used in this area is from a Cambrian- to Mississippian-age carbonate aquifer system that has beds of limestone, dolomite, shale, and sandstone. The water occurs in solution openings, joints, and fractures in these units. It is hard or very hard but is otherwise of excellent quality. Wells in this aquifer generally are less than 300 feet (90 meters) deep, and the aquifer is constantly recharged with freshwater (rainfall), so the level of total dissolved solids is fairly low for a carbonate aquifer. The median level of total dissolved solids is about 150, 126, and 270 parts per million (milligrams per liter) in Alabama, Georgia, and Tennessee, respectively. High levels of iron occur in some areas, such as the areas in the part of this MLRA in Tennessee. These high levels of iron may exceed the national secondary standard for drinking water, which is 300 parts per billion (micrograms per liter). The secondary standard is esthetic. The iron can stain ceramic and porcelain and precipitate in pipes. Since this aquifer is close to the surface and water moves through it quickly, it is highly susceptible to contamination from runoff. Many communities and rural landowners in areas away from surface water supplies rely on this aquifer for drinking water.

Soils

The soils in this area are mainly Udults and, to a lesser extent, Udepts. They have a udic soil moisture regime and a thermic or mesic soil temperature regime; are dominantly well drained, strongly acid, and highly leached; and have a clay-enriched subsoil. They range from shallow on sandstone and shale ridges to very deep in valleys and on large limestone formations.

Paleudults (Decatur, Dewey, Frederick, Fullerton, and Pailo series, commonly cherty) are in the many extensive areas underlain by limestone that traverse the MLRA from southwest to northeast. Hapludults (Townley and Armuchee series) are dominant in valleys underlain by acid shale. Steep, shallow or moderately deep, shaly and stony Dystrudepts (Weikert, Wallen, Montevallo, and Calvin series) are on the sides of steep ridges. Shallow, shaly Eutrudepts (Bays and Dandridge series) are in areas of the shale formation extending along the eastern side of the MLRA. Eutrudepts (Hamblen, Sullivan, and Pettyjon series) are on narrow bottom land.

Biological Resources

This area supports hardwoods or mixed hardwoods and pine. The deeper soils support good oak-hickory stands. The shallower soils, mostly on south and west aspects, support pine or oak-pine types. The understory vegetation also is affected by aspect. Little bluestem is the dominant grass species.

Some of the major wildlife species in this area are red fox, gray fox, raccoon, skunk, opossum, muskrat, mink, cottontail, gray squirrel, fox squirrel, bobwhite quail, and mourning dove. The species of fish in the area include carp, bullhead, largemouth bass, and bluegill.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 12%
Grassland—private, 21%; Federal, 1%
Forest—private, 41%; Federal, 2%
Urban development—private, 16%
Water—private, 5%
Other—private, 2%

Most of this area consists of small and medium-size farms. More than two-fifths of the area supports mixed hardwoods. Most of the forestland, except for a few wooded mountain ridges, is in small farm woodlots. Hay, pasture, and some grain for beef cattle and dairy cattle are the principal crops grown in this area. Burley tobacco is the important cash crop in the southern two-thirds of the area, excluding Georgia. Some cotton is grown south of Chattanooga. Corn and soybeans are grown on small acreages throughout the area, mainly in narrow strips of bottom land and on the adjacent low terraces.

The major soil resource concerns are sheet and rill erosion on pasture, land slippage, streambank erosion, gullying, surface compaction caused by livestock trampling, and a reduced content of organic matter on cropland. Conservation practices on cropland generally include crop rotations, contour farming, nutrient management, grassed and forested riparian buffers, cover crops, hayland planting, diversions, and grassed waterways. Pasture management includes rotational grazing, watering systems, fencing, managed livestock access to streams, pasture planting, and nutrient management. Forest management includes properly constructed forest harvest trails, critical area planting, and water bars on trails. ■

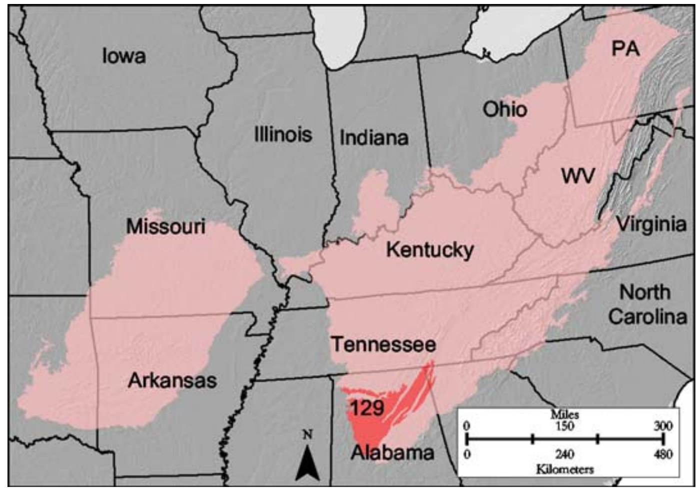

Figure 129-1: Location of MLRA 129 in Land Resource Region N.

129—Sand Mountain

This area (shown in fig. 129-1) is in Alabama (96 percent), Georgia (3 percent), and Tennessee (1 percent). It makes up about 8,030 square miles (20,805 square kilometers). The towns of Jasper, Cullman, and Fort Payne, Alabama, are in this MLRA. Interstate 65 crosses this area from north to south, and Interstates 24 and 59 join in the area just west of Chattanooga, Tennessee, which is just outside the northeast tip of the MLRA. Areas of the Redstone Arsenal Military Reservation are in the northern part of the MLRA. The William B. Bankhead National Forest and the Sipsey National Forest Wilderness are in the western part.

Physiography

Most of this area is in the Cumberland Plateau Section of the Appalachian Plateaus Province of the Appalachian Highlands. This MLRA is deeply dissected and consists mainly of a series of rather narrow valleys, steep escarpments, and broad plateaus that are underlain by consolidated bedrock. Elevation ranges from 330 to 2,300 feet (100 to 700 meters). Valley floors are commonly about 100 to 400 feet (30 to 120 meters) below the adjacent plateau summits, but local relief may be as much as 1,200 feet (365 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Mobile-Tombigbee (0316), 50 percent; Middle Tennessee-Elk (0603), 25 percent; Alabama (0315), 21 percent; and Middle Tennessee-Hiwassee (0602), 4 percent. The Sipsey Fork, Locust Fork, and Mulberry Fork Rivers, headwaters of the Black Warrior River, are in this area. The Tennessee River forms part of the northern boundary of the area.

Geology

The bedrock in this area consists of alternating beds of limestone, dolomite, shale, and sandstone of early Paleozoic age (mostly Mississippian and Pennsylvanian age). The summits of ridges and plateaus are capped with the more resistant carbonate and sandstone layers, and valleys have been eroded into the less resistant shale beds. These mostly level-bedded sedimentary rocks are at the southernmost extent of the Appalachian Mountains. The narrow river valleys are filled with unconsolidated deposits of clay, silt, sand, and gravel.

Climate

The average annual precipitation in most of this area is 53 to 60 inches (1,345 to 1,525 millimeters). It is as much as 68 inches (1,725 millimeters) at the higher elevations in the northern tip of the area. The precipitation is somewhat unevenly distributed throughout the year. The maximum occurs in midwinter, and the amount decreases gradually from spring to autumn and increases slightly in midsummer. Winter rainfall occurs as moderate-intensity, tropical storms that can produce large amounts of rain. During the rest of the year, rainfall occurs as high-intensity, convective thunderstorms. Snowfall is rare in winter, and the snow does not remain on the ground for long periods. The average annual temperature is 55 to 63 degrees F (13 to 17 degrees C). The freeze-free period averages 225 days and ranges from 200 to 255 days. The longer freeze-free periods occur in some of the valleys.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 8.3%; ground water, 2.5%
Livestock—surface water, 0.8%; ground water, 0.7%
Irrigation—surface water, 0.1%; ground water, 0.4%
Other—surface water, 86.6%; ground water, 0.6%

The total withdrawals average 1,225 million gallons per day (4,635 million liters per day). About 4 percent is from ground water sources, and 96 percent is from surface water sources. In most years precipitation is adequate for crops and pasture. Droughts are short and infrequent. Streams, springs, and ponds provide water for livestock. Most streams flow intermittently and are often dry in summer and autumn, except after rainstorms. A few large reservoirs on the Elk and Tennessee Rivers are in the area. The surface water is suitable for almost all uses. Rivers below the reservoirs in this area commonly have water with low levels of dissolved oxygen because of the release of water from the bottom of the reservoirs.

Deep wells provide an adequate supply of water for most domestic, municipal, and industrial uses. Good-quality ground water occurs in solution channels in limestone and dolomite and in fractures and partings along bedding planes in shale and sandstone bedrock layers. The ground water is very hard, and the median level of total dissolved solids is about 150 parts per million (milligrams per liter). This Paleozoic aquifer system is susceptible to contamination from surface sources because of the vertical fractures and the cavernous limestone and dolomite layers. The median level of nitrates, 1.3 parts per million (milligrams per liter), is about four times greater than the median level in any other aquifer in this area.

Soils

The dominant soil orders in this MLRA are Ultisols and Inceptisols. The soils in the area dominantly have a thermic soil temperature regime, a udic soil moisture regime, and mixed or siliceous mineralogy. They are shallow to very deep, generally well drained, and loamy. Hapludults (Albertville, Hartsells, Gorgas, Linker, Nauvoo, Sipsey, Sunlight, and Townley series), Fragiudults (Wynnville series), Dystrudepts (Bankhead, Hector, and Montevallo series), and Eutrudepts (Limrock series) formed in residuum on hills, ridges, and plateaus and in residuum and colluvium on mountainsides.

Biological Resources

This area supports mixed oak, hickory-pine, and oak-hickory forests. Shortleaf pine, loblolly pine, Virginia pine, sweetgum, yellow-poplar, hickory, American beech, red oak, and white oak are the major overstory species. Dogwood and redbud are the major midstory species. Japanese honeysuckle, greenbrier, low panicums, bluestems, and native lespedezas are the major understory species.

Some of the major wildlife species in this area are white-tailed deer, fox, bobcat, raccoon, skunk, opossum, mink, rabbit, gray squirrel, quail, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 7%
Grassland—private, 14%; Federal, 1%
Forest—private, 60%; Federal, 3%
Urban development—private, 9%
Water—private, 3%
Other—private, 3%

Almost two-thirds of this area is forestland, less than one-tenth is cropland, and more than one-tenth is pasture. About three-fifths of the forestland is privately owned, about one-tenth is industry owned, and less than one-tenth is federally owned. Timber production occurs mostly in the western half of the area. The poultry industry, which produces broilers and eggs, is the major farm enterprise. Corn, soybeans, tomatoes, and potatoes are the major cash crops. Pastures are grazed mainly by beef cattle and are important disposal areas for poultry waste. Haying provides feed during the long winters. Some areas are used for coal mining or urban development.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include crop residue management, cover crops, crop rotations, water disposal, pest management, and nutrient management. The most important conservation practice on pasture is prescribed grazing. Critically eroding areas and areas of livestock concentration must be monitored regularly and treated promptly. ■

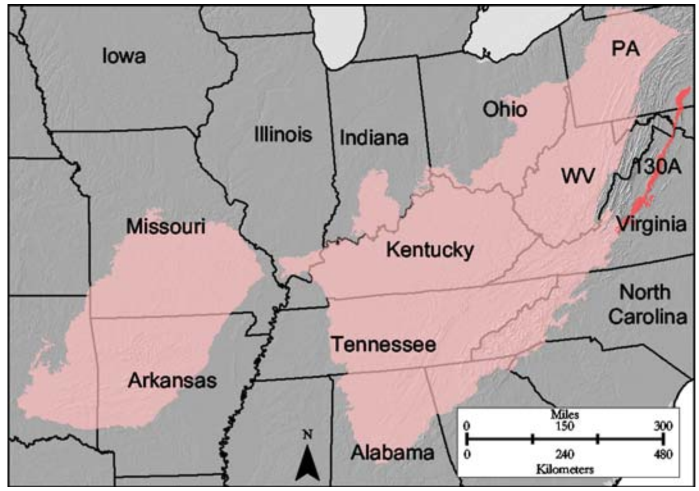

Figure 130A-1: Location of MLRA 130A in Land Resource Region N.

130A—Northern Blue Ridge

This area (shown in fig. 130A-1) is in Virginia (61 percent), Pennsylvania (22 percent), Maryland (14 percent), and West Virginia (3 percent). It makes up about 1,555 square miles (4,030 square kilometers). It is locally known as the Northern Appalachians. It includes the towns of Boonsboro and Thurmont, Maryland; Harpers Ferry, West Virginia; Blue Ridge Summit, Wenksville, and Laurel, Pennsylvania; and Buena Vista and Front Royal, Virginia. The city of Roanoke, Virginia, is in the southern end of the MLRA. Interstates 64, 66, 70, and 81 cross this area. The area is rich in colonial and Civil War historical sites. The George Washington Monument State Park is in the part of the area in Maryland. Harpers Ferry National Historic Park is in the part in West Virginia. The Chesapeake and Ohio Canal National Historic Park parallels the Potomac River on the Maryland-Virginia border. The Shenandoah National Park, the Blue Ridge Parkway, and the Jefferson and George Washington National Forests are major recreation areas in the part of the MLRA in Virginia. The Appalachian Trail also is in this MLRA.

Physiography

Most of this area is in the Northern Section of the Blue Ridge Province of the Appalachian Highlands. The eastern third of the area is in the Piedmont Upland Section of the Piedmont Province of the Appalachian Highlands. The southern tip of the area is in the Southern Section of the Blue Ridge Province of the Appalachian Highlands. The rugged mountains in this MLRA have steep slopes, sharp crests, and narrow valleys. Stream dissection is deep and intricate. The major streams and their tributaries flow through gorges and gaps in the mountains. Broad valleys and basins and rolling hills are extensive throughout the area. Elevation ranges from about 820 feet (250 meters) in the lower valleys and on footslopes along the Potomac River just east of Harpers Ferry, where West Virginia joins Maryland and Virginia, to more than 4,200 feet (1,280 meters) along the Appalachian Trail in Bedford County, Virginia. Apple Orchard Mountain, the highest peak, is at an elevation of 4,225 feet (1,288 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Chowan-Roanoke (0301), 33 percent; Lower Chesapeake (0208), 32 percent; Potomac (0207), 23 percent; and Susquehanna (0205), 12 percent. From north to south, the major rivers in this area are the Conococheaque River in Pennsylvania, the Catoctin and Potomac Rivers in Maryland, and the Shenandoah, Rappahannock, Rapidan, James, and Roanoke Rivers in Virginia. Catoctin and Goose Creeks and the Shenandoah and Rappahannock Rivers have been designated National Wild and Scenic Rivers in this area.

Geology

This area includes the eroded core of the Appalachian Mountains, formed during a period of post-Cretaceous uplift along the east coast of North America. The part of the area that extends into Maryland and Pennsylvania, including the South and Catoctin Mountains, is the northeast plunging nose of the Catoctin-Blue Ridge anticline. This is an old fold exposed during the latest uplift. A resistant, Late Proterozoic to Cambrian cover sequence that includes chlorite-actinolite schist, schistose metabasalt, siliceous metabreccia, laminated metasedimentary gneiss, quartzite, phyllitic, and rhyolitic layers forms linear ridges that flank the coarse grained granitoid and gneissic basement rocks exposed in the Proterozoic core of the anticline in northern Virginia. In central Virginia, the Blue Ridge has a series of upthrust crystalline shingle blocks of resistant granite, augen gneiss, or quartzite where narrow fault valleys are underlain by less resistant mylonitic gneiss and schist units. Surficial Pleistocene deposits and more recent deposits include colluvial material on fans and aprons along the higher ridges and alluvial material along the major streams.

Climate

The average annual precipitation in most of this area is 36 to 45 inches (915 to 1,145 millimeters). It can be as high as 61 inches (1,550 millimeters) at the higher elevations. Snow covers the ground frequently in winter and is a major contributor to the annual amount of precipitation. The average annual temperature is 49 to 56 degrees F (9 to 14 degrees C). The freeze-free period averages 195 days and ranges from 165 to 225 days. The lower average annual temperatures and shorter freeze-free periods occur at the higher elevations.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 13.2%; ground water, 1.9%
Livestock—surface water, 0.8%; ground water, 0.4%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 74.0%; ground water, 9.7%

The total withdrawals average 330 million gallons per day (1,250 million liters per day). About 12 percent is from ground water sources, and 88 percent is from surface water sources. Streams, some ponds, and springs provide water for livestock. Springs also provide some domestic drinking water. The many rivers crossing this area are sources of public supply and industrial water. Most of this water is of good quality and is suitable for most uses. Limited use is made of the water from the South Fork of the Shenandoah River at the north end of this area because of residual mercury from historic industrial waste discharges.

Springs and shallow wells provide domestic water in rural areas, but the yield of ground water from wells is generally small and variable. The water is in joints and fractures in the rocks, so deep wells are required to intercept enough openings to obtain a suitable yield. The abundance of ground water depends largely on landscape position and geology. The most abundant sources are in coves and valleys. The water sources on side slopes and ridge summits are not so abundant or dependable. The primary source of domestic ground water in this area is the Piedmont and Blue Ridge crystalline rock aquifer in Virginia and Maryland. It consists of intrusive igneous and metamorphic rocks. The water from this aquifer has very low levels of total dissolved solids and is generally soft or moderately hard. It generally is acidic, however, and the acidity can damage copper and lead in pipes and plumbing connections. The iron content and hardness vary with the mineralogy of the source rocks, and naturally high radiation levels are common. The Sandstone and Shale aquifer is the primary source of ground water in the northern end of this area, in Pennsylvania. The quality of the water in this aquifer is similar to that of the water in the Piedmont and Blue Ridge crystalline rock aquifer to the south, but radiation contamination is not a problem in the sedimentary rocks in Pennsylvania.

Soils

The dominant soils in this MLRA are Dystrudepts, Hapludults, Hapludalfs, or Kanhapludults. They range from moderately deep to very deep and from loamy-skeletal and sandy-skeletal to clayey (fine textured). The soils have a mesic soil temperature regime, a udic soil moisture regime, and dominantly mixed mineralogy. Dystrudepts (Brandywine, Hazel, Peaks, Cataska, and Sylco series) and Hapludults (Edneytown and Edgemont series) are the principal low-fertility soils on the steep slopes of mountains. More fertile Hapludalfs (Myersville and Highfield series) and Eutrudepts (Catoctin series) are equally prominent on these slopes. Hapludults (Thurmont and Braddock series) formed in colluvium on footslopes and in coves. Kanhapludults (Hayesville series) are on the broader and flatter residual summits and shoulders and on the less steep side slopes. In some areas boulders and outcrops of bedrock are extensive on mountain slopes. Dystrudepts (Comus and Codorus series) are along the many narrow streams that flow through, and out of, the area. These soils are frequently flooded unless they are protected.

Biological Resources

This area supports Appalachian oaks. White pine-hemlock, chestnut oak, white oak-red oak-hickory, northern red oak-basswood-white ash, yellow-poplar-white oak-northern red oak, and loblolly pine-shortleaf pine are the most common cover types. Dogwood, hornbeam, pawpaw, sassafras, persimmon, greenbrier, leatherwood, mountain laurel, rhododendron, and witch hazel are included in the understory.

The major large mammal species in this area are raccoon, white-tailed deer, coyote, beaver, black bear, red fox, gray fox, and bobcat. The smaller mammal species include white-footed mouse, eastern chipmunk, gray squirrel, and eastern cottontail. The area has numerous species of birds. Open areas, fences, riparian strips, forests, wetlands, ponds, and rocky areas maintain this avian diversity. The area has three species of trout—the native Southern Appalachian brook trout and the introduced rainbow trout and brown trout. Smallmouth and largemouth bass, sunfish, bluegills, and crappies are in some of the manmade lakes and ponds. This area provides excellent habitat for snakes, turtles, frogs, newts, toads, and salamanders.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 10%
Grassland—private, 17%
Forest—private, 49%; Federal, 10%
Urban development—private, 9%
Water—private, 2%; Federal, 1%
Other—private, 2%

About three-fifths of this area is forested. About one-fifth of the area consists of national parks and forests. Parts of the area are popular resort and recreation sites. About one-tenth of the area is cropland, mainly on small farms in valleys and coves, and one-sixth is pasture. Corn and hay are the chief crops, but small grains, potatoes, and many kinds of fruits and vegetables also are grown. Tobacco is an important crop in some areas. Most of the farms are part-time enterprises, and the occupants earn a large part of their livelihood elsewhere.

Erosion along poorly constructed and maintained access roads is a major management concern in this area. Sediment from access roads and urban development is the main pollutant of streams in the area. This sedimentation not only is harmful to aquatic life but also impacts local economies that are dependent on tourism and recreational industries. With increasing urbanization, access roads and homes have been built in marginally suitable areas, such as steep side slopes. Because of improper site preparation in these areas, the hazards of sedimentation, soil slippage, and slope instability are increased.

Poor air quality, especially in summer, is both a health and economic problem. Air pollution flowing from the industrial Midwest affects people who are sensitive to pollutants, such as ozone, and those who suffer from breathing disorders. Decreased visibility from air pollution impacts the tourism industry. Air quality also is a concern in urbanized intermountain basins where thermal inversions trap pollutants. Proper woodland management is extremely important since privately held forestland makes up a significant portion of the land area in the MLRA. Promotion and use of the best management practices among private landowners can help to maintain timber quality and productivity. Proper design and construction of access roads and stabilization of roadbanks can minimize the impact of timber management on water quality.

Conservation practices on cropland generally include field borders, grassed waterways, diversions, and riparian buffers along streams. Prescribed grazing and proper forage, nutrient, and pest management practices are critical in maintaining the productivity of grazing land.

In areas where streams have been channelized, riparian areas have been removed, and livestock access is unchecked, streambank erosion is a major concern. Stabilizing streambanks and channels and restoring and maintaining riparian forest buffers help to maintain or improve water quality. The condition of streambanks and channels becomes increasingly important in managing the storm-water runoff from growing urban areas. ■

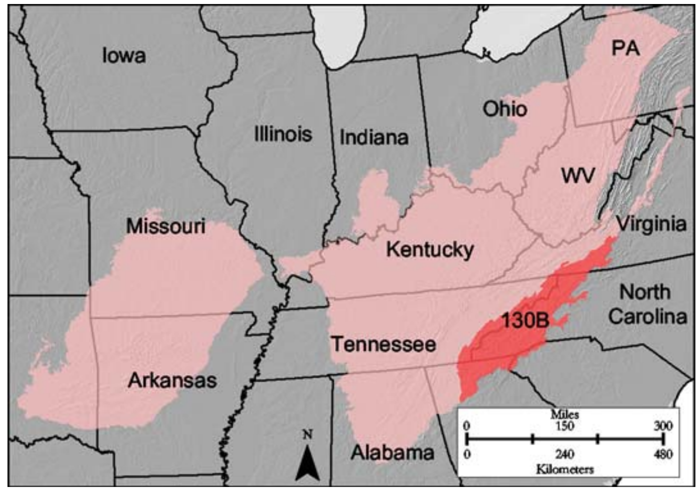

Figure 130B-1: Location of MLRA 130B in Land Resource Region N.

130B—Southern Blue Ridge

This area (shown in fig. 130B-1) is in North Carolina (51 percent), Tennessee (18 percent), Georgia (17 percent), Virginia (10 percent), and South Carolina (4 percent). It makes up about 16,080 square miles (41,665 square kilometers). It is locally known as the Southern Appalachians. It includes Lenoir, Morganton, Marion, Hendersonville, Waynesville, and Asheville, North Carolina; Gatlinburg, Tennessee; Damascus and Galax, Virginia; Walhalla, South Carolina; and Cleveland, Dahlonega, and Ellijay, Georgia. Interstate 40 crosses the parts of the area in Tennessee and North Carolina. Interstate 77 crosses the part in Virginia. Many national forests are in the area, including the Jefferson, Cherokee, Nantahala, Pisgah, and Chattahoochee National Forests. The Appalachian Trail begins on Springer Mountain in Georgia, near Amicalola State Park. The Great Smoky Mountains National Park is in this MLRA. The Mount Rogers National Recreation Area is in the part of the MLRA in Virginia. The Cherokee Indian Reservation is west of Waynesville, North Carolina.

Physiography

This MLRA is mainly in the Southern Section of the Blue Ridge Province of the Appalachian Highlands. The southern tip of the MLRA and two protruding areas to the east are in the Piedmont Uplands Section of the Piedmont Province of the Appalachian Highlands. This MLRA consists of several distinct topographic areas, including the Blue Ridge Escarpment on the eastern edge of the area, the New River Plateau on the northern end, interior low and intermediate mountains throughout the MLRA, intermountain basins between the major mountains, and the high mountains making up the bulk of the MLRA. Elevation ranges from about 900 feet (275 meters) at the south and southwest boundaries of the area to more than 6,600 feet (2,010 meters) at the crest of the Great Smoky and Black Mountain ranges.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Tennessee (0601), 46 percent; Kanawha (0505), 13 percent; Middle Tennessee-Hiwassee (0602), 12 percent; Edisto-Santee (0305), 9 percent; Alabama (0315), 8 percent; Ogeechee-Savannah (0306), 6 percent; Pee Dee (0304), 4 percent; Chowan-Roanoke (0301), 1 percent; and Apalachicola (0313), 1 percent. From north to south, the major rivers in this area are the New River in Virginia; the Yadkin, Catawba, French Broad, Little Tennessee, and Hiwassee Rivers in North Carolina; the Saluda, Seneca, Chattooga, and Tugaloo Rivers in South Carolina; and the Toccoa and Coosawattee Rivers in Georgia. The Tugaloo River is a headwater stream of the Savannah River, and the French Broad, Little Tennessee, Hiwassee, and Ocoee Rivers also flow into Tennessee in this area. The Hiwassee River in Tennessee and the Conasauga River in Georgia have been designated National Wild and Scenic Rivers in this area. The Chattooga River in South Carolina is a National Scenic River.

Geology

The bedrock geology in this area consists mostly of Precambrian metamorphic rock formations with a few small bodies and windows of igneous and sedimentary rocks. The degree of metamorphism varies but generally decreases westward. The higher grade metamorphic rocks include formations of gneiss, schist, and amphibolite. Low-grade metamorphic formations in the southwestern part of the MLRA include distinct and interbedded bodies of metasandstone, slate, phyllite, metasiltstone, and metaconglomerate. Surficial deposits include colluvial material on fans and aprons along the ridges and alluvial material along the major streams.

Climate

The average annual precipitation in this area generally is 36 to 60 inches (915 to 1,525 millimeters), generally increasing with elevation. It is 60 to 90 inches (1,525 to 2,285 millimeters) in southwestern North Carolina and northeastern Georgia and can be as much as 119 inches (3,025 millimeters) on the higher peaks in the MLRA. Much of the precipitation occurs as snow at the higher elevations. The amount of precipitation is lowest in the fall. The average annual temperature ranges from 46 to 60 degrees F (8 to 16 degrees C), decreasing with elevation. The freeze-free period averages 185 days and ranges from 135 to 235 days. The freeze-free period is shorter at high elevations and on valley floors because of cold air drainage. Microclimate differences resulting from aspect significantly affect the type and vigor of the plant communities in the area. South- and west-facing slopes are warmer and drier than north- and east-facing slopes and those shaded by the higher mountains.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 4.6%; ground water, 1.8%
Livestock—surface water, 4.4%; ground water, 1.0%
Irrigation—surface water, 0.2%; ground water, 0.1%
Other—surface water, 85.3%; ground water, 2.7%

The total withdrawals average 710 million gallons per day (2,685 million liters per day). About 6 percent is from ground water sources, and 94 percent is from surface water sources. Streams, some ponds, and springs provide water for livestock. Springs also supply some domestic drinking water. The many rivers crossing this area are sources of public supply and industrial water. The Tennessee Valley Authority, Duke Power, and Alcoa operate several reservoirs and dams for electric power production, flood control, water supply, and recreation. Protected watersheds and reservoirs supply water to municipal areas. These watersheds commonly are protected lands managed by the U.S. Forest Service and are sources of high-quality water. Most of the water is of excellent quality and is suitable for most uses. Acid-mine drainage from coal mines in the Appalachian Plateau to the west of the northern end of this area causes some contamination in rivers draining that area. The limestone bedrock underlying these drainages, however, provides enough carbonates in runoff water to mitigate most of the contamination, so this surface water is still usable within this area. Wastewater discharges from textile, wood, and paper mills in North Carolina can cause some local water-quality problems.

Springs and shallow wells provide domestic water in rural areas, but the yields of ground water from wells are generally small and variable. The water is in joints and fractures within the rocks, so deep wells are required to intercept enough openings to obtain a suitable yield. The abundance of ground water depends largely on landscape position and geology. The most abundant sources generally are in coves and valleys. The sources on side slopes and ridge summits are not so abundant or dependable. The primary source of domestic ground water in this area is the Piedmont and Blue Ridge crystalline rock aquifer in Virginia and South Carolina or the Crystalline Rock aquifer in the other States in the area. It consists of intrusive igneous and metamorphic rocks. This water has very low levels of total dissolved solids and is generally soft or moderately hard. In Virginia, it generally is acidic, and the acidity can damage copper and lead in pipes and plumbing connections. The iron content and hardness vary with the mineralogy of the source rocks. Iron levels are generally less than 300 parts per billion (micrograms per liter), which is the national secondary standard (for esthetics) for drinking water. The median level of iron in the ground water in Tennessee is twice the level in the ground water in the other States in the area. Naturally high radiation levels are common in the ground water in Virginia.

Soils

The dominant soil orders in this MLRA are Inceptisols and Ultisols. The soil moisture regime is udic. The soil temperature regime typically is mesic, but it is frigid at elevations above 4,200 feet (1,280 meters). Soil depth ranges from shallow to very deep. The general textural class is loamy or clayey.

In areas at elevations of less than 3,500 feet (1,065 meters), the soils on uplands generally are red, fine-loamy or fine Typic Hapludults (Evard, Junaluska, and Hayesville series). Humic Hapludults (Trimont and Snowbird series) are on north and east aspects. Soils that formed in colluvium in coves are Typic Dystrudepts (Tate, Greenlee, and Northcove series), Typic Hapludults (Lonon and Keener series), or Humic Hapludults (Saunook and Thunder series).

At elevations between 3,500 and 4,200 feet (1,065 and 1,280 meters), the soils on uplands generally are brown, fine-loamy or coarse-loamy Dystrudepts. Humic Dystrudepts (Plott, Porters, and Cheoah series) are common on north and east aspects, and Typic Dystrudepts (Edneyville, Chestnut, Ditney, and Stecoah series) are common on south and west aspects. Soils that formed in colluvium in coves are Humic Dystrudepts (Cullasaja, Spivey, Tuckasegee, and Santeetlah series) or Humic Hapludults (Saunook and Thunder series).

In areas at elevations above 4,200 feet (1,280 meters), the soils on uplands generally are brown, fine-loamy or coarse-loamy Humic Dystrudepts with a frigid soil temperature regime (Burton, Oconaluftee, and Breakneck series). Soils that formed in colluvium also are Humic Dystrudepts (Balsam and Chiltoskie series). Soils that formed in alluvium vary with stream gradient, energy, and entrenchment into the valley floor. In the upper reaches of watersheds where flood plains are narrow, the soils are Oxyaquic and Fluvaquentic Dystrudepts (Dellwood, Reddies, and Cullowhee series). In the lower and broader river valleys, Udipsamments (Biltmore series) and coarse-loamy Dystrudepts (Rosman series) are in areas closest to rivers and streams on flood plains. Humaquepts (Ela, Nikwasi, and Toxaway series) are in low-lying, frequently flooded or ponded areas. Ultisols are most common on the more stable stream terraces. Fine-loamy Aquic and Typic Hapludults (Dillard and Statler series) are on low terraces, and fine Typic Hapludults (Braddock and Unison series) are on high terraces.

Biological Resources

This area supports a wide diversity of plant and animal life because of highly varied topography and climatic conditions. The kind of vegetation changes with elevation and slope aspect. At the lower elevations, below 3,000 feet (915 meters), the most common trees are white oak, black oak, scarlet oak, chestnut oak, hickory, eastern white pine, Virginia pine, and pitch pine. Yellow-poplar and northern red oak are common in the northern part of the MLRA. At the middle elevations, the most common trees are yellow-poplar, black cherry, black birch, sugar maple, northern red oak, American basswood, eastern hemlock, and yellow buckeye. At the higher elevations, above 5,000 feet (1,525 meters), red spruce and Fraser fir are the dominant tree species. In some areas at a high elevation, grassy and heath “balds” are evident. These are large meadows or treeless areas. Grassy balds are dominated by grass species and are home to rare shade-intolerant plant varieties. Heath balds support shrubs, such as rhododendron, mountain laurel, blueberry, flame azalea, hawthorn, huckleberry, and sand myrtle.

The diverse plant communities provide habitat for many species of wildlife. Black bear, white-tailed deer, and wild turkey are plentiful. The higher elevations provide suitable habitat for the birds and animals that are common in northern latitudes, such as northern saw-whet owl, Canada warbler, common raven, northern flying squirrel, and red squirrel.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 4%
Grassland—private, 10%; Federal, 3%
Forest—private, 46%; Federal, 23%
Urban development—private, 8%; Federal, 1%
Water—private, 2%; Federal, 1%
Other—private, 1%; Federal, 1%

More than two-thirds of this area is forestland used for timber production, watershed protection, recreation, and wildlife habitat. The federally owned forestland in the area is mainly U.S. Forest Service or National Park Service land. The small acreage of cropland is used for vegetables, fruit orchards, native ornamental crops, and Christmas trees as well as corn and small grain. About 10 percent of the MLRA is in pastured areas used for dairy, beef, and wool production. The largest urban area in this MLRA is Asheville, North Carolina. The MLRA is a popular area for tourism and retirement living. As a result, steady or rapid urban growth occurs in many areas.

Erosion from poorly constructed and maintained access roads is a major management concern in this area. Sediment from access roads and urban development is the main pollutant of streams in the area.

Poor air quality, especially in summer, is both a health and economic problem. Air pollution flowing from the industrial Midwest affects people who are sensitive to pollutants, such as ozone, and those who suffer from breathing disorders. At high elevations, air pollution and acid deposition are thought to be partially responsible for damage to the spruce and fir forests.

Proper woodland management is extremely important since privately held forestland makes up a significant portion of the land area in this MLRA. Proper design and construction of access roads and stabilization of roadbanks can minimize the impact of timber management on water quality.

Conservation practices in agricultural areas include field borders, grassed waterways, diversions, and riparian buffers along streams. Prescribed grazing and proper forage, nutrient, and pest management practices are critical in maintaining the productivity of grazing land.

In areas where streams have been channelized, riparian areas have been removed, and livestock access is unchecked, streambank erosion is a major concern. Stabilizing streambanks and channels and restoring and maintaining riparian forest buffers can maintain or improve water quality. The condition of streambanks and channels becomes increasingly important in managing the storm-water runoff from growing urban areas. ■

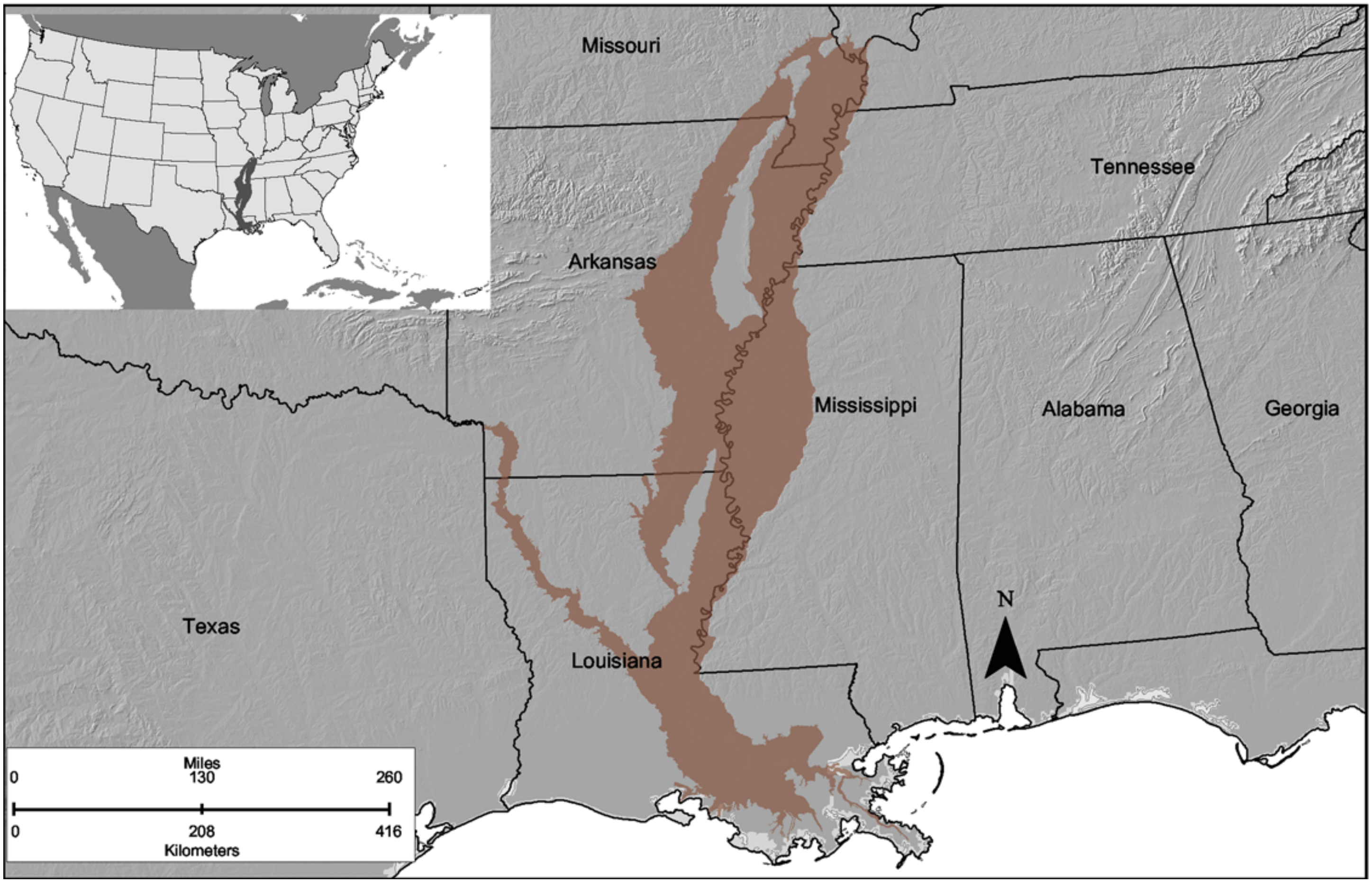

Figure O-1: Location of Land Resource Region O.

O—Mississippi Delta Cotton and Feed Grains Region

Nearly all of this region (shown in fig. O-1) is in Arkansas (35 percent), Louisiana (34 percent), Mississippi (20 percent), Missouri (9 percent), and Tennessee (2 percent). Very small areas of the region are in Kentucky and Illinois. The region makes up 38,865 square miles (100,710 square kilometers).

Fertile soils, smooth topography, abundant moisture, and a long growing season favor agricultural production in this region. If crops are to be grown, artificial drainage typically is needed to lower the water table. Levees are used to protect cropland from flood damage.

This region is on smooth terraces and flood plains along the Mississippi River and its major tributaries south of its confluence with the Ohio River. The geologic material in the region consists of very thick deposits of sandy to clayey alluvium of Pleistocene to Holocene age. This material was deposited by the rivers. Local relief is typically less than 15 feet (5 meters).

The climate in this region is hot and humid. It is characterized by long, hot summers and short, mild winters. The mean annual precipitation is 47 to 62 inches (1,195 to 1,575 millimeters), generally increasing from north to south. The precipitation falls almost entirely as rainfall during frontal storms in late fall, winter, and early spring; as rainfall occurring as convective storms during the growing season; and as heavy rainfall produced by tropical storms. The mean annual air temperature throughout most of the region is 60 to 67 degrees F (15 to 19 degrees C). The freeze-free period ranges from 235 to 305 days. The mean annual air temperature and the length of the freeze-free period increase from north to south.

The total withdrawals of freshwater in this region average about 11,130 million gallons per day (43,300 million liters per day). About 55 percent is from ground water sources, and 45

Figure O-2: Levee and rice in an area of Land Resource Region O.

percent is from surface water sources. About 57 percent of the water is used for irrigation, and 37 percent is used for industry and for cooling thermoelectric power plants.

The soils in this region are dominantly Alfisols, Vertisols, Inceptisols, or Entisols. Aqualfs and Aquerts are the dominant suborders. Epiaqualfs and Epiaquerts are dominant in areas of Pleistocene-age material on terraces, and Epiaquepts and Udifluvents are dominant in areas of Holocene-age material. The soils typically have a high proportion of montmorillonitic clays and have a thermic soil temperature regime and an aquic soil moisture regime.

About 97 percent of the land in this region is privately owned. The native vegetation consists of deciduous bottom-land forests. The diverse array of crops grown in the region includes cotton, soybeans, milo, corn, rice (fig. O-2), sugarcane, and wheat. The major management concerns on cropland include flooding, excess water, and contamination of ground water. ■

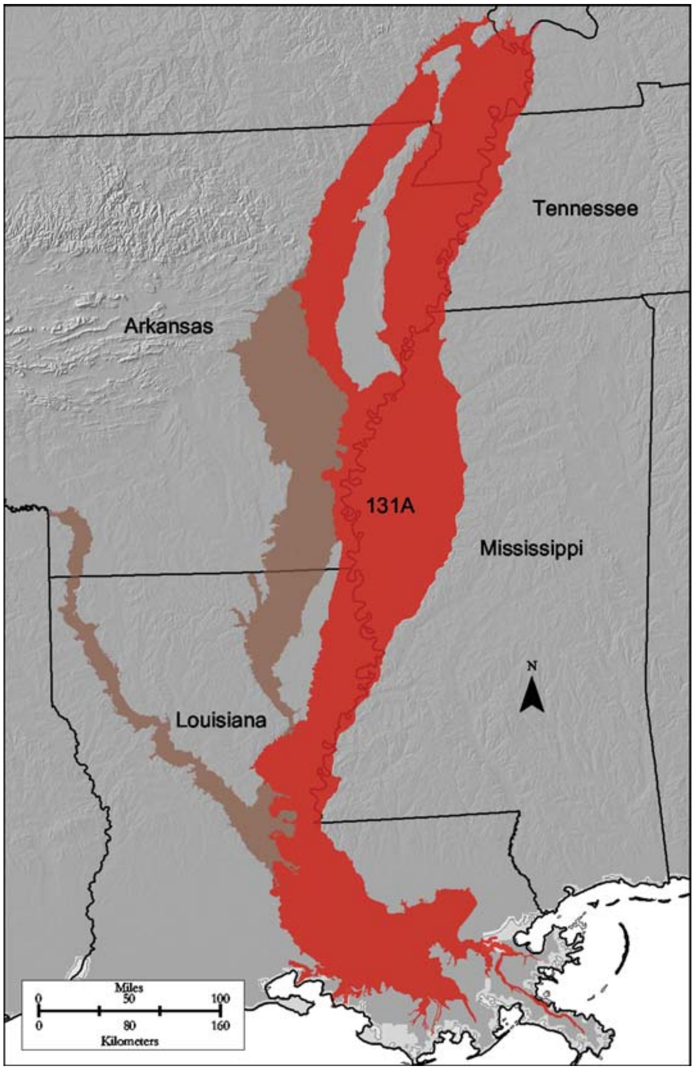

Figure 131A-1: Location of MLRA 131A in Land Resource Region O.

131A—Southern Mississippi River Alluvium

This area (shown in fig. 131A-1) is in Louisiana (32 percent), Arkansas (26 percent), Mississippi (26 percent), Missouri (12 percent), Tennessee (3 percent), and Kentucky (1 percent). A small part of Illinois also is in the area. This MLRA makes up about 29,555 square miles (76,585 square kilometers). It includes the towns or cities of Lake Providence, Morgan City, and Houma, Louisiana; Greenville, Yazoo City, and Clarksville, Mississippi; Eudora, Helena, and West Memphis, Arkansas; Caruthersville, Kennett, and Sikeston, Missouri; and the west edge of Memphis, Tennessee. The cities of Baton Rouge and New Orleans, Louisiana, are just outside this area. From north to south, Interstates 57, 55, 40, 20, and 10 cross this area. The Delta National Forest is in the part of this area in Mississippi. Numerous national wildlife refuges and State parks are throughout this area. Eaker Air Force Base and a small portion of the St. Francis National Forest is in the part of the area in Arkansas. This area is along a major flightpath for migratory waterfowl.

Physiography

This area makes up most of the Mississippi Alluvial Plain Section of the Coastal Plain Province of the Atlantic Plain. It is on the alluvial plain along the lower Mississippi River, south of its confluence with the Ohio River. The landforms in the area are level or depressional to very gently undulating alluvial plains, backswamps, oxbows, natural levees, and terraces. The parts of the MLRA south of Baton Rouge, Louisiana, are on a deltaic plain. Landform shapes range from convex on natural levees and undulating terraces to concave in oxbows. These shapes differentiate water-shedding positions from water-receiving positions, both of which have a major role in soil formation and hydrology. Average elevations start at sea level in the southern part of the area and gradually rise to about 330 feet (100 meters) in the northwestern part. Maximum local relief is about 15 feet (5 meters), but relief is considerably lower in most of the area.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Mississippi-St. Francis (0802), 30 percent; Lower Mississippi-Yazoo (0803), 25 percent; Louisiana Coastal (0808), 8 percent; Boeuf-Tensas (0805), 7 percent; Lower Mississippi-Lake Maurepas (0807), 6 percent; Lower Mississippi (0809), 6 percent; Upper White (1101), 6 percent; Lower Red-Ouachita (0804), 5 percent; Lower Mississippi-Hatchie (0801), 5 percent; and Lower Mississippi-Big Black (0806), 2 percent. The lower Mississippi River and its tributaries drain nearly all of the MLRA, but the Atchafalaya River drains the extreme southwest part.

Geology

Bedrock in this area consists of Tertiary and Cretaceous sands formed as beach deposits during the retreat of the Cretaceous ocean from the midsection of the U.S. Alluvial deposits from flooding and lateral migration of the Mississippi River typically lie above the bedrock. These sediments are sandy to clayey fluvial deposits of Quaternary age and are many meters thick. The Yazoo, Tensas, and Atchafalaya Basins and the modern deltaic plain are in areas of Holocene deposits. The St. Francis Basin, in the northwestern part of the MLRA, and some surfaces surrounded by the Yazoo Basin, in the central part of the MLRA, are in areas of Wisconsin Stage deposits of Pleistocene age. Some small areas in the western part of the MLRA are covered by a thin mantle of pre-Wisconsin, Quaternary-age loess deposits.

Climate

The average annual precipitation in most of this area is 46 to 60 inches (1,170 to 1,525 millimeters). It can be as high as 65 inches (1,650 millimeters) in parts of the southern third of the MLRA. Most of the rainfall occurs as frontal storms during late fall, winter, and early spring, although an appreciable amount of precipitation also occurs as convective thunderstorms during the early part of the growing season. Hurricanes also can produce high amounts of rainfall. The total amount of the precipitation that occurs as snow ranges from less than 1 percent in the southern part of the MLRA to 28 percent in the northern part. The average annual temperature ranges from 56 to 69 degrees F (14 to 21 degrees C), increasing from north to south. The freeze-free period averages 285 days. It ranges from 210 days in the northern part of the area to 355 days in the southern part.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 1.3%; ground water, 1.9%
Livestock—surface water, 1.3%; ground water, 2.4%
Irrigation—surface water, 7.7%; ground water, 51.4%
Other—surface water, 31.5%; ground water, 2.6%

The total withdrawals average 7,965 million gallons per day (30,150 million liters per day). This is the sixth highest amount of water among all of the MLRAs. About 58 percent is from ground water sources, and 42 percent is from surface water sources. In most years the supply of moisture is adequate for maximum crop production. Surface water for public supply, industrial use, and some irrigation is available in quantity from the bayous, oxbow lakes, canals, and rivers throughout this area. The dominant use of the surface water in the area is for cooling thermoelectric power plants. Farms and small communities use treated surface or ground water for most purposes, except for irrigation. Numerous small, above-ground water impoundments are used for raising commercial catfish throughout the area. Most of the surface water is of good quality and is suitable for most uses with some treatment. High concentrations of suspended sediments, agricultural chemicals, and municipal and industrial wastewater discharges contribute to some local water-quality problems. Flooding is a major concern in most of the area.

The principal sources of ground water in this area are sandy and loamy materials in the Mississippi River alluvial deposits. For example, 74 percent of all the ground water used in Mississippi and almost all the irrigation water used in the “boot heel” area of Missouri are pumped from alluvial aquifers. Impermeable or very slowly permeable, smectitic clay layers many meters thick overlie these aquifers in many parts of the MLRA. Water moves through the clays via large desiccation cracks that open during dry periods and swell closed during wet periods. The ground water is used primarily for domestic purposes and irrigation, but it also is used for public supply and industry. It typically has levels of total dissolved solids that are less than the national secondary drinking water standard of 500 parts per million (milligrams per liter). At the extreme southern end of the area, in Louisiana, however, intrusion of seawater has raised the level of total dissolved solids enough that this water is not suitable for drinking or industrial use. Calcium, manganese, sodium, sulfate, and bicarbonate are the major ions in the ground water. Water in the river alluvium is generally hard or very hard. The iron content is extremely high in Arkansas but generally is not a significant problem in other parts of the area. Where the ground water in the alluvial aquifer is of poor quality, rural landowners obtain better quality drinking water from Tertiary and Cretaceous sands below the river alluvium.

Soils

The dominant soil orders in this MLRA are Alfisols, Vertisols, Inceptisols, and Entisols. The soil temperature regime is thermic in most of the MLRA. It is hyperthermic, however, south of Baton Rouge, Louisiana. The soils in the MLRA dominantly have an aquic soil moisture regime, smectitic clay mineralogy, and mixed sand and silt fraction mineralogy. The soils are very deep, dominantly poorly drained and somewhat poorly drained, and dominantly loamy or clayey. Nearly level Epiaquerts (Sharkey series), Vertic Epiaquepts (Tunica series), and Vertic Endoaquepts (Dowling series) dominate the alluvial flats and backswamps of Holocene to late Pleistocene age. Nearly level to gently sloping Endoaquepts (Commerce series), Udifluvents (Robinsonville series), and Fluvaquents (Convent series) dominate the natural levees of Holocene age. Nearly level to gently undulating, sandy Udifluvents (Bruno series) and Udipsamments (Crevasse series) dominate the levee splays and point bars of Holocene age. Nearly level to gently undulating Endoaqualfs (Dundee series), Hapludalfs (Dubbs series), and Epiaqualfs (Tensas series) dominate the terraces of Pleistocene age.

Biological Resources

This area once consisted entirely of bottom-land hardwood deciduous forests and mixed hardwood and cypress swamps. The major tree species in the native plant communities in the areas of bottom-land hardwoods formerly were and currently are water oak, Nuttall oak, cherrybark oak, native pecan, red maple, sweetgum, eastern cottonwood, and hickory. The major tree species in the native plant communities in the swamps formerly were and currently are cypress, water tupelo, water oak, green ash, red maple, and black willow. The important native understory species are palmetto, greenbrier, wild grape, and poison ivy in the areas of bottom-land hardwoods and buttonbush, lizardtail, waterlily, water hyacinth, sedges, and rushes in the swamps.

Some of the major wildlife species in this area are white-tailed deer, feral hogs, red fox, coyote, rabbit, gray squirrel, American alligator, water turtles, water snakes, frogs, otters, beavers, armadillo, crawfish, wild turkey, mourning doves, ducks, and geese. Fishing is mainly in oxbow lakes, rivers, and bayous. The species of fish in the area include largemouth bass, smallmouth bass, catfish, drum, bluegill, gar, and yellow perch. Crawdads are a commercial species in the southern end of this MLRA.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 70%
Grassland—private, 2%
Forest—private, 15%; Federal, 3%
Urban development—private, 3%
Water—private, 6%
Other—private, 1%

Most of this area is in farms, which produce mainly cash crops. Cotton, soybeans, milo, and corn are the main crops, and sugarcane is a major crop in the southernmost part of the area. Furrow irrigation is used in many areas during droughty parts of the growing season. Rice is grown in some land-leveled, flood-irrigated areas. Catfish and crawfish are produced commercially on farm ponds that are contained by levees. The catfish are produced throughout the MLRA, and the crawfish are produced in the southern part of the area. Migratory waterfowl are harvested throughout the area. Hardwood timber is harvested on most forested wetlands, and most of the forested areas are managed for wildlife.

About 29 percent of this MLRA is not protected from flooding, and flooding occurs occasionally or frequently in these unprotected areas. Levees protect nearly all of the cropland, urban land, and grassland from flooding. Most areas of forested wetlands are not protected from flooding. Networks of drainage canals and ditches help to remove excess surface water from the cropland.

The major resource concerns are control of surface water, management of soil moisture, and maintenance of the content of organic matter and productivity of the soils. Conservation practices on cropland generally include nutrient management, crop residue management, and alternative tillage systems, especially no-till systems that reduce the cost of tillage. In many areas land leveling or shaping optimizes the control of surface water. Other major cropland management practices are control of competing vegetation and insects through aerial or ground spraying and fertility management programs that make use of chemical fertilizers. ■

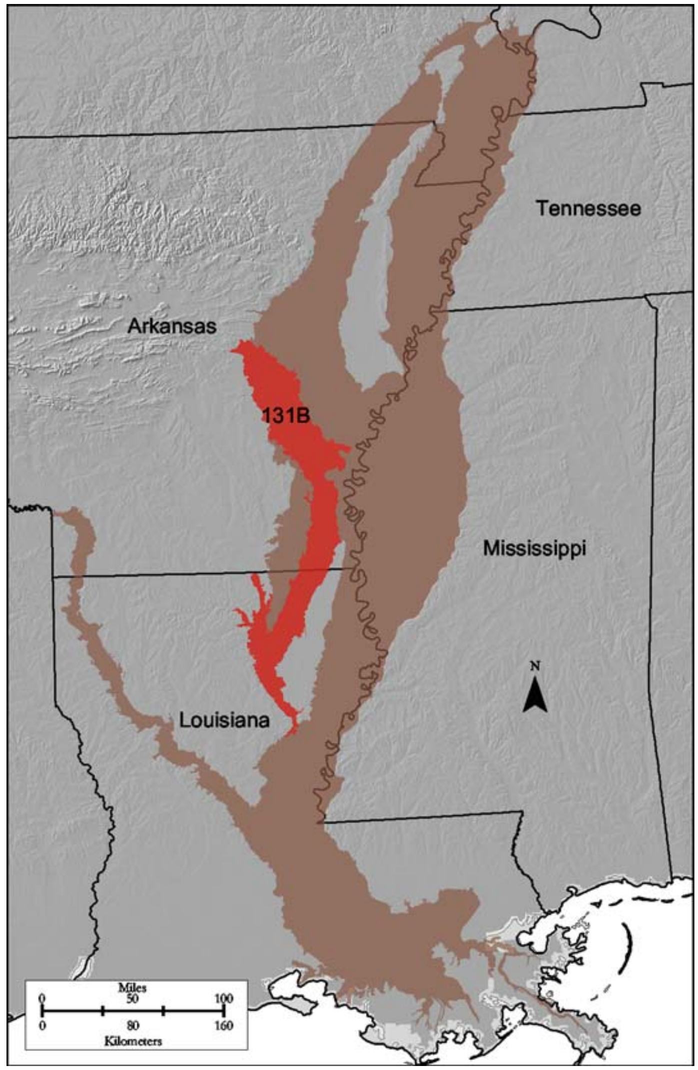

Figure 131B-1: Location of MLRA 131B in Land Resource Region O.

131B—Arkansas River Alluvium

This area (shown in fig. 131B-1) is in Arkansas (67 percent) and Louisiana (33 percent). It makes up about 3,955 square miles (10,245 square kilometers). The towns of Montrose, Dumas, and England, Arkansas, and Monroe, Louisiana, are in this MLRA. Interstate 20 passes through Monroe, Louisiana. Most parts of the Overflow National Wildlife Refuge, the Upper Ouachita National Wildlife Refuge, and the D'Arbonne National Wildlife Area are in this MLRA. The area is along a major flightpath of migratory waterfowl.

Physiography

This area is in the Mississippi Alluvial Plain Section of the Coastal Plain Province of the Atlantic Plain. It is on the alluvial plains along the lower Arkansas River in Arkansas and the Ouachita River in Louisiana and Arkansas. The landforms in the area are level or depressional to very gently undulating alluvial plains, backswamps, oxbows, natural levees, and terraces. Landform shapes range from convex on natural levees and undulating terraces to concave in oxbows. Landform shapes differentiate water-shedding positions from water-receiving positions, both of which affect soil formation and hydrology. Average elevations start at about 50 feet (15 meters) in the southern part of the area and gradually rise to about 250 feet (75 meters) in the northwestern part. Maximum local relief is about 10 feet (3 meters), but relief is considerably lower in most of the area.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Boeuf-Tensas (0805), 48 percent; Lower Mississippi-St. Francis (0802), 26 percent; Lower Red-Ouachita (0804), 20 percent; and Lower Arkansas (1111), 6 percent. The lower reaches of the Arkansas River, the Ouachita River, and the tributaries of both these rivers drain the entire MLRA. A short reach of Bayou Bartholomew, a National Wild and Scenic River, is in the southern part of the area.

Geology

Bedrock in this area consists of Tertiary and Cretaceous sands formed as beach deposits during the retreat of the Cretaceous ocean from the midsection of the U.S. Alluvial deposits from flooding and lateral migration of the Arkansas and Ouachita Rivers typically lie above the bedrock. These sediments are sandy to clayey fluvial deposits of Holocene to late Pleistocene age and are many meters thick. The geologic surfaces are identified as the Arkansas Lowlands, which extend from the Yazoo Basin up the Arkansas River to the margin of the Coastal Plain, and the parts of the Tensas Basin west of Macon Ridge. The deposits on both of these surfaces are of Holocene age. In some areas late Pleistocene terrace deposits are within several meters of the present surfaces, but they do not crop out in the MLRA.

Climate

The average annual precipitation ranges from 49 to 58 inches (1,245 to 1,475 millimeters), increasing from north to south. Most of the rainfall occurs as frontal storms during late fall, winter, and early spring, although an appreciable amount of precipitation also occurs as convective thunderstorms during the early part of the growing season. The total amount of the precipitation that occurs as snow ranges from less than 1 percent in the southern part of the MLRA to 5 percent in the northern part. The average annual temperature is 62 to 65 degrees F (16 to 18 degrees C). The freeze-free period averages 260 days and ranges from 250 to 275 days. It increases in length from north to south.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 2.1%; ground water, 1.2%
Livestock—surface water, 0.8%; ground water, 0.5%
Irrigation—surface water, 10.8%; ground water, 50.9%
Other—surface water, 31.7%; ground water, 1.9%

The total withdrawals average 1,570 million gallons per day (5,940 million liters per day). About 55 percent is from ground water sources, and 45 percent is from surface water sources. In most years the supply of moisture is adequate for maximum crop production. Surface water for public supply, industrial use, and some irrigation is available in quantity from bayous, oxbow lakes, canals, and rivers throughout this area. The dominant use of surface water in the area is for cooling thermoelectric power plants. Numerous small, above-ground water impoundments are used for raising commercial catfish throughout the MLRA. Most of the surface water is of good quality and is suitable for most uses with some treatment. High concentrations of suspended sediments, agricultural chemicals, and municipal and industrial wastewater discharges contribute to some local water-quality problems. Flooding is a major concern in most of the area.

The principal sources of ground water in this area are sandy and loamy materials within the Arkansas and Mississippi River alluvial deposits. The ground water is used primarily for irrigation, but it also is used for public supply and industry. The median level of total dissolved solids is 330 parts per million (milligrams per liter), and the water is very hard. The iron content is extremely high in the part of this area in Arkansas but generally is not a significant problem in the part in Louisiana. The level of total dissolved solids can reach 4,000 parts per million (micrograms per liter) in the southeast corner of the part of the area in Arkansas, making the water from the alluvial aquifer unusable. The Sparta and Cockfield bedrock aquifers are used in the northern tip of this area. The ground water in these aquifers is lower in salts than the water in the alluvial aquifer, and it is soft. The iron content generally is below the national secondary standard for drinking water of 300 parts per billion (micrograms per million). These aquifers provide drinking water for rural landowners and small communities. They also provide water for public supply in larger communities and for industry. More and more irrigation wells are being developed in the Sparta aquifer.

Soils

The dominant soil orders in this MLRA are Vertisols, Alfisols, Inceptisols, and Entisols. The soils in the area have a thermic soil temperature regime. They dominantly have an aquic soil moisture regime, smectitic clay mineralogy, and mixed sand and silt fraction mineralogy. They are very deep and generally are poorly drained to well drained and loamy or clayey. Nearly level Epiaquerts (Perry series), Vertic Hapludolls (Desha series), and Vertic Epiaquepts (Portland series) dominate the Holocene-age alluvial flats and backswamps. Nearly level to gently sloping Eutrudepts (Coushatta series), Udifluvents (Roxana series), and Vertic Epiaquepts (Latanier series) dominate the recent Holocene-age natural levees. Nearly level to gently undulating, sandy Udifluvents (Bruno series) and Udipsamments (Crevasse series) dominate the recent Holocene-age levee splays and point bars. Nearly level to gently undulating Epiaqualfs (Hebert series), Hapludalfs (Rilla and Sterlington series), and Argiudolls (Caspiana series) dominate the Holocene-age natural levees along the older meander scars.

Biological Resources

This area once consisted entirely of bottom-land hardwood deciduous forest and mixed hardwood and cypress swamps. The major tree species in the native plant communities in the areas of bottom-land hardwoods formerly were and currently are water oak, Nuttall oak, cherrybark oak, native pecan, red maple, sweetgum, eastern cottonwood, and hickory. The major tree species in the native plant communities in the swamps formerly were and currently are cypress, water tupelo, water oak, green ash, red maple, and black willow. The important native understory species are palmetto, greenbrier, wild grape, and poison ivy in the areas of bottom-land hardwoods and buttonbush, lizardtail, waterlily, water hyacinth, sedges, and rushes in the swamps.

Some of the major wildlife species in this area are white-tailed deer, feral hogs, red fox, coyote, rabbit, gray squirrel, American alligator, water turtles, water snakes, frogs, otters, beavers, armadillo, crawfish, wild turkey, mourning doves, ducks, and geese. Fishing is mainly in oxbow lakes, rivers, and bayous. The species of fish in the area include largemouth bass, smallmouth bass, catfish, drum, bluegill, gar, and yellow perch.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 70%
Grassland—private, 2%
Forest—private, 22%; Federal, 1%
Urban development—private, 1%
Water—private, 3%
Other—private, 1%

Farms and scattered tracts of forested wetlands make up nearly all of this area. The farms produce mainly cash crops. Cotton, soybeans, milo, and corn are the main crops. In many areas furrow irrigation is used during droughty parts of the growing season. Throughout the area, catfish are produced commercially on farm ponds that are contained by levees. Migratory waterfowl are harvested throughout the area. Hardwood timber is harvested on some forested wetlands, and most forested areas are managed for wildlife.

About 15 percent of this MLRA is not protected from flooding, and flooding occurs occasionally or frequently in these unprotected areas. Levees protect nearly all of the cropland from flooding. Most of the forested wetlands are not protected from flooding. Networks of drainage canals and ditches help to remove excess surface water from the cropland.

The major resource concerns are control of surface water, management of soil moisture, and maintenance of the content of organic matter and productivity of the soils. Conservation practices on cropland generally include nutrient management, crop residue management, and alternative tillage systems, especially no-till systems. In many areas land leveling or shaping optimizes the control of surface water. Other major cropland management practices are control of competing vegetation and insects through aerial or ground spraying of herbicides and insecticides and fertility management programs that make use of chemical fertilizers. ■

131C—Red River Alluvium

This area (shown in fig. 131C-1) is in Louisiana (86 percent) and Arkansas (14 percent). It makes up about 2,410 square miles (6,245 square kilometers). The eastern half of the city of Shreveport and the towns of Alexandria and Bossier City, Louisiana, are in this MLRA. Interstate 20 crosses this area and intersects Interstate 49 in Shreveport. Interstate 30 crosses the northern tip of the area, in Arkansas. Small areas of the Kisatchie National Forest are along the southwest edge of this MLRA. The England and Barksdale Air Force Bases are in this area. The area is along a major flightpath of migratory waterfowl.

Physiography

Almost all of this area is in the West Gulf Coastal Plain Section of the Coastal Plain Province of the Atlantic Plain. The southern end is in the Mississippi Alluvial Plain Section of the same province and division. This MLRA is on the alluvial plain along the lower Red River in Arkansas and Louisiana. The landforms in the area are level or depressional to very gently undulating alluvial plains, backswamps, oxbows, natural levees, and terraces. Landform shapes range from

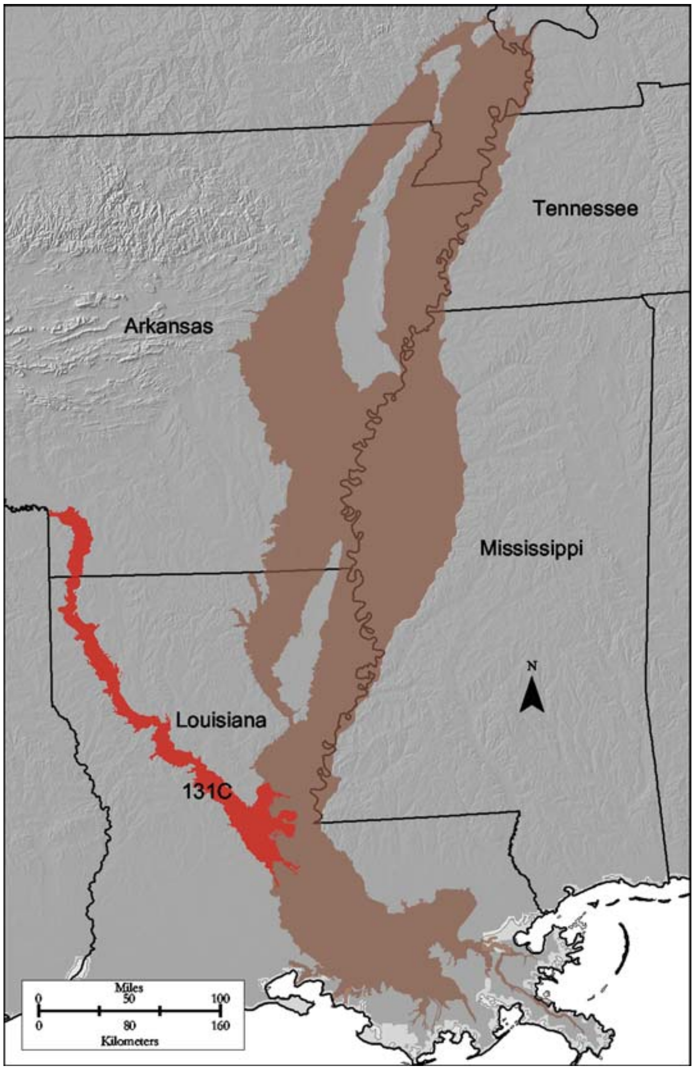

Figure 131C-1: Location of MLRA 131C in Land Resource Region O.

convex on natural levees and undulating terraces to concave in oxbows. Landform shapes differentiate water-shedding positions from water-receiving positions, both of which have a major effect on soil formation and hydrology. Average elevations start at about 40 feet (12 meters) in the southern part of the area and gradually rise to about 270 feet (80 meters) in the northwestern part. Maximum local relief is about 10 feet (3 meters), but relief is considerably lower in most of the area.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Red-Sulphur (1114), 63 percent; Louisiana Coastal (0808), 35 percent; and Lower Red-Ouachita (0804), 2 percent. The lower Red River and its tributaries drain the MLRA to its confluence with the Atchafalaya and Mississippi Rivers, which occurs in MLRA 131A.

Geology

Bedrock in this area consists of Tertiary and Cretaceous sands formed as beach deposits during the retreat of the Cretaceous ocean from the midsection of the U.S. Alluvial deposits from flooding and lateral migration of the Red River typically lie above the bedrock. These sediments are sandy to clayey fluvial deposits of Holocene to late Pleistocene age and are many meters thick. In some areas late Pleistocene terrace deposits are within several meters of the present surfaces, but they do not crop out in this MLRA. The geologic history of the area is greatly influenced by a large logjam that formed in the Red River channel in the middle part of the area during the late 18th century and the early 19th century. At the time of its largest extent, the logjam obstructed the river and its tributary outlets for a distance of 160 miles downstream from the Arkansas State boundary. Backwater flooding, reformation of natural levees, and crevasse splays caused by this logjam played a major role in covering large parts of the area with a mantle of recent clayey to sandy material. Destruction of the logjam in the late 1800s resulted in the drainage of many large lakes that had formed.

Climate

The average annual precipitation in this area ranges from 47 to 62 inches (1,195 to 1,575 millimeters), increasing from north to south. Most of the rainfall occurs as frontal storms during late fall, winter, and early spring, although an appreciable amount of precipitation also occurs as convective thunderstorms during the early part of the growing season. The total amount of the precipitation that occurs as snow ranges from less than 1 percent in the southern part of the area to 5 percent in the northern part. The average annual temperature ranges from 63 to 67 degrees F (17 to 19 degrees C). The freeze-free period averages 280 days. It ranges from 255 days in the northern part of the area to 305 days in the southern part.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 3.1%; ground water, 3.3%
Livestock—surface water, 1.4%; ground water, 1.1%
Irrigation—surface water, 1.3%; ground water, 8.1%
Other—surface water, 77.3%; ground water, 4.4%

The total withdrawals average 840 million gallons per day (3,180 million liters per day). About 17 percent is from ground water sources, and 83 percent is from surface water sources. In most years the supply of moisture is adequate for maximum crop production. Surface water for public supply, industrial use, and some irrigation is available in quantity from bayous, oxbow lakes, canals, and rivers throughout the area. The dominant use of surface water in the area is for cooling thermoelectric power plants. Numerous small, above-ground water impoundments are used for raising commercial catfish throughout the MLRA. Most of the surface water is of good quality and is suitable for most uses with some treatment. High concentrations of suspended sediments, agricultural chemicals, and municipal and industrial wastewater discharges contribute to some local water-quality problems. Flooding is a major concern in most of the area.

The principal sources of ground water in this area are sandy and loamy materials within the Red River alluvial deposits. Impermeable or very slowly permeable smectitic clays overlie these aquifers in many parts of the MLRA, and these clay layers are many meters thick in some areas. Water moves through the smectitic clays via large desiccation cracks that open during dry periods and swell closed and form slickensides during wet periods. The ground water is used primarily for irrigation, but it also is used for public supply and industry. The median level of total dissolved solids is 330 parts per million (milligrams per liter), and the water is very hard. The iron content is generally high in the part of this area in Arkansas, but it generally is not a significant problem in the part in Louisiana. The level of total dissolved solids can reach 4,000 parts per million (micrograms per liter) in the southwest corner of the part of the area in Arkansas, making the water from the alluvial aquifer unusable. The Sparta and Cockfield bedrock aquifers are used in the northern end of this area, in Arkansas. The ground water in these aquifers has a lower mineral content than the water in the alluvial aquifer, and it is soft. The iron content generally is below the national secondary standard for drinking water of 300 parts per billion (micrograms per million). These aquifers provide drinking water for rural landowners and small communities. They also provide water for public water supply in the larger communities. More and more irrigation wells are being developed in the Sparta aquifer.

Soils

The dominant soil orders in this MLRA are Vertisols, Entisols, Inceptisols, and Alfisols. The soils in the area have a thermic soil temperature regime. They dominantly have an aquic soil moisture regime, smectitic clay mineralogy, and mixed sand and silt fraction mineralogy. They are very deep and generally are poorly drained to moderately well drained and loamy or clayey. Nearly level Epiaquerts (Moreland series) and Vertic Endoaquepts (Yorktown series) dominate the Holocene-age alluvial flats and backswamps. Nearly level to gently sloping Endoaquepts (Coushatta series), Udifluvents (Severn and Roxana series), and Vertic Epiaquepts (Latanier series) dominate the Holocene-age natural levees. Nearly level to gently undulating, coarse-silty over clayey Udifluvents (Caplis series) and sandy Udifluvents (Kiomatia series) dominate the Holocene-age levee splays and point bars. Nearly level to gently undulating Hapludalfs (Gallion and Rilla series) and Argiudolls (Caspiana series) dominate the Holocene-age natural levees along the older meander scars.

Biological Resources

This area once consisted entirely of bottom-land hardwood deciduous forest and mixed hardwood and cypress swamps. The major tree species in the native plant communities in the areas of bottom-land hardwoods formerly were and currently are water oak, Nuttall oak, cherrybark oak, native pecan, red maple, sweetgum, eastern cottonwood, and hickory. The major tree species in the native plant communities in the swamps formerly were and currently are cypress, water tupelo, water oak, green ash, red maple, and black willow. The important native understory species are palmetto, greenbrier, wild grape, and poison ivy in the areas of bottom-land hardwoods and buttonbush, lizardtail, waterlily, water hyacinth, sedges, and rushes in the swamps.

Some of the major wildlife species in this area are white-tailed deer, feral hogs, red fox, coyote, rabbit, gray squirrel, American alligator, water turtles, water snakes, frogs, otters, beavers, armadillo, crawfish, wild turkey, mourning doves, ducks, and geese. Fishing is mainly in oxbow lakes, rivers, and bayous. The species of fish in the area include largemouth bass, smallmouth bass, catfish, drum, bluegill, gar, and yellow perch.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 37%
Grassland—private, 20%
Forest—private, 30%; Federal, 1%
Urban development—private, 5%
Water—private, 5%
Other—private, 2%

Farms and scattered tracts of forested wetlands make up nearly all of this area. The farms produce mainly cash crops. Cotton, soybeans, milo, and corn are the main crops. Sugarcane is a major crop in the southernmost part of the area. In many areas furrow irrigation is used during droughty parts of the growing season. Throughout the area, catfish are produced commercially on farm ponds that are contained by levees. Migratory waterfowl are harvested throughout the area. Hardwood timber is harvested on some forested wetlands, and most forested areas are managed for wildlife.

About 22 percent of this MLRA is not protected from flooding, and flooding occurs occasionally or frequently. Levees protect nearly all of the cropland from flooding. Most of the forested wetlands are not protected from flooding. Networks of drainage canals and ditches help to remove excess surface water from the cropland.

The major resource concerns are control of surface water, management of soil moisture, and maintenance of the content of organic matter and productivity of the soils. Conservation practices on cropland generally include nutrient management, crop residue management, and alternative tillage systems, especially no-till systems. In many areas land leveling or shaping optimizes the control of surface water. Other major cropland management practices are control of competing vegetation and insects through aerial or ground spraying of herbicides and insecticides and fertility management programs that make use of chemical fertilizers. ■

131D—Southern Mississippi River Terraces

This area (shown in fig. 131D-1) is in Arkansas (88 percent) and Louisiana (12 percent). It is in two separate areas that together make up about 2,945 square miles (7,635 square kilometers). The towns of Lonoke and Stuttgart, Arkansas, are in the northeastern part of the MLRA, which is called the Grand Prairie. Bastrop, Louisiana, is in the southwestern part of the MLRA. Interstate 40 crosses the northern tip of the Grand Prairie area. The Bayou Meto Wildlife Preserve and the White River and Overflow National Wildlife Refuges are in this MLRA. The MLRA is along a major flightpath of migratory waterfowl.

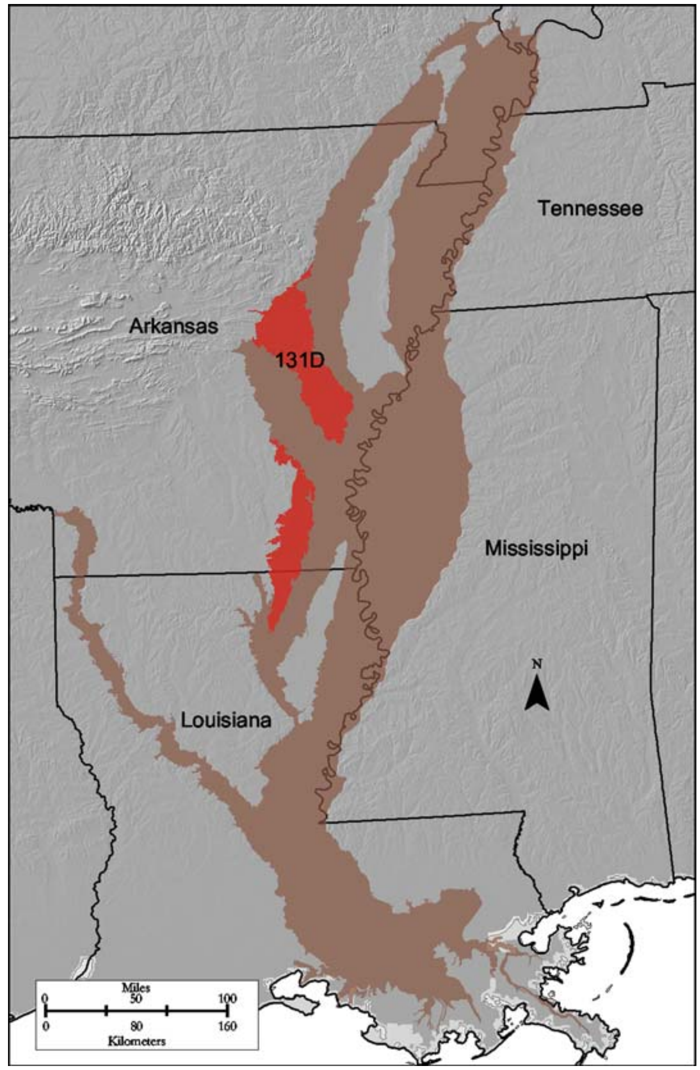

Figure 131D-1: Location of MLRA 131D in Land Resource Region O.

Physiography

This MLRA is in the Mississippi Alluvial Plain Section of the Coastal Plain Province of the Atlantic Plain. It consists dominantly of Pleistocene-age, level to gently sloping terraces along the Mississippi River. Slopes generally range from level to gently sloping but are steep along terrace escarpments. Channel scars are evident in some areas. Elevation is generally 50 to 250 feet (15 to 75 meters) on the terraces.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Mississippi-St. Francis (0802), 56 percent; Lower Red-Ouachita (0804), 41 percent; and Boeuf-Tensas (805), 3 percent. Bayou Bartholomew and LaGrue Bayou are major tributaries in this area. La Grue Bayou drains the Grand Prairie area. Bayou Bartholomew, in the southwestern part of the MLRA, has been designated a National Wild and Scenic River.

Geology

Bedrock in this area consists of Tertiary and Cretaceous sands formed as beach deposits during the retreat of the Cretaceous ocean from the midsection of the U.S. Alluvial deposits from flooding and lateral migration of the rivers crossing this area typically lie above the bedrock. These sediments form Pleistocene-age alluvial terraces. Silty alluvium underlies most of the area. Clayey sediments are in old channel scars. The Pleistocene terraces are part of the Prairie Terrace complex. A minor portion of the area is in the Deweyville and Montgomery terrace formation. These terraces have a base of red alluvium capped by one to several meters of brownish alluvium.

Climate

The average annual precipitation in thia area is 49 to 56 inches (1,245 to 1,420 millimeters), increasing from north to south. Most of the rainfall occurs as frontal storms in spring and early summer. Some high-intensity, convective thunderstorms occur in summer. The average seasonal snowfall is 5 inches (12 centimeters). The average annual temperature is 61 to 65 degrees F (16 to 18 degrees C), increasing from north to south. The freeze-free period averages 255 days. It ranges from 245 days in the northern part of the area to 270 days in the southern part.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 1.4%; ground water, 1.2%
Livestock—surface water, 0.9%; ground water, 1.4%
Irrigation—surface water, 11.5%; ground water, 67.4%
Other—surface water, 15.0%; ground water, 1.1%

The total withdrawals average 750 million gallons per day (2,840 million liters per day). About 71 percent is from ground water sources, and 29 percent is from surface water sources. In most years the supply of moisture is not adequate for maximum crop production because of the distribution of rainfall during the growing season. Some surface water for industrial use and some limited irrigation is available from bayous, canals, and rivers throughout the area. Most of the surface water is of good quality and is suitable for most uses with some treatment. Some farms and small communities depend on treated surface water. High concentrations of suspended sediments, agricultural chemicals, and municipal and industrial wastewater discharges contribute to some local water-quality problems.

The principal sources of ground water in this area are sandy and silty materials within the alluvial terraces and the Cockfield and Sparta bedrock aquifers. The Sparta aquifer is a sole-source aquifer for most of the communities in the area. The ground water is used primarily for irrigation, but it is also used for domestic purposes and for public supply and industry. The median level of total dissolved solids in the alluvial aquifer is 330 parts per million (milligrams per liter), and the water in this aquifer is very hard. The iron content is generally high in the part of this MLRA in Arkansas, but it generally is not a significant problem in the part in Louisiana. The water in the Sparta and Cockfield bedrock aquifers typically has a lower content of salts than the water in the alluvial aquifer, and it is soft. The content of iron generally is below the national secondary standard for drinking water of 300 parts per billion (micrograms per million). These aquifers provide drinking water for rural landowners and small communities. They also provide water for public supply in the larger communities. More and more irrigation wells are being developed in the Sparta aquifer.

The aquifers in this area are recharged by the Arkansas and White Rivers. Pumping has exceeded the amount of recharge, so water levels have been dropping almost 1 foot per year. The historical decline in the elevation of the water table has prompted a major federally funded water resources project to be undertaken in the Grand Prairie part of this area. The focus of the project is on improving irrigation water management. The U.S. Army Corps of Engineers, in cooperation with the Natural Resources Conservation Service, other Federal agencies, and State agencies, is assisting farmers in the construction of canals, pipelines, and on-farm reservoirs for irrigation tailwater reclamation and reuse.

Soils

The dominant soils in this MLRA are Alfisols. They have a thermic soil temperature regime, an ustic or aquic soil moisture regime, and mixed mineralogy. They are very deep and formed dominantly in silty alluvium. They generally are moderately well drained to poorly drained. Gently sloping Hapludalfs (Goodwill series) are on natural levees and low terraces. Gently sloping to level Hapludalfs (Immanuel and Stuttgart series) and Fraglossudalfs (Grenada series) are on broad interfluves and along terrace escarpments. Level Endoaqualfs (Idee series), Albaqualfs (Dewitt series), Glossaqualfs (Ethel series), Epiaqualfs (Lagrue), and Fragiaqualfs (Henry series) are on low terraces and natural levees. Nearly level and level Endoaqualfs (Tichnor and Forestdale series) are on low terraces, natural levees, and flood plains. Nearly level Dystrudepts (Oaklimeter series) are along drainageways and on flood plains.

Biological Resources

This area supports hardwoods and pines. The Grand Prairie area, in Arkansas, originally supported tall prairie grasses interlaced with hardwood timber. Cherrybark and Shumard oak are widely distributed. Yellow-poplar, white ash, cottonwood, and black walnut are important species on the flood plains. Loblolly pine and shortleaf pine are on a wide variety of sites, mainly the eroded soils on uplands and ridges. Other hardwood species that commonly grow in this area are white oak, basswood, sweetgum, water oak, American elm, blackgum, sycamore, sassafras, southern red oak, chinkapin oak, American beech, and hickory.

Some of the major wildlife species in this area are white-tailed deer, coyote, bobcat, beaver, raccoon, skunk, armadillo, mink, cottontail, turkey, mourning dove, ducks, and geese. The species of fish in the area include channel catfish, largemouth black bass, crappie, and bluegill.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 42%
Grassland—private, 4%
Forest—private, 46%; Federal, 1%
Urban development—private, 3%
Water—private, 3%
Other—private, 1%

Scattered tracts of forests and farms make up nearly all of this area. Rice, soybeans, and wheat are the main crops. In most areas furrow or flood irrigation is used throughout the growing season. Hardwood timber is harvested on some forested wetlands, and most forested areas are managed for wildlife. Bait fish are produced commercially in ponds that are contained by levees. Migratory waterfowl are harvested throughout the area.

The major soil resource concerns are management of soil moisture, erosion control, and maintenance of the content of organic matter and productivity of the soils. Depletion of ground water through excessive pumping is a major concern in the Grand Prairie area.

Conservation practices on cropland generally include nutrient management, crop residue management, and alternative tillage systems, especially no-till systems that reduce the need for tillage. In many areas land leveling or shaping optimizes the control of surface water. Other major cropland management practices are control of competing vegetation and insects through aerial or ground spraying of herbicides and insecticides and fertility management programs that make use of chemical fertilizers. ■

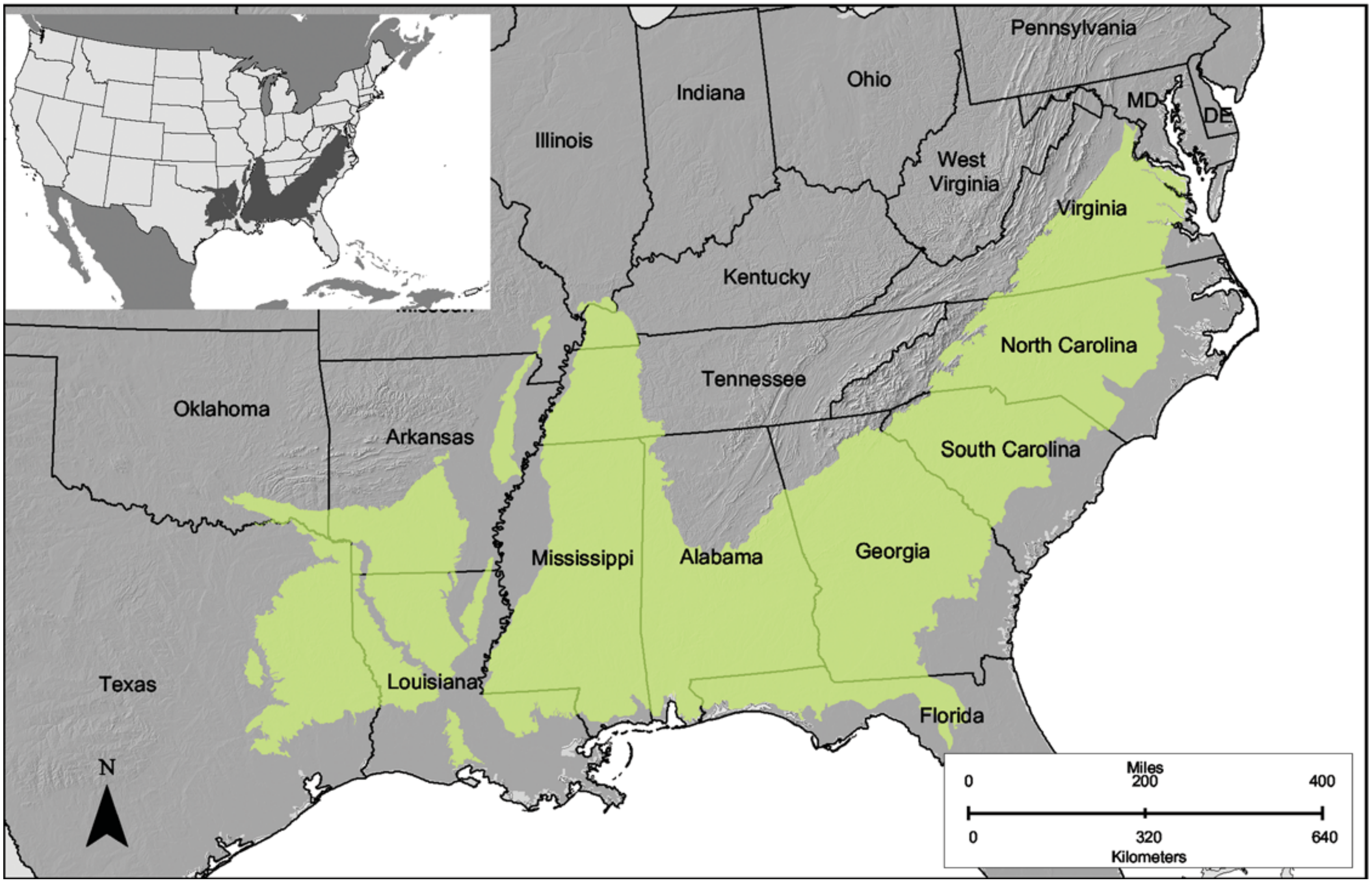

Figure P-1: Location of Land Resource Region P.

P—South Atlantic and Gulf Slope Cash Crops, Forest, and Livestock Region

This region (shown in fig. P-1) is in Georgia (16 percent), Mississippi (15 percent), Alabama (14 percent), North Carolina (11 percent), Texas (8 percent), Louisiana (7 percent), South Carolina (7 percent), Virginia (7 percent), Arkansas (5 percent), Florida (4 percent), Tennessee (4 percent), Kentucky (1 percent), and Oklahoma (1 percent). Also, very small parts of the region are in Illinois and Missouri. The region makes up 264,095 square miles (684,340 square kilometers).

This region consists of generally smooth Atlantic and Gulf Coast marine terraces and the hilly piedmont area (fig. P-2). Elevation ranges from 80 to 655 feet (25 to 200 meters) on the coastal plain and from 330 to 1,310 feet (100 to 400 meters) in the piedmont. Local relief typically ranges from 10 to 100 feet (3 to 30 meters) on the coastal plain and from 20 to 200 feet (6 to 60 meters) in the piedmont. The geologic material consists of very thick deposits of sandy to clayey marine sediments on the coastal plain and Precambrian and Paleozoic metamorphic and igneous rocks in the piedmont.

Abundant moisture and a long growing season favor agricultural production in this region. If crops are to be grown, artificial drainage typically is needed to lower the water table on the lower marine terraces. The climate is hot and humid. It is characterized by long, hot summers and short, mild winters. The mean annual precipitation is 44 to 63 inches (1,120 to 1,600 millimeters). The precipitation falls almost entirely as rainfall during frontal storms in late fall, winter, and early spring; as rainfall occurring as convective storms during the growing season; and as heavy rainfall produced by tropical storms. Typically, snowfall is light in the northern part of the region and does not occur in the southern part. The mean annual air temperature in most of the region is 59 to 66 degrees F (15 to 19 degrees C). The freeze-free period ranges from 225 to 290 days. The mean annual air temperature and the length of the freeze-free period increase from north to south.

The total withdrawals of freshwater in this region average about 30,370 million gallons per day (118,140 million liters per day). This region is one of six major land resource regions

Figure P-2: An area of Land Resource Region P.

in which more than 30,000 million gallons per day (113,550 million liters per day) is used. About 81 percent is from surface water sources, and 19 percent is from ground water sources. About 78 percent of the water is used for cooling thermoelectric power plants and for mining and industry, and 12 percent is used for public supplies.

The soils in this region are dominantly Alfisols, Entisols, Inceptisols, Ultisols, or Vertisols. They typically have a thermic soil temperature regime and a udic soil moisture regime. Hapludults, Kandiudults, Hapludalfs, and Paleudults formed in marine sediments on the coastal plain. Hapludalfs, Fraglossudalfs, and Fragiudalfs formed in thick deposits of loess east of the Mississippi River. Dystruderts, Hapluderts, and Paleudalfs formed in clayey deposits in the central part of the region. Eutrudepts and Hapludalfs formed on the ridgetops and Hapluderts on the bottom land in the northwest corner of the region. Hapludalfs, Hapludults, and Kanhapludults formed in material weathered from the crystalline rocks in the piedmont. Dystrudepts and Fluvaquents formed in alluvium on flood plains. Paleudults, Hapludalfs, and Quartzipsamments are in the southeast corner of the region.

About 97 percent of the land in this region is privately owned. The native vegetation consists of oak-pine forests. The diverse array of crops includes cotton, soybeans, peanuts, corn, rice, sugarcane, and wheat. The major management concerns on cropland include maintenance of the productivity of the soils, control of erosion, and prevention of ground-water contamination. ■

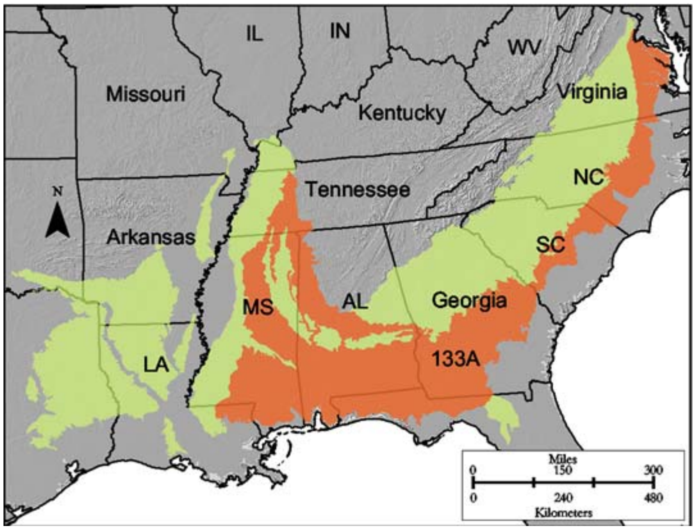

Figure 133A-1: Location of MLRA 133A in Land Resource Region P.

133A—Southern Coastal Plain

This area (shown in fig. 133A-1) is in Alabama (26 percent), Mississippi (24 percent), Georgia (21 percent), Florida (8 percent), North Carolina (7 percent), Virginia (5 percent), South Carolina (4 percent), Tennessee (4 percent), and Louisiana (1 percent). It makes up about 106,485 square miles (275,930 square kilometers). It is the largest MLRA in the U.S. The city of Alexandria, Virginia, is at the northernmost tip of the area. The MLRA also includes Fredericksburg, Richmond, and Petersburg, Virginia; Rocky Mount, Goldsboro, Fayetteville, and Lumberton, North Carolina; Florence, Sumter, and Orangeburg, South Carolina; Albany and Tifton, Georgia; Tallahassee, Florida; Tuskegee, Eufaula, Selma, and Tuscaloosa, Alabama; Savannah, Tennessee; Corinth, Starkville, Grenada, Meridian, Hattiesburg, and McComb, Mississippi; and Bogalusa, Louisiana. Interstates 95, 64, 85, 40, 20, 20/59, 26, 16, 75, 10, 65, 59, and 55 cross this area from north to south.

Forts Belvoir and A.P. Hill, Cameron Station Military Reservation, and Quantico Marine Corps Combat Development Command are in the part of this area in Virginia. The MLRA also includes Fort Bragg and Pope Air Force Base near Fayetteville, North Carolina; a small part of Fort Gordon and Fort Stewart in Georgia; Maxwell Air Force Base and Fort Rucker in Alabama; Whiting Naval Air Station and Eglin Air Force Base in Florida; the National Aeronautics and Space Administration's National Space Technology Center in Mississippi; and the western edge of the Department of Energy's nuclear materials production facility at the Savannah River Site in South Carolina.

Mt. Vernon, George Washington's Birthplace National Monument, and Robert E. Lee's birthplace are in the part of this MLRA in Virginia. A number of national wildlife refuges, State forests, and State parks are throughout this area. A number of national forests and National Wild and Scenic Rivers are in the southern part of the area. The Choctaw Indian Reservation is in the part of the area in Mississippi.

Physiography

This area extends from Virginia to Louisiana and Mississippi, but it is almost entirely within three sections of the Coastal Plain Province of the Atlantic Plain. The northern part is in the Embayed Section, the middle part is in the Sea Island Section, and the southern part is in the East Gulf Coastal Plain Section. This MLRA is strongly dissected into nearly level and gently undulating valleys and gently sloping to steep uplands. Stream valleys generally are narrow in their upper reaches but become broad and have widely meandering stream channels as they approach the coast. Elevation ranges from 80 to 655 feet (25 to 200 meters), increasing gradually from the lower Coastal Plain northward. Local relief is mainly 10 to 20 feet (3 to 6 meters), but it is 80 to 165 feet (25 to 50 meters) in some of the more deeply dissected areas.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Mobile-Tombigbee (0316), 12 percent; Choctawhatchee-Escambia (0314), 12 percent; Apalachicola (0313), 10 percent; Pascagoula (0317), 9 percent; Altamaha-St. Marys (0307), 7 percent; Alabama (0315), 6 percent; Pearl (0318), 6 percent; Suwannee (0311), 4 percent; Ogeechee-Savannah (0306), 4 percent; Pee Dee (0304), 4 percent; Lower Mississippi-Yazoo (0803), 4 percent; Lower Chesapeake (0208), 3 percent; Cape Fear (0303), 3 percent; Ochlockonee (0312), 2 percent; Neuse-Pamlico (0302), 2 percent; Lower Mississippi-Hatchie (0801), 2 percent; Lower Tennessee (0604), 2 percent; Chowan-Roanoke (0301), 2 percent; Edisto-Santee (0305), 2 percent; Middle Tennessee-Elk (0603), 1 percent; Lower Mississippi-Lake Maurepas (0807), 1 percent; Lower Mississippi-Big Black (0806), 1 percent; and Potomac (0207), 1 percent. This MLRA stretches from the Chesapeake Bay in the north to just short of the Mississippi River in Louisiana and Mississippi. A great number of major rivers originating in the Appalachian Mountains west of this area cross the MLRA and empty into the Atlantic Ocean or the Gulf of Mexico.

Geology

This MLRA is bordered on the west and north by the "fall line." This line of water falls marks the western and northern extent of the unconsolidated Coastal Plain sediments. It is an erosional scarp formed when this area was the Atlantic Ocean shore in Mesozoic time. The MLRA is underlain by eroded igneous and metamorphic bedrock. Rivers and streams draining the Appalachians deposited a thick wedge of silt, sand, and gravel east and south of the fall line as delta deposits in the Atlantic Ocean. These Jurassic and Cretaceous river sediments were eventually exposed as the Coastal Plain uplifted and the sea level changed. When the sea level rose again, the Coastal Plain was submerged and covered by a thin layer of Cretaceous sands in the eastern half of the area. In the western part of the area, the water was deeper and limestone, dolomite, and calcareous sands were deposited. As the Coastal Plain continued to uplift and the sea level dropped again, Quaternary material consisting of unconsolidated clay, silt, sand, and gravel was deposited over the Tertiary sand and carbonates. Subsequent changes in the sea level created terraces in these younger deposits along many of the streams and rivers draining this area. Much of the MLRA has a "benched" appearance because of the cycles of erosion and deposition that occurred as the area was exposed and submerged numerous times in its geologic history.

Climate

The average annual precipitation in most of this area is 41 to 60 inches (1,040 to 1,525 millimeters), increasing from north to south. It is typically 61 to 72 inches (1,550 to 1,830 millimeters) in the extreme southwest part of the area, inland along the Gulf Coast. The minimum precipitation occurs in autumn throughout the area. The maximum precipitation occurs during midsummer in the eastern part of the area and during winter and spring in the western part. Rainfall typically occurs as high-intensity, convective thunderstorms during the summer, but moderate-intensity tropical storms can produce large amounts of rainfall during winter in the eastern and southwestern parts of the area. Snowfall does not occur in the southern part of the area, and it occasionally occurs in the northern part. The average annual temperature is 55 to 68 degrees F (13 to 20 degrees C), increasing from north to south. The freeze-free period averages 250 days and ranges from 200 to 305 days, increasing in length from north to south.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 6.1%; ground water, 5.1%
Livestock—surface water, 1.9%; ground water, 4.4%
Irrigation—surface water, 3.9%; ground water, 4.5%
Other—surface water, 69.7%; ground water, 4.4%

The total withdrawals average 7,030 million gallons per day (26,610 million liters per day). This MLRA is among the top 10 MLRAs in total amount of water used. About 18 percent is from ground water sources, and 82 percent is from surface water sources. Precipitation and perennial streams provide an abundance of water. Water for livestock is primarily obtained from perennial streams and small farm ponds. The many perennial streams have the potential for supplying water for municipal use, human consumption, and farming but have been little used for these purposes. A few large reservoirs are available for recreation and other uses. Most of the surface water in this area is used for cooling thermoelectric power plants. The surface water is suitable for all uses.

Domestic water supplies in this area are obtained mainly from shallow wells. In most areas one or more aquifers provide ample ground water for irrigation and for municipal and industrial uses. The Floridan aquifer (limestone, dolomite, and calcareous sand) is heavily used in the southern part of the area, and the Cretaceous sand aquifer is extensively used throughout the area. Both of these aquifers have some of the best quality water in the area. The level of total dissolved solids generally is less than 250 parts per million (milligrams per liter), and the water is typically soft or moderately hard. A number of more minor aquifers are used for ground water throughout the area. Mississippi, for example, obtains water from 12 of the 14 principal aquifers in that State. Since the ground water is shallow throughout the area, nitrate contamination from barnyards, confined animal-feeding operations, septic systems, and poor nutrient management practices is always a potential problem. Some ground water in Mississippi has naturally high levels of iron, and many wells in South Carolina pump water that exceeds the national drinking water standard for sodium. Brine water is commonly encountered in wells in the part of this area in Louisiana. The brine originates from salt domes and moves up to the shallow aquifers along faults created by the upward migration of the domes.

Soils

The dominant soil orders in this MLRA are Ultisols, Entisols, and Inceptisols. The soils in the area dominantly have a thermic soil temperature regime, a udic or aquic soil moisture regime, and siliceous or kaolinitic mineralogy. They generally are very deep, somewhat excessively drained to poorly drained, and loamy. Hapludults formed in marine sediments (Luverne and Sweatman series) and mixed marine sediments and alluvium (Smithdale series) on hills and ridges. Kandiudults formed in marine sediments (Dothan, Fuquay, Norfolk, and Orangeburg series) and mixed marine and fluvial sediments (Troup series) on hills and ridges. Fragiudults (Ora and Savannah series) and Paleudults (Ruston series) formed in mixed marine and fluvial sediments on uplands and stream terraces. Fluvaquents (Bibb series) and Endoaquepts (Mantachie series) formed in alluvium on flood plains. Quartzipsamments (Lakeland series) formed in sandy eolian or marine material on uplands. Paleaquults (Rains series) formed in marine and fluvial sediments on terraces.

Biological Resources

This area supports mixed oak-pine vegetation. Loblolly pine, longleaf pine, slash pine, shortleaf pine, sweetgum, yellow-poplar, red oak, and white oak are the major overstory species. Dogwood, gallberry, and farkleberry are the major understory species. Common sweetleaf, American holly, greenbrier, southern bayberry, little bluestem, Elliott bluestem, threeawn, grassleaf goldaster, native lespedezas, and low panicums are other understory species.

Some of the major wildlife species in this area are white-tailed deer, turkey, rabbit, squirrel, bobwhite quail, and mourning dove. The species of fish in the area include bass, bluegill, and channel catfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 17%
Grassland—private, 8%
Forest—private, 61%; Federal, 3%
Urban development—private, 6%
Water—private, 3%
Other—private, 2%

Timber production, cash-grain crops, and forage production are important in this MLRA. Soybeans, cotton, corn, and wheat are the major crops grown throughout the area. Pastures are grazed mainly by beef cattle, but some dairy cattle and hogs are raised in the area.

The major resource concerns are water erosion, maintenance of the content of organic matter and productivity of the soils, control of surface water, artificial drainage, and management of surface compaction and soil moisture. Conservation practices on cropland generally include systems of crop residue management, cover crops, crop rotations, water disposal, subsoiling or deep tillage, pest management, and nutrient management. The most important conservation practice in pastured areas is prescribed grazing. Pastures commonly are overseeded with small grains and/or legumes to supplement forage production during winter. Haying also helps to provide supplemental feed during the long winters. Critically eroding areas and areas where animals congregate should be monitored and treated. ■

133B—Western Coastal Plain

This area (shown in fig. 133B-1) is in Texas (47 percent), Louisiana (31 percent), Arkansas (21 percent), and Oklahoma (1 percent). It makes up about 45,450 square miles (117,770 square kilometers). The towns of Longview, Lufkin, Marshall, Nacogdoches, and Tyler, Texas, are in the southwestern part of the area. The towns of Minden, Ruston, and West Monroe, Louisiana, are in the southern part. The towns of Magnolia, Hope, Camden, El Dorado, and Pine Bluff, Arkansas, are in the northern part. Shreveport, Louisiana, and Little Rock, Arkansas, are major cities in this MLRA. Interstate 30 crosses the northernmost part of this area, in Texas and Arkansas, and Interstate 20 crosses the central part, in Texas and Louisiana. Interstate 49 runs from Shreveport south through Louisiana. The MLRA includes parts of Camp Joseph T. Robinson, the Little Rock Air Force Base, and the Pine Bluff Arsenal in Arkansas and Fort Polk in Louisiana. It also includes the Angelina, Davy Crockett, Kisatchie, Sabine, and Sam Houston National Forests, parts of the Ouchita National Forest, and the Big Thicket National Preserve. The northern half of the Alabama and Coushatta Indian Reservation is in the part of this area in Texas.

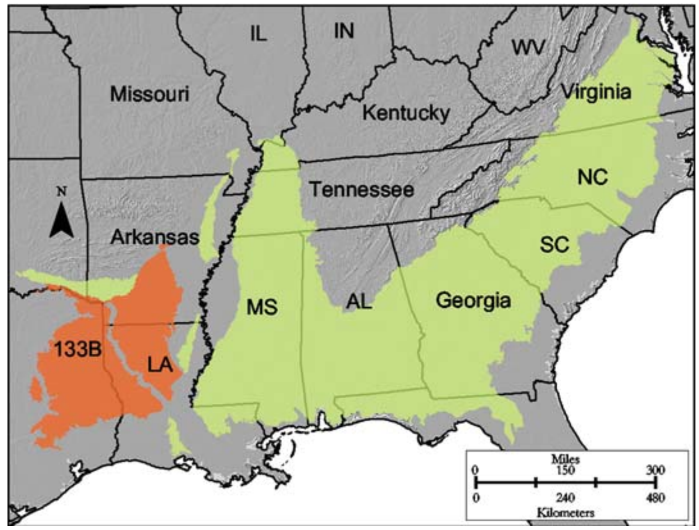

Figure 133B-1: Location of MLRA 133B in Land Resource Region P.

Physiography

This area is in the West Gulf Coastal Plain Section of the Coastal Plain Province of the Atlantic Plain. It consists of level to steep uplands that are intricately dissected by streams. Broad flood plains and terraces are along some streams. Elevation ranges from 80 to 650 feet (25 to 200 meters), increasing gradually from southeast to northwest. Local relief is generally less than 30 feet (9 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Red-Ouachita (804), 29 percent; Red-Sulphur (1114), 26 percent; Neches (1202), 17 percent; Sabine (1201), 14 percent; Trinity (1203), 7 percent; Louisiana Coastal (0808), 3 percent; Galveston Bay-San Jacinto (1204), 3 percent; and Lower Arkansas (1111), 1 percent. The headwaters of the Angelina, Calcasieu, and Neches Rivers are in this area. The Trinity River passes through the far western part of the area. Tributaries of the Ouachita and the Sabine Rivers also drain the area. The Saline

River in Arkansas and Louisiana and the Little, Black Lake Bayou, Calcasieu, and Bayou D'Arbonne Rivers in Louisiana are National Wild and Scenic Rivers.

Geology

Tertiary and Cretaceous marine sediments underlie most of this area. Tertiary units include the Wilcox and Midway Groups, the Claiborne Group, the Jackson Group, the Catahoula Formation, and the Willis Formation. They consist of interbedded sandstone, siltstone, and shale and unconsolidated sands, silts, and clays. The Reklaw and Weches Formations in the Claiborne Group form the Redland area in east Texas. The Cretaceous marine sediments of the Fleming and Oakville Formations are of minor extent in the area. They consist of calcareous clays and marls. Sand, silt, and clay alluvium is under the flood plains and terraces along the major drainages.

Climate

The average annual precipitation in this area is 39 to 63 inches (990 to 1,600 millimeters). It increases from northwest to southeast. Most of the rainfall occurs as frontal storms in spring and early summer. High-intensity, convective thunderstorms occur in late summer and in fall. Some heavy rains occur during tropical storms in winter. The average annual temperature is 61 to 68 degrees F (16 to 20 degrees C). The freeze-free period averages 270 days. It ranges from 235 days in the northern part of the area to 305 days in the southern part.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 6.5%; ground water, 7.8%
Livestock—surface water, 3.5%; ground water, 4.6%
Irrigation—surface water, 3.1%; ground water, 2.3%
Other—surface water, 21.0%; ground water, 51.3%

The total withdrawals average 3,050 million gallons per day (11,545 million liters per day). About 66 percent is from ground water sources, and 34 percent is from surface water sources. The water generally is abundant because of precipitation, perennial streams, and the supply of ground water. Even though summer rainfall is generally adequate for crops, droughts are common. There is a summer moisture deficit of 2 to 6 inches (50 to 150 millimeters). Wet soils must be drained before they can be used for crops. Several large reservoirs on the major streams provide municipal and industrial water and also serve as recreation sites. The surface water in the area is used dominantly for industry and for cooling thermoelectric power plants. Most of the surface water is of good quality and is suitable for most uses with some treatment. High concentrations of suspended sediments, agricultural chemicals, and municipal and industrial wastewater discharges contribute to some local water-quality problems. The lower tributaries of the Ouachita River are contaminated with wastes from oil and gas production. Fecal-coliform bacteria counts have caused water-quality problems on the Red River near Shreveport and in the Toledo Bend Reservoir on the Sabine River. A low level of dissolved oxygen is a problem in rivers below reservoirs where deep, oxygen-deficient water is released. Flooding is a concern in many parts of the area.

The principal sources of ground water in this area are bedrock aquifers. They include the Carrizo-Wilcox aquifer in Texas and Louisiana, the Trinity Group in Texas, the Cockfield and Sparta aquifers in Arkansas and Louisiana, the Wilcox aquifer in Arkansas, and the Pliocene-Miocene aquifers in Louisiana. The Wilcox aquifer in southwest Arkansas is not used extensively in this area. The ground water is used primarily for industry, but it also is used for public supply. Most rural landowners rely on the bedrock aquifers for domestic and livestock water. The median level of total dissolved solids is typically less than 400 parts per million (milligrams per liter), but water in the Trinity Group near the Texas-Oklahoma State line has a median level of 619 parts per million (milligrams per liter). The ground water is soft in Louisiana and Arkansas, but it is moderately hard to very hard in Texas. The iron content can be very high in some areas in Arkansas, and it may also cause some problems in the part of the area in Louisiana. A declining water level is a problem in the Trinity Group aquifer in Texas. About 30 percent of the samples from this aquifer exceeded the 10 parts per million (milligrams per liter) national standard for nitrate in drinking water. The water in the Pliocene-Miocene sands in west-central Louisiana has high levels of fluoride, and its color limits its use for drinking water. Locally, the color of the water in the Cockfield and Sparta aquifers in Louisiana limits the use of those aquifers for public supply.

Soils

The dominant soil orders in this MLRA are Alfisols and Ultisols. The soils in the area dominantly have a thermic soil temperature regime, a udic or aquic soil moisture regime, and siliceous, mixed, or smectitic mineralogy. They generally are very deep, well drained to poorly drained, and loamy or clayey. Hapludults formed in residuum (Cuthbert and Kirvin series) and marine sediments (Sacul series) on hills and ridges. Paleudults formed in marine sediments (Bowie and Malbis series) and mixed marine sediments and alluvium (Ruston series) on uplands. Endoaquults (Amy series) formed in old alluvium on stream terraces. Fragiudults (Savannah series) formed in mixed marine sediments and alluvium on uplands and stream terraces. Hapludalfs (Eastwood and Woodtell series) formed in marine sediments on hills and ridges. Glossaqualfs formed in alluvium on flood plains and stream terraces (Guyton series) and in old alluvium on stream terraces (Wrightsville series).

Biological Resources

This area supports pine-hardwood vegetation. The dominant trees are loblolly pine, shortleaf pine, sweetgum, southern red oak, white oak, flowering dogwood, and post oak. American beautyberry, greenbrier, hawthorns, and berry vines are included in the woody understory. Little bluestem and pinhole bluestem are the dominant herbaceous species. Other major grasses include beaked panicum, longleaf uniola, spike uniola, and yellow Indiangrass. The plant community has many species of low-growing panicums and paspalums and perennial forbs.

The major wildlife species in this area include white-tailed deer, coyote, beaver, raccoon, skunk, opossum, muskrat, mink, cottontail, squirrel, weasel, armadillo, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 2%
Grassland—private, 18%
Forest—private, 65%; Federal, 4%
Urban development—private, 6%
Water—private, 3%; Federal, 1%
Other—private, 1%

The forested areas in this MLRA are used for the production of lumber and pulpwood. The cleared land is used mostly for pasture and hay. Where the water supply is adequate, such crops as corn, grain sorghum, oats, soybeans, peanuts, rice, and vegetables are grown.

The major resource concerns are water erosion, wetland restoration, and water supplies for livestock. Conservation practices on cropland generally include buffer strips, which help to control erosion and runoff. They also include the proper use and timing of irrigation. ■

134—Southern Mississippi Valley Loess

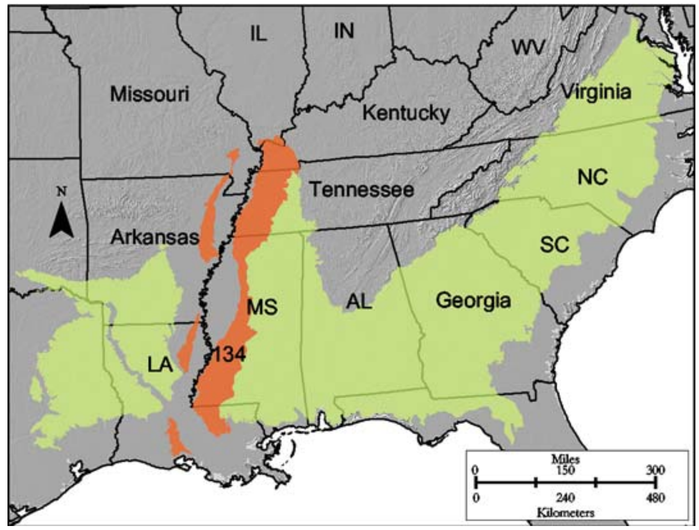

Figure 134-1: Location of MLRA 134 in Land Resource Region P.

This area is in Mississippi (39 percent), Tennessee (23 percent), Louisiana (15 percent), Arkansas (11 percent), Kentucky (9 percent), Missouri (2 percent), and Illinois (1 percent). It makes up about 26,520 square miles (68,715 square kilometers). The northern part of the area includes Paducah and Murray, Kentucky; Paragould, Jonesboro, and Forrest City, Arkansas; and Memphis, Dyersburg, Bartlett, and Germantown, Tennessee. The southern part includes Yazoo City, Clinton, and Jackson, Mississippi, and Baton Rouge, Opelousas, Lafayette, and New Iberia, Louisiana. Interstates 24, 55, 40, 20, 12, 49, and 10 cross this area. The area includes the Homochitto National Forest in Mississippi, the St. Francis National Forest in Arkansas, and the Shawnee National Forest in Illinois. A number of State parks and a few national wildlife refuges are in the southern part of this MLRA.

Physiography

This area is in the Coastal Plain Province of the Atlantic Plain. Most of the part of the area east of the Mississippi River is in the East Gulf Coastal Plain Section of the province. Parts of the western edge of the area, the part of the area in Arkansas, and the isolated part in northern Louisiana are in the Mississippi Alluvial Plain Section. The farthest southwest part in Louisiana is in the West Gulf Coastal Plain Section. The sharply dissected plains in this MLRA have a loess mantle that is thick at the valley wall and thins rapidly as distance from the valley wall increases. Valley sides are hilly to steep, especially in the western part of the area. The intervening ridges generally are narrow and rolling, but some of the interfluves between the upper reaches of the valleys are broad and flat. Stream valleys are narrow in the upper reaches but broaden rapidly downstream and have wide, flat flood plains and meandering stream channels. Elevation ranges from 80 to 600 feet (25 to 185 meters). Local relief is mainly 10 to 20 feet (3 to 6 meters), but it can be 80 to 165 feet (25 to 50 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Mississippi-Hatchie (0801), 28 percent; Lower Mississippi-Big Black (0806), 20 percent; Lower Mississippi-St. Francis (0802), 12 percent; Lower Mississippi-Yazoo (0803), 12 percent; Lower Mississippi-Lake Maurepas (0807), 9 percent; Boeuf-Tensas (0805), 5 percent; Louisiana Coastal (0808), 4 percent; Pearl (0318), 4 percent; Lower Tennessee

(0604), 4 percent; and Lower Ohio (0514), 2 percent. There are no major rivers in the part of this area west of the Mississippi River. A tributary of the Tennessee River (and lake) is in the part of this area in the southwest corner of Kentucky. The Obion and Hatchie Rivers are in the part of the area in Tennessee. The Hatchie River is a National Wild and Scenic River. Many of the tributaries of the Yazoo River are in the part of the area in northern Mississippi. The Big Black River crosses this area in southern Mississippi. The Mississippi River is in the extreme southeast corner of the area, near Baton Rouge, Louisiana.

Geology

This area is mantled with loess, which varies in thickness. The area is underlain by unconsolidated sand, silt, and clay, mainly of marine origin. Crowley's Ridge is underlain by Pliocene sand and gravel. The seas extended up the present-day valley of the Mississippi River in Tertiary time, when these sediments were deposited by rivers draining the surrounding uplands. Throughout Quaternary and Recent time, the valley floor received fine grained sediments each time the Mississippi River flooded. After these sediments dried, winds picked them up and deposited them as loess in the higher areas on each side of the valley. There are five known periods of loess deposition in the area. The surface deposit is the Peoria Loess, which is of Late Wisconsin age (about 10,000 years ago). Pre-Peorian Loess, which is of Middle Wisconsin age (about 20,000 to 40,000 years ago), occurs in some areas. This loess is thinner than the Peorian Loess and is generally redder or darker. Loveland-Sicily Island Loess, which is of pre-Wisconsin age (85,000 to 130,000 years ago), is at the surface in some areas in the southern part of this MLRA. It has a well developed reddish paleosol (buried soil). Two other loess deposits have been described on Crowley's Ridge. They have been identified as Marianna Loess and Crowley's Ridge Loess. These deposits are not exposed at the surface. They have well developed paleosols.

Climate

The average annual precipitation in this area increases from north to south. In most of this area, it is 47 to 60 inches (1,195 to 1,525 millimeters). It is 61 to 70 inches (1,550 to 1,780 millimeters) in parts of the extreme southern end of the area. The maximum precipitation occurs in winter and spring. The precipitation decreases gradually throughout the summer, except for a moderate increase in midsummer. Rainfall occurs primarily as high-intensity, convective thunderstorms, but moderate-intensity tropical storms can produce large amounts of rainfall during winter in the southern part of the area. Snowfall generally occurs in the northern part of the area. The average annual snowfall in Stoddard County, Missouri, is 11 inches (28 centimeters). South of the Missouri-Arkansas State line, snowfall occurs but is rare. The average annual temperature is 57 to 68 degrees F (14 to 20 degrees C), increasing from north to south. The freeze-free period averages 270 days and ranges from 215 to 325 days, increasing in length from north to south.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 2.3%; ground water, 5.8%
Livestock—surface water, 0.7%; ground water, 2.0%
Irrigation—surface water, 5.1%; ground water, 18.1%
Other—surface water, 61.7%; ground water, 4.3%

The total withdrawals average 5,270 million gallons per day (19,945 million liters per day). About 30 percent is from ground water sources, and 70 percent is from surface water sources. Precipitation is abundant, but most streams are small and flow intermittently. They flow most of the time in winter and spring. In summer and autumn, however, they flow only during and immediately after storms. Reservoirs store water for use when flows in streams decline. In the uplands, ponds and rural water systems are the main sources of water for domestic use and livestock. The surface water in the area is suitable for almost all uses. Most of the water used is for cooling thermoelectric power plants.

Ground water is abundant in this area, but shallow wells provide small quantities of water. In the uplands, shallow wells are used to fill cisterns for domestic use and livestock. Deep wells in the underlying unconsolidated sand and gravel of Cretaceous and Tertiary age yield large quantities of water. Most of the ground water east of the Mississippi River is suitable for all uses. It is soft and generally has less than 200 parts per million (milligrams per liter) total dissolved solids. Some of the water in the part of this area in Kentucky requires treatment for high levels of iron if it is to be used as drinking water.

In the part of Louisiana west of the Mississippi River, water from the Chicot aquifer system exceeds the drinking water standards for iron and water from the alluvial aquifer generally is not suitable for drinking because of high levels of total dissolved solids and iron and hardness. In Arkansas, water from the alluvial aquifer is very hard and has a median level of iron of almost 4,000 parts per billion (micrograms per liter). Water from the Sparta and Wilcox aquifers is soft, but most samples tested show levels of iron exceeding the 300 parts per billion (micrograms per liter) secondary standard for drinking water. All of the water west of the Mississippi River is very fresh and has median levels of total dissolved solids in the range of 100 to 350 parts per million (milligrams per liter).

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Inceptisols, and Ultisols. The soils in the area are very deep or deep, are medium textured, and have a thermic soil temperature regime, a udic soil moisture regime, and mixed mineralogy.

Well drained, nearly level to very steep Hapludalfs (Memphis series) are on uplands. Nearly level to steep, well drained Hapludalfs (Memphis, Coteau, and Feliciana series), moderately well drained and somewhat poorly drained Fraglossudalfs (Olivier, Grenada, and Calloway series), moderately well drained Fragiudalfs (Loring series), and well drained Eutrudepts (Natchez series) formed in thick deposits of loess. Nearly level to gently sloping, somewhat poorly drained Epiaqualfs (Patoutville series), moderately well drained Fragiudults (Gigger, Toula, and Tangi series), well drained to somewhat poorly drained Hapludalfs (Colyell and Dexter series), and well drained Paleudults (Lytle series) formed in deposits of loess 2 to 4 feet (1 meter) thick. Nearly level and very gently sloping, somewhat poorly drained and poorly drained Glossaqualfs (Calhoun, Encrow, and Frost series), somewhat poorly drained Glossudalfs (Egypt series), somewhat poorly drained Hapludalfs (Satsuma series), and somewhat poorly drained Argiaquolls (Jeanerette series) formed in a thin mantle of loess over loamy alluvium or mixed loess and loamy alluvium. Deep, gently sloping, well drained Eutrudepts (Weyanoke series), somewhat poorly drained Fragiudults (Bude series), and somewhat poorly drained Fraglossudalfs (Fluker series) formed in silty material or in a mantle of loess and the underlying late Pleistocene loamy terrace material.

In the eastern part of the area, where the loess mantle thins, well drained Paleudalfs (Lexington series), moderately well drained Fragiudalfs (Dulac and Providence series), well drained Hapludults (Brandon and Silerton series), and well drained Paleudults (Smithdale series), all of which are gently sloping to steep, are on ridgetops and side slopes. Well drained Dystrudepts (Ariel series), moderately well drained Udifluvents (Collins series), moderately well drained Dystrudepts (Oaklimeter series), and somewhat poorly drained Fluvaquents (Gillsburg series) are on flood plains.

Biological Resources

This area supports hardwood-pine vegetation. Cherrybark oak, Shumard oak, white oak, post oak, southern red oak, and southern magnolia are widely distributed. Loblolly pine and shortleaf pine are the dominant pines. Yellow-poplar, white ash, swamp chestnut, cottonwood, sweetgum, and black walnut are important species on the flood plains. Loblolly pine and shortleaf pine are on a wide variety of sites, mainly the eroded soils on uplands and ridges. Other hardwood species that commonly grow in this area are white oak, basswood, sweetgum, water oak, American elm, blackgum, sycamore, sassafras, southern red oak, chinkapin oak, American beech, and hickory. Beech-magnolia-holly forests are dominant on narrow ridges and in steep ravines in the Tunica Hills of Louisiana.

Some of the major wildlife species in this area are white-tailed deer, red fox, gray fox, raccoon, opossum, skunk, muskrat, cottontail, gray squirrel, fox squirrel, bobwhite quail, and mourning dove. The species of fish in the area include largemouth bass, bluegill, and bullhead.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 36%
Grassland—private, 13%
Forest—private, 38%; Federal, 2%
Urban development—private, 7%
Water—private, 2%
Other—private, 2%

Most of this area is in farms. A small acreage is federally owned. About one-third of the area is cropland, but the proportion varies greatly from county to county, depending on the soils and the topography. This is largely a cash-crop area. Cotton, corn, rice, soybeans, and wheat are the major crops. Strawberries are important in Louisiana. Feed grains and forage are grown on dairy farms. Less than 15 percent of the area is pasture or hayland. About two-fifths is forest of mixed pine and hardwoods. Lumber is the major forest product, and some pulpwood is harvested. The present trend is toward the conversion of pasture and forest to cropland. Some areas are used for urban development, which is expanding near the metropolitan areas.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Water erosion is a hazard in sloping areas that are bare because of tree harvesting. Conservation practices on forestland generally include systems of tree residue management and reforestation. Conservation practices on cropland generally include crop residue management, which increases the content of organic matter in the soils, and applications of lime in areas of low pH. Many of the soils remain wet or have a high water table for some or most of the year. Measures that improve drainage should be applied, or the crops adapted to the wet conditions should be selected for planting. ■

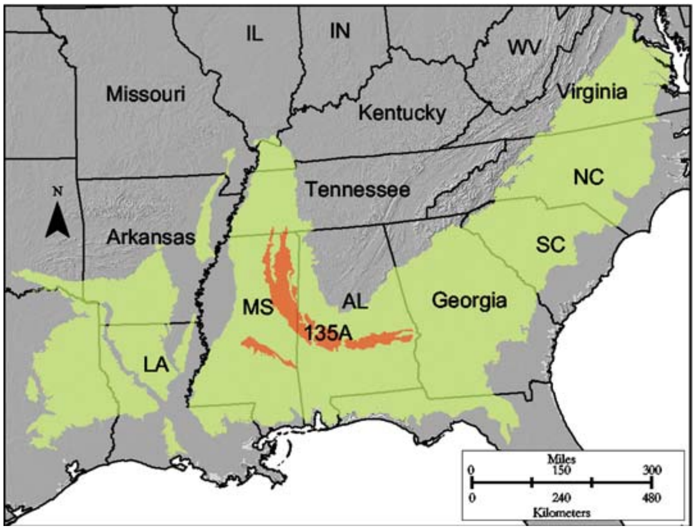

Figure 135A-1: Location of MLRA 135A in Land Resource Region P.

135A—Alabama and Mississippi Blackland Prairie

This area (shown in fig. 135A-1) is in Alabama (53 percent) and Mississippi (47 percent). It makes up about 6,370 square miles (16,510 square kilometers). Tupelo, Mississippi, is the only major town in this MLRA. The small towns of Demopolis and Uniontown are in west Alabama. The cities of Montgomery and Selma are just outside this area, on terraces along the Alabama River, which bisects the MLRA. Interstates 20 and 20/59 cross parts of this area, and U.S. Highway 80 runs through the center of the part of the MLRA in Alabama. The Bienville National Forest is in the part in Mississippi.

Physiography

This area is in the East Gulf Coastal Plain Section of the Coastal Plain Province of the Atlantic Plain. The northern part of the area is a slightly elevated plain that is hilly, and the separate southwestern part is locally known as the Jackson Prairie portion of the East Gulf Coastal Plain Section in Mississippi. Elevation ranges from 100 to 590 feet (30 to 180 meters). Local relief is mainly 50 to 100 feet (15 to 30 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Mobile-Tombigbee (0316), 55 percent; Alabama (0315), 28 percent; Pascagoula (0317), 10 percent; and Pearl (0318), 7 percent. Tributaries of the Tombigbee, Pearl, and Pascagoula Rivers cross the part of this area in Mississippi. The valleys along the Tombigbee and Alabama Rivers separate the three parts of this area in Alabama.

Geology

Most of this area is underlain by Cretaceous-age clay, marl, soft limestone, or chalk of the Selma Group. The Jackson Prairie part, in southern Mississippi, and parts of the area in southwest Alabama are underlain by Tertiary-age clay, marl, soft limestone, or chalk of the Vicksburg and Jackson Groups.

Climate

The average annual precipitation in this area is 53 to 61 inches (1,345 to 1,550 millimeters). The maximum precipitation occurs early in winter, in spring, and in midsummer. The lowest rainfall occurs in autumn. The rainfall typically occurs during high-intensity, convective thunderstorms in summer, but some heavy rains occur during tropical storms in winter. The average annual temperature is 60 to 65 degrees F (16 to 18 degrees C), decreasing from south to north. The freeze-free period averages 250 days and ranges from 230 to 275 days, increasing in length to the south.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 7.3%; ground water, 9.3%
Livestock—surface water, 2.2%; ground water, 9.3%
Irrigation—surface water, 1.8%; ground water, 7.3%
Other—surface water, 61.9%; ground water, 0.9%

The total withdrawals average 55 million gallons per day (208 million liters per day). About 27 percent is from ground water sources, and 73 percent is from surface water sources. Precipitation and perennial streams are important sources of water. Ponds provide water for livestock and are used locally for recreation. A few large reservoirs are available for recreation and other uses. The surface water in the area is suitable for all uses. Most of it is used for cooling thermoelectric power plants.

Moderately deep and deep wells are the principal sources of ground water for both domestic and municipal uses in this area. In Alabama, good-quality ground water is obtained primarily from Tertiary and Cretaceous sand aquifers. The southern part of the area in Alabama also has access to the Floridan and Citronelle aquifers. The ground water in Alabama generally is hard but is low in total dissolved solids. Most of the part of this area in Mississippi has no significant aquifers. The Cockfield silty clay and sand aquifer underlies parts of the isolated portion of this area in southern Mississippi. The water from this aquifer is soft and generally has less than 400 parts per million (milligrams per liter) total dissolved solids. It generally exceeds the color standard for drinking water, which is 15 units. The color has no known effects on health.

Soils

The dominant soil orders in this MLRA are Inceptisols and Vertisols. The soils in the area dominantly have a thermic soil temperature regime, a udic or aquic soil moisture regime, and smectitic or carbonatic mineralogy. They are shallow to very deep, generally well drained to somewhat poorly drained, and loamy or clayey. Epiaquepts (Leeper and Urbo series), Epiaquerts (Sucarnoochee and Houlka series), and Hapludolls (Catalpa series) formed in clayey alluvium on flood plains. Eutrudepts formed in loamy alluvium on flood plains (Marietta series) and in clayey sediments and residuum on uplands (Sumter series). Dystruderts (Oktibbeha, Hannon, Watsonia, and Vaiden series), Hapluderts (Brooksville, Okolona, and Houston series), and Paleudalfs (Kipling and Searcy series) formed in clayey sediments on uplands. Udorthents (Demopolis series) formed in residuum on ridges and hills.

Biological Resources

This area supports both deciduous hardwoods and conifers. Red oak, white oak, sweetgum, blackgum, loblolly pine, and shortleaf pine are the dominant overstory species. Forests of mixed oaks and loblolly pine are dominant on acid soils. Mixed hardwood forests dominate flood plains, and forests of eastern redcedar and sugarberry dominate alkaline hills and side slopes. Eastern redcedar, dogwood, and osage orange are the major midstory species. Japanese honeysuckle, greenbrier, little bluestem, native lespedezas, plumegrass, low panicums, sedges, and rushes are the dominant understory species.

Some of the major wildlife species in this area are white-tailed deer, cottontail, squirrel, turkey, bobwhite quail, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 16%
Grassland—private, 29%
Forest—private, 45%; Federal, 3%
Urban development—private, 4%
Water—private, 2%
Other—private, 1%

Most areas have been disturbed, and only small remnants of the former prairie vegetation remain. The major crop on the cropland in the area is soybeans, but corn, small grains, and cotton also are grown. Pastures are used mainly for beef production, but in some areas dairying is an important industry. About three-fourths of the forestland in the area is privately owned, and about one-fourth is owned by industry. The production of pond-raised catfish is important in west Alabama. Some areas are used for urban development.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Water erosion and the infestation of Johnsongrass are major management concerns in cultivated areas. Conservation practices on cropland generally include systems of crop residue management, cover crops, crop rotations, water disposal, pest management, and nutrient management. The most important conservation practice on pasture is prescribed grazing. Pastures commonly are overseeded with small grains and/or legumes to supplement forage production during winter. Haying also helps to provide supplemental feed during the long winters. Critically eroding areas and areas where animals congregate should be monitored and treated. ■

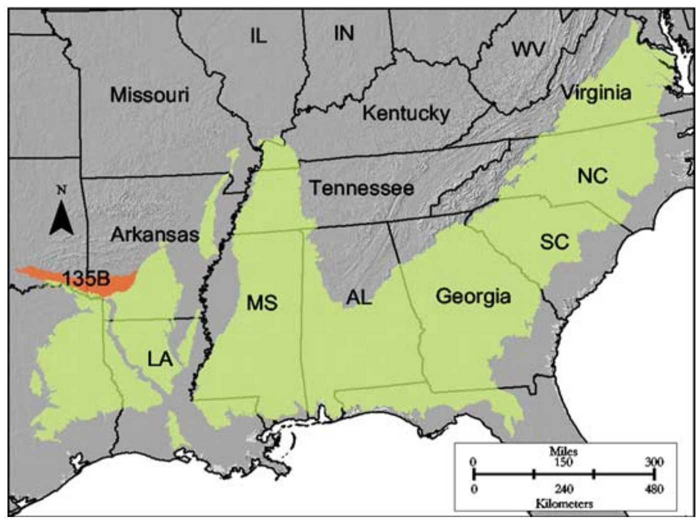

Figure 135B-1: Location of MLRA 135B in Land Resource Region P.

135B—Cretaceous Western Coastal Plain

This area (shown in fig. 135B-1) is in Arkansas (56 percent) and Oklahoma (44 percent). It makes up about 3,970 square miles (10,290 square kilometers). The towns of Ashdown, De Queen, Nashville, Murfreesboro, and Arkadelphia, Arkansas, and Broken Bow, Durant, Caddo, Hugo, and Idabel, Oklahoma, are in the area. U.S. Highway 71 bisects the area from north to south, and Interstate 30 crosses the eastern half of the area, in Arkansas. Crater of Diamonds State Park is in the part of this area in Arkansas, and the Ouachita National Forest is in the part in Oklahoma.

Physiography

This MLRA is in the West Gulf Coastal Plain Section of the Coastal Plain Province of the Atlantic Plain. It consists of nearly level to moderately sloping uplands and level and nearly level, low terraces and flood plains. Valley floors, side slopes, and ridgetops are underlain by clay, marl, and chalk. These parent materials are highly erodible, and gullies have cut this area. Elevation generally ranges from 80 to 350 feet (25 to 105 meters), but it is less than 80 feet (25 meters) on some of the more prominent valley floors and is more than 360 feet (110 meters) on a few ridgetops. Local relief is mainly a few meters.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Red-Sulphur (1114), 75 percent, and Lower Red-Ouachita (0804), 25 percent. The Little River flows from the western part of this MLRA, in Oklahoma, into Millwood Lake, in Arkansas. Also, the Cossatot and Saline Rivers flow into Millwood Lake from the northern part of the area in Arkansas.

Geology

Cretaceous marine sediments underlie almost all of this area. Geologic members of the Lower Cretaceous include a basal member of gravel and conglomerate rocks. Other formations are dominantly limestone that is crystalline and contains many fossils. Gypsum is mined commercially from the limestone in parts of the MLRA. Members of the Upper Cretaceous consist of clay marls, thin limestones, sandy marls, and some fine grained sands. Other formations consist of chalk and marly chalk, which are hard and contain many fossils.

Climate

The average annual precipitation in this area is 41 to 55 inches (1,040 to 1,400 millimeters). Most of the rainfall occurs as frontal storms in spring and early summer. Some high-intensity, convective thunderstorms occur in summer. The average seasonal snowfall is 5 inches (12 centimeters). The average annual temperature is 61 to 64 degrees F (16 to 18 degrees C). The freeze-free period averages about 250 days and ranges from 235 to 265 days, increasing in length to the south.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 11.6%; ground water, 6.6%
Livestock—surface water, 1.9%; ground water, 2.4%
Irrigation—surface water, 0.0%; ground water, 1.2%
Other—surface water, 70.3%; ground water, 6.1%

The total withdrawals average 82 million gallons per day (310 million liters per day). About 16 percent is from ground water sources, and 84 percent is from surface water sources. Precipitation and perennial streams are important sources of water in this area. Ponds provide water for livestock and locally are used for recreation. A few large reservoirs are available for recreation and other uses. The dominant uses of the surface water are for industry and for cooling thermoelectric power plants, but some communities use the water for public supply. Most of the surface water is of good quality and is suitable for most uses with some treatment. High concentrations of suspended sediments, agricultural chemicals, and municipal and oil and gas production wastewater discharges contribute to some local water-quality problems.

The principal sources of ground water in this area are bedrock aquifers, including the Antlers aquifer in Oklahoma and the Nacatoch aquifer in Arkansas. The Antlers aquifer is the northern end of the carbonate and clastic rock aquifer in Texas, which is called the Trinity Group. The ground water in this area is used primarily for public supply. Most rural landowners also rely on the bedrock aquifers for domestic water. The median level of total dissolved solids is close to 500 parts per million (milligrams per liter) in the Nacatoch aquifer and 619 parts per million (milligrams per liter) in the Antlers aquifer. The ground water is soft to hard in Arkansas and very hard in Oklahoma. The iron content may require treatment in some areas in Arkansas. About 30 percent of the samples from the Antlers aquifer exceeded the 10 parts per million (milligrams per liter) national standard for nitrate in drinking water.

Soils

The dominant soil orders in this MLRA are Inceptisols and Alfisols. Entisols and Vertisols are of lesser extent. The soils in the area dominantly have a thermic soil temperature regime, an ustic soil moisture regime, and smectitic or mixed mineralogy. They generally are moderately deep or deep over soft limestone or chalk and typically shrink, swell, and crack. Nearly level to strongly sloping, well drained Eutrudepts (Sumter series) and moderately well drained to poorly drained Hapludalfs (Oktibbeha and Vaiden series) are on wide ridgetops and narrow side slopes. Shallow Udorthents (Demopolis series) locally are of small extent. Moderately well drained to poorly drained, nearly level to gently sloping Epiaquepts (Leeper series), Epiaquerts (Terouge series), and Hapluderts (Trinity series) are on bottom land and in low areas on uplands. The outer perimeter of the area is intermittently ringed with moderately well drained to somewhat poorly drained Paleudalfs (Boswell and Susquehanna series) and moderately well drained and well drained, shallow to very deep Hapludults (Sacul, Tiak, and Saffell series).

Biological Resources

This area dominantly supports deciduous hardwoods. A few areas are suitable for pine. Red oak, white oak, sweetgum, and blackgum are the dominant overstory species. Eastern redcedar, dogwood, and osage orange are the major midstory species. Japanese honeysuckle, greenbrier, little bluestem, native lespedezas, plumegrass, low panicums, sedges, and rushes are the dominant understory species.

Some of the major wildlife species in this area include white-tailed deer, coyote, armadillo, bobcat, beaver, raccoon, skunk, mink, cottontail, turkey, and mourning dove. The species of fish in the area include channel catfish, flathead catfish, white bass, largemouth black bass, and bluegill.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 5%
Grassland—private, 25%
Forest—private, 54%; Federal, 9%
Urban development—private, 3%
Water—private, 3%
Other—private, 1%

Nearly all of this area is privately owned land consisting of farm woodlots and pasture. The poultry business has grown into a major industry in the area. Most of the cropland in the area is on the less sloping soils. Small grains and hay are the major crops. Orchards, vineyards, vegetable crops, and watermelons are important locally. Pastures on the bottom land along small streams and throughout cleared parts of the uplands support a mixture of cultivated and native grasses and legumes.

The major resource concerns are excessive nutrients and organic material in surface water; forest and pasture productivity, health, and vigor; inadequate water sources for domestic animals; and structure failures of dams caused by a high content of smectitic clay in the soils. The structure failures result in the formation of ponds and small lakes. Conservation practices on cropland generally include proper management of the application of chicken litter and riparian forest buffers. Conservation practices on pasture generally include proper management of the application of chicken litter, prescribed grazing, ponds, pipelines, development of springs, and riparian forest buffers. Conservation practices on forestland generally include forest stand improvement and riparian forest buffers. The riparian forest buffers on cropland, pasture, and forestland help to preserve water quality. ■

136—Southern Piedmont

This area (shown in fig. 136-1) is in North Carolina (29 percent), Georgia (27 percent), Virginia (21 percent), South Carolina (16 percent), and Alabama (7 percent). It makes up about 64,395 square miles (166,865 square kilometers). It includes the cities of Auburn, Alabama; Atlanta, Georgia; Greenville, South Carolina; Charlotte, Raleigh, and Winston-Salem, North Carolina; and Richmond and Arlington, Virginia. Interstate 85 runs from Auburn, Alabama, to Greensboro, North Carolina, in this MLRA. Other interstate highways in this area are, from south to north, Interstates 75, 20, 26, 40, 64, 66, and 95. The MLRA includes the Talladega National Forest and Horseshoe Bend National Military Park in Alabama; Kennesaw Mountain National Battlefield Park, the Oconee National Forest, and parts of the Chattahoochee National Forest in Georgia; King's Mountain National Military Park, Cowpens National Battlefield, and Sumter National Forest in South Carolina; parts of the Pisgah and Uwharrie National Forests and Guilford C.H. National Military Park in North Carolina; Appomattox Courthouse National Historic Park, Fort Pickett, Fredericksburg, and Spotsylvania National Military Park, and Quantico Marine Corps Combat Development Command in Virginia; and Thomas Jefferson's home in Monticello, Virginia. The farm of Hugh Hammond Bennett, the "father of soil conservation," is in this MLRA. Bennett designed many of the early conservation practices to address the severe erosion that historically occurred in this area. A number of State forests and State parks are throughout the area.

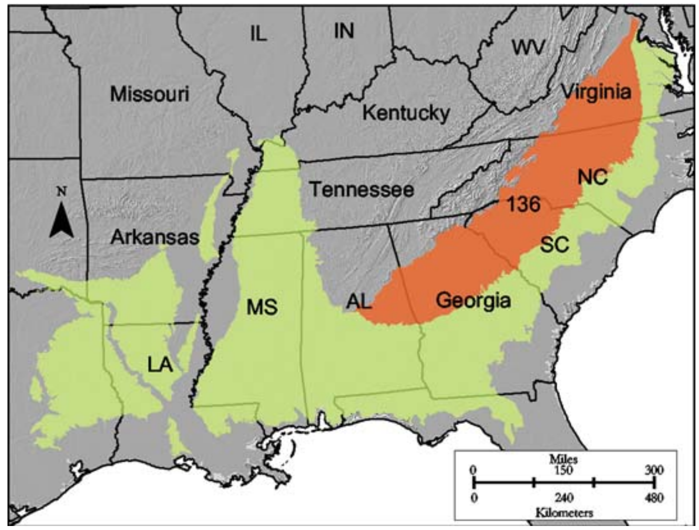

Figure 136-1: Location of MLRA 136 in Land Resource Region P.

Physiography

Almost all of this area is in the Piedmont Upland Section of the Piedmont Province of the Appalachian Highlands. A very small part of the MLRA, in central North Carolina, is in the Atlantic Plain Division. A very small part in the Roanoke, Virginia, area is on the eastern edge of the Blue Ridge Province of the Appalachian Highlands. This MLRA is a rolling to hilly upland with a well defined drainage pattern. Streams have dissected the original plateau, leaving narrow to fairly broad upland ridgetops and short slopes adjacent to the major streams. The valley floors are generally narrow and make up about 10 percent or less of the land area. The associated stream terraces are minor. Elevation ranges from 330 to 1,310 feet (100 to 400 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Edisto-Santee (0305), 18 percent; Chowan-Roanoke (0301), 14 percent; Apalachicola (0313), 10 percent; Pee Dee (0304), 10 percent; Ogeechee-Savannah (0306), 10 percent; Alabama (0315), 9 percent; Altamaha-St. Marys (0307), 9 percent; Lower Chesapeake (0208), 9 percent; Neuse-Pamlico (0302), 5 percent; Cape Fear (0303), 5 percent; and Potomac (0207), 1 percent. Some of the major rivers in this MLRA are, from north to south, the Roanoke, Cape Fear, Savannah, Altamaha, Chattahoochee, and Alabama Rivers. These rivers typically form within the Piedmont Province and flow east and south across the Coastal Plain Province and empty into the Atlantic Ocean or Gulf of Mexico. Reaches of the Rappahannock, Rivanna, and Roanoke (Staunton) Rivers have been designated National Wild and Scenic Rivers in Virginia.

Geology

Precambrian and Paleozoic metamorphic and igneous rocks underlie almost all of this MLRA. The dominant metamorphic rock types include biotite gneiss, schist, slate, quartzite, phyllite, and amphibolite. The dominant igneous rock types are granite and metamorphosed granite. Some gabbro and other mafic igneous rocks also occur, and diabase dikes are not uncommon. The Carolina Slate terrane occurs just east of an imaginary centerline in this MLRA. It consists of metamorphic rocks with some metavolcanics and metasediments. Scattered graben basins, which are bounded by faults where the ground between the faults has dropped down, occur from South Carolina to south of Charlottesville and Richmond, Virginia. These basins have Triassic and Jurassic siltstone, shale, sandstone, and mudstone. River valleys have recent alluvium and few terraces.

Climate

The average annual precipitation is 37 to 45 inches (940 to 1,145 millimeters) at the northern end of this area, is 45 to 60 inches (1,145 to 1,525 millimeters) at the southern end, and is as much as 75 inches (1,905 millimeters) in a small, high-elevation area in northeastern Georgia. The precipitation generally is evenly distributed throughout the year. It is lowest in autumn. Most of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. Significant moisture also comes from the movement of warm and cold fronts across the MLRA from November to April. High amounts of rain can occur during hurricanes at the same time of the year. Snowfall typically is light. The average annual temperature is 53 to 64 degrees F (12 to 18 degrees C). The freeze-free period averages 230 days and ranges from 185 to 275 days. Both the mean annual temperature and length of the freeze-free period increase from north to south and with decreasing elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 11.1%; ground water, 1.1%
Livestock—surface water, 0.7%; ground water, 0.2%
Irrigation—surface water, 0.5%; ground water, 0.1%
Other—surface water, 83.9%; ground water, 2.5%

The total withdrawals average 12,720 million gallons per day (48,145 million liters per day). This MLRA ranks third among all of the MLRAs in total amount of water used. About 4 percent is from ground water sources, and 96 percent is from surface water sources. Precipitation, perennial streams, rivers, and lakes provide an abundance of good-quality, soft surface water throughout this MLRA. Small farm ponds are important sources of water for livestock. Industry and thermoelectric power plants use most of the surface water in this area. Toxins, nutrients, and sediment are the primary contaminants in the water. Fecal coliform contamination from point and nonpoint sources is a problem in South Carolina.

Ground water supplies are relatively small, but shallow and deep wells in the crystalline bedrock aquifer are the principal sources of water for domestic use in the area. The water is drawn from joints, fractures, and bedding planes in the crystalline rocks. It generally is soft, but it can be hard or very hard, depending on the type of rock from which the well is drawing its water. High concentrations of manganese and iron can be a problem in some wells. Naturally high levels of radiation in the ground water in this MLRA can cause radon gas problems in basements.

Soils

The dominant soil orders in this MLRA are Ultisols, Inceptisols, and Alfisols. The soils in the area dominantly have a thermic soil temperature regime, a udic soil moisture regime, and kaolinitic or mixed mineralogy. They are shallow to very deep, generally well drained, and loamy or clayey. Hapludalfs (Enon and Wilkes series), Hapludults (Badin, Nason, and Tatum series), and Kanhapludults (Appling, Cecil, Georgeville, Herndon, Madison, Pacolet, and Wedowee series) formed in residuum on hills and ridges. Dystrudepts (Chewacla series) formed in alluvium on flood plains. Udults in the Rhodic subgroup (Davidson, Hiwassee, and Lloyd series) formed in old alluvium on stream terraces or in residuum derived from mafic rocks.

Biological Resources

The uplands in this area generally support a mixture of hardwoods and pine. Loblolly pine, slash pine, white oak, red oak, gum, yellow-poplar, and sycamore are the principal species. Pine is dominant on eroded sites. Hardwoods or mixed stands of pine and hardwoods are on slightly eroded soils and the flood plains along streams. The understory includes dogwood, honeysuckle, pinehill bluestem, and briars.

Some of the major wildlife species in this area are white-tailed deer, cottontail, squirrel, bobwhite quail, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 9%
Grassland—private, 11%
Forest—private, 58%; Federal, 2%
Urban development—private, 15%
Water—private, 3%
Other—private, 2%

Most of this area is in small farms, but a sizable acreage is controlled by forest products companies. Although most of the land was once cultivated, much has reverted to mixed stands of pine and hardwoods. Most of the open areas are used as pasture, but some crops, such as soybeans, corn, cotton, and wheat and other small grains, are grown in these areas. Tobacco is grown to a lesser extent. Dairy cattle and poultry are important locally. Rural land adjacent to the major cities is being converted to residential development and associated urban development. This land use conversion is occurring rapidly in the corridor called the Piedmont Crescent, which extends from Atlanta, Georgia, to Raleigh, North Carolina.

The major soil resource concerns are water erosion and the increasing conversion of prime farmland and farmland of statewide importance to urban uses. Conservation practices on cropland generally include conservation tillage, crop residue management, field borders, vegetative wind barriers, and nutrient and pest management. ■

137—Carolina and Georgia Sand Hills

This area (shown in fig. 137-1) is in South Carolina (44 percent), Georgia (34 percent), North Carolina (21 percent), and Alabama (1 percent). It makes up about 8,665 square miles (22,450 square kilometers). It includes the towns of Sanford, Pinehurst, and Fort Bragg, North Carolina; Columbia and Aiken, South Carolina; Augusta and Columbus, Georgia; and Phenix City, Alabama. Interstates 185, 75, 20, 26, and 77 cross this area. Interstate 26 transects a major portion of the area from east of Columbia, South Carolina, to west of Augusta, Georgia. Forts Benning, Gordon, Jackson, and Bragg are in this MLRA. The southeastern edge of the Uwharrie National Forest and the Department of Energy's nuclear materials production plant, Savannah River Site, are in this area. The Ocmulgee National Monument, just south of Macon, Georgia, is in the MLRA.

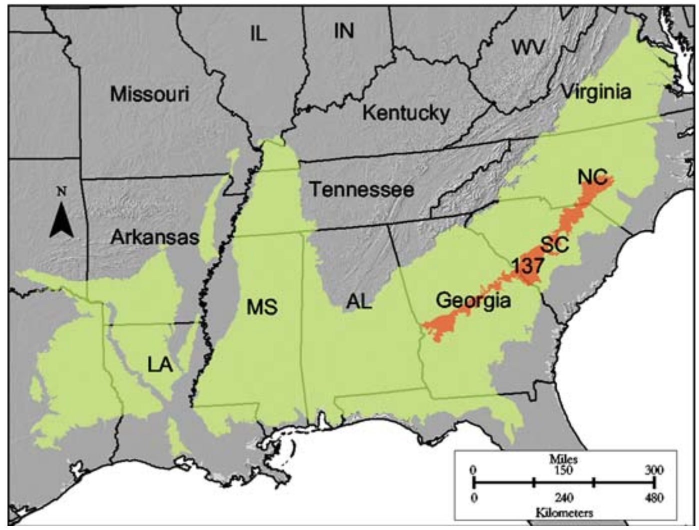

Figure 137-1: Location of MLRA 137 in Land Resource Region P.

Physiography

This area is in a transitional zone between the true Piedmont and the Coastal Plain. Most of the area is in the Sea Island Section of the Coastal Plain Province of the Atlantic Plain. Part of the area in Alabama and the western half of the area in Georgia are in the East Gulf Coastal Plain Section of the same province and division. Parts of the inland edge and half of the northern end of the area are in the Piedmont Upland Section of the Piedmont Province of the Appalachian Highlands. This MLRA is a dissected, rolling to hilly upland. Many of the more dissected areas have stabilized dunes, resulting in very irregular slopes. Elevation ranges from 165 to 660 feet (50 to 200 meters), increasing gradually from south to north. Local relief is mainly 10 to 20 feet (3 to 6 meters), but a few hills are 80 to 165 feet (25 to 50 meters) above the adjacent areas.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Edisto-Santee (0305), 24 percent; Pee Dee (0304), 23 percent; Apalachicola (0313), 16 percent; Ogeechee-Savannah (0306), 15 percent; Altamaha-St. Marys (0307), 11 percent; and Cape Fear (0303), 11 percent. From North Carolina to Alabama, the major rivers crossing this area are the Lumber, Pee Dee, Little Lynches, Wateree, Congaree, North and South Forks of the Edisto, Savannah, Brier, Ogeechee, Oconee, Ocmulgee, Flint, and Chattahoochee Rivers.

Geology

The Sand Hills area is just below the “fall line,” which marks the boundary between the older crystalline rocks in the Piedmont and the younger, unconsolidated sediments of the Coastal Plain. Deep Cretaceous sands deposited in this ancient shoreline area were reworked during periods of submergence of the Coastal Plain in Pleistocene time. Several areas have deposits of kaolin and high-silica sands that are mined. Stabilized sand dunes are common in the area. Deposits of siltstone, shale, and marl generally lie beneath the coastal plain side of this area, and the crystalline rocks of the Piedmont lie beneath the sands on the inland side.

Climate

The average annual precipitation in this area is 41 to 53 inches (1,040 to 1,345 millimeters). The maximum precipitation occurs in midsummer, and the minimum occurs in autumn. Rainfall occurs during high-intensity, convective thunderstorms in summer. Snowfall is light if it occurs at all. The average annual temperature is 59 to 65 degrees F (15 to 18 degrees C). The freeze-free period averages 250 days and ranges from 220 to 280 days, increasing in length to the south.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 5.7%; ground water, 6.5%
Livestock—surface water, 0.4%; ground water, 0.3%
Irrigation—surface water, 0.3%; ground water, 0.5%
Other—surface water, 78.2%; ground water, 8.1%

The total withdrawals average 2,070 million gallons per day (7,835 million liters per day). About 15 percent is from ground water sources, and 85 percent is from surface water sources. Precipitation, perennial streams, and aquifers provide an abundance of water. The kind and amount of plant growth are severely limited by low moisture in the rapidly permeable, sandy soils that are dominant in this area. The surface water in the area is suitable for all uses. Most of it is used for industry and for cooling thermoelectric power plants.

Ground water is available in both the crystalline igneous and metamorphic rocks aquifer and the Cretaceous sediments aquifer in this area. Both of these aquifers have soft water that is very low in total dissolved solids, having median concentrations of less than 100 parts per million (milligrams per liter). Water in the Cretaceous aquifer is a sodium bicarbonate type and is typically used for industry and public supply. It also is used for irrigating the many golf courses in this area. In North Carolina, the Cretaceous aquifer is actually called the surficial aquifer. Water from this aquifer in North Carolina has low pH, so it can be corrosive. The Middendorf sands are the primary sources of ground water in the part of this area in Georgia. The water in these sands is similar in quality to the water in the surficial aquifer in North Carolina. The crystalline rocks aquifer has a calcium bicarbonate type of water and supplies mostly domestic water in the area. The water in some wells in the crystalline rocks exceeds the secondary drinking water standard for iron.

Soils

The dominant soil orders in this MLRA are Ultisols and Entisols. The soils dominantly have a thermic soil temperature regime, a udic soil moisture regime, and kaolinitic or siliceous mineralogy. They generally are very deep, well drained to excessively drained, and loamy or sandy. Hapludults (Blaney series) and Kanhapludults (Ailey, Pelion, and Vaucluse series) formed in marine sediments on flats, hills, and ridges. Kandiudults formed in marine sediments (Fuquay series) and mixed marine and alluvial sediments (Troup series) on uplands. Paleudults formed in marine sediments (Candor series) and mixed marine and eolian deposits (Blanton series) on uplands and stream terraces. Quartzipsamments (Lakeland series) formed in mixed marine and eolian deposits on uplands.

Biological Resources

This area supports pine-oak vegetation. Longleaf pine is the dominant species. Turkey oak, blackjack oak, bluejack oak, and sand live oak also occur. Little bluestem, panicums, pineland threeawn, and associated grasses and forbs make up the ground cover.

Some of the major wildlife species in this area are white-tailed deer, red fox, gray fox, beaver, raccoon, opossum, cottontail, gray squirrel, turkey vulture, black vulture, crow, screech owl, barred owl, mallard, wood duck, bobwhite quail, Carolina wren, and mourning dove. The large stands of longleaf pine provide critical nesting areas for the red-cockaded woodpecker, an endangered species.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 12%
Grassland—private, 4%
Forest—private, 58%; Federal, 10%
Urban development—private, 13%
Water—private, 1%
Other—private, 2%

Most of this area is in farms, most of which are part-time or subsistence farms. About one-tenth of the area is federally owned and used for military posts and training areas. The forested areas support pine and scrub oaks. Pulpwood and some lumber are the principal forest products. The cropland in the area is used mainly for corn or cotton. A substantial acreage in the area is used for urban development.

The major resource concerns are controlling water erosion and enhancing the available water capacity of the soils. Conservation practices on cropland generally include systems of crop residue management, diversions, and grassed waterways. Field borders provide cover for bobwhite quail and cottontail. Conversion to a permanent cover of vegetation has been a continuing recommendation for the soils that are low in natural productivity. ■

138—North-Central Florida Ridge

This area is entirely in Florida (fig. 138-1). It makes up about 2,240 square miles (5,810 square kilometers). Lake City and Live Oak are the only towns of significant size in the area. Interstate 75 crosses the entire length of this area, and it intersects with Interstate 10 at the northern end of the area. The southwest corner of the Osceola National Forest is in this area. A number of State parks are throughout the area. The Stephen Foster State Folk Culture Center is in the area.

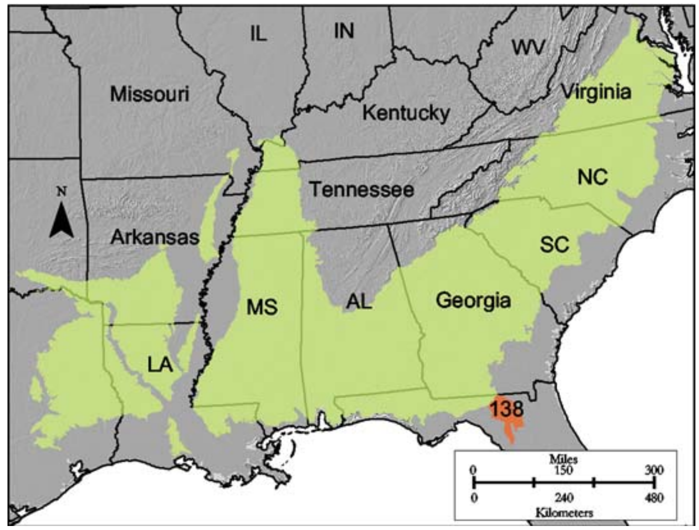

Figure 138-1: Location of MLRA 138 in Land Resource Region P.

Physiography

Most of this area is in the East Gulf Coastal Plain Section of the Coastal Plain Province of the Atlantic Plain. The southern one-quarter is in the Floridian Section of the same province and division. This MLRA is on a sand-mantled limestone upland that has an irregular, gently rolling topography. Many limestone sinkholes, some filled with water, dot the area. Only a few streams are in the area. Elevation ranges from 80 to 165 feet (25 to 50 meters). Local relief is generally 10 to 20 feet (3 to 6 meters) but can be as much as 35 feet (10 meters).

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is Suwannee (0311). The Suwannee River originates in the Okefenokee Swamp northeast of this area. It is spring-fed and flows through this MLRA. The Alapaha and Withlacoochee Rivers join the Suwannee River in the MLRA. Another Suwannee River tributary, the Santa Fe River, crosses the southern part of the area.

Geology

This area is a young marine plain underlain by Tertiary-age rocks that are primarily carbonates. Some of the oldest rocks in Florida, from the Eocene age, are at the surface at the southern end of this area. The rocks are progressively younger to the north. They include very fine grained shale, mudstone, limestone, and dolomite beds. A sandy marine deposit of Pleistocene age occurs at the surface, overlying limestone in most of the area.

Climate

The average annual precipitation in this area is 53 to 60 inches (1,345 to 1,525 millimeters). The maximum precipitation occurs in summer, and the minimum occurs in winter and late in autumn. Rainfall occurs during high-intensity, convective thunderstorms in summer. The average annual temperature is 67 to 69 degrees F (19 to 21 degrees C). The freeze-free period averages 295 days and ranges from 280 to 305 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.5%; ground water, 17.9%
Livestock—surface water, 0.1%; ground water, 1.2%
Irrigation—surface water, 15.8%; ground water, 52.5%
Other—surface water, 2.1%; ground water, 10.0%

The total withdrawals average 95 million gallons per day (360 million liters per day). About 82 percent is from ground water sources, and 18 percent is from surface water sources. The abundant rainfall and the Floridan aquifer are the principal sources of water in the area. The many lakes and ponds are used for recreation. The Suwannee River has been designated as an "Outstanding Florida Water" by the State. One thermoelectric power plant uses river water for cooling. With the exception of one tributary below an active phosphate mine, the river water is suitable for almost all uses.

Shallow and deep wells in the Floridan aquifer provide water for public supply, domestic use, industry, mining, livestock, and irrigation in this MLRA. This aquifer is one of the most productive sources of ground water in the U.S. Its water is hard but of good quality. Wells yield large quantities of calcium bicarbonate type of water. The Floridan aquifer is a thick sequence of Tertiary limestone and dolomite. The Eocene Avon Park Formation and Ocala Limestone are the thickest and most productive units in the aquifer system.

Soils

The dominant soil orders in this MLRA are Ultisols, Entisols, and Alfisols. The soils dominantly have a thermic soil temperature regime, a udic soil moisture regime, and siliceous mineralogy. Well drained and somewhat poorly drained Paleudults (Blanton and Albany series) have thick sandy layers over a loamy subsoil. Excessively drained and moderately well drained Quartzipsamments (Alpin and Chipley series) are sandy throughout. Well drained, sandy Hapludalfs (Archer series), which have a clayey subsoil, and poorly drained, sandy Alaquods (Mascotte and Leon series), which have a weakly cemented layer, are less extensive in the area.

Biological Resources

This area supports open pine and oak vegetation. Longleaf pine and turkey oak are the dominant trees. Several bluestem species, Indiangrass, and several threeawn species dominate the ground cover. Hairy panicum and many sedges are in scattered areas. The MLRA also supports legumes and many annual forbs.

Some of the major wildlife species in this area are white-tailed deer, raccoon, skunk, opossum, rabbit, gray squirrel, fox squirrel, turkey, bobwhite quail, and mourning dove.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 9%
Grassland—private, 21%
Forest—private, 58%; Federal, 1%
Urban development—private, 8%
Water—private, 1%
Other—private, 2%

Most of this area is in wooded farms, and some large holdings are used exclusively for forestry. Pulpwood and lumber are the principal forest products. The cropland in the area is used mainly for corn, peanuts, tobacco, soybeans, vegetables, and melons. Some hay and feed grains are grown for livestock.

The major resource concerns are maintenance of the content of organic matter and productivity of the soils, management of soil moisture, and management of animal waste. Conservation practices on cropland generally include crop rotations, cover crops, nutrient management, pest management, and irrigation water management. ■

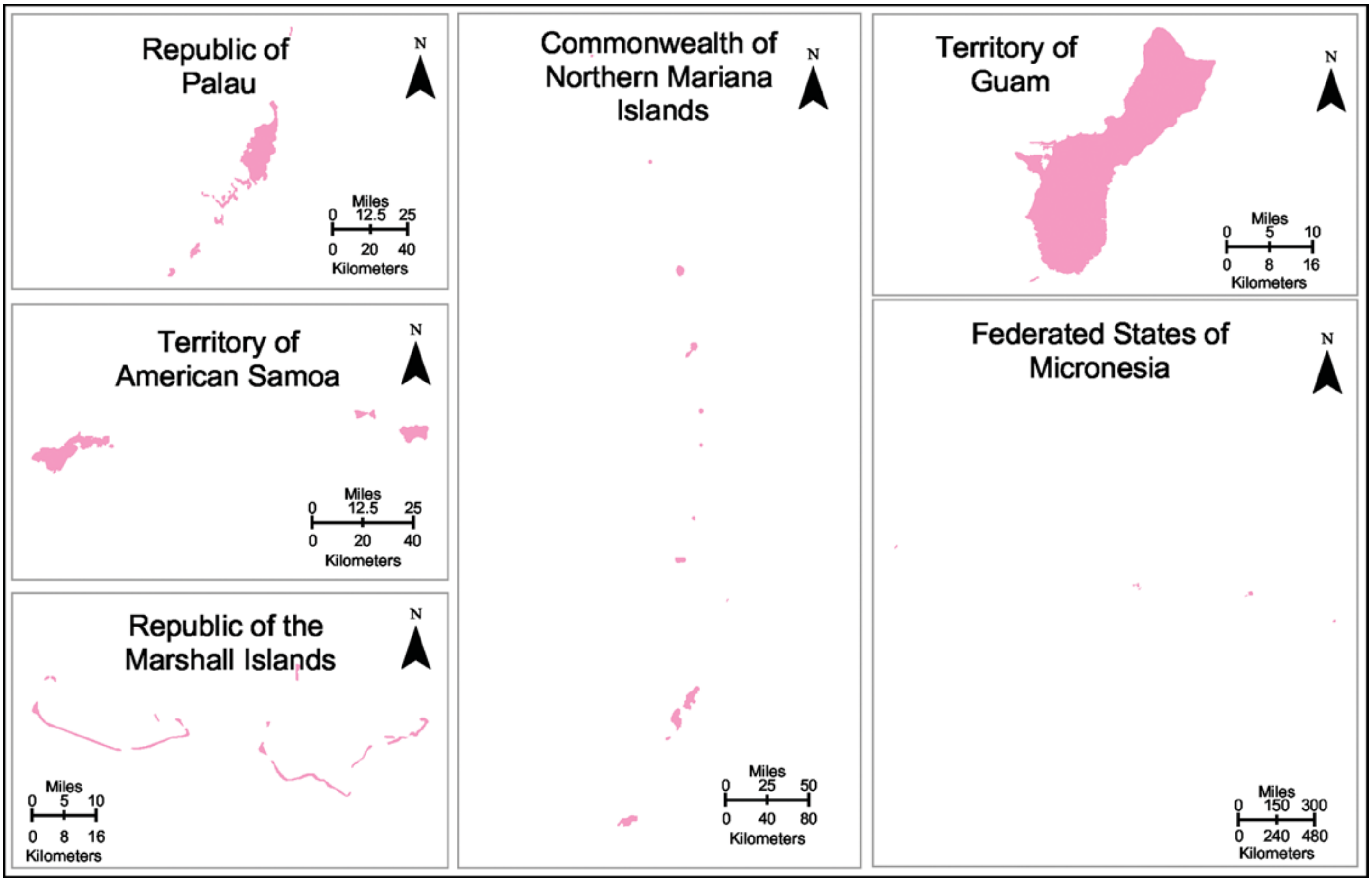

Figure Q-1: Location of Land Resource Region Q.

Q—Pacific Basin Region

This region is made up of parts of four island groups in the Pacific Ocean (fig. Q-1). The island groups include the Caroline Islands (45 percent), Mariana Islands (41 percent), and Marshall Islands (7 percent) in the North Pacific Ocean and American Samoa (7 percent) in the South Pacific Ocean. This region makes up 999 square miles (2,585 square kilometers).

The islands in this region (fig. Q-2) are typically high volcanic islands (such as Pohnpei, Chuuk, Kosrae, and Palau), coralline limestone islands (Tinian), or atolls (the Marshall Islands and Ulithi Atoll). Many of the volcanic areas are steep, some of them having slopes of more than 100 percent. Gently rolling terrain with steep escarpments is common on the coralline limestone islands. Some of the atoll islands have a high elevation of only 6 feet (2 meters) above mean high tide, in contrast to Pohnpei, where volcanic peaks reach an elevation of more than 3,050 feet (930 meters), and Guam, which has coralline limestone plateaus as high as 570 feet (175 meters).

The climate in this region is generally wet, hot, and humid. The annual precipitation is 80 to 145 inches (2,030 to 3,685 millimeters) in most of the region. It decreases to the north, away from the Equator, and is more than 200 inches (5,080 millimeters) in high-elevation areas. The wettest part of the year is from December to March in American Samoa and from July to November in the rest of the region. The driest part of the year is from June to September in American Samoa and from January or February to April or May in the rest of the region. The average annual temperature is about 81 degrees F (27 degrees C), and all of this region is freeze-free. Daily fluctuations in air temperature are typically wider than the annual variability.

The total withdrawals of freshwater in this region are not known. Based on area served, about 26 percent is from ground water sources and 74 percent is from surface water sources. Much of the surface water used in the region is from rainwater catchments. Most of the water is used for domestic and public drinking water supply.

The soils in this region are dominantly Mollisols, but Entisols, Inceptisols, and Oxisols also are common. Andisols, Alfisols, and Histosols are of more limited extent. The soils on the Mariana Islands have an ustic soil moisture regime. Those on the other islands in the region have a perudic or udic soil moisture regime. All of the soils have an isohyperthermic soil

Figure Q-2: An area of Land Resource Region Q.

temperature regime. They formed in residuum derived from weathered or hard volcanic rock, coralline sand, or weathered ash over coralline limestone.

About 90 percent of the land in this region is privately owned. Tropical forest is the climax vegetation in most of the region. The forests are used for ground water recharge, agroforestry, woodland, and wildlife habitat. Many eroded mountainous areas are in savanna because of periodic fires during short dry periods. Mangrove forests ring some of the islands protected by fringing or barrier reefs. Examples of these islands are Pohnpei, Kosrae, Chuuk, Yap, and Palau.

The coral reefs and beaches support a variety of tourism services, such as snorkeling, diving, sailing, sea kayaking, hiking, and fishing. The tourism industry is significant on some islands and has drawn many people into more concentrated urban centers, especially on Guam and Palau. Golf courses and high-rise hotels are common new additions to the landscape in the Marianas. This shift began in the 1970s and continues. The capital of the Federated States of Micronesia on the island of Pohnpei draws people from the surrounding Caroline Islands in search of economic opportunity, and the growth in population has increased pressure on the local resources.

Most of the agriculture in this region is at the subsistence level. Shifting cultivation is the norm. Many families have gardens and maintain free-ranging pigs and poultry. Steep slopes, low soil fertility, stoniness, and high acidity reduce the variety of agriculture on most soils throughout the region. High humidity and rainfall also are important management concerns. Small but profitable commercial farms in the Marianas produce cabbage, taro, sweet potatoes, cucumbers, melons, papaya, and other fruits and vegetables for local consumption. In most of the region, the population lives in the coastal areas where commercial or subsistence fishing is an important activity. ■

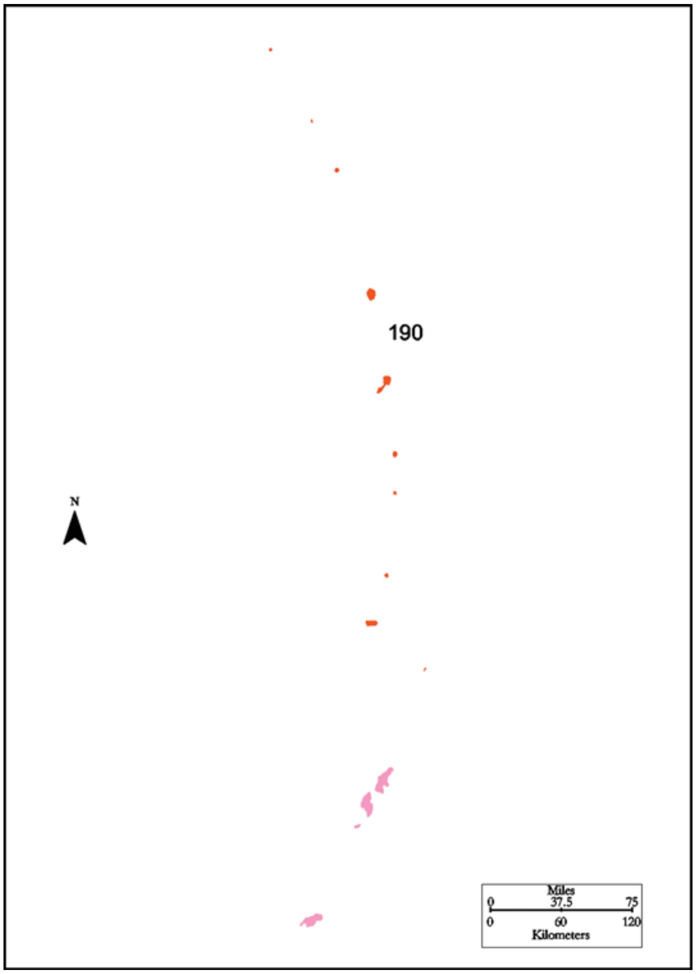

Figure 190-1: Location of MLRA 190 in Land Resource Region Q.

190—Stratovolcanoes of the Mariana Islands

This area (shown in fig. 190-1) consists of Pagan, 26 percent; Anatahan, 17 percent; Agrigan (or Agrihan), 16 percent; Alamagan, 6 percent; Sarigan (or Sariguan), 3 percent; and five smaller islands, 32 percent. It makes up about 71 square miles (183 square kilometers). The area is north of Saipan, in the western Pacific Ocean, about 1,600 miles (2,580 kilometers) east of the Philippines and 3,800 miles (6,130 kilometers) west-southwest of Hawaii. This island group is called the Northern Islands of the Commonwealth of the Northern Mariana Islands (CNMI). The islands are largely unpopulated. Pagan and Sarigan have no permanent residents. Evacuations of Pagan in 1981 and Anatahan in 2003 were completed because of volcanic activity. Civil Defense authorities have not allowed residents to resettle these volcanically active islands.

Physiography

This area is in the Pacific Islands Province of the Pacific Rim Area. The Northern Mariana Islands form the northern group of the Mariana Arc archipelago. The Northern Islands are the younger (Quaternary age) of two arcuate chains of volcanoes that make up the archipelago. They formed at the subduction zone between the Philippine and Pacific tectonic plates. The islands are cone-shaped stratovolcanoes covered with volcanic ash and cinder deposits on steep and very steep slopes. Many steep slopes have eroded into deep gulches. Cliffs, steep slopes, and boulder and cobble beaches characterize the coastlines. There are small streams but no rivers in this area. Agrigan has the highest elevation in the Mariana Arc, ranging from sea level to 3,185 feet (970 meters).

Geology

Quaternary-age basalt and andesite lavas dominate on these stratovolcanoes. Lava flows, volcanic ash, and cinder deposits are common. The volcano on northern Pagan Island is considered active, having last erupted in 1981. Anatahan Island last erupted in April 2005. The United States Geological Survey considers Maug a “volcano of concern” in this area and also notes that hot spots offshore could become volcanoes in the future.

Climate

The average annual precipitation in this area is about 80 inches (2,030 millimeters). Rainfall likely decreases northwards and slightly increases with elevation. Climate data are scarce for these remote islands. About two-thirds of the precipitation falls between July and November. The average annual temperature is about 79 degrees F (26 degrees C). The cooler dry season is between January and May. It is enhanced by persistent trade winds from the northeast and east-northeast. Typhoons frequently pass close to the Northern Mariana Islands. Typhoons are less common in the north than on Guam in the MLRA to the south, which is severely impacted by large storms about once every 8 years on average. This area is freeze-free.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 100.0%; ground water, 0.0%
Livestock—surface water, 0.0%; ground water, 0.0%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 0.0%; ground water, 0.0%

Only a few people live on these islands, and the total quantity of withdrawals is not known. All of the water used in this area is probably for domestic supply, and the local people probably rely on surface water as their primary source of drinking water. There are no perennial streams in the Northern Islands. Two saline lakes are on Pagan. Also on Pagan, ground water can be obtained from wells that reach sea level, as is likely true in all of the Northern Islands. Hot springs and seeps occur on the islands but are generally not of sufficient quality or quantity to be considered water sources. Catchment water is the best quality water on the islands, and it is used as drinking water. Rainfall is nearly double the potential evapotranspiration from July through November but only half of the potential evapotranspiration from January into May.

Soils

The young age of volcanic deposits in this area has not allowed for great differences among soils. The soils are Andisols, Inceptisols, or Entisols. The soil moisture regime is ustic in most areas but is aquic in depressions. All of the soils have an isohyperthermic soil temperature regime. Most of the soils are well drained and are on steep mountainsides or ridges. Although some soils are very shallow or moderately deep to bedrock or to cemented pyroclastic layers, most are very deep. Haplustepts (Apilam series) and Haplustands (Plasanbola series) are on ridge summits. Ustorthents (Shomushon series) and Ustivitrands (Dekairu series) are on backslopes. Endoaquepts (Benedicto series) are in broad basins in calderas, and Ustivitrands (Songsong series) formed in alluvium and mudflow deposits. Undifferentiated Entisols are on very young landscapes, such as lava flows and talus slopes. Cinder land, rock outcrops, and lava flows make up a considerable amount of the surficial materials. The extent of the different soils and miscellaneous areas has not been determined. A soil survey has been completed only on the islands of Agrigan, Alamagan, Anatahan, Pagan, and Sarigan. The total acreage of the Northern Islands covered by soil surveys is 48.8 square miles (126.4 square kilometers).

Biological Resources

Abandoned copra (coconut) plantations occur on low-elevation coastal sites. Areas above an elevation of 330 feet (100 meters) are dominated by grassland, which supports mainly swordgrass. Forest species are mixed tropical hardwoods, including ironwood, pandanus, joga, coconut, and beach hibiscus.

Large populations of feral cows, pigs, and goats are on some of the islands. The endemic fruit bat and coconut crab are locally important food sources (although the fruit bat is a federally listed endangered species). A number of skinks and geckos also are native to the Marianas. Several endemic bird species, rufous fantail, the fairy tern, and the Vanikoro swiftlet, also an endangered species, inhabit the islands. A wide range of coral, anemones, shellfish, and reef and pelagic fish species are within surrounding reef systems and open waters.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—private, 0.5%
Forest—private, 86.0%
Other—private, 13.0%: Federal, 0.5%

Ground water recharge and wildlife habitat are the main land uses in this area. Asuncion, Farallon de Pajaros (Uracas), Guguan, and Maug Islands are wildlife reserves for sea birds. There are small areas of subsistence farming and agroforestry on Agrigan, Anatahan, and Alamagan Islands. The main subsistence crops are coconut, bananas, breadfruit, mango, limes, taro, and yams. Copra plantations were once an important land use.

The major resource concerns are the threat of lava flows and ash deposition from volcanic eruptions on Pagan and Anatahan. Feral animals contribute to erosion and changes in the plant community. Multistory cropping is the main conservation practice in this area. ■

191—High Limestone Plateaus of the Mariana Islands

This area (shown in fig. 191-1) consists of the northern half of Guam (53 percent) and the islands of Saipan (18 percent), Tinian (15 percent), Rota (13 percent), and Aguijan, or Aguiguan (1 percent). This MLRA makes up about 256 square miles (663 square kilometers). These islands are in the western Pacific Ocean, roughly 1,600 miles (2,580 kilometers) east of the Philippine Islands and approximately 3,730 miles (6,015 kilometers) west-southwest of Hawaii. This area includes the Territory of Guam and the Commonwealth of the Northern Mariana Islands (CNMI). Guam is the largest island of the Mariana Islands and the economic hub of Micronesia.

Physiography

This area is in the Pacific Islands Province of the Pacific Rim Area. The islands in the area are the southernmost islands of the Mariana Arc archipelago. The topography ranges from nearly level to gently sloping limestone plateaus to steep, complex slopes in areas of volcanic bedrock. Precipitous cliffs along limestone plateaus surround most of the northern half of Guam and Saipan, as well as areas of Rota and Tinian. Cliffs, steep

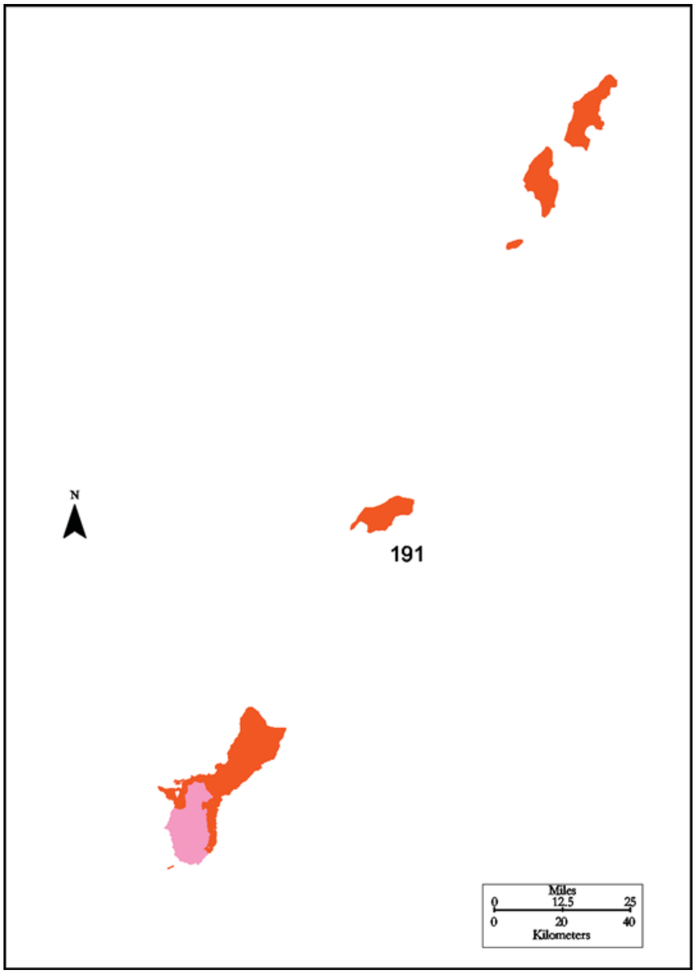

Figure 191-1: Location of MLRA 191 in Land Resource Region Q.

slopes, beaches, and reef flats characterize the coastlines. The highest elevations are 1,637 feet (499 meters) on Rota, 1,555 feet (474 meters) on Saipan, 617 feet (188 meters) on Tinian, and 828 feet (252 meters) in the northern part of Guam. There are streams and a few small rivers in this area. Barrier and fringing reefs are around the area.

Geology

The volcanic cores of these islands are the result of the Pacific tectonic plate sliding under the Philippine tectonic plate. Earthquakes are common. Reef and lagoon deposits formed around the central volcanic cores of the islands. As a result, limestone is the most extensive exposed bedrock. Most of the limestone dates to the Pliocene and Pleistocene epochs. The limestone plateaus and volcanic peaks were uplifted through tectonic activity during the Tertiary and Quaternary periods. Deeply weathered volcanic rock is exposed on ridges and slopes.

Climate

The average annual rainfall is about 100 inches (2,540 millimeters) on northern Guam and 80 inches (2,030 millimeters) on Saipan, Tinian, Aguijan, and Rota. The rainy season occurs from July through November, and the dry season occurs from December through June. The dry season is enhanced by persistent trade winds from the northeast. The average annual temperature is 79 degrees F (26 degrees C). Humidity is high throughout the year, averaging 76 percent. Typhoons frequently pass close to the islands. The chance of a typhoon severely impacting Guam is once in 8 years. The chance of one severely impacting the CNMI islands is slightly longer. Wind and rainfall are the most variable climatic factors in this area, whereas temperature and humidity remain fairly constant throughout the year. This area is freeze-free.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 45.0%; ground water, 53.9%
Livestock—surface water, 0.0%; ground water, 0.1%
Irrigation—surface water, 0.0%; ground water, 1.0%
Other—surface water, 0.0%; ground water, 0.0%

The total quantity of withdrawals is not known. About 55 percent is from ground water sources, and 45 percent is from surface water sources. Except for springs around the periphery of the shoreline and in areas of volcanic rocks, there are few areas of fresh surface water. There are generally no streams or rivers on the limestone bedrock. Some streams cut through the limestone if they originate in volcanic landscapes upslope. Two springs on Saipan and one on Rota are developed as a freshwater supply. In 1986, these two islands used about 0.4 million gallons (1.5 million liters) of surface water per day.

Almost all of the people on Saipan and about 80 percent of the population on Guam rely on ground water for domestic and public supplies. Guam used approximately 33 million gallons per day (125 million liters per day) for public supply in 1986. About 78 percent was from ground water sources, and 21 percent was from surface water sources. Crops are irrigated by the domestic water delivery system. Some farms and homes still rely on rainwater catchment systems.

The principal aquifers in this area are the Tagpochau and Mariana Limestone on Saipan and the Barrigada and Mariana Limestone in northern Guam. The ground water in these aquifers occurs as a thin lens of freshwater that floats on denser, basal saltwater. The water from all these aquifers is very hard, and its median level of total dissolved solids is about 850 and 600 parts per million (milligrams per liter), respectively, in the two aquifers on Saipan and 308 and 574 parts per million (milligrams per liter), respectively, in the two aquifers on Guam.

During the dry season on Saipan, the freshwater lens becomes overdrawn, resulting in saltwater intrusion. The two limestone aquifers on Guam have been designated as "principal source aquifers" by the Environmental Protection Agency, and Guam has established special management practices to protect the quality of the ground water. Increasing population in this MLRA is putting more pressure on the ground water resources. The increased pumping is creating more problems with saltwater intrusion, and the increased extent of impervious surfaces in urbanizing areas is decreasing the amount of freshwater recharging the aquifers.

Soils

The soils in this MLRA are Alfisols, Andisols, Entisols, Mollisols, or Oxisols. The dominant soil moisture regime is ustic, and all of the soils have an isohyperthermic soil temperature regime. The soils are very shallow to deep, moderately well drained to somewhat excessively drained, and fine textured or coarse textured and have amorphic, carbonatic, ferruginous, gibbsitic, kaolinitic, mixed, oxidic, parasesquic, or smectitic mineralogy. Almost all of the soils consist of highly weathered clays and formed in limestone residuum. In some areas volcanic ash has been added to the soils. All of the soil orders occur on nearly level or rolling limestone plateaus. Most of the soils overlying limestone are shallow. They include Ustorthents (Guam series), Argiustolls (Banaderu series), Haplustolls (Chinen series), and Haplustalfs (Pulantat series). Shallow Haplustolls (Takpochao series) and Ustorthents (Ritidian series) are on limestone escarpments and steep slopes. Shallow Haplustands (Luta series) are on limestone plateaus on Rota. The deep soils on limestone plateaus are Eutrustox (Saipan series), Acrustox (Yigo series), and Haplustepts (Dandan series). Deep alluvial soils are Endoaquepts (Inarajan series) on valley bottoms and Paleustalfs (Chacha series) on limestone plateaus. Ustipsamments (Shioya series) are on nearly level coastal strands.

Biological Resources

The native vegetation in this area consists of mixed tropical hardwoods, but the introduced tangantangan is the dominant forest species in areas underlain by limestone. Other prominent trees are gulos, Formosan koa, putting (or fishkill), and gaogao (or tiger claw).

The only mammal endemic to the Mariana Islands is the Marianas fruit bat. Other mammals, such as Sambar deer, pigs, goats, and water buffalo, have been introduced and can be seen in the wild. A number of skinks and geckos are native to the Marianas. Several endemic bird species, rufous fantail, the fairy tern, and the Vanikoro swiftlet, an endangered species, inhabit the islands. The native bird populations on Guam have been decimated through the accidental introduction of the brown tree snake. A wide range of coral, anemones, and shellfish and various reef and pelagic fish species are in the surrounding reef systems and open waters.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 4.0%
Grassland—private, 9.0%; Federal, 11.0%
Forest—private, 46.0%; Federal, 17.0%
Urban development—private, 11.0%
Other—private, 2.0%

The U.S. Department of Defense has a significant impact on these islands. A considerable amount of land has been developed for airstrips, barracks, and fortifications, especially on Guam and Tinian. Level areas are used for diverse agricultural systems ranging from traditional subsistence farming and gardening to modern commercial farming. The important commercial crops are bananas, taro, eggplant, beans, cucumbers, green peppers, tomatoes, many other vegetable and fruit crops, and ornamentals. Urban development is occurring on a significant acreage of these islands. Remote areas are used for wildlife habitat, ground water recharge, and recreation.

The major soil resource concerns are water erosion and maintenance of the productivity of the soils. Saltwater intrusion into the fresh ground water lens used for domestic purposes also is a concern, especially on Saipan. Conservation practices on cropland generally include contour tillage and cover crops. In northern Guam, no-till, strip-till, and mulching are common conservation practices. ■

192—Volcanic Highlands of the Mariana Islands

This area is entirely in southern Guam (fig. 192-1). It makes up about 78 square miles (202 square kilometers), or about 37 percent of Guam. The Territory of Guam is in the western Pacific Ocean, about 1,600 miles (2,580 kilometers) east of the Philippine Islands and about 3,800 miles (6,130 kilometers) west-southwest of Hawaii. Guam is the largest island of the Mariana Islands and the economic hub of Micronesia.

Physiography

This area is in the Pacific Islands Province of the Pacific Rim Area. Guam is the largest and southernmost island of the Mariana Arc archipelago. The interior of south Guam has steep or very steep mountains deeply dissected by numerous streams and some rivers. The windward east side of the area consists of nearly level to moderately sloping plateaus that are highly dissected by streams. The highest elevation in Guam, 1,336 feet

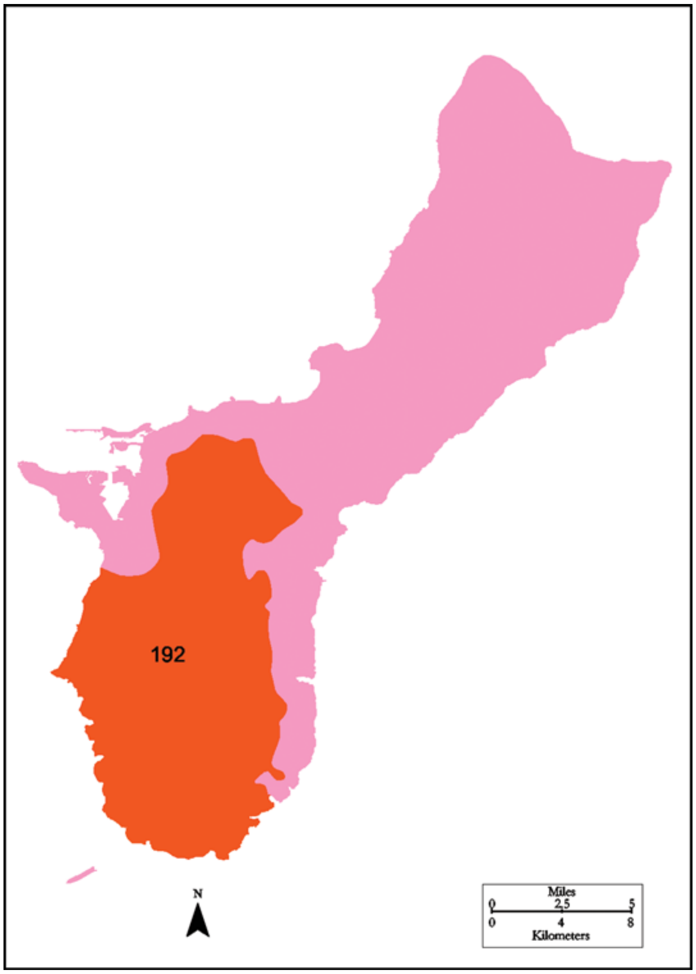

Figure 192-1: Location of MLRA 192 in Land Resource Region Q.

(407 meters), is on a north- to south-trending ridge on the leeward west side of the area. Cliffs, gentle to steep slopes, beaches, and reef flats characterize the shoreline. Barrier and fringing reef occurs around the area. More than 40 rivers and streams form the drainage pattern in the area, and the Fena Reservoir is near the center of the area.

Geology

South Guam consists primarily of deeply weathered volcanic rock from an uplifted submarine volcano. This volcanic origin is linked to the tectonic subduction of the Pacific Plate under the Philippine Plate. Movement along the plate boundary results in frequent earthquakes. The volcanic material is primarily andesite and basalt reworked as tuff, tuff breccia, tuffaceous sandstone, shale, and volcanic conglomerate formed during the Oligocene and Miocene epochs. Areas of limestone are along the southeast coast and on the tops of ridges in some of the highest mountains.

Climate

The average annual rainfall ranges from about 85 to 100 inches (2,160 to 2,540 millimeters) in the northern half of this MLRA and from about 95 to 118 inches (2,415 to 2,995 millimeters) in the southern half. The average annual temperature is 79 degrees F (26 degrees C). The primary seasons in the area are the dry season, from January through April, and the rainy season, from July through November. Trade winds are persistent during the dry season. Relative humidity is generally high, averaging 76 percent. Variations in temperature and humidity are small throughout the year. Typhoons frequently pass close to Guam. The chance of a typhoon severely impacting the island is once in 8 years. This area is freeze-free.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 100.0%; ground water, 0.0%
Livestock—surface water, 0.0%; ground water, 0.0%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 0.0%; ground water, 0.0%

The total quantity of withdrawals is not known. All of the water used in this area is from surface water sources. Many rivers and streams on the volcanic bedrock provide abundant, good-quality surface water. Municipal water is stored in the Fena Reservoir, which supplied approximately 7 to 9 million gallons per day (25 to 35 million liters per day) to the U.S. Naval Station in 1986. The Ugum River is a source of domestic water. The water in some small ponds is used for irrigating crops. Irrigation water also is obtained from the domestic water delivery system. In addition to the Mariana and Barrigada limestone aquifers described in MLRA 191, the Umatac and Alutom formations are two volcanic rock aquifers that provide some good-quality water for domestic use in southern Guam. Some domestic water is pumped from sedimentary material in the northwest corner of the area, along the coast.

Soils

The soils in this MLRA are Alfisols, Inceptisols, Mollisols, or Oxisols. The dominant soil moisture regime is ustic, and all of the soils have an isohyperthermic soil temperature regime. The soils are shallow to deep, well drained to somewhat poorly drained, and fine textured. Most of the MLRA is mapped as a complex of Haplustox (Akina series) and Haplustolls (Agfayan series). These soils, along with Haplustalfs (Atate series) and Haplustepts (Sasalaguan and Togcha series), are on moderately sloping to steep uplands. Endoaquepts (Inarajan series) and Haplustepts (Ylig series) are on broad valley bottoms and coastal lowlands. Ustipsamments (Shioya series) are in beach areas.

Biological Resources

This area is a mosaic of savanna grassland and patches of forest. Except for remnants of a forest plant community in the wetter gulches and river valleys, the native vegetation has been largely replaced by grasses through repeated burning. The grasses commonly are tall swordgrass and foxtail. The bottoms of ravines and hillside springs are filled with coarse reeds, karriso, and neti, which are adapted to wet soils. Forests, occurring dominantly in ravines and on valley bottoms but also on some hillsides, support pago (or beach hibiscus), kafu (or pandanus or screw pine), and ahgao (or false elder).

The only mammal endemic to the Mariana Islands is the Marianas fruit bat. Other mammals, such as Sambar deer, pigs, goats, and water buffalo, have been introduced and can be seen in the wild. A number of skinks and geckos are native to the Marianas. Several endemic bird species, rufous fantail, the fairy tern, and the Vanikoro swiftlet, an endangered species, inhabit the islands. The native bird populations on Guam have been decimated through the accidental introduction of the brown tree snake. A wide range of coral, anemones, and shellfish and various reef and pelagic fish species are in the surrounding reef systems and open waters.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 1.5%; Federal, 0.5%
Grassland—private, 5.5%; Federal, 10.5%
Forest—private, 35.0%; Federal, 21.5%
Urban development—private, 18.0%; Federal, 1.5%
Water—private, 0.5%; Federal, 0.5%
Other—private, 4.5%; Federal, 0.5%

This MLRA is dominantly undeveloped grassland and forest used for drinking water supply and wildlife habitat. Small truck farms operate on valley bottoms and gently sloping uplands. The main crops are bananas, taro, eggplant, beans, cucumbers, green peppers, many other vegetable crops, and ornamentals. The U.S. Department of Defense manages the Fena Reservoir. Urban development is occurring primarily around the coastline.

The major soil resource management concern is water erosion. Excessive erosion has led to the formation of badlands that are difficult to revegetate. Excessive sediment overloads the filtration capacity of the domestic water supply system and causes periodic water delivery shutdowns during prolonged periods of rainfall. Siltation of the adjacent coral reefs adversely affects fisheries. Curbing human-induced grassland fires and revegetating bare areas are additional resource management concerns.

The most common conservation practices are contour farming, strip-till or no-till, mulching, hillside ditches, terraces, and grassed waterways on uplands and strip-till or no-till, riparian forest buffers, filter strips, and field borders on the wetter lowlands. ■

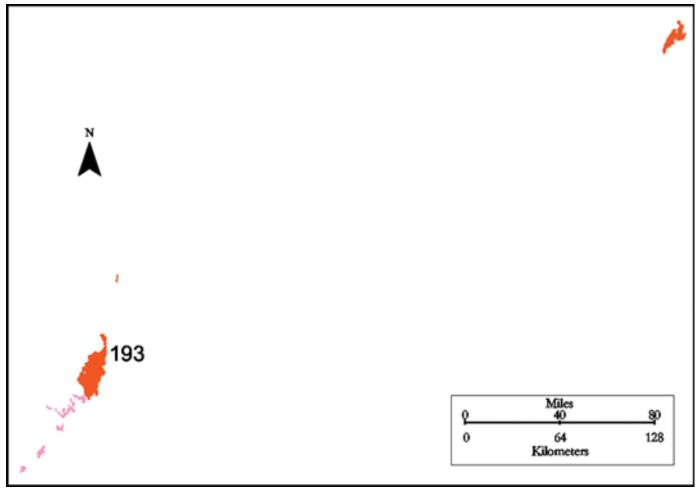

Figure 193-1: Location of MLRA 193 in Land Resource Region Q.

193—Volcanic Islands of Western Micronesia

This area includes most of the Palau (77 percent) and Yap (23 percent) Islands in the western Caroline Islands group (fig. 193-1). It makes up about 196 square miles (508 square kilometers). The Palau Islands are about 4,600 miles (7,420 kilometers) west-southwest of Hawaii and about 560 miles (905 kilometers) east of the southern Philippine Islands. The Yap Islands are approximately 290 miles (465 kilometers) northeast of Palau. The islands of Babeldaob, Koror, Malakal, and Arakabesan are in the northern part of the Republic of Palau. The Yap islands are in the western part of the Federated States of Micronesia (FSM).

Physiography

This area is in the Pacific Islands Province of the Pacific Rim Area. It is characterized by uplands underlain by volcanic and metamorphic rocks. The Palau Islands range from level to very steep and are characterized by deep, dendritic drainageways and generally rounded hills. Raised marine terraces are exposed in a few areas. The Yap Islands range from nearly level on raised, dissected benches of volcanic rocks to hilly and mountainous in areas of metamorphic rocks. The highest elevation is about 794 feet (242 meters) on Palau and about 555 feet (169 meters) on

Yap. Mangrove swamps, barrier reefs, and some fringing reefs surround both of these island groups. Small streams and rivers are in this area.

Geology

The Palau and Yap Islands are primarily of volcanic origin, consisting of tuff and breccia derived from basalt and andesite. Eocene, and probably Oligocene, eruptions were mainly submarine. Tectonic forces subsequently uplifted the islands. Schist, a metamorphic rock derived from volcanic rocks, is the bedrock in about half of the main Yap Islands. Like the Mariana Islands to the north, the islands in this MLRA formed on the boundary where the Pacific tectonic plate is being subducted under the Philippine tectonic plate. Scattered marine terraces and raised coral formations are mainly in coastal areas. Bauxite was mined on volcanic rocks on Babeldaob in the 1920s and 1930s.

Climate

The average annual rainfall in this area is 122 to 145 inches (3,100 to 3,685 millimeters). This MLRA is in the intertropical convergence zone. This zone is an area of low pressure where the Northeast Trade Winds meet the Southeast Trade Winds near the Equator. As these winds converge, moist air is forced upward and thunderstorms and heavy rainfall occur. In this area, the rain intensifies with increased solar heating during the summer and diminishes as the sun moves farther from the earth. The driest season is from February through April. The average annual temperature is 81 degrees F (27 degrees C). Humidity averages about 90 percent at night and 75 to 80 percent during the day. Typhoons are not common in this area. The area is freeze-free.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 99.5%; ground water, 0.5%
Livestock—surface water, 0.0%; ground water, 0.0%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 0.0%; ground water, 0.0%

The total quantity of withdrawals is not known. Almost all of the water used in this area is for domestic supply, and its source is perennial streams. Some areas on both island groups use water catchment systems. Crops are not typically irrigated. The Ngerikiil Watershed provides most of the drinking water for approximately 75 percent of the people of Palau. The island of Babeldaob has 16 watersheds that supply continuous surface water for the potable water needs of that island. About 70 percent of the rain falling on the island runs off to the ocean. In the past, test wells were drilled in the fractured volcanic rocks on the islands and ground water was obtained. The high levels of iron and manganese in the water, however, created a favorable environment for anaerobic bacteria. The bacteria caused blockages in the pumps, so the wells did not yield water for long. Shallow wells in bedrock that are probably drawing water from surface sources provide some domestic water in this area.

Soils

Most of the volcanic soils on uplands in this MLRA are Oxisols, but some are Ultisols or Inceptisols. Alfisols and Mollisols are in areas underlain by schist bedrock. Histosols, Inceptisols, and Entisols are in low areas and coastal areas. The dominant soil moisture regimes are perudic, udic, and aquic, and the area is characterized by an isohyperthermic soil temperature regime. The soils generally are moderately deep to very deep, poorly drained to somewhat excessively drained, and fine textured. Hapludalfs (Gitam and Rumung series) and Argiudolls (Weloy series) are in areas underlain by schist. They are somewhat poorly drained to well drained soils on nearly level to very steep uplands and plains. The soils on volcanic uplands include well drained Acroperox (Ngardok series), Eutroperox (Yap series), Haploperox (Aimeliik, Palau, and Gagil series), and Kandiperox (Babelthuap series). Haplosaprists (Mesei series) are on wet freshwater bottom land, and Sulfihemists (Ilachetomel and Ngerungor series) are very poorly drained, organic soils in the coastal intertidal areas. Dystrudepts are in somewhat poorly drained areas on bottom land (Ngersuul and Sonahnpil series) and in well drained areas on uplands (Ollei series). Endoaquepts (Dechel series) are important agricultural soils on bottom land. The soils on marine terraces include Haploperox (Ngatpang series) and Kandiperox (Tabecheding series).

Biological Resources

The native vegetation in this area consists of tropical hardwood trees and savanna grasses. The mountainous areas support tropical hardwoods. The upland forest in Palau is considered one of the most diverse forests in Micronesia. Because of the different languages spoken on the individual islands, there are numerous common names for the many plant species in this area. As a result, scientific names for plants are given in this paragraph. The common tree species in the uplands are *Campnosperma brevipetiolata*, *Parinari corymbosa*, *Alphitonia carolinensis*, and *Rhus taitensis*. Open savanna on Babeldaob and the Yap Islands is common and is thought to be the result of human activity, such as wildfire and land clearing. *Pandanus* species may form a scattered overstory with grasses (*Ischaemum* species and *Miscanthus floridulus*). Some degraded savanna is dominated by the fern *Gleichenia linearis*. Savanna also has a component of shrubs, including *Wikstroemia elliptica*, *Melastroma malabathricum*, and *Decaspermum* species. Swamp forest, which is inundated with fresh or slightly brackish water, is characterized by *Hibiscus tiliaceus*, *Horsfeldia amklaal*, and *Cynometra ramiflora*. Mangrove forests occupy most of the coastal intertidal wetlands and are dominantly *Sonneratia alba* and *Rhizophora mucronata* toward the sea and *Lumnitzera littorea* and *Xylocarpus granatum* on the landward side of the mangroves.

The surrounding reef systems and open waters have a wide range of coral, anemones, shellfish, and other marine and pelagic fish species.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 11.0%
Grassland—private, 11.0%
Forest—private, 72.0%
Urban development—private, 4.5%
Water—private, 1.0%
Other—private, 0.5%

Forest, grassland, and agroforestry dominate the current land uses. Valley bottoms and low-lying areas along the coast are the most productive agricultural lands. Traditional agroforestry systems are dominant, especially on Yap. Small commercial farms growing truck crops are on uplands and bottom lands on Babeldaob. Coconut, breadfruit, betel nut, papaya, bananas, cassava, and taro are the principal crops.

The major soil resource concern is maintaining soil quality and productivity in very infertile soils with a thin topsoil. Preserving the quality of drinking water in southern Babeldaob also is a major concern. ■

194—Low Limestone Islands of Western Micronesia

This area includes hundreds of islands in the southern part of the Palau archipelago in the Western Caroline Islands group (fig. 194-1). The area makes up about 27 square miles (70 square kilometers). The Palau Islands are about 3,830 miles (6,180 kilometers) west-southwest of Hawaii and about 450 miles (725 kilometers) east of the southern Philippine Islands. The main islands in this MLRA are Peleliu and Angaur, which are 55 miles (90 kilometers) and 69 miles (110 kilometers), respectively, southwest of the capital Koror. Over 350 smaller Rock Islands are between Koror and Peleliu.

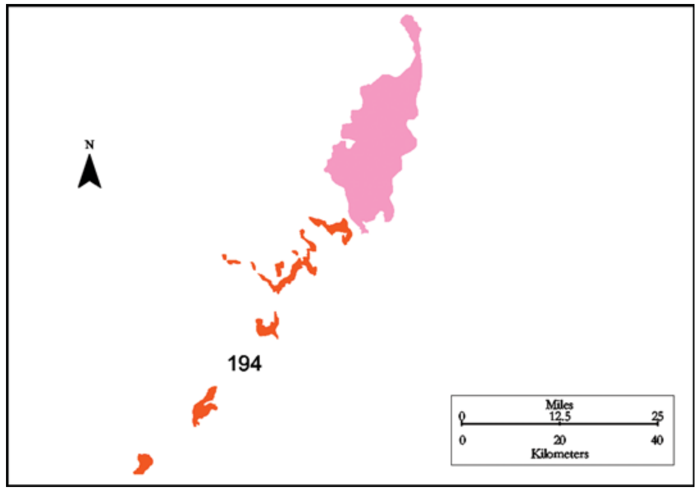

Figure 194-1: Location of MLRA 194 in Land Resource Region Q.

Physiography

This area is in the Pacific Islands Province of the Pacific Rim Area. It is characterized by low, raised coralline limestone islands. Broad areas of Angaur and Peleliu are nearly flat and have an elevation of 15 to 30 feet (5 to 10 meters). Prominent ridges of rugged limestone are as much as 262 feet (80 meters) above sea level. North of these islands lies a maze of large and small, extremely steep and rugged limestone islands, referred to as the Rock Islands. There are no streams or rivers in this area, but barrier and fringing reefs surround the islands.

Geology

The islands in this area consist of uplifted limestone. Phosphate deposits were once mined on Angaur and Peleliu.

Climate

The average annual rainfall in this area is 148 inches (3,760 millimeters). This MLRA is in the intertropical convergence zone. This zone is an area of low pressure where the Northeast Trade Winds meet the Southeast Trade Winds near the Equator. As these winds converge, moist air is forced upward and heavy rainfall occurs. In this area, the rain intensifies with increased solar heating during the summer. The rainiest months are June, July, and August. The driest season is February through April. The average annual temperature is 81 degrees F (27 degrees C). Humidity averages about 90 percent at night and 75 to 80 percent during the day. Typhoons are not common in this area. The area is freeze-free.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 50.0%; ground water, 50.0%
Livestock—surface water, 0.0%; ground water, 0.0%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 0.0%; ground water, 0.0%

The total quantity of withdrawals is not known. About 50 percent is from ground water sources, and 50 percent is from surface water sources. The islands are too small to have an adequate supply of fresh ground water. Wells provide mostly brackish water on Peleliu and Angaur. Catchment water is used for domestic purposes. Crops are not irrigated.

Soils

This MLRA is characterized by uplands underlain by coral bedrock. Most of the soils on uplands are Mollisols that formed in limestone residuum. Histosols are of lesser extent in the areas underlain by limestone. Entisols formed in wind- and water-deposited coral sand in low-lying coastal areas. The dominant soil moisture regimes are perudic and udic, and the area is characterized by an isohyperthermic soil temperature regime. The soils generally are shallow, well drained, and fine textured. Well drained Haprendolls (Peleliu series) and Udifolists (proposed Chelbacheb series) formed in residuum and are interspersed with rock outcrop on nearly level to very steep uplands. Udipsamments (Ngedebus series) formed in wind- and water-deposited sand in coastal areas. The total area of the MLRA that is covered by soil surveys is about 56 percent, or 15 square miles (39 square kilometers).

Biological Resources

The biological resources in this area include forests and fisheries. The area supports a diverse forest community. Because of the different languages spoken on the individual islands, there are numerous common names for the many plant species in this area. As a result, scientific names for plants are given in this paragraph. Some of the more common species are *Gulubia palauensis*, *Ptychosperma palauensis*, *Semecarpus venenosus*, *Intsia bijuga*, *Psychotria* species, *Premna obtusifolia*, *Cordia* species, *Clerodendrum inerme*, *Pandanus* species, *Dracaena multiflora*, and *Bikkia palauensis*. Mangrove forest occurs in protected areas on Angaur and Peleliu. It includes *Rhizophora apiculata*, *Bruguiera gymnorhiza*, and *Ceriops tagal*.

The common bird species are the fruit dove, Micronesian pigeon, collared kingfisher, white tern, black noddy, brown noddy, and the tropic bird. The only native mammals are insectivorous bats and fruit bats. Macaque monkeys are an introduced species on Angaur. Saltwater crocodiles inhabit mangrove swamps. The surrounding reef systems and open waters have a wide range of coral, anemones, shellfish, and other marine and pelagic fish species.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 2.5%
Forest—private, 87.0%
Urban development—private, 7.5%
Other—private, 3.0%

Most of this MLRA is a tropical hardwood forest. Low-lying areas along the coast of Angaur and Peleliu are the most productive agricultural lands. Coconut, cassava, breadfruit, betel nut, papaya, bananas, and taro are the principal crops. Small areas of urban land are near the coast. Deep pits and surface scars remain in areas that formerly were mined for phosphate.

The major soil resource concern is maintaining soil quality. Water erosion is not a problem. Measures that curb the spread of invasive species and preserve the quality of the forests and marine life are needed because this area is heavily used for ecotourism. Developing a supply of quality drinking water is a major concern. The most common conservation practices are multistory cropping, mulching, hillside ditches, contour farming, and cover crops. ■

195—Volcanic Islands of Central and Eastern Micronesia

This area includes the islands of Pohnpei (59 percent) and Kosrae (19 percent) and the Chuuk Islands (22 percent) in the eastern Caroline Islands group (fig. 195-1). The area makes up about 224 square miles (580 square kilometers). The Chuuk Islands are approximately 2,100 miles (3,380 kilometers) south-southeast of Tokyo, Japan, and 3,500 miles (5,630 kilometers) southwest of Honolulu, Hawaii. Pohnpei is approximately 440 miles (710 kilometers) east of Chuuk, and Kosrae is approximately 360 miles (580 kilometers) east-southeast of Pohnpei. The States of Pohnpei (Ponape), Chuuk (Truk), and Kosrae (Kosaie) are in the Federated States of Micronesia (FSM).

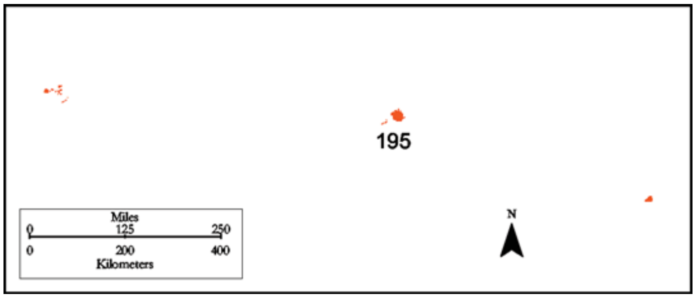

Figure 195-1: Location of MLRA 195 in Land Resource Region Q.

Physiography

This area is in the Pacific Islands Province of the Pacific Rim Area. It consists of dozens of high volcanic islands and low islands and atolls consisting of coral. The high volcanic islands are steep and very steep, highly dissected mountains. Only about a third of the area of most of the islands consists of rolling hills, alluvial coastal plains, and mangrove swamps that surround the mountainous areas. Coastal plains account for most of the relatively flat ground. Elevations range from sea level to about 1,444 feet (440 meters) in Chuuk, 2,625 feet (800 meters) in Pohnpei, and 2,077 feet (633 meters) in Kosrae. Fringing and barrier coral reefs surround these islands. The area has streams and small rivers.

Geology

The high islands are derived from Tertiary-age, basic igneous rock, mainly basalt, andesite, and trachyte lava flows and dikes. Geomorphic development suggests that Chuuk is the oldest of the major islands. It is the most eroded, and drowned river valleys attest to recent subsidence. To the east are the younger islands of Pohnpei and Kosrae, which also are highly eroded.

Climate

The climate in this area is characterized by high rainfall, high temperatures, and high humidity. The average annual rainfall generally ranges from about 145 to 225 inches (3,685 to 5,715 millimeters) but is estimated to be as high as 295 inches (7,495 millimeters) in the highest mountains. January through March is the driest season. Northeasterly trade winds affect the weather from November to June. The islands are frequently under the influence of the intertropical convergence zone between July and November, when moist southerly winds and tropical disturbances are most frequent and when the humidity is often very high. The average annual temperature is 81 degrees F (27 degrees C). Variations in temperature are very minimal throughout the year. Typhoons are not common in this area. The area is freeze-free.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 85.0%; ground water, 15.0%
Livestock—surface water, 0.0%; ground water, 0.0%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 0.0%; ground water, 0.0%

The total quantity of withdrawals is not known. About 15 percent is from ground water sources, and 85 percent is from surface water sources. Domestic water is supplied by perennial streams and rivers. In some areas water catchment systems provide water for domestic use. Crops typically are not irrigated. Wells tap the freshwater in joints and fractures in the volcanic rocks or solution openings in the limestone or coral deposits that have been raised above sea level.

Soils

Most of the soils on volcanic uplands are Inceptisols or Oxisols, whereas the soils on bottom land are Entisols or Histosols. The dominant soil moisture regime is perudic, and the soil temperature regime is isohyperthermic. The soils are dominantly shallow to very deep and are well drained to very poorly drained. The soils on uplands are mostly fine textured and have mixed or oxidic mineralogy. The soils on bottom land generally are sandy and have carbonatic mineralogy. The soils on volcanic uplands are nearly level to very steep, well drained Dystrudepts (Dolen, Dolekei, Fomseng, Finol, and Sonahnpil series), Acroperox (Rakied, Wahrekdam, and Umpump series), and Hapludalfs (Tolonier series) and poorly drained Endoaquepts (Inkosr and Nansepsep series). The soils on bottom land and in coastal areas are nearly level, somewhat poorly drained to excessively drained Udipsamments (Dublon and Ngedebus series); steep, well drained Udorthents (Oatuu series); and nearly level, poorly drained Psammaquents (Insak series), Sulfaquents (Naniak series), Sulfihemists (Ngerungor and Chia series), and Haplohemists (Mesei variant). There are 19 high volcanic islands within Chuuk Lagoon, but only the 9 largest islands were included in a soil survey.

Biological Resources

This area generally is forested, but it includes a few small savannas, fern lands, and cleared and cultivated areas in the lowlands and on mid-mountain slopes. Tropical palms and broadleaf trees are the dominant plants in the mountain forests on steep slopes. The most common trees are campnosperma, eucalyptus, Honduras mahogany, teak, pandanus, and mangrove. Agroforestry consists of a canopy layer of broadleaf tree species, such as breadfruit and mango, as well as coconut and pandanus cultivars, and a lower layer of bananas, kava, cassava, medicinals, and other home-garden shrubs and herb plants. Mangrove forests make up most of the coastal intertidal wetlands.

The most common birds in the area are doves, pigeons, kingfishers, swiftlets, terns, herons, gulls, petrels, tropic birds, and frigate birds. The only native mammals are fruit bats. The surrounding reef systems and open waters have a wide range of coral, anemones, shellfish, and reef and pelagic fish species.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 33.5%
Grassland—private, 1.5%
Forest—private, 62.0%
Urban development—private, 2.0%
Water—private, 0.5%
Other—private, 0.5%

Most of this MLRA is tropical hardwood forest and scattered grassland. Most of the population lives on the coastal plains. Subsistence farming occurs in river basins and on lowlands and mid-mountain slopes. Valley bottoms and low-lying areas along the coast are the most productive agricultural lands. Traditional agroforestry systems dominate the landscape. Breadfruit, betel nut, coconut, bananas, cassava, and taro are the principal crops. Wildlife habitat and tourism are other important land uses.

The major soil resource concern is maintaining soil quality and productivity in very infertile soils with a thin topsoil. The most common conservation practices are multistory cropping, forest stand improvement, tree planting, and mulching. ■

196—Coral Atolls of Micronesia

This area consists primarily of coral atolls and some small, low coral islands in the Republic of the Marshall Islands at the eastern end of the Caroline Islands group (fig. 196-1). The area makes up about 70 square miles (180 square kilometers). It is roughly 2,300 miles (3,700 kilometers) southwest of Hawaii. The 29 atolls made up of 1,225 islands in the Marshall Islands are scattered over 502,000 square miles (1.3 million square kilometers) between 4 and 14 degrees north latitude and 160 and 173 degrees east longitude.

Physiography

This MLRA is in the Pacific Islands Province of the Pacific Rim Area. It consists of more than 1,000 low coral islands within 29 atolls. The coral atolls consist of low, nearly level, long, narrow islands. Most islets in the Marshall Islands are less than 3,300 feet (1,005 meters) long and 1,650 feet (505 meters) wide. The average island height is about 6 feet (2 meters), and

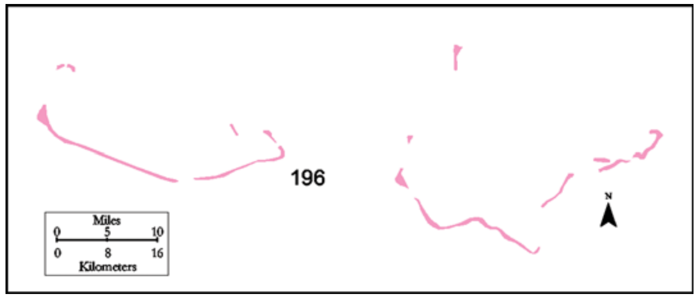

Figure 196-1: Location of MLRA 196 in Land Resource Region Q.

the highest elevation is about 20 feet (6 meters), on Likiep Atoll. Fringing and barrier coral reefs surround these islands. The area has no streams or rivers.

Geology

These islands originated as high volcanic islands, but over time they have been lowered by erosion and tectonic subsidence. Corals grew around the submerged islands, forming atolls and shallow reefs.

Climate

The climate in this area is characterized by high rainfall, high temperatures, and high humidity. The average annual rainfall generally ranges from about 40 to 145 inches (1,015 to 3,685 millimeters). It decreases to the north, and the northern atolls are prone to drought between December and May. January, February, and March are generally the driest months in the southern atolls, which receive 6 to 9 inches (150 to 230 millimeters) of rain during these months compared with a range of 11 to 15 inches (280 to 380 millimeters) during the remaining months. The average annual temperature is 81 degrees F (27 degrees C). Variations in temperature are very minimal throughout the year. Typhoons are not common in this area. The area is freeze-free.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 95.0%; ground water, 5.0%
Livestock—surface water, 0.0%; ground water, 0.0%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 0.0%; ground water, 0.0%

The total quantity of withdrawals is not known. About 5 percent is from ground water sources, and 95 percent is from surface water sources. Domestic water is supplied by wells and water catchment systems. Crops typically are not irrigated. Wells tap freshwater in solution openings in the limestone or coral deposits where these deposits have been elevated above sea level.

Soils

The soils in this MLRA are mainly Entisols, which are very deep and somewhat excessively drained. The soil moisture regime probably ranges from perudic to ustic, and all of the mineral soils in the area have an isohyperthermic soil temperature regime and carbonatic mineralogy. A soil survey covers 6 square miles (15.5 square kilometers) on the islands of Airik, Arno, Majuro, Mili, and Taroa of the Ratak chain. Cobbly sands on the ocean side of the islands are Udorthents (Majuro series), whereas noncobbly sands on the lagoon side are Udipsamments (Ngedebus series). Ustipsamments and Ustorthents (no series identified) may occur where the dry season is more pronounced than in the area covered by the soil survey. Manmade organic soils used for taro production are probably Haplosaprists (Mesei series).

Biological Resources

These islands commonly have atoll-strand forest on the fringes and agroforestry crops in the interior. Coconut trees cover about 60 percent of the land area. Half-flower tree, pandanus, ironwood, and hibiscus also are common. Agroforestry consists of a canopy layer of useful tree species, such as breadfruit, mango, and coconut, and a lower layer of bananas and other garden plants.

The most common birds are fruit doves, pigeons, and a variety of sea birds. The area has no native mammals. The surrounding reef systems and open waters have a wide range of coral, anemones, shellfish, and other marine and pelagic fish species.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 27.0%
Grassland—private, 9.5%
Forest—private, 33.5%
Urban development—private, 30.0%

Most of the cropland in this area is used for agroforestry, but taro patches also are significant. Much of the land is covered by roads, buildings, swamps, or beaches. The different islands have small areas of subsistence agriculture and urban land.

The major soil resource concern is maintaining soil quality and productivity in infertile soils with a thin topsoil. Maintaining the content of organic matter in the soils is crucial for sustainable agricultural productivity. Water conservation and prevention of ground-water and lagoon pollution are additional resource concerns. The most common conservation practices are multistory cropping and mulching. ■

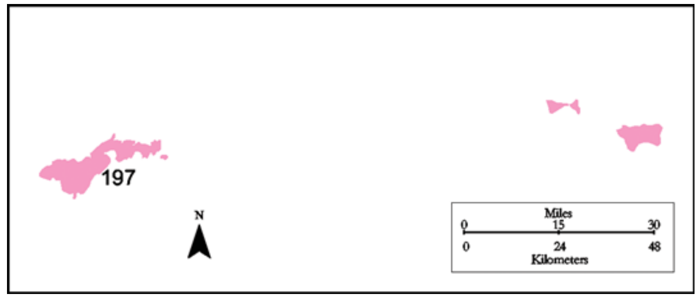

Figure 197-1: Location of MLRA 197 in Land Resource Region Q.

197—Volcanic Islands of American Samoa

This area consists of the American Samoa islands of Tutuila, Aunu`u, Ofu, Olosega, and Ta`u in the southern Pacific Ocean (fig. 197-1). The islands that are not volcanic include Swains Island and Rose Island. This MLRA makes up about 77 square miles (199 square kilometers). It is approximately 2,300 miles (3,710 kilometers) south-southwest of Hawaii and 4,150 miles (6,695 kilometers) southwest of California.

Physiography

This area is in the Pacific Islands Province of the Pacific Rim Area. The islands are characterized by extremely steep, highly dissected volcanic mountains, small valleys, and a narrow coastal plain leading into deep waters offshore. Landslide scars are common on the steep mountainsides. More than half of this area has slopes of more than 70 percent. The overall slope of the landscape is derived from recent giant landslides and stream erosion. Recent lava flows have built up a broad lava plain on the south side of Tutuila, and there are a number of cinder cones in this area. The highest elevation, 3,056 feet (931 meters), is on Lata Mountain, on Ta`u. The second highest elevation, 2,142 feet (653 meters), is on Matafao Peak, on Tutuila. Fringing and barrier coral reefs surround these islands. The area has streams but no rivers.

Geology

This area consists of volcanic islands made up of Pleistocene-age, basic igneous rocks, mainly basalt and lesser amounts of andesite and trachyte. These rocks are weathered to a considerable depth in some areas. Volcanic ash and cinders have accumulated mostly on young, gently sloping surfaces. Colluvium is common at the base of mountain slopes.

Climate

This area is characterized by a tropical maritime climate with abundant rain and warm, humid days and nights. The average annual precipitation is generally about 125 inches (3,175 millimeters) but is more than 250 inches (6,350 millimeters) in some areas. The amount of rainfall varies greatly over short distances because of the effects of topography. The driest months are June through September (winter), and the wettest are December through March (summer). The average annual temperature is 81 degrees F (27 degrees C). The relative humidity ranges from 73 to 90 percent throughout the year. The prevailing winds throughout the year are easterly trade winds. They are less prevalent in summer than in winter. Typhoons occasionally strike this area. The area is freeze-free.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 10.0%; ground water, 90.0%
Livestock—surface water, 0.0%; ground water, 0.0%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 0.0%; ground water, 0.0%

The total quantity of withdrawals is not known. About 90 percent is from ground water sources, and 10 percent is from surface water sources. Fresh ground water is confined by dikes at the higher elevations and is perched on saltwater at the lower elevations. Ground water is pumped to large storage tanks, from which it is distributed for domestic use. In 1986, about 36,000 people on Tutuila relied on ground water for their public and industrial water supply. The Leone volcanic rock aquifer supplied almost all of this water. The water is hard, but the median level of total dissolved solids is only about 300 parts per million (milligrams per liter). An increasing population and increasing urbanization are putting pressure on the ground water supply. Ground water recharge decreases as the area of impervious surfaces increases, and heavy pumping is causing some problems with saltwater intrusion. Also, fecal coliform contamination has been detected in some wells on Tutuila.

In some areas water catchment systems from roofs into cement tanks provide water for domestic use. Because of the abundant rainfall, crops are seldom irrigated in this area. Some perennial and intermittent streams are in the area.

Soils

Most of the soils on volcanic uplands are Mollisols and Andisols that are shallow to very deep and generally are well drained. The dominant soil moisture regime is perudic, and the dominant soil temperature regime is isohyperthermic. The soils generally are fine textured and have mixed, halloysitic, or amorphic mineralogy. The soils on bottom land are Entisols with sandy textures and carbonatic mineralogy and Histosols. They range from shallow to very deep. Nearly level to very steep, mostly well drained Hapludolls are on valley bottoms (Leafu series) and talus slopes (Aua series) and are the dominant soils on mountainsides (Fagasa series and Ofu and Sogi variants). Steep, well drained Acroperox (Ofu series) also are on mountainsides. Hapludands are mostly on gently sloping to steep, young landscapes (Iliili, Puapua, and Sogi series) but also occur on steep mountainsides (Olotania series). Gently sloping to very steep, well drained Fulvudands (Pavaiai series) and Hydrudands (Oloava series) are on uplands. Nearly level, excessively drained Udipsamments (Ngedebus series), nearly level, poorly drained Psammaquents (Insak series), nearly level, excessively drained Udorthents (Ngedebus variant), and nearly level, very poorly drained Haplosaprists (Mesei series) are on bottom land and in coastal areas. Gently sloping, well drained Udifolists (Tafuna series) are on young uplands upwind of most sources of volcanic ash. The coral atolls of Rose and Swains Islands are not included in a soil survey of the area.

Biological Resources

Rain forests cover most of this area. Tropical palms and broadleaf trees are the dominant plants on steep slopes in the mountain forests. The most common tree species are maota mea, laga´ali, asi, mamalava, and tava.

The most common birds in the forests are barn owls, tropic bird, Samoan starlings, white-collared kingfisher, and the many-colored fruit dove. Sea birds include frigate bird, brown booby, gray-backed tern, and white tern. The surrounding reef systems and open waters have a wide range of coral, anemones, shellfish, and other marine and pelagic fish species.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 31.0%
Grassland—private, 1.0%
Forest—private, 57.0%
Urban development—private, 10.5%
Other—private, 0.5%

Most of this MLRA is in tropical hardwood forests. The interiors of the islands are virtually inaccessible because of very steep mountainous terrain and dense vegetation. Most of the population lives on the coastal plains and in valleys. Subsistence farming occurs on lowlands and on mid-mountain slopes. Valley bottoms and wet, low-lying areas are the most productive lands for the staple crop of taro. Traditional agroforestry systems dominate the agricultural landscape. Agroforestry consists of a canopy layer of useful tree species, such as breadfruit, coconut, and mango, and a lower layer of bananas, kava, cassava, taro, and other garden plants. Coconut, cassava, breadfruit, papaya, bananas, and taro are the principal crops. Wildlife habitat is another important land use.

The major soil resource concern is water erosion on steep slopes. The most common conservation practices are multistory cropping, mulching, hillside ditches, contour farming, and cover crops. ■

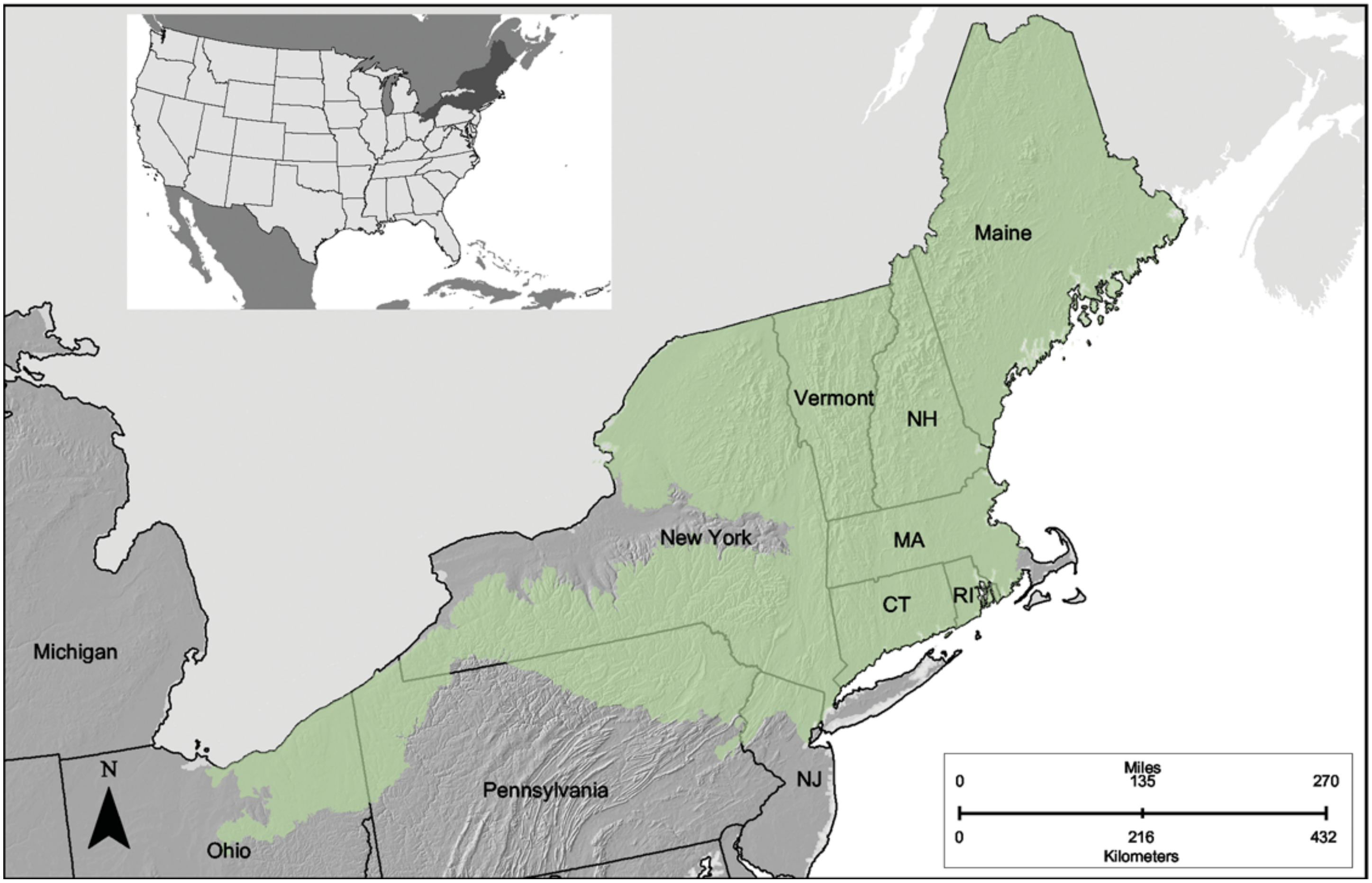

Figure R-1: Location of Land Resource Region R.

R—Northeastern Forage and Forest Region

This region (shown in fig. R-1) is in New York (31 percent), Maine (27 percent), Pennsylvania (9 percent), Vermont (8 percent), New Hampshire (8 percent), Massachusetts (6 percent), Ohio (5 percent), Connecticut (4 percent), New Jersey (1 percent), and Rhode Island (1 percent). It makes up 120,635 square miles (312,625 square kilometers).

Plateaus, plains, and mountains characterize this region. The climate is generally cool and humid. The average annual precipitation is generally 34 to 62 inches (865 to 1,575 millimeters). In most of the region, more than one-half of the precipitation falls during the freeze-free period. The average annual temperature is typically 40 to 48 degrees F (4 to 9 degrees C). The freeze-free period generally is 130 to 200 days, but it ranges from 110 days in the higher mountains to 240 days in some areas along the Atlantic coast.

The total withdrawals of freshwater in this region average about 19,100 million gallons per day (72,295 million liters per day). About 93 percent is from surface water sources, and 7 percent is from ground water sources. About 78 percent of the water is used for the timber industry and manufacturing and 21 percent for public supply.

The soils in this region are dominantly Entisols or Spodosols. They commonly have a fragipan. Alfisols are less extensive. They formed in limy parent material and have a fragipan. The dominant suborders are Ochrepts and Orthods at the higher elevations and Aqualfs, Aquepts, and Histosols on lowlands and in depressions. The soils on flood plains (Fluvents) are of small extent but are important for many uses. The soils in the region dominantly have a frigid or mesic soil temperature regime, a udic soil moisture regime, and mixed mineralogy.

Most of the land in this region, especially the land in the steeper areas, is forested, and 98 percent is privately owned. Significant amounts of lumber and pulpwood are produced.

Figure R-2: Potato fields in an area of Land Resource Region R.

Locally, Christmas trees and maple syrup are important forest products. Forage and grains for dairy cattle are the principal crops. In areas where markets, climate, and soils are favorable, fruits, tobacco, potatoes (fig. R-2), and vegetables are important crops. Wildlife habitat and recreation are important land uses. Stoniness and steep slopes limit the use of many of the soils. ■

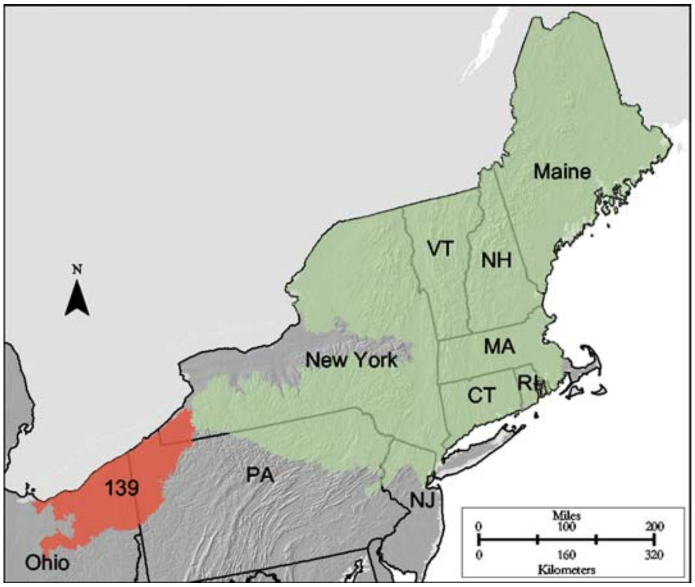

Figure 139-1: Location of MLRA 139 in Land Resource Region R.

139—Lake Erie Glaciated Plateau

This area (shown in fig. 139-1) is in Ohio (62 percent), Pennsylvania (29 percent), and New York (9 percent). It makes up about 10,715 square miles (27,770 square kilometers). It includes the cities of Cleveland, Akron, Kent, Warren, Youngstown, Massillon, Wooster, and Mansfield, Ohio; Dunkirk, Fredonia, and Jamestown, New York; and Erie, Sharon, and Newcastle, Pennsylvania. Interstates 76, 80, and 90 cross this area from east to west, and Interstates 71 and 77 cross it from north to south. Interstate 79 crosses the northeastern and eastern parts of the area. The Erie National Wildlife Refuge is in the part of the area in Pennsylvania. Numerous State forests are in the northeast corner of the area, in New York, and a number of State parks are throughout the area. The Cuyahoga Valley National Recreational Area is between Cleveland and Akron.

Physiography

Almost all of this area is in the Southern New York Section of the Appalachian Plateaus Province of the Appalachian Highlands. The southern edge of the area is in the Kanawha Section of the same province and division. The western suburbs of Cleveland, in the western tip of the area, are in the Till Plains Section of the Central Lowland Province of the Interior Plains. A narrow band along the shore of Lake Erie is in the Eastern Lake Section of the same province and division. Most of this MLRA is a gently rolling to strongly rolling, dissected glaciated plateau. The narrow band along Lake Erie is fairly flat. Stream valleys are narrow and are not deeply incised, but the valley walls are typically steep. In some areas the interfluves are broad and nearly level. Elevation ranges from 660 to 1,000 feet (200 to 305 meters), increasing gradually from north to south. Local relief is about 7 to 50 feet (2 to 15 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Southern Lake Erie (0411), 28 percent; Upper Ohio (0503), 25 percent; Allegheny (0501), 23 percent; Muskingum (0504), 16 percent; Eastern Lake Erie-Lake Erie (0412), 6 percent; and Western Lake Erie (0410), 2 percent. The Cuyahoga and Grand Rivers are designated as National Wild and Scenic Rivers in northeastern Ohio. Most of the rivers in this MLRA flow north to Lake Erie. The headwaters of the Ohio River are in the northeast corner of this area, in Pennsylvania, and some of the headwaters of the Muskingum River are in the central part of the area, in Ohio.

Geology

The bedrock in this area consists mostly of alternating beds of sandstone, siltstone, and shale of upper Devonian, Mississippian, and Pennsylvanian age. Shale units are dominant closer to the surface along Lake Erie and the western edge of the area. The surface is mantled with glacial till, outwash of unconsolidated sand and gravel, glacial lake sediments, and stratified drift deposits (kames and eskers). The outwash, lake sediments, and stratified drift deposits that fill valleys are important sources of ground water. Younger stream deposits cover the glacial deposits in some of the river valleys.

Climate

The average annual precipitation in this area is 34 to 50 inches (865 to 1,270 millimeters). Rainfall occurs as high-intensity, convective thunderstorms during the summer. The seasonal snowfall averages 40 inches (100 centimeters). The average annual temperature is 44 to 51 degrees F (7 to 10 degrees C). The freeze-free period averages 180 days and ranges from 145 to 215 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 8.1%; ground water, 1.1%
Livestock—surface water, 0.2%; ground water, 0.1%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 89.9%; ground water, 0.5%

The total withdrawals average 6,190 million gallons per day (23,430 million liters per day). This MLRA ranks tenth among all of the MLRAs in total amount of water used. About 2 percent is from ground water sources, and 98 percent is from surface water sources. Precipitation and perennial streams provide an abundance of good-quality surface water. Lake Erie and large reservoirs on perennial streams provide water for public supply and industrial use in several of the large cities in the area. On many farms, small constructed ponds provide water for livestock and irrigation and are used for recreation.

Shallow and deep wells are the main sources of water for domestic use and municipal supplies in this area. One source of ground water is the glacial deposits in the valleys. The water from these aquifers is hard or very hard and generally requires softening. The level of total dissolved solids typically ranges from 200 to 400 parts per million (milligrams per liter). This good-quality water is susceptible to contamination from surface activities because the aquifer is often directly recharged from precipitation and runoff on the valley floors.

A second source of ground water in this area is the sandstone bedrock. The water from this aquifer is generally very hard and requires treatment prior to use. It is a calcium bicarbonate type of water that has a median value of 322 parts per million (milligrams per liter) total dissolved solids. At a depth of more than 300 feet, this water is saline. Contamination of the water in this bedrock aquifer is rare.

Soils

The dominant soil order in this MLRA is Alfisols. The soils in the area dominantly have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed or illitic mineralogy. They are very deep, well drained to poorly drained, and loamy or clayey. Epiaqualfs (Mahoning series) formed in till on till plains. Hapludalfs formed in outwash deposits on outwash plains, terraces, kames, and beach ridges (Chili series) and in till on till plains (Ellsworth series). Fragiudalfs formed in till (Canfield and Rittman series) and loess over till (Wooster series) on till plains and moraines. Fragiaqualfs (Frenchtown, Platea, Ravenna, Sheffield, Venango, and Wadsworth series) formed in till on till plains and moraines.

Biological Resources

This area supports mostly beech forest vegetation. American beech, sugar maple, red oak, white ash, and white oak are the dominant species. Other species include American basswood, shagbark hickory, black cherry, and cucumbertree. American beech and sugar maple are dominant on some poorly drained flatlands. Mixed, mesophytic oak-sugar maple and oak forest types occur in some areas.

Some of the major wildlife species in this area are white-tailed deer, cottontail, squirrel, pheasant, and quail.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 29%
Grassland—private, 6%
Forest—private, 36%; Federal, 1%
Urban development—private, 21%
Water—private, 2%
Other—private, 5%

About three-fourths of this area is in farms. Feed grains (corn, soybeans, winter wheat, and oats) and forage (grass-legume hay, tall fescue pasture, and alfalfa hay) for dairy cattle are the main crops in the western part of the area. Similar crops are grown in the eastern part, where there are many part-time farms and many rural residences. The area has some cow-calf operations. Some areas are used for potatoes or small fruit crops. A large amount of the milk produced in the area is converted to cheese. The areas of hardwood forest in the MLRA are mainly in farm woodlots. Sawlogs for rough construction, firewood, and some high-quality sawlogs for specialty uses are harvested from the numerous farm woodlots. Some large holdings are used for watershed protection.

The major soil resource concerns are sheet and rill erosion, sedimentation by storm-water runoff, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management (such as conservation tillage), winter cover crops, grass-legume plantings, contour farming, irrigation water management, compost facilities, nutrient management, manure management, and pesticide management. Excluding livestock from wetlands and watercourses and developing rotational grazing systems help to control erosion and protect water quality. Conservation practices that are important to community development include critical site planting and urban storm-water management. ■

140—Glaciated Allegheny Plateau and Catskill Mountains

This area (shown in fig. 140-1) is in New York (65 percent), Pennsylvania (34 percent), and New Jersey (1 percent). It makes up about 22,370 square miles (57,975 square kilometers). It includes the cities of Binghamton, Johnson City, Endicott, Elmira, and Corning, New York, and Carbondale, Scranton, and Wilkes-Barre, Pennsylvania. Interstate 81 connects the cities of Binghamton and Scranton, Interstate 84 crosses the southeast corner of the area, Interstate 90 (the New York Thruway) crosses the northern part, and Interstate 87 parallels the eastern border.

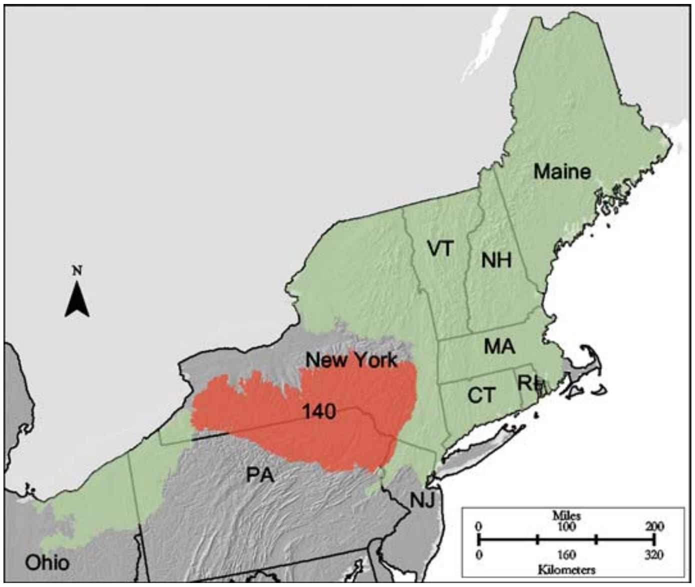

Figure 140-1: Location of MLRA 140 in Land Resource Region R.

Numerous State forests and State parks are throughout this MLRA. The Catskill Mountains are in the eastern part of this area, in New York.

Physiography

This area is primarily in the Southern New York Section of the Appalachian Plateaus Province of the Appalachian Highlands. The east-central part is in the Catskill Section of the same province and division. A small portion of the Allegheny Mountain Section is in the south-central part of this MLRA, and the southwest corner of the MLRA is in the Kanawha Section. These two sections are in the Appalachian Plateaus Province of the Appalachian Highlands. The southeast edge and a fingerlike area protruding into the southeast corner of the MLRA are in the Middle Section of the Valley and Ridge Province of the Appalachian Highlands. The top of the dissected plateau in this MLRA is broad and is nearly level to moderately sloping. The narrow valleys have steep walls and smooth floors. The Catskills in the east have steep slopes. Elevation is typically 650 to 1,000 feet (200 to 305 meters) on valley floors; 1,650 to 2,000 feet (505 to 610 meters) on the plateau surface; and 3,600 feet (1,100 meters) or more in parts of the Catskills.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Susquehanna (0205), 50 percent; Delaware (0204), 20 percent; Upper Hudson (0202), 9 percent; Southwestern Lake Ontario (0413), 8 percent; Southeastern Lake Ontario (0414), 5 percent; Eastern Lake Erie-Lake Erie (0412), 4 percent; and Allegheny (0501), 4 percent. This MLRA includes the headwaters of the Susquehanna, Delaware, and Allegheny Rivers. The Genesee River, in the southwestern part of this area, is one of the few rivers in the area that flow north.

Geology

The bedrock in this area includes alternating shale and sandstone beds of Devonian age. Some of the upper Devonian layers have been eroded away in the part of the area in New York. Glacial drift mantles the area. Significant deposits of glacial outwash, consisting of unconsolidated sand and gravel, fill most of the valley floors. Some glacial lake sediments and ice-contact and stratified drift deposits occur in most of the valleys. These deposits are the primary aquifers in this area. Younger stream deposits cover some of the glacial deposits on the valley floors.

Climate

The average annual precipitation in most of this area is 30 to 45 inches (760 to 1,145 millimeters). It is 45 to 64 inches (1,145 to 1,625 millimeters) in small areas at the higher elevations in the eastern part of the MLRA. Rainfall occurs as high-intensity, convective thunderstorms during the summer, but most of the precipitation in this area occurs as snow. The average annual temperature is 40 to 50 degrees F (4 to 10 degrees C). The freeze-free period averages 165 days and ranges from 130 to 200 days. The coldest temperatures and the shortest freeze-free periods are in the high-elevation areas in the eastern part of the MLRA.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 7.2%; ground water, 4.0%
Livestock—surface water, 0.1%; ground water, 0.4%
Irrigation—surface water, 0.3%; ground water, 0.0%
Other—surface water, 83.3%; ground water, 4.7%

The total withdrawals average 3,100 million gallons per day (11,735 million liters per day). About 9 percent is from ground water sources, and 91 percent is from surface water sources. Precipitation and perennial streams and lakes provide an abundance of good-quality surface water in this area. Soils that have a fragipan are too wet in winter and spring for cultivation and are deficient in moisture during much of the growing season.

The primary source of ground water in this area is the glacial outwash deposits in the valleys. The water in these deposits is hard or very hard and may require softening. The average level of total dissolved solids is about 200 parts per million (milligrams per liter). This good-quality water is susceptible to contamination from surface activities because the aquifer is often directly recharged from precipitation and runoff on the valley floors. The valleys are the sites of the most intensive land use activities in this hilly area.

A secondary source of ground water, primarily in the southern half of the area, in Pennsylvania, is the sandstone and shale aquifer. Water from this aquifer varies in quality, depending on the source rocks. The water from dominantly sandstone units is soft, and the water from the shale units generally is hard and requires treatment prior to use. The water from this aquifer is a calcium bicarbonate type that has about 300 parts per million (milligrams per liter) total dissolved solids. Contamination from surface activities is rare.

Soils

The dominant soil order in this MLRA is Inceptisols. The soils in the area dominantly have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. They are shallow to very deep, well drained to very poorly drained, and loamy or loamy-skeletal. Dystrudepts (Arnot, Lordstown, and Oquaga series) formed in till on hills and dissected plateaus. Fragiudepts (Bath, Lackawanna, Mardin, Swartswood, Wellsboro, and Wurtsboro series) and Fragiaquepts (Chippewa, Morris, Norwich, and Volusia series) formed in till (dense till in some areas) on hills and till plains.

Biological Resources

This area supports forest vegetation, particularly hardwood species. Beech-birch-maple and elm-ash-red maple are the potential forest types. The extent of oak species increases from east to west, particularly in areas of shallow and dry soils. In some areas conifers, such as white pine, are important. Aspen, hemlock, northern white-cedar, and black ash grow on the wetter soils. In some parts of the area, sugar maple has potential economic significance.

Some of the major wildlife species in this area are white-tailed deer, cottontail, turkey, pheasant, and grouse.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 17%
Grassland—private, 10%
Forest—private, 60%; Federal, 1%
Urban development—private, 8%
Water—private, 2%
Other—private, 2%

A large acreage in this area is in second- and third-growth forests of oak and northern hardwoods. Much of the area is in farms. Hay, pasture, and some grain for dairy cattle are the principal crops. Potatoes are an important crop on the top of the plateau, and poultry, fruits, and truck crops are produced in many of the narrow valleys. Abandoned or idle land, which is common in the steeper areas, is reverting to grasses, weeds, shrubs, and trees. Urban development is expanding in some areas. The Catskills are used mainly for recreation.

The major soil resource concerns in this area are water erosion, soil wetness, and maintenance of the content of organic matter and productivity of the soils. Sedimentation from nonpoint sources, such as agricultural and urban runoff, also is a concern. Conservation practices on cropland generally include conservation tillage, contour stripcropping, crop rotations, crop residue management (mulch-till), cover crops, diversions, and grassed waterways. Conservation practices on forestland generally include forest stand improvement and proper construction, use, and maintenance of skid trails, water bars, access roads, and log landings. ■

141—Tughill Plateau

This area is entirely in New York (fig. 141-1). It makes up about 1,175 square miles (3,045 square kilometers). It has no major towns or roads. This plateau lies between Lake Ontario and the Adirondack Mountains. State highways and secondary roads skirt the lowlands around the base of the plateau. The area has numerous State forests, and the public trail system in the area is used heavily by drivers of all-terrain vehicles and snowmobiles.

Physiography

Most of this area is in the Mohawk Section of the Appalachian Plateaus Province of the Appalachian Highlands. The west and southwest third of the area is in the Eastern Lake Section of the Central Lowland Province of the Interior Plains. This MLRA is nearly level to gently sloping across the top of the plateau and hilly to steep around the margins. Elevation ranges from 980 feet (300 meters) along the lower margins to 1,970 feet (600 meters) at the top of the plateau. Local relief generally is 15 to 80 feet (5 to 25 meters), but the bordering lowlands are typically about 330 feet (100 meters) below the top of the plateau.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Southeastern Lake Ontario (0414), 80 percent; Northeastern Lake Ontario-Lake Ontario-St. Lawrence (0415), 15 percent; and Upper Hudson (0202), 5 percent. Streams flow off the plateau in several directions. The principal rivers in the area are the Salmon and Mad Rivers and the East and West Branches of the Fish River.

Geology

This plateau is underlain mostly by Ordovician-age sandstones. The Queenston shale occurs in the southwest part

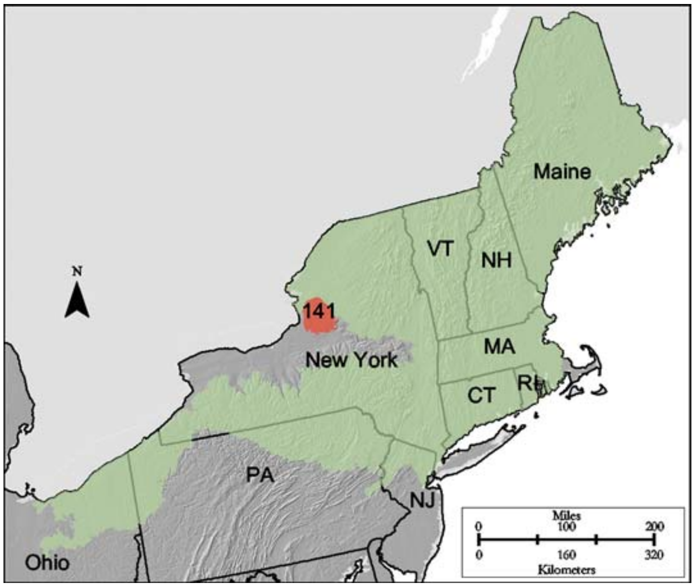

Figure 141-1: Location of MLRA 141 in Land Resource Region R.

of the area, and the Oswego and Pulaski sandstone, siltstone, and shale beds occur in the rest of the area. All of the area has a thin mantle of glacial till. Some glacial lake sediments and moraines occur in the southwest part of the area.

Climate

The average annual precipitation in most of this area is 45 to 63 inches (1,145 to 1,600 millimeters). It is 41 to 45 inches (1,040 to 1,145 millimeters) around the lower margins of the plateau. The precipitation is evenly distributed throughout the year. Rainfall occurs as high-intensity, convective thunderstorms during the summer. Lake-effect snowfall is heavy from late in autumn to early in spring. In some areas the seasonal snowfall is as much as 140 inches (355 centimeters). The average annual temperature is 40 to 46 degrees F (4 to 8 degrees C). The freeze-free period averages 160 days and ranges from 135 to 180 days. The lowest temperatures and the shortest freeze-free periods are on the summit of the plateau.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 11.5%; ground water, 17.2%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 23.8%; ground water, 47.5%

The total withdrawals are about 0.4 million gallons per day (1.5 million liters per day). About 65 percent is from ground water sources, and 35 percent is from surface water sources. Precipitation and perennial streams provide an abundance of good-quality surface water. The area has few natural ponds or lakes, and the water resources available in the area are little used because of the lack of urban centers, mining, industry, or suitable agricultural land. Dense fragipans in most of the soils perch ground water for extended periods in winter and spring.

Shallow and deep wells supply water for domestic use and for livestock, the two main uses of water in this area. Stratified glacial drift is a source of ground water in the central and southeastern parts of this MLRA. In nearly level areas consisting mainly of glacial lake sediments, ground water is close to the surface during part of the year. The water from this aquifer is hard or very hard, but it typically has less than 150 parts per million (milligrams per liter) total dissolved solids.

A sandstone bedrock aquifer occurs under almost all of this area. It has very hard water, but the median value of total dissolved solids is only about 300 parts per million (milligrams per liter). The water in this aquifer has the highest levels of chloride of all the aquifers in this area. The median value of 100 parts per million (milligrams per liter), however, is well below the drinking water standard of 250 parts per million (milligrams per liter).

Soils

Most of the soils in this MLRA are Orthods or Aquods. They have a frigid soil temperature regime, a udic or aquic soil moisture regime, and mixed or isotic mineralogy. Many have a fragipan. Most are very deep to bedrock. The soils are loamy or sandy and have varying amounts of gravel. Surface stones and boulders are common. The soils formed mostly in glacial till derived primarily from acid sandstone. The till is compact and dense in many places. Well drained and moderately well drained Fragiorthods (Worth and Empeyville series) are in undulating to sloping areas. Nearly level to gently sloping, somewhat poorly drained Fragiaquods (Westbury series) are in the lower areas. Very poorly drained Endoaquepts (Tughill series) are extensive on flats and in depressions. Very poorly drained Haplohemists (Rifle series) are in bogs in a few of the large, deeper and wetter depressions. Somewhat excessively drained and excessively drained Haplorthods (Colosse and Adams series) that formed in sandy or gravelly outwash are prominent locally but are of small extent in the MLRA.

Biological Resources

This area supports northern hardwoods. The beech-birch-sugar maple forest type is of primary importance. Sugar maple is of particular economic significance. The elm-ash-red maple type also has potential in some parts of the area. Red spruce, balsam fir, and white pine can be expected to occur in mixed stands. Early succession vegetation includes highbush blueberry, lowbush blueberry, and aspen-birch forest types. As succession approaches climax, sugar maple, beech, and hemlock increase in importance. Eastern hemlock, white spruce, American elm, black ash, and red maple grow on the wetter soils. A mixture of moss, Labrador tea, and fern occurs on extremely wet, organic soils.

Some of the major wildlife species in this area are white-tailed deer, snowshoe hare, cottontail, and ruffed grouse.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 8%
Grassland—private, 6%
Forest—private, 79%
Urban development—private, 3%
Water—private, 2%
Other—private, 2%

Most of this area is forested with mixed hardwoods and conifers. Part of the forestland is abandoned cropland that has reverted to forest vegetation. Pulpwood, sawlogs, Christmas trees, and maple syrup are the principal forest products. The cropland in the area is used mainly for forage and some feed grains grown for dairy cattle. A sizable acreage has reverted to unproductive brush and weeds. A small acreage is used for urban development.

The major soil resource concerns in this area are water erosion, soil wetness, and maintenance of the content of organic matter and productivity of the soils. Sedimentation from nonpoint sources, such as agricultural and urban runoff, also is a concern. Conservation practices on cropland generally include conservation tillage, contour stripcropping, crop rotations, crop residue management (mulch-till), cover crops, diversions, and grassed waterways. Conservation practices on forestland generally include forest stand improvement and proper construction, use, and maintenance of skid trails, water bars, access roads, and log landings. ■

142—St. Lawrence-Champlain Plain

This area (shown in fig. 142-1) is in New York (73 percent) and Vermont (27 percent). It makes up about 7,040 square miles (18,240 square kilometers). Burlington, Vermont, and Ogdensburg, Plattsburgh, and Watertown, New York, are important cities in this area. The area is served by Interstates 81, 87, and 89, which run north and south. Fort Drum Military Reservation is in the southwestern part of the area. Parts of the MLRA are in Adirondack State Park. The St. Lawrence River and the Canadian border form the north end of this area. The area is bounded on the west by Lake Ontario, on the south by the Adirondack Mountains, and on the east by the Green Mountains. It surrounds Lake Champlain at the New York-Vermont border.

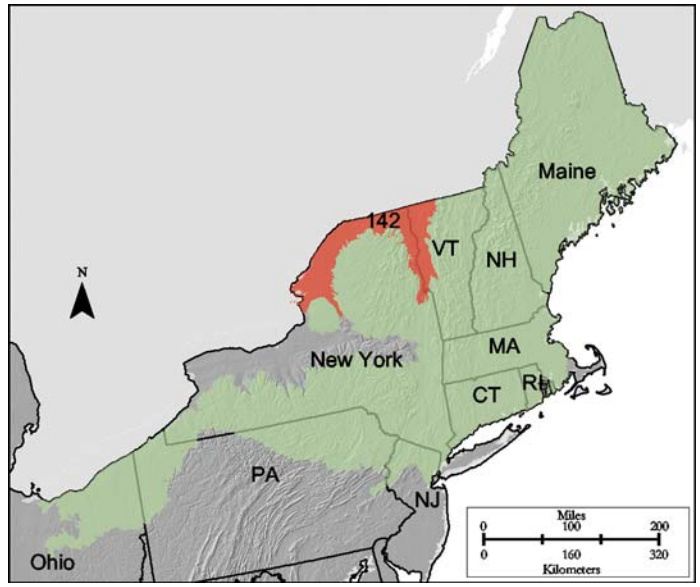

Figure 142-1: Location of MLRA 142 in Land Resource Region R.

Physiography

The northern half of this area is in the Champlain Section of the St. Lawrence Valley Province of the Appalachian Highlands. Small areas in the northern part of the MLRA are in the Adirondack Province of the same division. Most of the southwest corner of the area is in the Eastern Lake Section of the Central Lowland Province of the Interior Plains. A small area in the southwest corner is in the Mohawk Section of the Appalachian Plateaus Province of the Appalachian Highlands. The southeastern extremities of the MLRA are in the Hudson Valley Section of the Valley and Ridge Province and the Taconic Section of the New England Province of the Appalachian Highlands. This MLRA is a glaciated area of low relief dominated by broad expanses of nearly level, sandy deltas and shallow lacustrine basins or plains punctuated by low hills of glacial till. Rivers and streams have cut relatively deep but narrow valleys across the plain. Elevation ranges from 80 to 1,000 feet (25 to 305 meters), increasing gradually from the St. Lawrence River southward and from Lake Champlain to the east and west. Local relief generally is less than 30 feet (10 meters), but glacial till ridges, till plains, and some outwash terraces rise 15 to 80 feet (5 to 25 meters) above the adjacent plains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Northeastern Lake Ontario-Lake Ontario-St. Lawrence (0415), 50 percent; Richelieu (0201), 47 percent; and Southeastern Lake Ontario (0414), 3 percent. The St. Lawrence River and Lake Champlain are important waterways in this area. Many rivers drain across the area from the Adirondack Mountains to the St. Lawrence River in the west and north and to Lake

Champlain in the east. These rivers include the Moose, Black, Beaver, Oswegatchie, Grass, Raquette, St. Regis, Saranac, Ausable, and Bouquet Rivers.

Geology

This area has been glaciated, and a thin mantle of till covers most of the bedrock. Extensive areas of sandy glacial outwash and eolian deposits also occur. Some glacial lake sediments have been deposited above glacial moraines. These deposits are thickest in the valleys and thinnest on the ridges and highlands. During the later stages of the Wisconsin glacial period, seawater entered the Champlain Valley and deposited marine sediments that were later covered by freshwater sediments. The marine deposits are unique to the area. Numerous bedrock outcrops occur in the western half of the area. The bedrock is primarily the Stony Point shale on top of a series of beds of limestone and dolomite of Ordovician age. Below these rocks are the Cambrian Potsdam sandstone and conglomerate. The limestone units and the Potsdam Sandstone are major aquifers. Some quartzite layers are in the carbonate rocks in the part of this area in northwestern Vermont.

Climate

The average annual precipitation in most of this area is 30 to 45 inches (760 to 1,145 millimeters). It is 45 to 60 inches (1,145 to 1,525 millimeters) in the high-elevation areas in the southern part of the area. The precipitation is evenly distributed throughout the year. Most of the rainfall occurs as high-intensity, convective thunderstorms during the summer. Snowfall is heavy from late in autumn to early in spring. The average annual temperature is 41 to 47 degrees F (5 to 9 degrees C). The freeze-free period averages 165 days and ranges from 140 to 190 days. It is longest in a narrow belt around Lake Champlain.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 10.0%; ground water, 0.8%
Livestock—surface water, 0.2%; ground water, 0.2%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 86.7%; ground water, 2.0%

The total withdrawals average 1,020 million gallons per day (3,860 million liters per day). About 3 percent is from ground water sources, and 97 percent is from surface water sources. Precipitation and numerous perennial streams provide an abundance of surface water. The St. Lawrence Seaway, which forms the northern border of the area, and Lake Champlain, on the eastern border, are important transportation arteries and are used extensively for recreation. Industry is generally the largest user of both surface and ground water in this area. The steep terrain provides numerous opportunities for hydropower facilities on rivers. Even though New York ranks third among the States in the production of electricity from hydropower, only 3 percent of the State's needs are met by this power source. The surface water in the area generally is of excellent quality. Acid rain is a problem. The acidity removes metals, such as aluminum, iron, and mercury, from soils, and these contaminants enter the streams, lakes, and reservoirs and eventually enter the food chain. Algae growth in Lake Champlain is a local concern.

Ground water is abundant in this MLRA. Deep wells in the stratified glacial drift yield moderate quantities of water for domestic use. In nearly level areas consisting mainly of heavy textured marine and lake sediments, ground water is close to the surface during part of the year. The unconsolidated sand and gravel in alluvial and glacial outwash deposits filling valley floors is a significant aquifer in the part of this area in Vermont. The water from this aquifer is hard or very hard, but it typically has less than 150 parts per million (milligrams per liter) total dissolved solids.

Two bedrock aquifers, a carbonate system and the Potsdam sandstone, occur in the northwestern, north-central, and northeastern parts of this MLRA. The water in the carbonate aquifer is the hardest encountered in New York and Vermont. It is the only water in the area that exceeds the national secondary drinking water standard for total dissolved solids, 500 parts per million (milligrams per liter). The Potsdam sandstone typically lies beneath the carbonate aquifer, but both aquifers do not always occur in a given area. The sandstone has very hard water, but the median value of total dissolved solids is only about 300 parts per million (milligrams per liter). The water in the sandstone has the highest levels of chloride of all the aquifers in this area. The median value of 100 parts per million (milligrams per liter), however, is well below the drinking water standard of 250 parts per million (milligrams per liter).

Soils

The dominant soil orders in this area are Alfisols, Inceptisols, Spodosols, and Entisols. The soils in the area have a frigid or mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed or isotic mineralogy. They are shallow to very deep, excessively drained to very poorly drained, and sandy to clayey. Hapludalfs (Hudson and Vergennes series), Endoaqualfs (Niagara and Rhinebeck series), and Epiaqualfs (Muskellunge series) formed in lacustrine sediments on lake plains. Dystrudepts formed in till on uplands (Charlton series) or on flood plains (Lovewell series). Epiaquepts (Malone series) formed in till on uplands. Eutrudepts (Amenia series) formed in dense till on uplands. Haplorthods and Udipsamments formed in sandy glaciofluvial or lacustrine deposits on outwash plains, lake plains, eskers, and terraces (Adams and Colton series, examples of Haplorthods, and Plainfield series, an example of

Udipsamments); in till on hills, mountains, and plateaus (Berkshire, Lyman, and Tunbridge series); and in loamy sediments over dense till (Becket and Potsdam series). Haplohumods (Rawsonville series) formed in till on hills, mountains, and plateaus. Fragiorthods (Worth series) formed in dense till on till plains. Cryofolists (Ricker series) formed in organic material on mountains and hills.

Biological Resources

This area supports hardwoods. The beech-birch-sugar maple forest type is the dominant climax forest type on uplands. Associated with this type are basswood, American elm, maple species, white ash, black cherry, and white pine. The aspen-birch type, earlier in succession, is economically important. Such species as eastern hemlock, red maple, American elm, and spruce are on wet soils.

Some of the major wildlife species in this area are white-tailed deer, red fox, raccoon, beaver, woodchuck, muskrat, cottontail, ruffed grouse, and woodcock.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 21%
Grassland—private, 11%; Federal, 1%
Forest—private, 49%; Federal, 2%
Urban development—private, 5%
Water—private, 8%
Other—private, 3%

Most of this area is in forests or farms. The forests consist of northern hardwoods and conifers. Sawlogs and pulpwood are the main forest products. Christmas trees and maple syrup also are produced throughout the area. Dairy operations and some beef operations are common. Hay for dairy cattle is the principal crop, but small grain and corn are grown for silage in some areas. Potatoes are an important cash crop in some areas, and a few apple orchards are on the slopes along Lake Champlain, but the total acreage of these crops is small. Some areas are used for urban development.

The major soil resource concerns on cropland are sheet, rill, and gully erosion; the content of organic matter and productivity of the soils; and surface compaction (resulting primarily from harvesting crops under wet conditions). Some erosion results from logging practices. Conservation practices on cropland generally include conservation tillage, contour stripcropping, crop rotations, crop residue management (primarily mulch-till), cover crops, diversions, and grassed waterways. Conservation practices on forestland generally include forest stand improvement and proper construction, use, and maintenance of skid trails, water bars, access roads, and log landings. ■

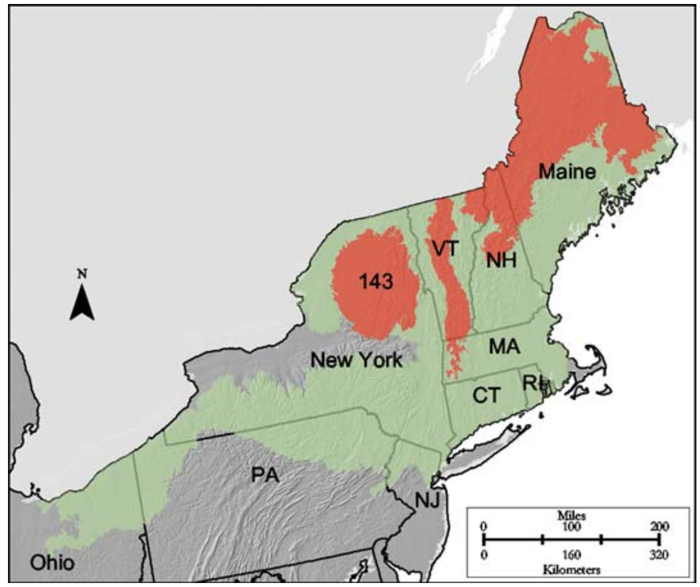

Figure 143-1: Location of MLRA 143 in Land Resource Region R.

143—Northeastern Mountains

This area (shown in fig. 143-1) is in Maine (54 percent), New York (25 percent), Vermont (12 percent), New Hampshire (7 percent), and Massachusetts (2 percent). It makes up about 36,840 square miles (95,465 square kilometers). This area is in three parts, separated by other MLRAs. The western part is in New York (primarily the Adirondack Mountains). The central part is mainly in the Green Mountains in Vermont and the Berkshires in Massachusetts. The eastern part is in the White Mountains in New Hampshire and most of northern Maine. There are no major cities in this mountainous MLRA. Interstate 95 cuts across the eastern part of the area, in Maine, and Interstate 89 cuts across the middle part, in Vermont. The westernmost part of the area is almost entirely in Adirondack State Park. The middle part of the area, in Vermont and Massachusetts, has more than 25 State forests. The Baxter, Connecticut Lakes, and Coleman State Parks and the Allagash Wilderness Waterway are in the eastern part of the area, in northern Maine. The Green Mountain and White Mountain National Forests are in the central and eastern parts of the MLRA, respectively.

Physiography

The westernmost part of this area is primarily in the Adirondack Province of the Appalachian Highlands. A small area in the southern end of the western part is in the Mohawk Section of the Appalachian Plateaus Province of the same division. The easternmost part, primarily in northern Maine, is in the New England Upland Section of the New England

Province of the Appalachian Highlands. The southwestern half of this part is in the White Mountain Section of the New England Province of the Appalachian Highlands, and the middle part of the MLRA is in the Green Mountain Section of the same province and division. The mountains and foothills in this MLRA are commonly rounded. They are underlain by bedrock and are typically covered with thin deposits of glacial till. The more rugged mountain areas are separated by high-gradient streams coursing through steep areas of colluvium or talus-laden valleys. Many glacially broadened valleys are filled with glacial outwash and have numerous swamps and lakes. The mountains and foothills are moderately steep to very steep, and the valleys are nearly level to sloping. Elevation generally ranges from 1,000 to 4,000 feet (305 to 1,220 meters), but it is more than 5,000 feet (1,525 meters) on a few isolated peaks and is less than 1,000 feet (305 meters) in some of the valleys, especially in northeastern Maine. Local relief ranges from moderate in some areas to high in ruggedly mountainous areas.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Penobscot (0102), 18 percent; St. John (0101), 16 percent; Northeastern Lake Ontario-Lake Ontario-St. Lawrence (0415), 11 percent; Upper Hudson (0202), 11 percent; Connecticut (0108), 10 percent; Richelieu (0201), 9 percent; Kennebec (0103), 9 percent; Androscoggin (0104), 6 percent; Maine Coastal (0105), 6 percent; Merrimack (0107), 1 percent; Saco (0106), 1 percent; Connecticut Coastal (0110), 1 percent; and St. Francois (0111), 1 percent. Almost all of the rivers draining the Adirondack Mountains have been designated as National Wild and Scenic Rivers. These include the Moose, Black, Canada Creek, Independence, Beaver, Oswegatchie, Grass, Raquette, St. Regis, Saranac, Ausable, Bouquet, Salmon, Hudson, and Sacandaga Rivers. In the central part of the MLRA, the Green Mountains are drained by numerous rivers that empty into the Hudson River or Lake Champlain to the west or the Connecticut River to the east. These include the Missisquoi, Lamoille, Winooski, and White Rivers, Otter Creek, and the Batten Kill and West Rivers. The major rivers in the part of this area in Maine include the Allagash and Aroostook Rivers, the East and West Branches of the Penobscot River, and the Androscoggin River.

Geology

The entire area was glaciated by the last continental ice sheet. In addition, evidence on the more rugged mountain peaks indicates that alpine glaciation may have lingered after the retreat of Wisconsin ice. A thin mantle of till covers most of the bedrock. Sandy glacial outwash has been deposited in many stream valleys, and ice-contact, stratified drift (on kames and eskers) has been deposited on the walls of the valleys. When the European and African Continents were squeezed up against the North American Continent by plate tectonic activity, the mountains in this MLRA must have appeared to be similar to the present Himalaya Mountains. For the past 500 million years, as the Atlantic Ocean opened up and the European and African continental plates were pushed east, erosion has been the dominant process. Only the roots of those ancient mountains remain in the area today. The bedrock consists primarily of igneous and metamorphic rocks. The metamorphic rocks (gneiss, schist, slate, metanorthosite, marble, and quartzite) are the oldest rocks. The igneous rocks, primarily granite and granodiorite, were intruded into the metamorphic rocks during the Triassic and Cretaceous periods. The deformation history and the weathering of these rocks have left numerous fractures, joints, bedding plane partings, and cleavage partings that now contain freshwater.

Climate

The average annual precipitation in most of this area is 32 to 45 inches (815 to 1,145 millimeters). It is typically 45 to 60 inches (1,145 to 1,525 millimeters) at the higher elevations in the mountains and is 60 to 105 inches (1,525 to 2,665 millimeters) on the highest peaks in the Green and White Mountains. More precipitation generally falls in summer than in winter. Most of the rainfall occurs as high-intensity, convective thunderstorms during the summer. Heavy snowfalls are common in winter. The average annual temperature is 35 to 46 degrees F (1 to 8 degrees C). The freeze-free period averages 145 days and ranges from 110 to 185 days, decreasing in length with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 9.8%; ground water, 5.1%
Livestock—surface water, 0.2%; ground water, 0.4%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 80.1%; ground water, 4.5%

The total withdrawals average 410 million gallons per day (1,550 million liters per day). About 10 percent is from ground water sources, and 90 percent is from surface water sources. Precipitation, perennial streams, and lakes provide an abundance of water. In the parts of the MLRA in New York and Vermont, the surface water is used primarily for recreation and the steep terrain provides numerous opportunities for hydropower facilities. The surface water in the part of the

MLRA in New Hampshire, Maine, and Massachusetts is used for light industry (textile and paper mills) and public supply. The surface water throughout the MLRA generally is of excellent quality. Acid rain is a problem. The acidity removes metals, such as aluminum, iron, and mercury, from soils, and these contaminants enter the streams, lakes, and reservoirs and eventually enter the food chain.

Ground water is abundant in deep glacial outwash in valleys but is scarce in the till and bedrock on uplands. Wells in the glacial till yield moderate quantities of water for domestic use. The water from the glacial aquifers can be soft to very hard, but it typically has less than 150 parts per million (milligrams per liter) total dissolved solids. The crystalline bedrock throughout this area yields moderately hard ground water of generally excellent quality. The level of total dissolved solids is very low; the median value is less than 150 parts per million (milligrams per liter). In the water from some wells, high, naturally occurring levels of iron and manganese can exceed the secondary standards for drinking water of 300 and 50 parts per billion (micrograms per liter), respectively. In Maine and New Hampshire, high, naturally occurring levels of radon cause problems in about 5 percent of the wells tested in this aquifer. Wells in granite with high amounts of muscovite and biotite appear to be the source of the radon-222.

Soils

The dominant soil orders in this MLRA are Inceptisols and Spodosols. The soils in the area dominantly have a frigid soil temperature regime, an aquic or udic soil moisture regime, and isotic or mixed mineralogy. At high elevations (above 3,000 feet, or 915 meters, in the Adirondack Mountains), the soil temperature regime is cryic. The soils are shallow to very deep, generally somewhat excessively drained to poorly drained, and loamy. Humaquepts (Burnham series) and Epiaquepts (Monarda series) formed in dense till in depressions on till plains. Haplorthods formed in loamy till on hills, mountains, and plateaus (Berkshire, Lyman, Thorndike, and Tunbridge series) and in dense till on drumlins, hills, and ridges (Becket, Colonel, Dixfield, Howland, Marlow, Peru, and Plaisted series).

Biological Resources

This area supports northern hardwoods, spruce, and fir. The most common trees are sugar maple, American beech, yellow birch, black cherry, white pine, balsam fir, red spruce, eastern hemlock, black spruce, and trembling aspen. Sugar maple, yellow birch, American beech, red spruce, and eastern hemlock are dominant on the better drained soils on hills and ridges. Red spruce and balsam fir are dominant on the wetter soils on long, gentle slopes and in depressions. Stunted balsam fir and red spruce are common on many of the high mountaintops.

Some of the major wildlife species in this area are white-tailed deer, snowshoe hare, and ruffed grouse.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 1%
Grassland—private, 1%
Forest—private, 85%; Federal, 5%
Urban development—private, 2%
Water—private, 5%
Other—private, 1%

The forested areas support northern hardwoods, spruce, and fir. Wood for lumber and pulp for the paper industry are the principal forest products. Maple sugar is an important product in many areas. Most farming is a part-time enterprise occurring on isolated farms. Much of the area in the Adirondacks in New York is in a State park. Although most of the area in New England is privately owned, a large part is in national forests, State forests, or State parks. This MLRA is widely used for year-round recreation. A small acreage is used for residential development.

The major soil resource concerns in this area are related to forestry and recreational development. They include sheet, rill, and gully erosion. Forest management concerns include erosion in scarified areas used as log decks and in areas along logging roads and skidder ruts that focus runoff up and down the slope. Construction sites for cottage and housing developments expose soil to the elements. The hazard of erosion becomes severe as the extent of disturbed areas and the slope increase. Erosion also is a severe hazard on ski slopes and in snowboarding areas because of the steepness and length of slopes and the difficulty in establishing stabilizing vegetation. Erosion on logging roads and skid trails is a potentially serious land use problem. Rill and gully erosion can occur in crop fields.

Conservation practices on forestland generally include forest stand improvement and proper construction, use, and maintenance of skid trails, water bars, access roads, and log landings. Critical area planting and sediment-control measures are needed on construction sites, ski slopes, and recreation trails. Conservation practices on cropland generally include conservation tillage, contour stripcropping, crop rotations, crop residue management (primarily mulch-till), cover crops, diversions, and grassed waterways. ■

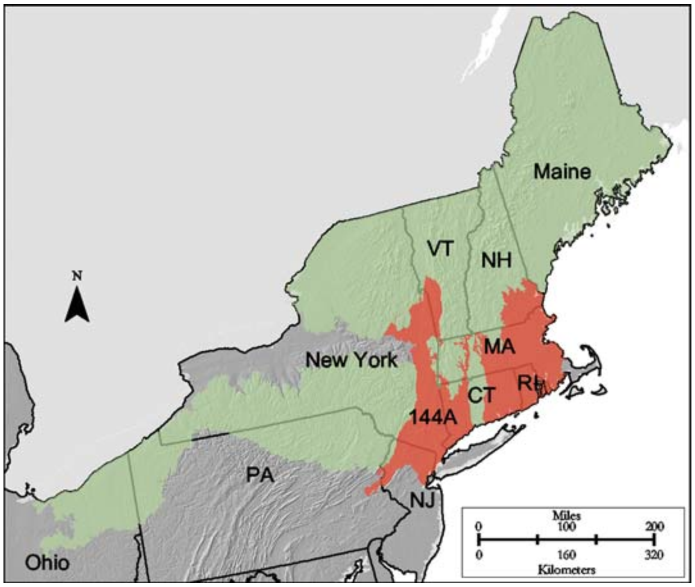

Figure 144A-1: Location of MLRA 144A in Land Resource Region R.

144A—New England and Eastern New York Upland, Southern Part

This area (shown in fig. 144A-1) is in New York (29 percent), Massachusetts (26 percent), Connecticut (20 percent), New Hampshire (10 percent), New Jersey (8 percent), Rhode Island (6 percent), and Vermont (1 percent). Also, Pennsylvania and Maine have a few square miles of this area. The MLRA makes up about 18,590 square miles (48,180 square kilometers). It consists of two separate parts, one east of MLRA 145 and one west of MLRA 145. The eastern part of MLRA 144A is primarily in Connecticut, Rhode Island, and Massachusetts, and the western part is primarily in southeastern New York. The western part includes the cities of Troy, Albany, and Poughkeepsie, New York, and the northern boroughs of New York City, in the Hudson River Valley. It also includes numerous cities on the New Jersey side of the Hudson River, across from New York City. The eastern part of the MLRA includes Storrs, Norwich, and New London, Connecticut; Providence, Rhode Island; Worcester, Boston, and New Bedford, Massachusetts; and Portsmouth, Concord, and Manchester, New Hampshire. The highways in the MLRA include Interstates 80, 84, 87, 89, 90, 93, and 95 and numerous extensions of Interstate 95.

This MLRA includes the West Point Military Academy in New York, the New London Naval Submarine Base and the United States Coast Guard Academy in Connecticut, and the South Weymouth Naval Air Station and Fort Devens Military Reservation in Massachusetts. It also includes the Saratoga National Historic Park in New York; the Cape Cod National Seashore, Minuteman National Historic Park, Wood's Hole Oceanographic Institution, and Martha's Vineyard State Forest in Massachusetts; and the first State forest in New England, the Meshomasic State Forest in Connecticut. A large number of State forests and State parks are throughout this MLRA.

Physiography

The eastern half of the eastern part of this MLRA is in the Seaboard Lowland Section of the New England Province of the Appalachian Highlands. The western half of the eastern part and the southeastern half of the western part are in the New England Upland Section of the same province and division. The northwestern half of the western part is in the Hudson Valley Section of the Valley and Ridge Province of the Appalachian Highlands. This MLRA is a very scenic area of rolling to hilly uplands that are broken by many gently sloping to level valleys that terminate in coastal lowlands. Elevation ranges from sea level to 1,000 feet (0 to 305 meters) in much of the area, but it is 2,000 feet (610 meters) on some hills. Relief is mostly about 6 to 65 feet (2 to 20 meters) in the valleys and about 80 to 330 feet (25 to 100 meters) in the uplands.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Hudson (0202), 22 percent; Connecticut Coastal (0110), 20 percent; Massachusetts-Rhode Island Coastal (0109), 19 percent; Merrimack (0107), 12 percent; Lower Hudson-Long Island (0203), 11 percent; Connecticut (0108), 9 percent; Saco (0106), 3 percent; Delaware (0204), 2 percent; and Richelieu (0201), 2 percent. The Hudson River flows south down the center of the long, narrow western part of this MLRA. The Housatonic and Connecticut Rivers are in the part of the MLRA in Connecticut. The Pawtuxet, Pawcatuck, Blackstone, and Wood Rivers are in the part in Rhode Island, and the Blackstone, Merrimack, Nashua, Mystic, and Charles Rivers are in the part in Massachusetts.

Geology

This area has been glaciated and consists almost entirely of till plains and drumlins dissected by narrow valleys with a thin mantle of till. The southernmost boundary of the area marks the farthest southward extent of glaciation on the eastern seaboard. The river valleys and coastal plains are filled with glacial lake sediments, marine sediments, and glacial outwash. The bedrock in the eastern half of the area consists primarily of igneous and metamorphic rocks of early Paleozoic age. Granite is the most common igneous rock, and gneiss, schist, and slate are the most common metamorphic rocks. In the parts of the MLRA in northeastern Pennsylvania and in eastern and southeastern New York, Devonian- to Pennsylvanian-age sandstone, shale, and limestone bedrock is dominant. Carbonate rocks, primarily dolomite and limestone, are the dominant kinds of bedrock in the part of this MLRA in northwestern Connecticut.

Climate

The average annual precipitation is 35 to 45 inches (890 to 1,145 millimeters) in the Hudson Valley, which is in the northern half of the western part of this area. It is 45 to 54 inches (1,145 to 1,370 millimeters) in the south end of the western part of the area and in most of the eastern part of the area. The precipitation generally is evenly distributed throughout the year. Near the coast, however, it is slightly lower in summer. It is slightly higher in spring and fall in inland areas. Rainfall occurs as high-intensity, convective thunderstorms during the summer. During the winter, most of the precipitation occurs as moderate-intensity storms (northeasters) that produce large amounts of rain or snow. The average annual temperature is 44 to 54 degrees F (6 to 12 degrees C), increasing from north to south. The freeze-free period averages 190 days and ranges from 145 to 240 days, increasing in length to the south.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 33.3%; ground water, 3.9%
Livestock—surface water, 0.0%; ground water, 0.1%
Irrigation—surface water, 1.4%; ground water, 0.1%
Other—surface water, 56.5%; ground water, 4.7%

The total withdrawals average 6,950 million gallons per day (26,305 million liters per day). This MLRA ranks eighth among all of the MLRAs in total amount of water used. About 9 percent is from ground water sources, and 91 percent is from surface water sources. Abundant precipitation, many perennial streams, and many natural lakes and ponds are important sources of surface water in this area. Many large and small reservoirs provide municipal and industrial water to urban areas that may lack sufficient water. For example, aqueducts that divert water from reservoirs in the basin of the Merrimack River provide half of the public water for Boston and many of its suburbs in eastern Massachusetts. The surface water in the area is suitable for almost all uses.

Some ground water is pumped for domestic use from the glacial till that covers most of this area. The quality of the ground water in the till is the same as that of the water in the stratified drift and valley fill aquifer. The stratified drift and glacial outwash deposits that fill the river valleys throughout this MLRA are the primary sources of most of the public water supply. Water from these units is very fresh. The water has not remained in this shallow aquifer for a very long period, and almost all of the unconsolidated sediments consist of quartz and feldspars, which offer few minerals for dissolution in water. The level of total dissolved solids typically ranges from 50 to 150 parts per million (milligrams per liter). The water is typically soft, but it can be hard in local areas where the more soluble minerals occur in the drift, for example in western Connecticut, where glaciers eroded the carbonate bedrock. High, naturally occurring levels of iron and manganese can occur, but the median levels of these metals generally are below the national and State primary standards for drinking water. Ground water in the valley fill generally is acidic. Corrosion of iron, lead, and concrete water lines is common in this area.

Many wells provide good-quality ground water from fractures, bedding planes, and joints in the crystalline igneous and metamorphic bedrock underlying almost all of this area. This aquifer provides water mainly for domestic use but also for public supply and industrial uses. This ground water is slightly alkaline. It has a low level of total dissolved solids, about 120 parts per million (milligrams per liter). In some areas the water has high levels of naturally occurring iron and manganese that exceed the national and State secondary standards for drinking water of 300 and 50 parts per billion (micrograms per liter), respectively. Water from wells that penetrate granite with high amounts of muscovite and biotite can contain high levels of a naturally occurring radionuclide, radon-222. This radionuclide can produce an odorless and inert gas that can cause health problems for humans when it collects in showers, bathrooms, and basements of residences.

Some younger carbonate and sandstone bedrock units are aquifers in the parts of this area in eastern New York, northwestern Connecticut, and northwestern Pennsylvania. Water from the sandstone units typically has 200 or less parts per million (milligrams per liter) total dissolved solids and commonly is soft. Water from the carbonate units typically has 250 or more parts per million (milligrams per liter) total dissolved solids and typically is very hard. Water from carbonate units in eastern New York is the only water from aquifers in the area that exceeds the national secondary drinking water standard for total dissolved solids of 500 parts per million (milligrams per liter). The water from both types of bedrock is slightly alkaline.

Because of a shallow depth to water and the openings in the rocks, all of the aquifers in this MLRA are susceptible to contamination from surface activities.

Soils

The dominant soil orders in this MLRA are Entisols, Histosols, and Inceptisols. The soils in the area dominantly have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. They generally are very deep, somewhat excessively drained to poorly drained, and loamy or sandy. Udorthents (Hinckley series) and Udipsamments (Windsor series) formed in outwash deposits on outwash plains, terraces, kames, and eskers. Haplosaprists (Freetown series) formed in organic material in depressions on uplands and outwash plains. Dystrudepts formed in till, loamy sediments over till, and dense till on till plains, hills, and ridges (Canton, Charlton, Chatfield, Gloucester, Hollis, Montauk, Paxton, Scituate, Sutton, and Woodbridge series) and in outwash deposits on outwash plains and terraces (Merrimac series). Endoaquepts (Leicester and Ridgebury series) and Epiaquepts (Ridgebury series) formed in till in depressions on hills and in drainageways. Fragiudults (Rockaway series) formed in till on hills.

Biological Resources

This area was cleared for agriculture in colonial times. The agricultural land was abandoned at the turn of the last century and then was reforested. The area is currently undergoing suburban and rural development. Historic and modern types of vegetation are similar. The area supports a mixture of northern and central hardwoods. Sugar maple, birch, and beech, as well as oaks and hickories, are the major species. White pine and hemlock are the dominant conifers. Pitch pine and red pine grow on sandy soils that formed in outwash. Red maple grows on the wetter sites. Northern white-cedar reaches its northern limit in bogs in this area. The nonnative, invasive plants include Japanese barberry, Asiatic bittersweet, and Norway maple. The most common understory plants are moosewood and hobblebush in the northern part of the MLRA and dogwood in the southern part. Abandoned agricultural land is dominated by white pine and paper birch in the northern part of the area and red cedar and gray birch in the southern part.

Numerous unique habitats are in scattered areas throughout this MLRA. Some of the maritime habitats include coastal grasslands, heaths, and dunes; tidal wetlands of estuaries; and freshwater tidal reaches of the major rivers. Away from the coast, freshwater marshes, swamps, flood plains, lowlands, areas of peat, sand barrens, rocky summits, limestone fens, and glades occur.

Black bear, beaver, fisher, wild turkey, vultures, and forest songbirds are woodland species that are increasing in population in this area. Animals that are tolerant of human settlement also are increasing in population. Examples are white-tailed deer, opossum, skunk, raccoon, and coyote. The species that are decreasing in population are animals that inhabit more open areas, such as woodchuck, vole, and red fox, and such birds as bobolinks, meadowlarks, whippoorwills, and nighthawks. The species of fish in the area include brook trout, brown trout, rainbow trout, largemouth bass, chain pickerel, flounder, bluefish, and striped bass.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 7%
Grassland—private, 4%
Forest—private, 50%; Federal, 1%
Urban development—private, 28%
Water—private, 6%
Other—private, 4%

About one-half of this area is in hardwood and pine forests. Most of the forests are in small holdings. Some are State forests or other large holdings. The forests in the MLRA are used for wood products and for hunting and other kinds of recreation. The acreage used for urban development is increasing rapidly in this area. Agriculture in the area is dominated by dairy, nursery, and greenhouse stock, much of which is driven by the increase in residential development and the demand for landscaping materials. Some forage crops for dairy cattle are still grown, and truck crops, small fruits, and apples are grown on some farms, mainly near the larger towns and cities. Many farmsteads are used as rural residences, and the residents earn their living from nonfarm occupations.

The major soil resource concerns on cropland and forestland are sheet and rill erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Storm-water runoff and subsequent erosion and sedimentation are the primary concerns in managing areas of urban expansion.

Conservation practices on cropland generally include systems of crop residue management, especially conservation tillage; winter cover crops; rotations of annual crops and grasses and legumes; contour farming; irrigation water management; compost facilities; and nutrient, manure, and pesticide management. Excluding dairy cattle from wetlands and watercourses and developing rotational grazing systems help to control erosion and protect water quality. Storm-water management and erosion- and sediment-control practices are needed in the rapidly expanding urban areas. ■

144B—New England and Eastern New York Upland, Northern Part

This area (shown in fig. 144B-1) is in Maine (56 percent), New Hampshire (22 percent), Vermont (14 percent), Massachusetts (5 percent), New York (2 percent), and Connecticut (1 percent). It makes up about 20,500 square miles (53,125 square kilometers). Most of this area is in Maine and New Hampshire, but a small, separate part is on the Vermont-Massachusetts border with New York. The majority of Maine's population is in this MLRA. This is the easternmost MLRA in the country. It includes the cities of Bangor, Augusta, and Portland, Maine; the towns of Littleton, Plymouth, and Laconia, New Hampshire; and the towns of Montpelier, Barre, and St. Johnsbury, Vermont. The separate part of the MLRA on the eastern border of New York has no cities. Interstates 89, 90, 91, 93, and 95 cross different parts of this MLRA. Some of the White Mountain National Forest is in the part of the MLRA in New Hampshire, and the Acadia National Park is in the part in Maine. The Rachel Carson National Wildlife Refuge is in the part in southeast Maine. A large number of State forests and State parks are throughout this MLRA.

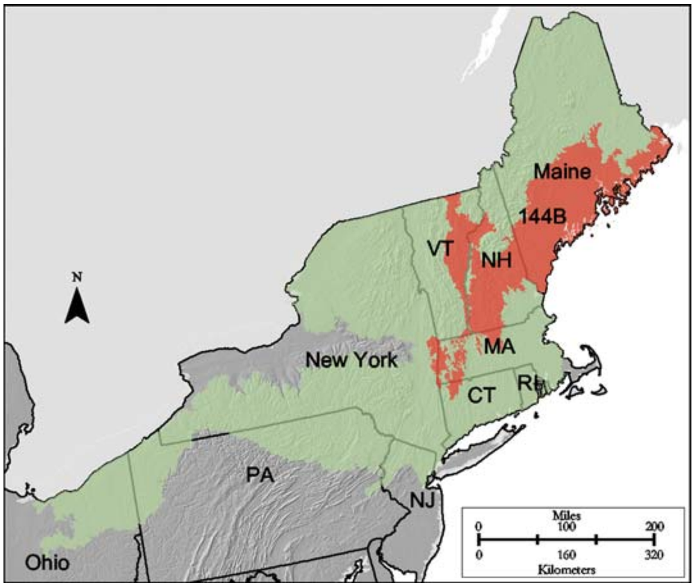

Figure 144B-1: Location of MLRA 144B in Land Resource Region R.

Physiography

This area is the New England Province of the Appalachian Highlands. The separate western part of the area is in the Taconic Section of the province. The rest of the area is mostly in the New England Upland Section. The part in southeastern Maine is in the Seaboard Lowland Section. This MLRA includes the entire coastal zone of Maine and extends inland along the major river valleys. Most of the area is characterized by rolling to hilly uplands. The area has some isolated mountain peaks. In the part of the area in southeastern Maine, gently sloping to level valleys terminate in coastal lowlands. Elevation ranges from sea level to 1,000 feet (0 to 305 meters) in much of the area. It is 2,000 feet (610 meters) on some hills and 2,950 feet (900 meters) on a few isolated peaks. Local relief is mostly low or moderate. It generally is highest in the northern part of the area and decreases as sea level is approached. An exception is the Taconic Mountains along the New York-Massachusetts border, where relief is substantial. Relief is mostly about 5 to 65 feet (2 to 20 meters) in the valleys and about 80 to 330 feet (25 to 100 meters) in the uplands.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Connecticut (0108), 20 percent; Maine Coastal (0105), 15 percent; Saco (0106), 15 percent; Kennebec (0103), 13 percent; Merrimack (0107), 11 percent; Penobscot (0102), 9 percent; Androscoggin (0104), 6 percent; Richelieu (0201), 4 percent; Upper Hudson (0202), 3 percent; St. Francois (0111), 2 percent; and Connecticut Coastal (0110), 2 percent. In this area, the Piscataqua and Saco Rivers begin in New Hampshire and flow into Maine. The Penobscot and Saco Rivers are in the part of this area in Maine. Another major river in the area is the Merrimack River in New Hampshire. The part of the area in Vermont encompasses the upper end of the Connecticut River drainage and the headwaters of the Lamoille and Winooski Rivers. The small, separate part of the MLRA on the eastern border of New York has short reaches of the Batten Kill River in Vermont, the Kinderhook River in New York, and the headwaters of the Housatonic River in Massachusetts.

Geology

Most of this MLRA is characterized by till-mantled, rolling to hilly uplands. The northern and eastern parts of the area are underlain mostly by granite, gneiss, and schist bedrock. Limestone, dolomite, and marble beds interspersed with basalt flows occur in the southern and western parts. Stratified drift deposits of unconsolidated sand and gravel, primarily glacial outwash, fill most of the narrow river valleys. Some marine sediments occur at the lower end of the valleys that terminate in the coastal lowlands in southeastern Maine. Some glacial lake sediments occur on valley floors behind glacial moraines. The areas of marine and glacial lake sediments are not extensive but are important agricultural areas.

Climate

The average annual precipitation in most of this area is 33 to 45 inches (840 to 1,145 millimeters). It is 45 to 69 inches (1,145 to 1,755 millimeters) in a few scattered, higher elevation areas and along the coast. The precipitation generally is evenly distributed throughout the year. Near the coast, however, it is slightly lower in summer. In inland areas, it is slightly higher in spring and fall. Rainfall occurs as high-intensity, convective thunderstorms during the summer. During the winter, most of the precipitation occurs as moderate-intensity storms (northeasters) that produce large amounts of rain or snow. Heavy snowfalls commonly occur late in winter. The average annual temperature is 39 to 48 degrees F (4 to 9 degrees C). The freeze-free period averages 160 days and ranges from 120 to 195 days. Temperatures and the length of the freeze-free period increase from north to south and closer to the coast.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 13.4%; ground water, 4.5%
Livestock—surface water, 0.2%; ground water, 0.3%
Irrigation—surface water, 0.2%; ground water, 0.0%
Other—surface water, 73.2%; ground water, 8.3%

The total withdrawals average 885 million gallons per day (3,350 million liters per day). About 13 percent is from ground water sources, and 87 percent is from surface water sources. Abundant precipitation, many perennial streams, and many natural lakes and ponds are important sources of surface water. Many large and small reservoirs provide municipal and industrial water. The surface water in the area is of good quality and is suitable for almost all uses with no or minimal treatment. Acid rain and municipal and industrial waste discharges are the primary sources of contamination of the surface water.

Ground water is scarce on the till-mantled uplands but is abundant in the deep outwash deposits in the valleys. Most public supplies and industries that use ground water obtain the water from the stratified drift aquifer in the river valleys. The water from this aquifer is soft to very hard, is acidic, and has very low levels of total dissolved solids, 75 to 125 parts per million (milligrams per liter). The aquifer is only about 100 feet (30 meters) thick, and the water table is typically at a depth of 30 feet (10 meters). As a result, water in the aquifer is very susceptible to contamination from surface activities.

Domestic and some public supply and light industry water is obtained from wells drilled in the granite, gneiss, and schist bedrock under the uplands in Vermont, New Hampshire, and Maine. This water has slightly more total dissolved solids and generally is harder than the water in the valley fill aquifers. Also, there are more instances of iron concentrations exceeding 300 parts per billion (micrograms per liter) in water from the crystalline bedrock aquifer. This is the national and State secondary standard for iron in drinking water. High levels of radon-222 occur in wells drilled into granite that has high amounts of muscovite and biotite.

Industrial and domestic wells pump water from a carbonate aquifer on the western edge of Massachusetts, in the northeast corner of Connecticut, and along the eastern border of New York. This aquifer consists of beds of limestone, dolomite, and marble interspersed with beds of schist and quartzite. The water from this aquifer is very hard and has more than 500 parts per million (milligrams per liter) total dissolved solids. This level exceeds the national secondary drinking water standard.

Soils

The dominant soil orders in this MLRA are Inceptisols and Spodosols. The soils in the area dominantly have a frigid soil temperature regime, an aquic or udic soil moisture regime, and isotic, illitic, or mixed mineralogy. They are shallow to very deep, generally excessively drained to poorly drained, and loamy or sandy. Eutrudepts (Buxton series) and Epiaquepts (Scantic series) formed in glaciomarine or glaciolacustrine deposits on coastal lowlands and in valleys. Dystrudepts formed in till on till plains and moraines (Lanesboro, Shelburne, and Colrain series) and on hills and ridges (Taconic series). Haplorthods formed in glaciofluvial deposits on outwash plains and eskers (Adams and Colton series); in till on till plains, ridges, and moraines (Bangor, Berkshire, Dixmont, Hermon, Lyman, Monadnock, and Tunbridge series); and in dense till on drumlins and uplands (Marlow and Peru series).

Biological Resources

This area supports northern hardwoods. Beech, white birch, yellow birch, sugar maple, and hemlock are dominant on the better drained soils. Spruce and balsam fir are dominant on the wetter soils and on mountaintops. The northern aspects of mountain slopes favor spruce and fir, and the southern aspects support northern hardwoods. White pine is common on abandoned farmland, in river valleys, and on outwash plains. Spruce fir, mountain cranberry, and similar acid-tolerant plants grow on alpine or subalpine mountaintops.

Some of the major wildlife species in this area are white-tailed deer, beaver, snowshoe hare, muskrat, mink, and ruffed grouse. The species of fish in the area include trout, salmon, alewife, striped bass, smelt, and eel.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 4%
Grassland—private, 2%
Forest—private, 76%; Federal, 1%
Urban development—private, 7%
Water—private, 6%
Other—private, 4%

Almost four-fifths of this area is in hardwood and conifer forests, most of which are in small holdings. Some areas are in State forests or in other large holdings. Sawlogs and pulp for paper mills are the principal products, but maple syrup and Christmas trees are produced on some sites. The forests are widely used for hunting and other kinds of recreation. A significant acreage of the forestland is used for residential and leisure home developments. Forage crops for dairy cattle are grown on most of the cropland in the area. Truck crops, small fruits, and apples are grown on some farms, mainly near the larger towns and cities. Native lowbush blueberries are produced in an area in the extreme eastern part of this MLRA. This is the largest blueberry production area in the world. Many farmsteads are used as rural residences, and the residents earn their living from nonfarm occupations. Urban development is increasing in this populous MLRA.

The major soil resource concerns are sheet, rill, and gully erosion on cropland and on logging roads and forest landings and sedimentation in urban areas during periods of construction. Other resource concerns on cropland include nutrient management, maintenance of the content of organic matter in the soils, maintenance of soil quality, and the loss of important farmland to development.

Conservation practices on cropland generally include crop residue management (no-till), diversions, grassed waterways, cover crops, and filter strips. They also include management of the storage and utilization of all sources of nutrients on farms.

Conservation practices on forestland generally include riparian buffer zones, sediment control on roads and in ditches, and proper stream crossings, which prevent sedimentation and help to maintain water quality. ■

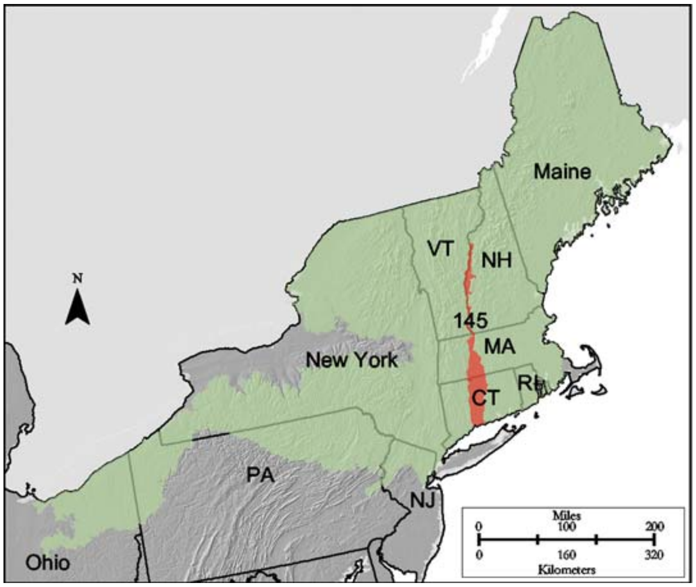

Figure 145-1: Location of MLRA 145 in Land Resource Region R.

145—Connecticut Valley

This area (shown in fig. 145-1) is in Connecticut (45 percent), Massachusetts (30 percent), New Hampshire (15 percent), and Vermont (10 percent). It makes up about 2,130 square miles (5,520 square kilometers). It includes the cities of Springfield, Massachusetts, and Hartford, Connecticut, and the towns of Lebanon and Claremont, New Hampshire; White River Junction and Brattleboro, Vermont; Amherst and Northampton, Massachusetts; and Middletown, Meriden, and New Haven, Connecticut. Interstate 91 follows the floor of the Connecticut River Valley for almost the entire length of this MLRA. Interstate 95 crosses the southern tip of the area, in New Haven, and Interstates 84, 90, and 89 cross the area. Dinosaur State Park in Connecticut and the Holyoke Dam in Massachusetts provide excellent sites for observing fossil dinosaur tracks. A large number of State forests and State parks are throughout this area.

Physiography

This area is in the New England Upland Section of the New England Province of the Appalachian Highlands. The nearly level floor of the Connecticut River Valley makes up most of the area. Nearly level to sloping lowlands are at the outer edges of the river valley. These lowlands are broken by isolated, north- to south-trending trap-rock ridges that are hilly and steep. Elevation ranges from sea level to 330 feet (100 meters) in the lowlands and from 650 to 1,000 feet (200 to 305 meters) on ridges. Local relief is typically 0 to 65 feet (0 to 20 meters) in the lowlands and about 160 to 330 feet (50 to 100 meters) on ridges.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Connecticut (0108), 85 percent, and Connecticut Coastal (0110), 15 percent. This area is on the floor of the Connecticut River Valley for nearly the entire length of the valley within the United States. The Connecticut River empties into Long Island Sound in the southeast corner of the area.

Geology

Recent alluvium has been deposited on the nearly level flood plain along the Connecticut River since the glacial retreat about 10,000 to 12,000 years ago. These deposits created some of the most productive agricultural soils in New England. Glacial lake deposits, outwash, and recent alluvial deposits dominate the part of the valley north of Rocky Hill, Connecticut. A great freshwater glacial lake, Lake Hitchcock, extended from Rocky Hill northward to Lyme, New Hampshire. For many thousands of years, this lake received sediments from the contributing uplands. Very thick deposits of varved clay, silt, and very fine sand were in the lake. Today, these deposits are as much as 200 feet thick. Water flowing off the higher hills along the valley created great delta deposits of sand and gravel. Outwash deposits along the valley walls were created whenever the sand and gravel were unable to reach the lake because of ice blockage. These kame terraces appear as linear deposits along the valley. After the glacial retreat, winds deposited fine sand on the lake deposits and over much of southern New England. This deposition resulted in dune deposits on the lake bottom and a loess cap throughout much of southern New England.

Late Triassic and early Jurassic bedrock lies beneath the glacial sediments. Rift valleys developed in this area during the migration of the continents to their present locations. These large basins were filled with a basalt-sandstone rock sequence locally known as the Newark Supergroup. These rocks occur from Nova Scotia to South Carolina. The bedrock in the Connecticut Valley consists of this sandstone, shale, and conglomerate sequence. Basalt flows along the rift zones periodically spread across these shallow freshwater sediments. Today, these igneous rocks form many of the landmarks throughout the upper valley, such as Mt. Tom, Mt. Holyoke, and Mt. Sugarloaf.

Climate

The average annual precipitation in this area is 33 to 52 inches (840 to 1,320 millimeters). The precipitation is evenly distributed throughout the year. Rainfall occurs as high-intensity, convective thunderstorms during the summer. During the winter, most of the precipitation occurs as moderate-intensity storms (northeasters) that produce large amounts of rain or snow. The seasonal snowfall averages 40 inches (100 centimeters). The average annual temperature is 42 to 52 degrees F (6 to 11 degrees C). The freeze-free period averages 180 days and ranges from 140 to 220 days. Temperatures and the length of the freeze-free period increase from north to south.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 34.9%; ground water, 16.0%
Livestock—surface water, 0.0%; ground water, 0.1%
Irrigation—surface water, 3.9%; ground water, 1.2%
Other—surface water, 38.0%; ground water, 5.9%

The total withdrawals average 515 million gallons per day (1,950 million liters per day). About 23 percent is from ground water sources, and 77 percent is from surface water sources. Precipitation, perennial streams, and lakes provide an abundance of good-quality surface water in this area. Water for municipal and industrial needs is stored in reservoirs in this area and in adjoining areas. The surface water is of good quality, but it commonly requires some treatment prior to use as drinking water. Progress has been made in cleaning up municipal and industrial waste discharges into the Connecticut River and its tributaries.

Public supply, municipal, and industrial water is obtained from the glacial outwash and the alluvial valley fill along the major rivers. The ground water in this aquifer is abundant. It is acidic, is soft to very hard, and is very low in total dissolved solids, typically 75 to 125 parts per million (milligrams per liter). This aquifer is typically less than 100 feet (30 meters) thick, and the water table is often at a depth of 30 feet (10 meters). As a result, the water in the aquifer is highly susceptible to contamination by surface activities.

Some public supply, municipal, and industrial water is obtained from the marine sediments in the parts of this area in Massachusetts and Connecticut. The water in this aquifer is moderately hard and has about 250 parts per million (milligrams per liter) total dissolved solids in the upper 200 feet (60 meters) of the aquifer. In the lower part of the aquifer, the level of total dissolved solids doubles and the water is very hard. Some deposits of copper, lead, zinc sulfides, and uranium minerals occur in this aquifer. Water pumped from areas with ore deposits must be treated before it can be used for drinking or for industrial purposes.

Many shallow domestic wells obtain ground water from the till deposits that cover the bedrock in the lowlands on each side of the flood plain along the Connecticut River. The water in the till is very similar in quality to the water in the valley fill aquifer. Some public supply and light industry water is obtained from wells drilled in the igneous and metamorphic rocks under the till in the lowlands. This water has slightly more total dissolved solids and generally is harder than the water in the valley fill and till aquifers. Also, there are more instances of iron concentrations exceeding 300 parts per billion (micrograms per liter) in the crystalline bedrock aquifer. This is the national and State secondary standard for iron in drinking water. High levels of radon-222 occur in wells drilled into granite that has high amounts of muscovite and biotite.

Soils

The dominant soil orders in this MLRA are Entisols and Inceptisols. Some Spodosols are in the northern part of the area. The soil temperature regime generally is mesic but is frigid in the northern part of the area. The soils in the area dominantly have an aquic or udic soil moisture regime and mixed mineralogy. They generally are very deep, excessively drained to poorly drained, and clayey, loamy, or sandy. Dystrudepts formed in outwash deposits on outwash plains and terraces (Agawam and Merrimac series), in dense till on till plains and hills (Ludlow and Wethersfield series), and in till on till plains, hills, and mountains (Cardigan, Cheshire, Dutchess, and Kearsarge series). Udorthents (Hinckley and Manchester series) and Udipsamments (Deerfield and Windsor series) formed in outwash on outwash plains, kames, terraces, and eskers. Endoaquepts (Scitico series) formed in glaciolacustrine material on terraces. Udifluvents (Hadley series) formed in alluvium on flood plains.

Biological Resources

Historic and modern types of vegetation are similar in this area. The area primarily supports central hardwoods. Some northern hardwoods are at the northern extent of the MLRA. Habitat loss and fragmentation are widespread throughout the lower part of the Connecticut River Valley. Attempts to cultivate infertile sandy areas were unsuccessful and have contributed to the “barren” appearance of the sand plains and the dominance of pitch pine in those areas. The major tree species in the rest of the forested areas are sugar maple, birch, beech, oaks, and hickory. White pine and hemlock are the dominant conifers, but pitch pine and red pine are more common on sandy soils. Red maple grows on the wetter sites. Japanese knotweed is one nonnative, invasive plant that hinders the growth and development of the more desirable plants in the area. The most common understory plants are moosewood and hobblebush in the northern part of the area and dogwood in the southern part. Abandoned agricultural land is dominated by white pine and paper birch in the northern part and red cedar and gray birch in the southern part.

The important upland habitats include trap-rock ridges and sand plains. Oak woodlands and cedar glades are common on the ridges. Black oak savannas mixed with pitch pine and varying amounts of little bluestem are common on the sand plains. Other habitats of significance include wetlands associated with the Connecticut River freshwater marshes, swamps, flood plains, and lowlands. The dominant trees on the flood plains are black willow, cottonwood, and sycamore.

Large mammals, such as white-tailed deer, moose, and black bear, are in the forests in the northern part of this area. Animals that are tolerant of human settlement are numerous throughout the rest of the MLRA. Examples are white-tailed deer, opossum, skunk, raccoon, and coyote. The species that are decreasing in population are animals that inhabit more open areas, such as woodchuck, vole, and red fox, and such birds as bobolinks, meadowlarks, whippoorwills, and nighthawks. The Connecticut River waterway is a significant anadromous fishery, supporting alewife, herring, and American shad. Atlantic salmon are being reintroduced, and shortnose sturgeon is in the lower reaches of the river.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 13%
Grassland—private, 3%
Forest—private, 42%
Urban development—private, 34%
Water—private, 4%
Other—private, 4%

The hardwood and pine forests in this area are used for residential development, recreation, wildlife habitat, and esthetic purposes. The agricultural land in the area is used mainly for nursery and greenhouse stock; truck crops, such as fruits and vegetables; and tobacco. The extent of industrial and residential development is increasing. The Connecticut Valley is one of the most productive and valuable areas in the Northeast because of the long growing season and the proximity to cities and towns. Urban and industrial expansion, however, is causing a rapid loss of agricultural land. Many of the current agricultural fields predate the discovery of America. Archaeological evidence indicates that these fields and the associated anadromous fishery in the lower reaches of the valley were used by American Indians during the Woodland period. As a result, later settlement of the area by Europeans was simplified.

The major soil resource concerns are sheet and rill erosion, erosion and sedimentation caused by storm-water runoff, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. The protection of agricultural land from encroaching development is a serious resource concern.

Conservation practices on cropland generally include systems of crop residue management (such as conservation tillage), winter cover crops, rotations of annual crops and grasses and legumes, contour farming, irrigation water management, compost facilities, nutrient management, manure management, and pesticide management. Excluding livestock from wetlands and watercourses and developing rotational grazing systems help to control erosion and preserve water quality. Conservation practices that are important in areas of community development include critical site planting and urban storm-water management. ■

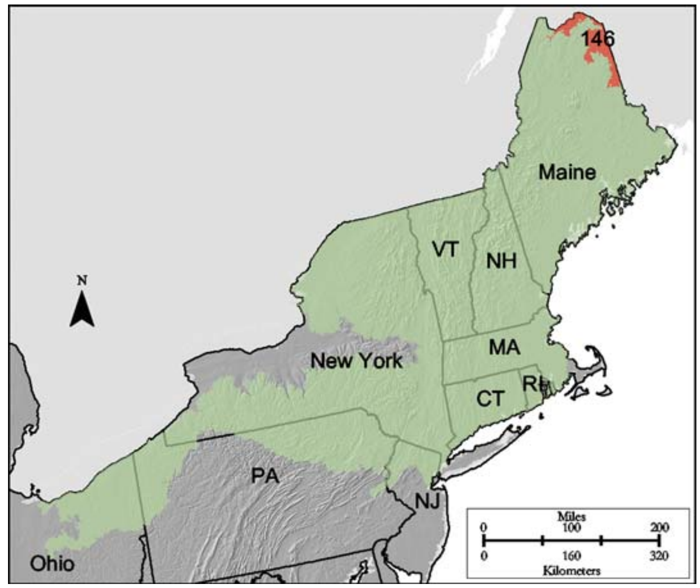

Figure 146-1: Location of MLRA 146 in Land Resource Region R.

146—Aroostook Area

This area is entirely in Maine (fig. 146-1). It makes up about 1,275 square miles (3,305 square kilometers). Presque Isle is the largest city in the area. Interstate 95 ends in the town of Houlton, at the border with New Brunswick, Canada. Aroostook State Park, Fort Kent Historic Site, and Loring Commerce Center are in this area. The Big Rock ski area is in the middle of this MLRA and is on the highest point, which is Mars Hill Mountain.

Physiography

This area is in the New England Upland Section of the New England Province of the Appalachian Highlands. It is mostly a nearly level to sloping lowland. Rolling hills are common in the north-central part of the area. The lowland is broken by isolated, north- to south-trending trap-rock ridges (basalt and diabase dikes) that are hilly and steep. These ridges are more common in the far northern parts of the area, near the Canadian border. Elevation ranges from sea level to 330 feet (0 to 100 meters) in the lowlands and from 650 to 1,000 feet (200 to 305 meters) on the ridges. Local relief is less than 5 feet to 65 feet (1 to 20 meters) on the lowlands. The ridges are about 165 to 330 feet (50 to 100 meters) above the lowlands.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: St. John (0101), 98 percent, and Penobscot (0102), 2 percent. The St. John River is on the northern border of this area, and its principal tributary, the Aroostook River, crosses the north-central part of the area.

Geology

Almost all of this area is mantled with a mixture of glacial till, outwash, stratified drift, and glacial lake and marine sediments. The till is more prominent on the uplands in the area, and the other surficial deposits are more common in the valleys and lowlands. Numerous basalt and diabase dikes occurring as north- to south-trending ridges cut across this area. Most of the eastern half of the area is underlain by the Cary Mills Formation, a bluish gray limestone with some dark gray calcareous shale and siltstone layers. The rest of the area is underlain by a variety of igneous and metamorphic rocks. The most common igneous rocks are granite, gabbro, diorite, granodiorite, and pegmatite. The metamorphic rocks include schist, gneiss, quartzite, slate, phyllite, and argillite. Recent deposits of river alluvium (unconsolidated sand and gravel) cover the flood plains along the major rivers.

Climate

The average annual precipitation in this area is 35 to 42 inches (890 to 1,065 millimeters). The precipitation is evenly distributed throughout the year. Rainfall occurs as high-intensity, convective thunderstorms during the summer. The seasonal snowfall averages 40 inches (100 centimeters). The average annual temperature is 37 to 41 degrees F (3 to 5 degrees C). The freeze-free period averages 140 days and ranges from 120 to 155 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 30.6%; ground water, 7.5%
Livestock—surface water, 0.2%; ground water, 0.1%
Irrigation—surface water, 2.2%; ground water, 0.0%
Other—surface water, 50.5%; ground water, 8.9%

The total withdrawals average 23 million gallons per day (87 million liters per day). About 17 percent is from ground water sources, and 83 percent is from surface water sources. Precipitation, perennial streams, lakes, and aquifers provide an abundance of water. Water for municipal and industrial needs is stored in reservoirs in this area and in adjoining areas. The surface water in the area is suitable for most uses with little to no treatment. In some soils that have dense till, the water table is perched from late in fall to early in spring. Soils on wetlands are saturated during a large part of the year.

The ground water used in this area typically comes from the glacial outwash and stratified drift aquifers on the valley floors along the St. John and Aroostook Rivers or from carbonate bedrock on the east edge of the area. Water from both of these aquifers is of very good quality. The median level of total dissolved solids is 80 parts per million (milligrams per liter) in water from the outwash and stratified drift aquifers and 256 parts per million (milligrams per liter) in the water from the carbonate bedrock. The water from the carbonate rocks is very hard and requires treatment for hardness, and the water from the glacial aquifers is soft. Because of the shallow depth to the water table in the glacial aquifers and the openings in the carbonate rock connected to the surface, both of these aquifers are susceptible to contamination from agriculture, urbanization, and industry.

Homeowners in the western half of this area and in the uplands above the river valleys typically use ground water from either the glacial till or the igneous and metamorphic bedrock. The water from these aquifers is of very good quality, but well yields are typically much lower than yields from wells in the more water-rich outwash, stratified drift, and carbonate aquifers.

Soils

The dominant soil orders in this MLRA are Spodosols and Inceptisols. The soils in the area dominantly have a frigid soil temperature regime, a udic soil moisture regime, and mixed or isotic mineralogy. They are moderately deep to very deep, well drained to excessively drained, and loamy to sandy-skeletal. Eutrudepts (Mapleton series) formed in till on till plains and ridges. Haplorthods formed in till (Caribou and Conant series) or dense till (Perham series) on till plains and ridges and in outwash deposits (Colton and Stetson series) on terraces, kames, eskers, and outwash plains.

Biological Resources

The native vegetation consists of both coniferous and deciduous trees. Maine is known for its wide variety of trees. The hardwoods include sugar maple, beech, quaking aspen, white birch, and yellow birch. The softwoods include red spruce, balsam fir, white pine, cedar, and tamarack. Tree plantations have been established since the 1960s on many farms. The typical species on these plantations are white spruce, Norway spruce, and red pine.

Some of the major wildlife species in this area are black bear, moose, white-tailed deer, red fox, eastern coyote, snowshoe hare, and ruffed grouse.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 13%
Grassland—private, 3%
Forest—private, 75%; Federal, 1%
Urban development—private, 4%
Water—private, 2%
Other—private, 2%

Most of this area is forested or is cropland reverting to forest. The forest products in the area are used mainly in the paper industry and for lumber. The cropland in the area is used mainly for potatoes, but broccoli, oats, canola, and barley also are grown.

The major soil resource concerns are sheet, rill, and gully erosion caused by rainfall, intensive cropping, and outdated methods of irrigation; the condition and tilth of the soils, surface compaction, and sediment deposition in areas used as cropland; and erosion and sedimentation along the forest roads used by the logging industry.

Conservation practices on cropland generally include crop rotations (especially where potatoes are grown), grassed waterways in areas of concentrated flow, stripcropping, cover crops, nutrient management, proper row direction, and irrigation water management. Conservation practices on forestland generally include forest stand improvement and proper construction, use, and maintenance of water bars, culverts, stream crossings, and access roads. ■

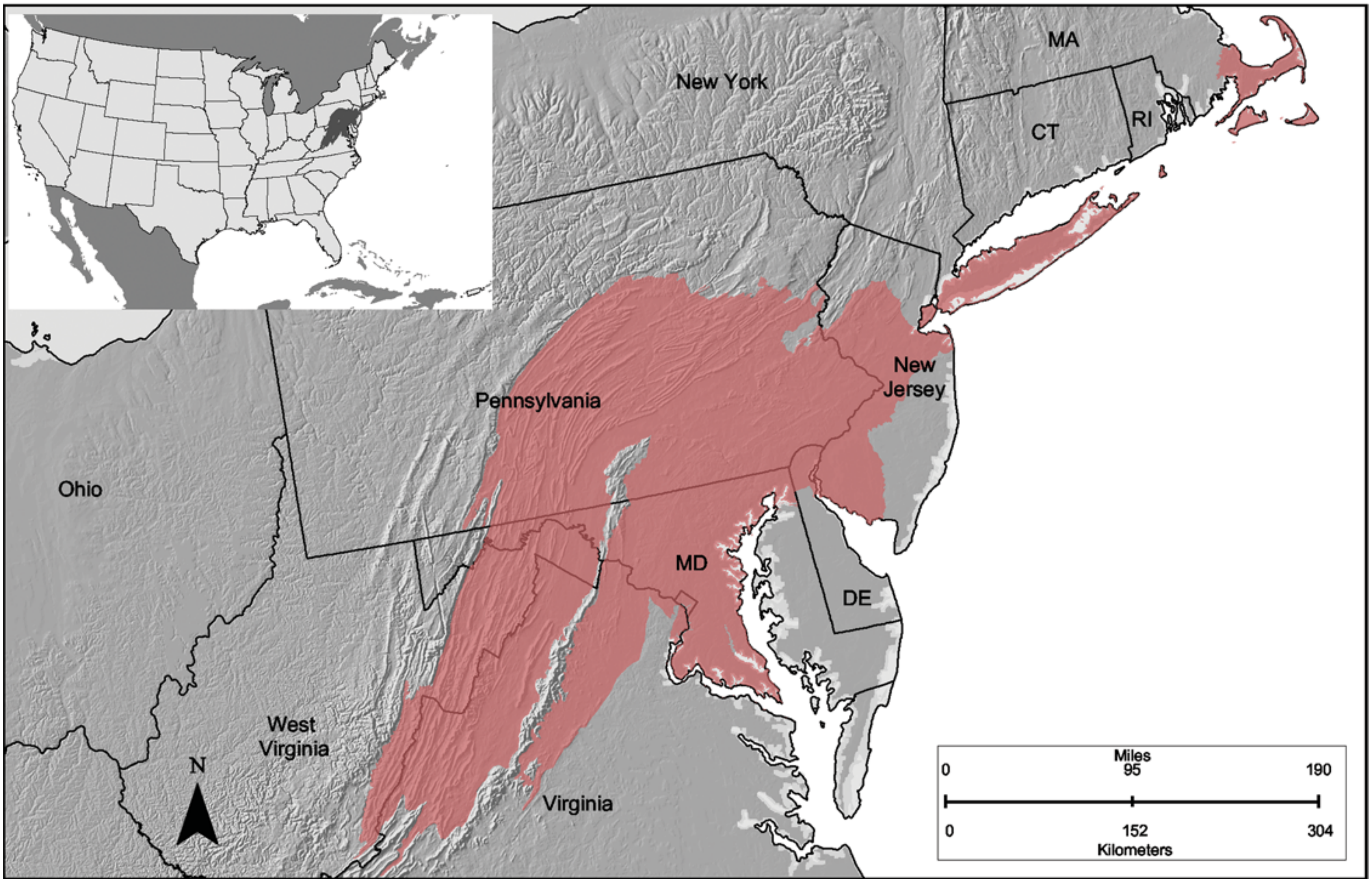

Figure S-1: Location of Land Resource Region S.

S—Northern Atlantic Slope Diversified Farming Region

This region (shown in fig. S-1) is in Pennsylvania (40 percent), Virginia (21 percent), Maryland (14 percent), West Virginia (10 percent), New Jersey (9 percent), New York (3 percent), Massachusetts (2 percent), Delaware (1 percent), the District of Columbia (less than 1 percent), and Rhode Island (less than 1 percent). It makes up 40,865 square miles (105,905 square kilometers).

This is a region of coastal lowlands, coastal plains, the piedmont, and ridges and valleys (fig. S-2). The climate is temperate and humid. The average annual precipitation is 37 to 45 inches (940 to 1,145 millimeters) in most of the region, but it is as high as 52 inches (1,320 millimeters) in the northeast corner of the region. Precipitation is slightly higher during spring and summer than during the rest of the year. The average annual temperature is 48 to 56 degrees F (9 to 14 degrees C). In most of the region, the freeze-free period ranges from 175 to 235 days. It is shortest in the mountains and longest along the Atlantic Ocean and the Chesapeake Bay.

The total withdrawals of freshwater in this region average about 8,220 million gallons per day (31,110 million liters per day). About 81 percent is from surface water sources, and 19 percent is from ground water sources. Abundant precipitation, numerous perennial streams, and good aquifers provide ample supplies of good-quality water for all uses in the region. One-third of the water used in this populous region is for public supply. Most of the remaining water is used for mining, municipal supply, and industry and for cooling thermoelectric power plants.

The soils in this region are dominantly Alfisols, Ultisols, or Inceptisols. The dominant suborders are Udalfs, Udults, and Ochrepts. These soils commonly have a fragipan. Aquults and Aquepts are on lowlands and in depressions, particularly on the coastal plains. Soils on flood plains, mainly Ochrepts and Fluvents, are of minor extent. Hydraquents, Sulfaquents, and Sulfihemists are in tidal marshes along the Chesapeake Bay and the Atlantic Ocean. Psamments are of major extent on the Long Island-Cape Cod coastal lowland and of minor extent on the coastal plains. The soils in the region dominantly have a mesic soil temperature regime, a udic soil moisture regime, and mixed mineralogy.

Figure S-2: Parallel ridges and intervening valleys in an area of Land Resource Region S.

About 92 percent of this region is privately owned land, mostly in farms. Farming is highly diversified. Truck crops, fruits, and poultry are important sources of income, particularly on the coastal plains. Forage crops, soybeans, and grain for dairy and beef cattle also are important. Many large-scale corporate farms on the coastal plains are associated with the canning and frozen food industries. Many farms are operated part-time by people who earn most of their living in the cities. Rural residences are on many sites that are less favorable for farming. Throughout the region, urban areas are encroaching on farmland. Steep slopes occur largely in forests used for timber production and for recreation. ■

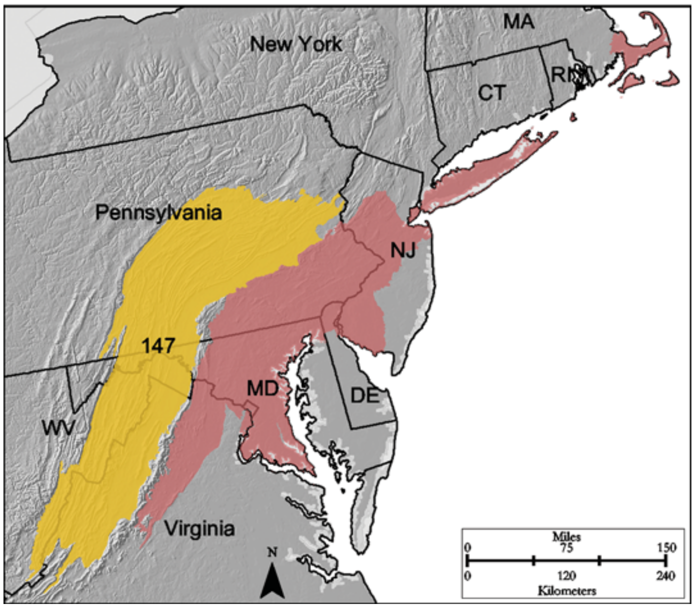

Figure 147-1: Location of MLRA 147 in Land Resource Region S.

147—Northern Appalachian Ridges and Valleys

This area (shown in fig. 147-1) is in Pennsylvania (54 percent), Virginia (23 percent), West Virginia (20 percent), and Maryland (3 percent). It makes up about 20,750 square miles (53,775 square kilometers). It includes the cities or towns of Harrisburg, Williamsport, Carlisle, and State College, Pennsylvania; Cumberland and Hagerstown, Maryland; Martinsburg, Moorefield, and White Sulphur Springs, West Virginia; and Winchester, Harrisonburg, and Staunton, Virginia. From north to south, the highways crossing this area include Interstates 80, 76, 81, 70, 68, 66, 64, and 77. Part of the Delaware Gap and Seneca Rocks National Recreation Areas and parts of the Jefferson, George Washington, and Monongahela National Forests are in this MLRA. The Chesapeake and Ohio National Historic Park and the Antietam National Battlefield also are in this area.

Physiography

This area is in the Middle Section of the Valley and Ridge Province of the Appalachian Highlands. It is a folded and faulted area of parallel ridges and valleys that are carved out of anticlines, synclines, and thrust blocks. Parallel sandstone and shale ridges are separated by narrow to moderately broad limestone and shale valleys. The ridges are strongly sloping to extremely steep and have narrow, rolling crests, and the valleys are mainly level to strongly sloping. The western side of the area is dominantly hilly to very steep and is rougher and much steeper than the eastern side, much of which is rolling and hilly. Elevation generally ranges from 330 to 985 feet (100 to 300 meters) in the valleys and from 1,310 to 2,625 feet (400 to 800 meters) on the ridges and mountains. It is as high as 2,955 feet (900 meters) on some mountain crests and is nearly 4,430 feet (1,350 meters) on a few isolated, linear mountain ridges. Local relief in the valleys is about 15 to 165 feet (5 to 50 meters). The ridges rise about 660 feet (200 meters) above the adjoining valleys.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Susquehanna (0205), 39 percent; Potomac (0207), 37 percent; Lower Chesapeake (0208), 10 percent; Delaware (0204), 10 percent; and Kanawha (0505), 4 percent. The Susquehanna, Potomac, Greenbrier, New, Clinch, and James Rivers are the major streams that drain this MLRA. Reaches of the Schuylkill, Lehigh, James, and Greenbrier Rivers and Anthony Creek have been designated as National Wild and Scenic Rivers in this area.

Geology

This area is underlain by Paleozoic sediments ranging in age from Cambrian to Pennsylvanian. The resistance of these sediments to erosion varies greatly and has a major effect on the topography. The ridge crests are made up primarily of resistant sandstones and conglomerate bedrock. The valleys are underlain by less resistant shales and limestone. The topographic orientation of the Valley and Ridge Province is dominantly northeast to southwest. The streams follow the less resistant rock types and cut through the more resistant rock types at an angle of 90 degrees, forming water gaps, most of which are along zones of intensive fracturing. As a result of this process, a trellis drainage pattern characterizes this MLRA.

Climate

The average annual precipitation in most of this area is 31 to 45 inches (785 to 1,145 millimeters). It is typically 45 to 52 inches (1,145 to 1,320 millimeters) in the northern end of the area, in Pennsylvania. The maximum precipitation occurs from late winter through early summer, and the minimum occurs in fall. About 21 to 26 inches (535 to 660 millimeters) falls during the growing season. The average annual snowfall ranges from 16 to more than 51 inches (40 to 130 centimeters). The average annual temperature is 44 to 57 degrees F (7 to 14 degrees C). The freeze-free period averages 180 days and ranges from 140 to 220 days. The cooler temperatures and the shorter freeze-free periods are at the higher elevations and the more northern latitudes.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 10.2%; ground water, 3.0%
Livestock—surface water, 0.3%; ground water, 0.5%
Irrigation—surface water, 0.3%; ground water, 0.1%
Other—surface water, 76.3%; ground water, 9.4%

The total withdrawals average 1,950 million gallons per day (7,380 million liters per day). About 13 percent is from ground water sources, and 87 percent is from surface water sources. In most years the supply of moisture is adequate for maximum crop production and other needs. Short dry periods early in summer occasionally reduce crop yields. Springs, farm ponds, reservoirs, and streams are the principal sources of water in this area. Streams, some ponds, and springs provide water for livestock. Springs also provide some domestic drinking water. The many rivers crossing this area are sources of public supply and industrial water. Most of the surface water in the area is of good quality and is suitable for most uses with minimal treatment.

The abundance of ground water depends largely on landscape and geology in this area. The most abundant water sources are in coves and valleys underlain by carbonate rocks. For example, the Valley and Ridge aquifers in Virginia consist of limestone and dolomite. The water in these aquifers is low in total dissolved solids, but it is very hard and may have a nitrate level that exceeds the national drinking water standard of 10 parts per million (milligrams per liter). This aquifer is called the Cambrian-Ordovician Carbonate aquifer in Tennessee, and it includes layers of sandstone and shale as well as carbonates. Similar rock types are used as aquifers in the parts of this area in Maryland and Pennsylvania. These aquifers all have water of similar quality, and they provide domestic water for rural landowners, for industry, and for communities. The water is in fractures, joints, and bedding planes in the sandstone and shale layers as well as in solution openings in the limestone and dolomite layers. Most wells are 300 or less feet (90 or less meters) deep. Because of the shallow depth to water, the concentration of agriculture, the urban areas, industrial plants on the valley floors, and the solution openings in the carbonate layers, the ground water in this area is susceptible to contamination from human activities.

Soils

The dominant soil orders in this MLRA are Inceptisols, Ultisols, and Alfisols. The soils in the area dominantly have a mesic soil temperature regime, a udic soil moisture regime, and mixed or siliceous mineralogy. They are shallow to very deep, generally excessively drained to moderately well drained, and loamy or clayey.

Steep and very steep, shallow to very deep, well drained, medium textured Dystrudepts (Berks, Calvin, Dekalb, Hazleton, Klinesville, Lehew, and Weikert series) are on the side slopes and ridges of mountains. Nearly level to sloping, very deep, well drained, medium textured to fine textured Hapludalfs (Hagerstown, Duffield, Edom, Carbo, and Washington series) are in limestone valleys. Gently sloping or sloping, deep and very deep, well drained and moderately well drained, medium textured to fine textured Hapludults (Bedington, Frankstown, Leck Kill, Mertz, and Murrill series), Fragiudults (Buchanan and Laidig series), and Paleudults (Frederick and Watahala series) are on the lower footslopes of the ridges and in the valleys. Most of these soils formed in residuum or colluvium derived from limestone (some of which is cherty), sandstone, or shale.

Nearly level to gently sloping, very deep, well drained to poorly drained, medium textured to fine textured Eutrudepts (Chagrin, Lobdell, and Tioga series) formed in alluvium on flood plains along drainageways.

Biological Resources

This area supports hardwoods. White oak, red oak, black oak, hickories, and associated upland hardwoods are the major species. Scarlet oak, chestnut oak, hickories, and scattered Virginia pine, pitch pine, shortleaf pine, and eastern white pine are common on the more shallow soils and on the south aspects, especially in the southern part of the area. Yellow-poplar, red oak, red maple, and other species that require more moisture grow in sheltered coves and on footslopes and north aspects.

Some of the major wildlife species in this area are white-tailed deer, wild turkey, gray squirrel, cottontail rabbit, raccoon, red fox, gray fox, ruffed grouse, and woodchucks. Smallmouth bass, rock bass, sunfish, catfish, and suckers are in the larger warm-water streams. Suitable cold-water streams are stocked with trout. Native brook trout inhabit many of the smaller streams.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 16%; Federal, 3%
Grassland—private, 11%; Federal, 1%
Forest—private, 48%; Federal, 7%
Urban development—private, 9%; Federal, 1%
Water—private, 1%
Other—private, 3%

Most of this area is in farms. The cropland in the area is used for a wide variety of crops, mainly corn, small grains, and forage for dairy and beef cattle. Other important crops are potatoes, soybeans, apples, peaches, and some tobacco and vegetables. Dairy, beef, and poultry farms are major enterprises.

The hardwood forests in the area are mainly small or medium-size holdings, but some are larger tracts of national and State forests, game lands, or parks. A significant acreage in the area is used for urban development or consists of land altered by urbanization. Much of the prime farmland in the valleys has been developed for urban uses.

The major soil resource concerns are water erosion, sedimentation, and maintenance of the content of organic matter and productivity of the soils. Conservation practices on cropland generally include conservation tillage (especially no-till systems), cover crops, contour farming, return of crop residue to the soil, and nutrient management. ■

148—Northern Piedmont

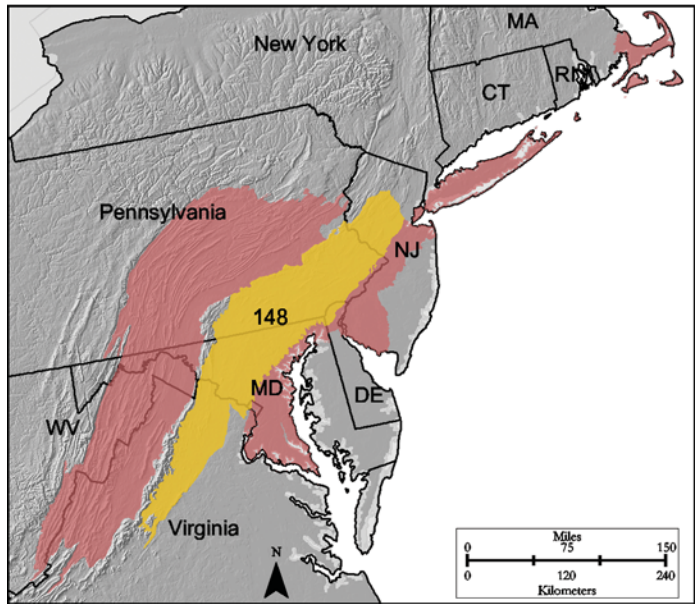

Figure 148-1: Location of MLRA 148 in Land Resource Region S.

This area (shown in fig. 148-1) is in Pennsylvania (38 percent), Virginia (30 percent), Maryland (21 percent), New Jersey (10 percent), and Delaware (1 percent). It makes up about 12,800 square miles (33,170 square kilometers). Philadelphia, Pennsylvania, is on the eastern boundary of this area. The north end of the MLRA, just southwest of the densely populated area of northeast New Jersey, includes the cities of Morristown, Plainfield, Somerset, and New Brunswick, New Jersey. The part of the MLRA in the western suburbs of the District of Columbia includes the cities of North Bethesda, Potomac, Rockville, Gaithersburg, and Germantown, Maryland. Another heavily populated area includes the greater part of Baltimore, Maryland, and cities just to the west of Baltimore. Charlottesville, Virginia, also is in this area. Interstates 80, 78, 76, 70, and 66 cross this area from east to west. Interstates 83 and 95 cross the area from north to south. The Chesapeake and Ohio Canal National Historic Park, along the Potomac River, and the Manassas National Battle Field, in northern Virginia, are in this MLRA. The Gettysburg National Military Park, in Pennsylvania, is just inside the west edge of the MLRA. The Fort Detrick Military Reservation is in the part of the area in Maryland. Many State parks and a few State forests are in this MLRA.

Physiography

Most of this area is in the Piedmont Upland Section of the Piedmont Province of the Appalachian Highlands. The southwest end and the northwest portion of the southwest half of this MLRA and the southeast portion of the northeast half of the MLRA are in the Piedmont Lowlands Section of the same province and division. The northwest portion of the northeast half of the MLRA is in the New England Upland Section of the New England Province of the Appalachian Highlands. Most of this area is an eroded part of the Piedmont Plateau. This MLRA is mostly gently sloping or sloping. Intrusive dikes and sills form fairly sharp ridges that interrupt the less steep terrain. Differential erosion has created low areas where rocks are soft and high areas where rocks are resistant to erosion. The steeper slopes generally are on ridges at the higher elevations or on side slopes adjacent to drainages. Elevation is dominantly 330 to 985 feet (100 to 300 meters) but ranges from 80 to 985 feet (25 to 300 meters) in most areas. It is as much as 1,650 feet (505 meters) or more on some ridges and isolated peaks.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Delaware (0204), 23 percent; Potomac (0207), 22 percent; Susquehanna (0205), 20 percent; Lower Chesapeake (0208), 18 percent; Upper Chesapeake (0206), 10 percent; and Lower Hudson-Long Island (0203), 7 percent. A number of National Wild and Scenic Rivers occur in this area. From New Jersey to Virginia, these rivers include the Schuylkill, Octoraro, Patuxent, Monocacy, and Rappahannock Rivers and Goose Creek and Deer Creek. The Delaware River separates Pennsylvania and Delaware from New Jersey in this area. The Susquehanna River crosses the northern end of the area, and the Potomac River separates the District of Columbia and Maryland from Virginia at the southern end of the area.

Geology

Most of this area is above the “fall line” on the east coast. The fall line is the boundary between Coastal Plain sediments and the crystalline bedrock of the interior uplands. The eastern third of the area is underlain mainly by Lower Paleozoic to Precambrian sediments and igneous rocks that have been metamorphosed. The typical rock types in this part of the MLRA are granite, gabbro, gneiss, serpentinite, marble, slate, and schist. The central part of the area is a crustal trough or basin that formed during the Triassic period. This basin represents the ancestral Atlantic Ocean that formed when the European-African continental plate began its movement westward from the North American plate. Many of the rocks in this part of the MLRA are the same rocks as those in the western British Isles, since they were deposited at a time when the North American, European, and African plates were all one landmass. The rocks deposited in the basins include Triassic sandstone, shale, and conglomerate. These ancient basins have been uplifted and are now in the uplands in this MLRA. Numerous Jurassic diabase and basalt dikes and sills cut the sedimentary rocks in the basins. The far western part of this MLRA is underlain mostly by Cambrian to Silurian limestone. The northern boundary of the MLRA marks the southernmost extent of the Wisconsin glaciers. Earlier periods of glaciation extend farther south in north-central New Jersey and in eastern Pennsylvania. Unconsolidated stream alluvium (primarily sand and gravel) fills the major river valleys.

Climate

The average annual precipitation in this area is 37 to 52 inches (940 to 1,320 millimeters). The maximum precipitation occurs as high-intensity, convective thunderstorms in spring and early in summer. Droughts of 10 to 14 days are common in summer. Snowfall occurs in winter. The average annual temperature ranges from 48 to 57 degrees F (9 to 14 degrees C). The freeze-free period averages 205 days and ranges from 170 to 240 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 28.5%; ground water, 3.1%
Livestock—surface water, 0.2%; ground water, 0.3%
Irrigation—surface water, 0.2%; ground water, 0.1%
Other—surface water, 61.8%; ground water, 5.8%

The total withdrawals average 3,160 million gallons per day. About 9 percent is from ground water sources, and 91 percent is from surface water sources. Precipitation and perennial streams are the important sources of water in this MLRA. The surface water is of marginal quality. It is suitable for almost all uses if properly treated. The lower Delaware, many New Jersey rivers, and the Potomac River were degraded for many years by sedimentation from agriculture and coal mining, acid mine drainage and other contaminants from surface mining, and waste discharges from cities and industrial sites. Many of these sources have been treated, so the surface water is now improved and is suitable for most uses with treatment. Water for urban areas is supplied largely by municipal reservoirs. Most of the water used for irrigation comes from streams and ponds.

Springs are common in rural areas. They provide water for many farmsteads. Some water for irrigation comes from wells. Shallow wells are important in rural areas, but most of the wells in the crystalline bedrock supply a limited quantity of water. The water in these igneous and metamorphic rocks is in joints, fractures, and openings along cleavage planes. This water is of excellent quality. It has less than 100 parts per million (milligrams per liter) total dissolved solids. The principal ions in the water are calcium, magnesium, and bicarbonate, and the water is typically soft.

Two other sources of ground water in this area are the alluvium filling the valley floors along most of the rivers and fractured shale and sandstone (the Newark Group). The water from both of these aquifers is very similar to that in the crystalline bedrock aquifers. It typically has 125 to 250 parts per million (milligrams per liter) total dissolved solids and is hard. Both of these aquifers lie beneath the most agriculturally productive soils in this area. Nitrate concentrations from fertilizers are somewhat higher in the water from these aquifers than in the water from any other aquifers in the area. The median values of all wells tested, however, are only 1 or 2 parts per million (milligrams per liter).

Some ground water is obtained from carbonate rocks in this area. The water occurs in solution channels, fractures, and partings in the rock, so wells in this aquifer typically produce much greater volumes of water than wells in any other aquifer in the area. The water is very hard, and its median value of total dissolved solids is 325 parts per million (milligrams per liter). The openings in the carbonate rocks extend to the surface, so this aquifer is very vulnerable to pollution from surface activities.

Soils

The dominant soil orders in this MLRA are Alfisols, Inceptisols, and Ultisols. The soils in the area dominantly have a mesic soil temperature regime, a udic soil moisture regime, and mixed, micaceous, or kaolinitic mineralogy. They are moderately deep to very deep, moderately well drained to somewhat excessively drained, and loamy or loamy-skeletal. Hapludalfs (Duffield, Neshaminy, and Penn series) and Dystrudepts (Manor, Parker, and Mt. Airy series) formed in residuum on hills. Fragiudalfs (Reedington series) formed in residuum on footslopes and in drainageways. Hapludults (Chester, Elioak, Gladstone, and Glenelg series) and Kanhapludults (Hayesville series) formed in residuum on hills, upland divides, and ridges. Fragiudults (Glenville series) formed in colluvium or residuum on hills. The far northeastern extent of the MLRA was affected by early periods of glaciation, and many soils formed in very deep, highly weathered till. The dominant soils in this part of the MLRA are Hapludalfs (Washington and Bartley series) and Fragiudults (Annandale and Califon series).

Biological Resources

This area supports deciduous hardwoods. Chestnut oak, white oak, red oak, hickories, ash, American elm, and yellow-poplar are the major species. Yellow-poplar is especially abundant on the northeast-facing slopes. Tree growth and wood production are considerably less extensive in the Triassic basins than elsewhere in the area. Black walnut and black cherry grow on the well drained soils on flood plains. Eastern redcedar is common in many areas of abandoned cropland.

Some of the major wildlife species in this area are white-tailed deer, fox, raccoon, muskrat, opossum, gray squirrel, cottontail, weasel, pheasant, ruffed grouse, and mourning dove. The abundance of black bear is increasing in the less densely populated, more mountainous northwest portion of the northeast half of this MLRA.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 29%
Grassland—private, 10%
Forest—private, 25%
Urban development—private, 32%
Water—private, 2%
Other—private, 2%

Approximately one-third of this area is in farms, and one-third either is urban or is urbanizing rapidly. The farms are intensively cropped in Maryland, in Pennsylvania, and in most of New Jersey. They are mostly in pasture or woodland in the northern parts of New Jersey and in Virginia. Forage crops, soybeans, and grain for dairy cattle make up the largest acreage of cropland. Forested areas, consisting mostly of farm woodlots, are extensive on the steepest parts of the area. Some areas are used for horticultural production, such as landscaping trees and shrubs and Christmas trees, and some are used by the forest products industry. Dairy farming, once a prominent activity, has greatly diminished within the past 30 years. Horse and "hobby" farms have become more numerous, particularly near the rural-suburban fringe. Recreational uses, such as parks, athletic fields, and golf courses, are common in or near areas of urban or suburban development.

The major soil resource concern affecting this area is the conversion of nonurban land, especially prime farmland, to urban and suburban uses. Erosion and the resultant degradation of stream quality commonly occur during construction activities associated with urbanization. Other concerns are erosion and degradation of soil quality in areas used for grain crops year after year.

The important conservation practices on cropland are those that reduce the hazard of erosion. They include contour farming, stripcropping, diversions, terraces, grassed waterways, crop rotations, cover crops, and crop residue management. Critical area planting, water- and sediment-control basins, and urban storm-water management are important in the areas used for urban development. ■

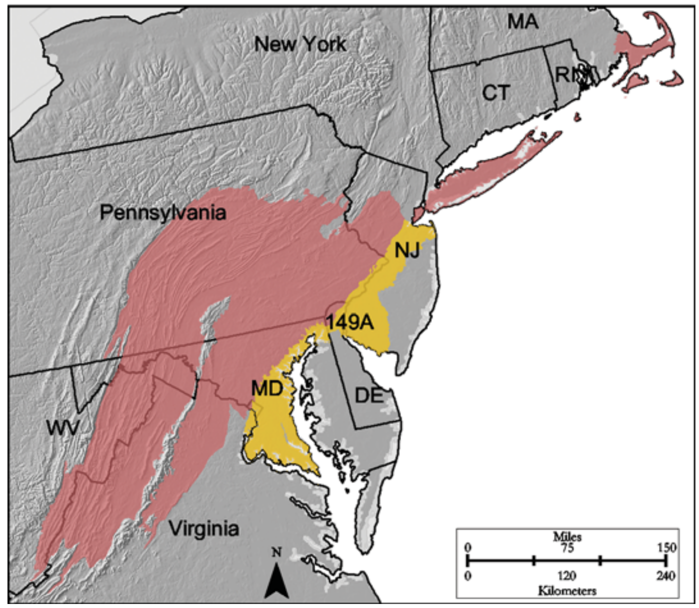

Figure 149A-1: Location of MLRA 149A in Land Resource Region S.

149A—Northern Coastal Plain

This area (shown in fig. 149A-1) is in Maryland (47 percent), New Jersey (44 percent), Pennsylvania (4 percent), Delaware (3 percent), Virginia (1 percent), and the District of Columbia (1 percent). It makes up about 5,205 square miles (13,495 square kilometers). Interstate 95 corresponds broadly to the north and west boundary of the MLRA from Maryland through New Jersey. Major cities include Washington, DC, at the southern edge of the MLRA and Baltimore, Maryland, Wilmington, Delaware, East Brunswick, Trenton, Cherry Hill (and many other cities across the Delaware River from Philadelphia, Pennsylvania), and Vineland, New Jersey, at the northern end. Part of the Fort Dix Military Reservation is in this area in New Jersey. Aberdeen Proving Ground, the Fort George G. Meade Military Reservation, the United States Naval Academy in Annapolis, and the United States National Agricultural Research Center in Beltsville, Maryland, are all in the MLRA, as well as Andrews Air Force Base just east of Washington, DC. There are some State forests and numerous State parks, wildlife management areas, and national wildlife refuges in this area.

Physiography

This area is in the Embayed Section of the Coastal Plain Province of the Atlantic Plain. This area is a nearly level to rolling, dissected coastal plain that has been subjected to episodes of rising and falling sea levels. During low sea levels, eroding streams have dissected the area, leaving a series of terraces across the landscape. The Raritan, Delaware, and Chesapeake Bays are classic drowned river valleys. Elevation ranges from sea level to 330 feet (100 meters). It is less than 165 feet (50 meters) in most of the area. Local relief is mostly 6 to 35 feet (2 to 10 meters), but it is 100 feet (30 meters) or more in a few areas.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Delaware (0204), 41 percent; Upper Chesapeake (0206), 28 percent; Potomac (0207), 22 percent; and Lower Hudson-Long Island (0203), 9 percent. The Delaware River separates Pennsylvania and Delaware from New Jersey in this area. It empties into the Delaware Bay. The Susquehanna River empties into the northern tip of the Chesapeake Bay in the area. The Raritan Bay marks the northern limit of the MLRA. The Potomac River separates the District of Columbia and Maryland from Virginia at the south tip of the area. The Anacostia, Patuxent, and Severn Rivers in Maryland and the Great Egg Harbor and Maurice Rivers in New Jersey are designated as National Wild and Scenic Rivers.

Geology

Most of this area is underlain by unconsolidated sand, silt, and clay sediments deposited in the near-shore environment of late Cretaceous seas. The rise and fall of sea level resulted in sand deposits separated by layers of clay and silt. High winds during periods of maximum glacial advance redeposited some of the sandy and silty sediments downwind. In addition, these sediments are sorted downwind from coarsest to finest and from thickest to thinnest. The north and west boundary of this MLRA almost parallels the “fall line” on the eastern seaboard. The fall line separates the bedrock of the interior uplands and the Coastal Plain. The Coastal Plain sediments are a source of ground water for the large cities built just below the fall line in this area. Southeast Maryland and New Jersey are covered by unconsolidated gravel deposited in the Tertiary and reworked by the Quaternary seas and erosion. This reworking left a pebble line as a pedisediment marker that separates the older deposits from the more recent eolian depositions. Glauconite is a common mineral in many of the unconsolidated sediments in the Northern Coastal Plain. Some gabbro, serpentite, Precambrian metamorphic rocks, and Triassic red shale are exposed along the extreme western edges of this area. The fall line is irregular, so some of the crystalline rocks that occur west of the fall line also occur in this area.

Climate

The average annual precipitation in this area is 40 to 47 inches (1,015 to 1,195 millimeters). Near the coast, most of the precipitation falls as high-intensity, convective thunderstorms in midsummer. The seasonal snowfall ranges from little or none in the southern part of the area to 30 inches (75 centimeters) in the northern part. The average annual temperature is 52 to 58 degrees F (11 to 14 degrees C). The freeze-free period averages 220 days and ranges from 190 to 250 days. Temperatures and the length of the freeze-free period decrease from south to north and from the coast inland.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 25.7%; ground water, 9.2%
Livestock—surface water, 0.2%; ground water, 0.2%
Irrigation—surface water, 0.9%; ground water, 0.8%
Other—surface water, 56.4%; ground water, 6.5%

The total withdrawals average 2,640 million gallons per day (9,990 million liters per day). About 17 percent is from ground water sources, and 83 percent is from surface water sources. Precipitation, perennial streams, and aquifers provide an abundance of water in this area. In most years, moisture is deficient in the coarse textured, well drained soils and irrigation water from streams, ponds, and wells is used for high-value crops. The surface water is suitable for almost all uses in this area. Reservoirs on the Potomac and Upper Chesapeake tributary streams supply water to the District of Columbia, and the reservoirs on the Upper Chesapeake also supply Baltimore and its suburbs with drinking water.

All of the ground water used in the urbanized corridor running along the north and west edges of this area comes from the unconsolidated sand and gravel in the Coastal Plain aquifer system. Some of these aquifers are the Potomac, Raritan, Magothy, Atlantic City 800-foot sand, Englishtown, and the Kirkwood-Cohansey. Domestic supplies are obtained mainly from shallow wells, but large supplies must be obtained from deep wells. Generally, very little treatment is required before the water from this aquifer system is used. The water is typically soft, but it can be moderately hard to very hard in some areas. The level of total dissolved solids is generally 100 to 200 parts per million (milligrams per liter). The level of iron may exceed the drinking water standard. The rocks in this aquifer system dip to the east and become thicker towards the ocean. Water from wells drilled closer to the ocean may have high levels of chloride because of seawater intrusion. Since this aquifer system is at or very near the surface throughout this area, the water is highly susceptible to contamination from land use activities.

Soils

The dominant soil order in this MLRA is Ultisols. Some Entisols, Inceptisols, Spodosols, and Histosols also occur. The soils in this area have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed, siliceous, or glauconitic mineralogy. They are very deep, excessively drained to very poorly drained, and primarily loamy or sandy. Some Hapludults formed in fluviomarine deposits on terraces and flats (Downer, Hammonton, Sassafras, and Woodstown series) and in near-shore marine deposits containing glauconite on uplands (Adelphia, Freehold, Collington, and Holmdel series). Other Hapludults formed in sandy eolian deposits (Galestown and Tinton series) and in silty loess deposits (Matapeake and Mattapex series). Fragiudults formed in old alluvium on hills and relict stream terraces (Aura series) and in silty deposits on broad flats (Beltsville series). Quartzipsamments (Evesboro and Lakehurst series) formed in eolian or marine sand deposits on dunes and flats along streams. Haplosaprists (Manahawkin series) formed in freshwater bogs and along stream corridors, and Sulfihemists (Transquaking series) formed in organic deposits in estuarine and tidal marshes. Alaquods (Atsion series) formed in sandy marine deposits on braided stream channels and broad low-lying flats.

Biological Resources

This area supports pine and hardwoods. Loblolly pine, Virginia pine, shortleaf pine, southern red oak, black oak, scarlet oak, pin oak, willow oak, northern red oak, black walnut, yellow-poplar, sweetgum, and red maple are the dominant species.

Some of the major wildlife species in this area are white-tailed deer, cottontail, squirrel, waterfowl, and songbirds.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 13%
Grassland—private, 3%
Forest—private, 25%; Federal, 2%
Urban development—private, 32%
Water—private, 18%; Federal, 1%
Other—private, 6%

About half of this area is in farms. Nearly one-third of the area is used for urban development. The extent of urban development is expanding rapidly. The major crops in the area are vegetables, corn, soybeans, small grains, and fruits. Tobacco is a specialty crop in Maryland. Specialty crops in New Jersey are highbush blueberries and cranberries. Forage crops and grains for dairy cattle are important locally. Poultry, nursery stock, and sod farms also are important locally. Most of the woodland in the area is in farm woodlots, but some is in large holdings. Pine pulpwood and hardwood lumber are the principal forest products. State forests and parks are extensive in some areas. A narrow band along the coast is intensively developed for resorts and for recreation.

The major soil resource concern affecting this area is the conversion of nonurban land, especially prime farmland, to urban and suburban uses. Erosion and the resultant degradation of stream quality commonly occur during construction activities associated with urbanization. Other concerns are erosion and degradation of soil quality in areas used for grain crops year after year. Improved drainage is needed on almost one-fourth of the farmland.

The important conservation practices on cropland are those that reduce the hazard of erosion. They include crop residue management (including no-till and minimum tillage systems), conservation cover crops, nutrient management, grassed waterways, filter strips, and riparian buffers. Where livestock or poultry are part of the farm operation, management of animal waste, including storage of the waste, is important. Farmland preservation programs are vital to maintaining the agricultural resources in the area. Critical area planting, water- and sediment-control basins, and urban storm-water management are important in the areas used for urban development. ■

149B—Long Island-Cape Cod Coastal Lowland

This area (shown in fig. 149B-1) is in New York (65 percent), Massachusetts (34 percent), and Rhode Island (1 percent). It makes up about 2,110 square miles (5,465 square kilometers). It includes New York City and Long Island, New York; Cape Cod, Martha's Vineyard, Nantucket Island, East Falmouth, Hyannis, and South Yarmouth, Massachusetts; and Block Island, Rhode Island. Numerous extensions of interstate highways occur at the western end of Long Island, in the city of New York. Numerous State parks and national wildlife refuges occur in this area. Fire Island National Seashore in New York and Cape Cod National Seashore and Martha's Vineyard State Forest in Massachusetts are in the area. The Poosepatuck and Shinnecock Indian Reservations are on Long Island, and the Otis Air National Guard Base is on Cape Cod. The Brookhaven National Laboratory, a Naval Weapons Industrial Reserve Plant, and the Plum Island Animal Disease Center are on Long Island. The Woods Hole Oceanographic Institute is on Cape Cod.

Physiography

This area is in the Embayed Section of the Coastal Plain Province of the Atlantic Plain. It is part of the partially

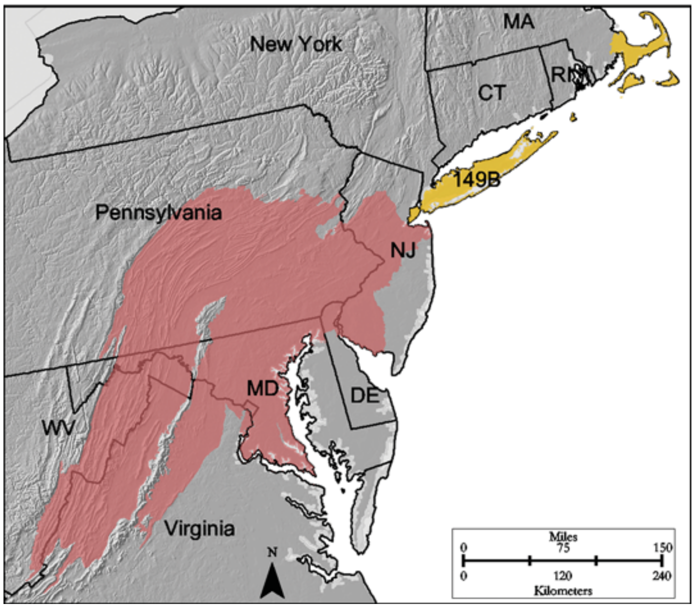

Figure 149B-1: Location of MLRA 149B in Land Resource Region S.

submerged coastal plain of New England. It is mostly an area of nearly level to rolling plains, but it has some steeper hills (glacial moraines). Ridges border the lower plains. Elevation generally ranges from sea level to 80 feet (0 to 25 meters), but it is as much as 330 feet (100 meters) in a few areas. Local relief is mainly 3 to 30 feet (1 to 10 meters), but it is as much as 65 feet (20 meters) in the more hilly areas.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Hudson-Long Island (0203), 65 percent, and Massachusetts-Rhode Island Coastal (0109), 35 percent. The Peconic and Carmans Rivers are on the eastern end of Long Island. The parts of this area in Massachusetts and Rhode Island have no major rivers.

Geology

This entire area is made up of deep, unconsolidated glacial outwash deposits of sand and gravel. A thin mantle of glacial till covers most of the surface. Some moraines form ridges and higher hills in this area of generally low relief. Sand dunes and tidal marshes are extensive along the coastline.

Climate

The average annual precipitation in this area is 41 to 48 inches (1,040 to 1,220 millimeters). The precipitation is fairly evenly distributed throughout the year. Rainfall occurs as high-intensity, convective thunderstorms during the summer. The seasonal snowfall is moderate to low in winter, and extended periods of no snow cover can be expected in winter because of relatively moderate temperatures. The average annual temperature is 49 to 54 degrees F (10 to 12 degrees C). The freeze-free period averages 220 days and ranges from 195 to 240 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 8.2%; ground water, 80.2%
Livestock—surface water, 0.0%; ground water, 0.3%
Irrigation—surface water, 0.2%; ground water, 3.8%
Other—surface water, 1.4%; ground water, 6.0%

The total withdrawals average 640 million gallons per day (2,420 million liters per day). About 90 percent is from ground water sources, and 10 percent is from surface water sources. Most of the water used in this area is for public supply for the urban population on Long Island. The area has only a few perennial streams, rivers, and lakes, so ground water supplies are used for most needs. In most years precipitation is adequate for crops. High-value vegetable crops grown on the drier sandy soils usually require irrigation for optimum yields. The surface water is generally of good quality. Coastal inlets and bays provide many opportunities for recreation and transportation.

The deep sand and gravel deposits underlying most of this area are excellent aquifers and are good sources of irrigation water and drinking water. The Magothy and Lloyd Sand make up the Coastal Plain aquifer in the middle and east end of Long Island and in Massachusetts and Rhode Island. This aquifer does not occur on the west end of Long Island, where most of the urban population resides. The water from this aquifer is soft and typically has 80 to 200 parts per million (milligrams per liter) total dissolved solids. Some of the water has high levels of iron and manganese, but the median level of these constituents is below the primary and secondary standards for drinking water. The level of nitrates is somewhat high, 2.4 to 4.2 parts per million (milligrams per liter). Encroachment of saltwater from the surrounding ocean is a continuing hazard in these freshwater aquifers. The ground water on Cape Cod and the offshore islands is acidic and may cause corrosion of metal pipes and concrete.

Soils

The dominant soil orders in this area are Inceptisols and Entisols. The dominant suborders are Ochrepts and Psamments. The soils in the area have a mesic soil temperature regime, a udic soil moisture regime, and mixed mineralogy. They are deep, moderately coarse textured or coarse textured, nearly level to sloping, and well drained. Ochrepts are on outwash plains, terraces, and remnant beach ridges underlain by deposits of sand and gravel. Excessively drained Psamments are extensive on sandy outwash plains and in the steeper areas. Well drained and moderately well drained Ochrepts are in some morainic areas dominated by glacial till. Somewhat poorly drained and poorly drained Aquents and Aquepts are in low areas and in drainageways. They are of small extent but are important locally. Sand dunes and tidal marshes are extensive along the coastline.

Biological Resources

This area supports hardwoods and softwoods. Extensive areas of the oak-pitch pine forest are on the droughty, sandy soils. Oak and beech-birch-sugar maple are two other potential forest types. White pine and red pine grow in many areas. Barberry and lowbush blueberry are common early succession types in burned-over areas. In areas of sand dunes, American beachgrass can occur on foredunes and a mixture of bayberry, sassafras, and American holly can occur on the more protected dunes.

Some of the major wildlife species in this area are white-tailed deer, fox, raccoon, cottontail, gray squirrel, pheasant, woodcock, bobwhite quail, and waterfowl. The species of fish in the area include marine fish and shellfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 4%
Grassland—private, 1%
Forest—private, 18%; Federal, 1%
Urban development—private, 45%; Federal, 3%
Water—private, 20%
Other—private, 8%

Almost half of this area is used for urban development, and urban expansion is continuing. Almost one-fifth of the area is forested. Recreational uses are extensive along shorelines. On the cropland in the area, cash crops and vegetables, such as potatoes, cauliflower, and cabbage, are particularly important. In a few areas duck and poultry farms are important enterprises.

The major soil resource concerns are sheet and rill erosion, the erosion and sedimentation caused by urban storm-water runoff and urban development, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management (such as conservation tillage), winter cover crops, rotations of annual crops and grasses and legumes, contour farming, irrigation water management, and compost facilities. Critical area planting, water- and sediment-control basins, and urban storm-water management are important in the areas used for urban development. ■

Figure T-1: Location of Land Resource Region T.

T—Atlantic and Gulf Coast Lowland Forest and Crop Region

This region (shown in fig. T-1) is in Texas (23 percent), Louisiana (15 percent), North Carolina (14 percent), South Carolina (12 percent), Georgia (12 percent), Florida (11 percent), Virginia (3 percent), Maryland (3 percent), New Jersey (3 percent), Delaware (2 percent), Mississippi (1 percent), and Alabama (1 percent). It makes up 92,630 square miles (240,055 square kilometers).

This is a region of coastal lowlands, coastal plains, and the Mississippi River Delta on the Gulf coast and coastal lowlands, coastal plains, drowned estuaries, tidal marshes, islands, and beaches along the Atlantic coast. The region is mostly level to gently sloping and has low relief. The climate is mostly temperate to hot and humid. The average annual precipitation is 42 to 54 inches (1,065 to 1,370 millimeters). It commonly exceeds 65 inches (1,650 millimeters) along the Louisiana, Mississippi, and Alabama coastlines. The region is generally driest at the northern end along the Atlantic coast and wettest at the southern end. The amount of precipitation is slightly higher during fall and winter than during the rest of the year. Snowfall occurs in the northern third of the region. The average annual temperature is 58 to 65 degrees F (14 to 18 degrees C). The freeze-free period ranges from 220 to 305 days, increasing in length to the south.

The total withdrawals of freshwater in this region average about 13,770 million gallons per day (52,120 million liters per day). About 79 percent is from surface water sources, and 21 percent is from ground water sources. Abundant precipitation, numerous perennial streams, and good aquifers provide ample supplies of good-quality water for all uses in the region. Almost three-fourths of the water used in this region is for municipal supply, for industry, or for cooling thermoelectric power plants.

The soils in this region are dominantly Alfisols, Entisols, and Ultisols, but Histosols and Spodosols are not uncommon. The dominant suborders are Aqualfs, Aquents, Aquults, Psamments, and Udults. Other important suborders are Aquods, Udalfs, Uderts, and Saprists. The soils in the region typically formed in alluvium on flood plains, in depressions, and on terraces. They dominantly have a thermic soil temperature

Figure T-2: Cotton in an area of Land Resource Region T.

regime, an aquic or udic soil moisture regime, and siliceous, mixed, or smectitic mineralogy.

The native vegetation in most of this region is a mixture of pines and hardwoods. Grass is more typical in the southwestern end of this region. About 94 percent of the region is privately owned. Most of the land is in large holdings and is used for the production of lumber and pulpwood. Less than 10 percent of this region is cropped (fig. T-2). The acreage of cropland is limited primarily because of a high water table and the frequency of flooding. Recreation is a major industry in this coastal region. Significant deposits of salt in domes, natural gas, and petroleum are buried beneath the surface all along the Gulf coast. The Atlantic coast and parts of the Gulf coast are very populous. The loss of wetlands, cropland, and forestland to urban development is a resource concern near these high-population zones. Wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture, salinity, and coastal flooding also are major resource concerns. ■

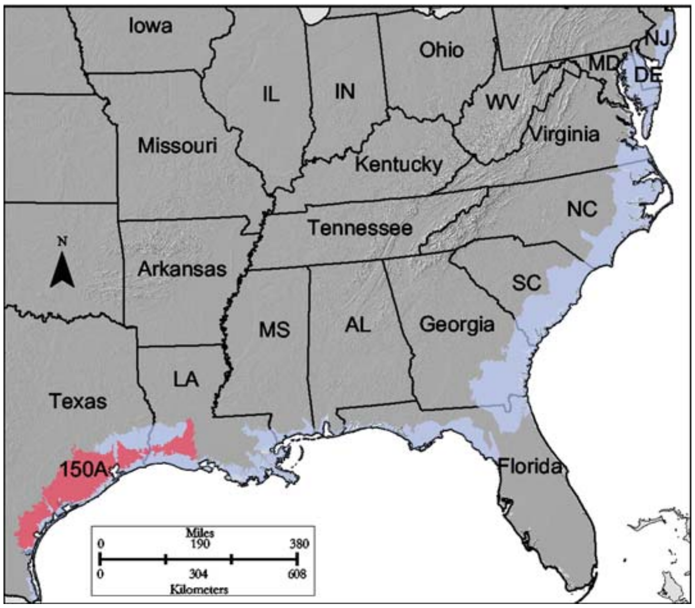

Figure 150A-1: Location of MLRA 150A in Land Resource Region T.

150A—Gulf Coast Prairies

This area (shown in fig. 150A-1) is in Texas (83 percent) and Louisiana (17 percent). It makes up about 16,365 square miles (42,410 square kilometers). It includes the towns of Crowley, Eunice, and Lake Charles, Louisiana, and Beaumont, Houston, Bay City, Victoria, Corpus Christi, Robstown, and Kingsville, Texas. Interstates 10 and 45 are in the northeastern part of the area, and Interstate 37 is in the southwestern part. U.S. Highways 90 and 190 are in the eastern part, in Louisiana. U.S. Highway 77 passes through Kingsville, Texas. The Chase and Kingsville Naval Air Stations are in this area. The Attwater Prairie Chicken National Wildlife Refuge and the Fannin Battleground State Historic Site are in the part of the area in Texas. The area has a few State parks.

Physiography

This area is in the West Gulf Coastal Plain Section of the Coastal Plain Province of the Atlantic Plain. It is characterized by nearly level plains that have low local relief and are dissected by rivers and streams that flow toward the Gulf of Mexico. Elevation ranges from sea level to about 165 feet (0 to 50 meters) along the interior margin.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Central Texas Coastal (1210), 28 percent; Galveston Bay-San Jacinto (1204), 22 percent; Louisiana Coastal (0808), 17 percent; Lower Colorado-San Bernard Coastal (1209), 13 percent; Nueces-Southwestern Texas Coastal (1211), 7 percent; Lower Brazos (1207), 7 percent; Trinity (1203), 3 percent; Neches (1202), 2 percent; and Sabine (1201), 1 percent. The Beckwith and Calcasieu Rivers are in the eastern end of this area, in Louisiana. The Sabine River forms the boundary between Texas and Louisiana. From north to south, the Neches, Trinity, San Jacinto, Brazos, San Bernard, Navidad, Lavaca, Guadalupe, San Antonio, Nueces, and Agua Dulce Rivers cross the part of this area in Texas.

Geology

This area is mostly a strip of land that is about 50 to 80 miles (80 to 130 kilometers) wide and runs along the Gulf of Mexico. The sedimentary rocks at the surface are of Pleistocene age. They were laid down during the last 2 million years. The deposits are deltaic and lagoonal clays and loams derived from older rocks to the west. At the western edge of this area, mostly within Texas, the sediments are older and more weathered and contain more sands. At the eastern edge, mostly within Louisiana, a cap of mixed loess and alluvium occurs on most soils. The loess was derived from the flood plain along the Mississippi River. Some Tertiary deposits occur along the interior edge of this MLRA. The weight of the recent deposits has caused them to tilt towards the Gulf of Mexico, so successively older deposits crop out from the coastal edge to the interior edge of the area. Salt domes, natural gas, and petroleum deposits are commonly below the surface throughout this area. Recent deposits of alluvial sand fill the valleys of the Brazos and Trinity Rivers and the other large rivers in the area.

Climate

The average annual precipitation in the northern two-thirds of this area is 45 to 63 inches (1,145 to 1,600 millimeters). It is 28 inches (710 millimeters) at the extreme southern tip of the area and 30 to 45 inches (760 to 1,145 millimeters) in the southwestern third of the area. The precipitation is fairly evenly distributed, but it is slightly higher in late summer and midsummer in the western part of the area and slightly higher in winter in the eastern part. Rainfall typically occurs as moderate-intensity, tropical storms that produce large amounts of rain during the winter. The average annual temperature is 66 to 72 degrees F (19 to 22 degrees C). The freeze-free period averages 325 days and ranges from 290 to 365 days, increasing in length to the southwest.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 8.5%; ground water, 6.0%
Livestock—surface water, 0.6%; ground water, 0.5%
Irrigation—surface water, 7.7%; ground water, 20.2%
Other—surface water, 53.6%; ground water, 2.8%

The total withdrawals average 4,390 million gallons per day (16,615 million liters per day). About 30 percent is from ground water sources, and 70 percent is from surface water sources. Rainfall and perennial streams provide abundant water that is suitable for almost all uses. Water for irrigating rice is often obtained from streams. The surface water also is used for municipal and industrial supplies and for cooling thermoelectric power plants. Treated sewage effluent from upstream sources makes up a significant portion of the low flow in the San Antonio River in this area. Urbanization and industrial wastes are threatening the surface and ground water supplies in the Houston area. Most of the soils must be drained for optimum growth of general farm crops.

Ground water is abundant in the Gulf Coast aquifer system in this area. The water from this system has a median level of 420 parts per million (milligrams per liter) total dissolved solids and typically is moderately hard. This system provides much of the domestic, public supply, and irrigation water used in this area.

Soils

The dominant soil orders in this MLRA are Alfisols, Mollisols, and Vertisols. The soils have a hyperthermic soil temperature regime in the southwestern part of the area and a thermic soil temperature regime in the northeastern part. The soils in the MLRA generally have an ustic soil moisture regime and smectitic mineralogy. Drainage ranges from well drained in very gently sloping and gently sloping soils in convex areas to very poorly drained in soils in enclosed depressions. Soils that formed in early Pleistocene sediments, generally occurring north of Interstate 10, are very deep and have a loamy surface layer and subsoil and siliceous mineralogy. Soils that formed in late Pleistocene sediments, generally occurring south of Interstate 10, are very deep and have a loamy or clayey surface layer and a clayey, very slowly permeable subsoil. Aqualfs and Udalfs (Crowley, Aris, and Vidrine series) are dominant in Louisiana and southeastern Texas. Uderts and Udalfs (League, Lake Charles, Laewest, Hockley, Katy, and Telferner series) are dominant in the eastern and central parts of the area. Usterts and Ustolls (Banquete, Cranell, Orelia, and Victoria series) are dominant in the western and southwestern parts.

Biological Resources

This area was originally a natural grass prairie with hardwood trees along the rivers and streams. Little bluestem, Indiangrass, switchgrass, and big bluestem are the dominant species. A few groves of live oak dot the landscape.

Some of the major wildlife species in this area are white-tailed deer, raccoon, opossum, rabbit, fox, coyote, squirrel, armadillo, nutria, quail, and mourning dove. Migratory waterfowl, such as ducks and geese, and neotropical migratory songbirds winter in this area. The species of fish in the area include bass, channel catfish, and bream.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 32%
Grassland—private, 39%; Federal, 1%
Forest—private, 5%
Urban development—private, 16%
Water—private, 5%
Other—private, 2%

Most of this area is in farms. Rice, soybeans, grain sorghum, cotton, corn, and hay are the chief crops. About two-fifths of the area is rangeland or pasture. The forested areas, consisting chiefly of hardwoods, border the rivers and streams that cross the MLRA. Urban development is rapidly expanding onto agricultural land throughout the area.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and tilth of the soils, and management of soil moisture. Increasing salinity is a problem in some areas. Conservation practices on cropland generally include systems of crop residue management, which help to control erosion and maintain the content of organic matter in the soils. Timely tillage and planting can help to maintain tilth and the supply of soil moisture. Conservation practices on pasture and rangeland generally include prescribed grazing, fences, watering facilities, and nutrient and pest management. ■

150B—Gulf Coast Saline Prairies

This area is entirely in Texas (fig. 150B-1). It makes up about 3,420 square miles (8,865 square kilometers). The towns of Groves, Texas City, Galveston, Lake Jackson, and Freeport are in the northern half of this area. The towns of South Padre Island, Loyola Beach, Corpus Christi, and Port Lavaca are in the southern half. Interstate 37 terminates in Corpus Christi, and Interstate 45 terminates in Galveston. The Padre Islands National Seashore, the Corpus Christi Naval Air Station, and a number of national wildlife refuges and State recreation areas are in this MLRA.

Physiography

This MLRA is in the West Gulf Coastal Plain Section of the Coastal Plain Province of the Atlantic Plain. It is characterized by nearly level to gently sloping coastal lowland plains dissected by rivers and streams that flow toward the Gulf of Mexico. Barrier islands and coastal beaches are part of this MLRA. The lowest parts of the area are covered by high tides,

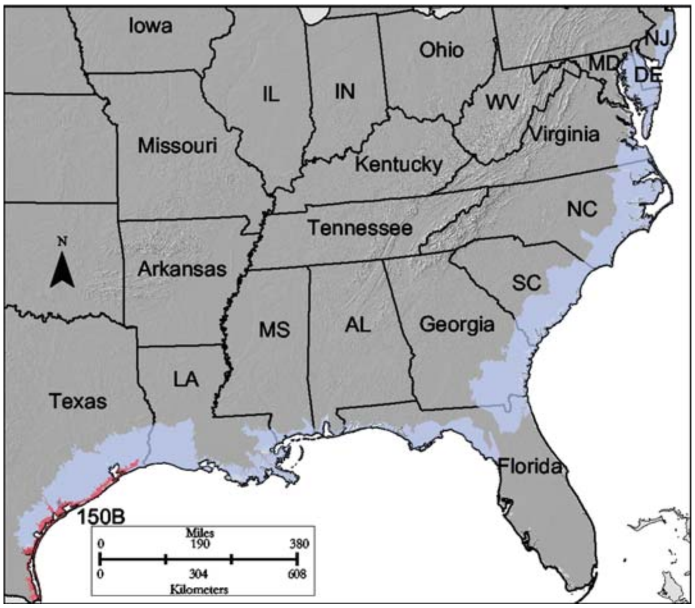

Figure 150B-1: Location of MLRA 150B in Land Resource Region T.

and the rest are periodically covered by storm tides. Parts of the area have been worked by wind, and the sandy areas have gently undulating to irregular topography because of low mounds or dunes. Broad, shallow flood plains are along streams flowing into the bays. Elevation generally ranges from sea level to about 10 feet (3 meters), but it is as much as 25 feet (8 meters) on some of the dunes. Local relief is mainly less than 3 feet (1 meter).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Central Texas Coastal (1210), 32 percent; Nueces-Southwestern Texas Coastal (1211), 30 percent; Galveston Bay-San Jacinto (1204), 28 percent; Lower Colorado-San Bernard Coastal (1209), 9 percent; and Lower Brazos (1207), 1 percent. The Rio Grande forms the international boundary between Texas and Mexico at the southwestern end of this area. Many other major rivers empty into the bays along the Gulf of Mexico in the area. Some of these include the Agua Dulce, Nueces, Lavaca, Navidad, San Bernard, Brazos, San Jacinto, and Neches Rivers. The Trinity River enters Galveston Bay just outside this area. The Guadalupe and San Antonio Rivers join just before emptying into San Antonio Bay in the area. The Sabine River empties into Lake Sabine just outside the northeastern tip of the area.

Geology

This area is underlain entirely by unconsolidated fluvial and marine sediments (the Beaumont Formation). Most of the surface is covered by Pleistocene-age sand that has been reworked by the wind into mounds and dunes. Recent deposits of clay, silt, and fine sand form deltas in areas where major rivers empty into saltwater bays. Salt domes, natural gas, and petroleum deposits are buried deeply beneath this area.

Climate

The average annual precipitation is 45 to 57 inches (1,145 to 1,450 millimeters) in the northeastern half of this area, 26 inches (660 millimeters) at the extreme southern tip of the area, and 30 to 45 inches (760 to 1,145 millimeters) in the rest of the area. Precipitation is abundant in spring and fall in the southwestern part of the area and is evenly distributed throughout the year in the northeastern part. Rainfall typically occurs as moderate-intensity, tropical storms that produce large amounts of rain during the winter. The average annual temperature is 68 to 74 degrees F (20 to 23 degrees C). The freeze-free period averages 340 days and ranges from 315 to 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 80.4%; ground water, 0.0%
Livestock—surface water, 5.4%; ground water, 0.3%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 13.4%; ground water, 0.5%

The total withdrawals average 35 million gallons per day (133 million liters per day). About 1 percent is from ground water sources, and 99 percent is from surface water sources. Rainfall is the source of water for pasture and range. A few freshwater streams and rivers flow into the area from the north, and many bays and small entrapments of salty water are throughout the area. Much of the surface water is not suitable for most uses because of mixing with seawater. Freshwater for urban uses is typically piped in from outside the area.

This area has little fresh ground water. Water for livestock comes mainly from dugout ponds or very shallow wells. The only freshwater is very near the surface in areas where sandy soils are high enough on the landscape to escape tidal inundation and yet are recharged by rainfall. Strata close to the surface in these soils can store the ground water and release it to wells. The water in the Gulf Coast aquifer system under this area is salty because of the intrusion of seawater.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Inceptisols, Mollisols, and Vertisols. The soils in the area have a hyperthermic soil temperature regime. The soils in the eastern and central parts of the area have an aquic or udic soil moisture regime, and those in the western part have an aquic or ustic soil moisture regime. Mineralogy is mixed or siliceous in sandy soils, mixed or siliceous in loamy soils, and smectitic in clayey soils. The soils are very deep. Drainage ranges from excessively drained in Psamments to very poorly drained in Aqualfs and Aquents. Many of the soils are appreciably saline. The Alfisols include Typic Natraqualfs (Dietrich, Livia, Matagorda, and Narta series). The Entisols include Quartzipsamments (Daggerhill and Greenhill series), Udipsamments (Galveston series), Psammaquents (Mustang series), and Fluvaquents (Veston series). The Inceptisols include Halaquepts (Barrada series). The Mollisols include Haplaquolls (Harris series). The Vertisols include Typic Natraquerts (Franeau series), Typic Hapluderts (Francitas series), and Sodic Haplusterts (Victine series).

Biological Resources

This area supports grassland vegetation. The more saline soils support a plant community dominated by gulf cordgrass and smaller amounts of little bluestem, switchgrass, seashore saltgrass, inland saltgrass, bushy sea-oxeye, marshhay cordgrass, rushes, sedges, and pickleweed. The less saline, sandy soils support a plant community dominated by little bluestem and lesser amounts of switchgrass, gulfdune paspalum, and marshhay cordgrass.

Some of the major wildlife species in this area are white-tailed deer, alligator, javelina, raccoon, skunk, opossum, jackrabbit, cottontail, armadillo, turkey, bobwhite quail, ducks, geese, and mourning dove. The species of fish in the area include channel catfish, yellow catfish, blue catfish, largemouth bass, red fish, speckled trout, and flounder.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 6%
Grassland—private, 31%; Federal, 3%
Forest—private, 1%
Urban development—private, 7%
Water—private, 40%; Federal, 3%
Other—private, 9%

Most of the coastal part of this MLRA is in areas of water where lowlands are inundated daily by tides. This part of the area is used primarily for recreation. The inland part of the MLRA is characterized by a natural grass prairie with hardwood trees along the rivers and streams. Nearly all of the inland area is in ranches or is used for recreation. More than 75 percent of the inland area is native rangeland that supports mainly salt-tolerant plant species. A small acreage is used for coastal bermudagrass pasture for beef cattle or for rice or grain sorghum. Urban and recreational developments are expanding, especially along the barrier islands in the central and southern parts of the area.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and tilth of the soils, and management of soil moisture. Salinity and coastal flooding preclude crop production in most of the MLRA. Conservation practices on rangeland generally include prescribed grazing, fences, nutrient management, pest management, pasture and hay planting, management of upland wildlife habitat, and watering facilities. Conservation practices on cropland generally include systems of crop residue management, which help to control erosion and maintain the content of organic matter in the soils. Timely tillage and planting can help to maintain tilth and the supply of soil moisture. ■

151—Gulf Coast Marsh

This area (shown in fig. 151-1) is in Louisiana (95 percent), Texas (4 percent), and Mississippi (1 percent). It makes up about 8,495 square miles (22,015 square kilometers). The towns of Gretna, Chalmette, and Marrero, Louisiana, and the city of New Orleans, Louisiana, are in the eastern part of this MLRA. The town of Port Arthur, Texas, is in the western part. Interstate 10 and U.S. Highway 90 cross the area. The New Orleans Naval Air Station is in this MLRA. Fort Jackson, overlooking the mouth of the Mississippi River, and the Jean Lafitte National Historic Park and Preserve are in the MLRA. A number of national wildlife refuges and State parks occur throughout this area.

Physiography

Vermilion Bay splits this area into an eastern half and a western half. The eastern half is in the Mississippi Alluvial Plain Section of the Coastal Plain Province of the Atlantic Plain. The western half is in the West Gulf Coastal Plain Section of the same province and division. The land east of Vermilion Bay, part of the Mississippi River Delta, has a ragged shoreline. The land west of Vermilion Bay has a smoother shoreline. Low, narrow sandy ridges characterize much of the area. There are many rivers, lakes, bayous, tidal channels, and manmade canals. Elevation generally ranges from sea level to about 7 feet (2 meters). It is as much as 10 feet (3 meters) on beach ridges, canal spoil banks, and natural levees and as much as 165 feet (50 meters) on salt dome islands. Some areas that are protected by levees have subsided below sea level.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Mississippi (0809), 60 percent; Louisiana Coastal (0808), 31 percent; Galveston Bay-San Jacinto (1204), 5 percent; Lower Mississippi-Lake Maurepas (0807), 2 percent; Sabine (1201), 1 percent; and Pearl (0318), 1 percent. The

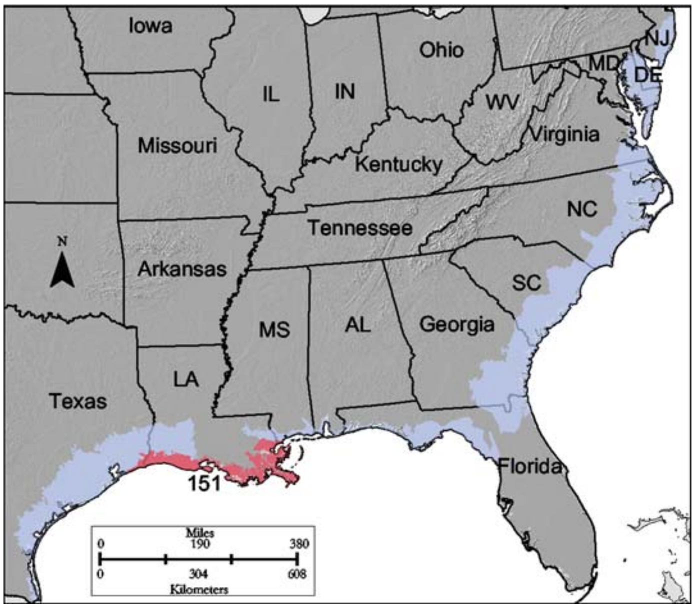

Figure 151-1: Location of MLRA 151 in Land Resource Region T.

Sabine River forms the boundary between Texas and Louisiana in this area, and the Beckwith and Calcasieu Rivers are at the western end of the area, in Louisiana. Other rivers in the part of the area in Louisiana include the Bayou Nezpique, Mermentau, Vermilion, Bayou Teche, Atchafalaya, and Mississippi Rivers.

Geology

The surface of this area is primarily Mississippi River clay, silt, and fine sand deposited over the past 2 million years. The eastern half of the area, part of the Mississippi River Delta, is underlain by a mixture of Recent alluvial material and Pleistocene-age marine sediments. The area west of Vermilion Bay is underlain by older alluvial and marine sediments. Salt domes, natural gas, and petroleum deposits are below the surface in this area.

Climate

The average annual precipitation in most of the eastern half of this area is 60 to 65 inches (1,525 to 1,650 millimeters). It is 49 to 60 inches (1,245 to 1,525 millimeters) in most of the western half. About 70 percent of the precipitation occurs during the growing season. Rainfall typically occurs as post-frontal precipitation in the winter and heat-convection showers and thundershowers in the spring and summer. In addition, tropical storms can bring large amounts of rainfall. The average annual temperature is 67 to 69 degrees F (19 to 21 degrees C). The freeze-free period averages 325 days and ranges from 290 to 365 days, increasing in length from north to south.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 6.5%; ground water, 0.8%
Livestock—surface water, 3.9%; ground water, 0.8%
Irrigation—surface water, 7.6%; ground water, 0.8%
Other—surface water, 75.3%; ground water, 4.4%

The total withdrawals average 1,310 million gallons per day (4,958 million liters per day). About 7 percent is from ground water sources, and 93 percent is from surface water sources. Most of the water used in this area is for public supply, thermoelectric power plants, and industry in the northeast corner. This area has many rivers, lakes, bayous, tidal channels, and manmade canals. About one-half of the marsh is fresh, and one-half is salty. Tidal channels allow free movement of salty water from the Gulf of Mexico into the parts of this area adjacent to the Gulf. Most of the area is susceptible to flooding either by freshwater drained from lands adjacent to the marsh or by saltwater from the Gulf of Mexico. Daily tides flood some areas. High tides and storm surges resulting from hurricanes or tropical storms can be as much as 10 feet (3 meters) above sea level and can flood most of the area.

River water in this area is generally of poor quality and requires treatment prior to human consumption. Contamination by fecal coliform bacteria is high in some rivers, and sediment problems from nonpoint sources and contamination by industrial wastes can occur in all of the rivers. Most soils of this area are very poorly drained, having a water table at or above the surface most of the time.

Ground water is scarce east of Vermilion Bay, in the Mississippi Delta. Fresh ground water is available in moderate to large quantities from the Gulf Coast (Texas) and Chicot (Louisiana) aquifer systems west of Vermilion Bay. The water from these Pleistocene-age river deposits is hard, and its median level of total dissolved solids is 300 to 450 parts per million (milligrams per liter). Iron concentrations exceed the national secondary standard for drinking water and approach 1,000 parts per billion (micrograms per liter) in some wells in Louisiana.

Soils

The dominant soil orders in this MLRA are Entisols and Histosols. The soils in the area dominantly have a hyperthermic soil temperature regime, an aquic soil moisture regime, and smectitic mineralogy. They generally are very deep, very poorly drained, and clayey. Hydraquents (Bancker, Creole, Larose, and Scatlake series) formed in clayey sediments in coastal marshes. Haplosaprists formed in organic deposits over alluvium (Allemands, Clovelly, and Lafitte series) or entirely in organic deposits (Kenner and Timbalier series).

Biological Resources

This area supports freshwater and saltwater marsh vegetation consisting of grasses, sedges, rushes, and other plants. Alligatorweed, spikerush, maidencane, cutgrass, and bulltongue characterize the freshwater vegetation. Roseau, common reed, bulltongue, and marshhay cordgrass characterize the intermediate water vegetation. Marshhay cordgrass, saltgrass, and Olney bulrush characterize the brackish water vegetation. Saltgrass, marshhay cordgrass, smooth cordgrass, and black needlerush are included in the saltwater vegetation.

Some of the major wildlife species in this area are white-tailed deer, alligator, nutria, raccoon, otter, muskrat, swamp rabbit, cottontail rabbit, mink, mottled duck, bobwhite quail, mourning dove, meadowlark, lark bunting, and crawfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 16%
Grassland—private, 6%
Forest—private, 8%
Urban development—private, 3%
Water—private, 33%
Other—private, 30%; Federal, 4%

Most of this area supports marsh vegetation and is used for wildlife habitat. The area is almost treeless. Much of the area is uninhabited. The area is in the fertile and productive estuarine complex that supports the marine life of the Gulf of Mexico. The area provides wintering ground for millions of migratory ducks and geese and habitat for many fur-bearing animals and for alligators. A significant acreage west of Vermilion Bay is firm enough to support livestock and is grazed by cattle in winter. A small acreage of freshwater marsh is drained by pumping systems and is used for pasture or for rice.

The major resource concerns are determined by land use and marsh type. Flooding is a major concern in New Orleans. The concerns in areas of native marsh include maintenance of the salinity level in the soils, ingress and egress of freshwater or saltwater, and the content of organic matter in the soils. The concerns on pasture and cropland include maintenance of the content of organic matter and control of the salinity level in the soils. Erosion caused by overland water from high rainfall or a storm surge in the Gulf is a concern in areas where the native vegetation has been altered.

Conservation practices on cropland include systems of crop residue management, which help to control erosion and maintain the content of organic matter in the soils. Timely tillage and planting can help to maintain tilth and the supply of soil moisture and control salinity. The practices on pasture include prescribed grazing, brush and pest management, prescribed burning, and watering facilities. Management of upland and wetland wildlife habitat is needed. ■

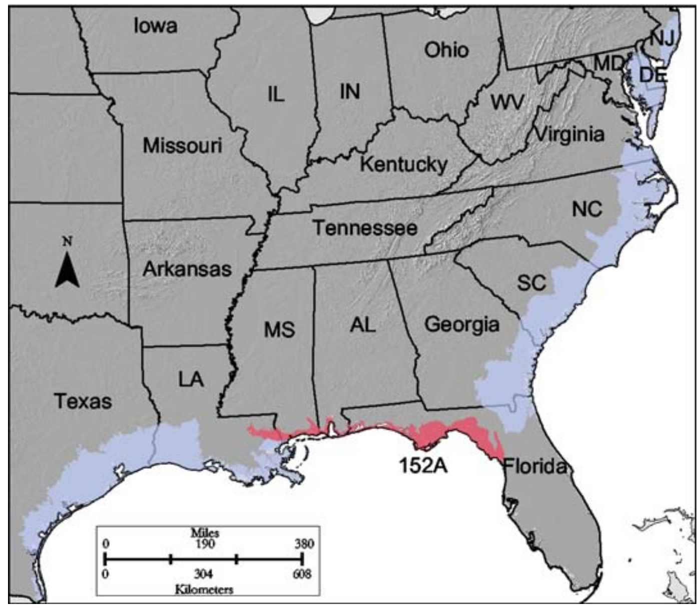

Figure 152A-1: Location of MLRA 152A in Land Resource Region T.

152A—Eastern Gulf Coast Flatwoods

This area (shown in fig. 152A-1) is in Florida (71 percent), Mississippi (12 percent), Alabama (9 percent), and Louisiana (8 percent). It makes up about 9,860 square miles (25,555 square kilometers). It includes Hammond and Covington, Louisiana; Gulfport, Biloxi, and Pascagoula, Mississippi; Mobile, Alabama; and Pensacola, Panama City, and Perry, Florida. Pascagoula, Mississippi, is one of the great ship-building centers of the world. Interstates 10, 12, 55, 59, and 65 and U.S. Highway 90 are in this area. The De Soto National Forest and the NASA National Space Technology Laboratories are in the part of this area in Mississippi. The Olf Summerdale Naval Military Reservation is in the part in Alabama. The San Marcos de Apalache State Historical Site, Apalachicola National Forest, and Gulf Islands National Seashore are in the part in Florida. The Tyndall and Eglin Air Force Bases and Pensacola Naval Air Station also are in the part in Florida. A number of national wildlife refuges and State parks and a few State forests are throughout this MLRA.

Physiography

Almost all of this area is in the East Gulf Coastal Plain Section of the Coastal Plain Province of the Atlantic Plain. The extreme southeast tip is in the Floridian Section of the same province and division. This MLRA is a nearly level, low coastal plain crossed by many large streams. The part of the area in Florida has many lakes and ponds. Elevation ranges from sea level to 80 feet (0 to 25 meters). Local relief is generally 10 to 20 feet (3 to 6 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Suwannee (0311), 31 percent; Choctawhatchee-Escambia (0314), 18 percent; Apalachicola (0313), 14 percent; Pascagoula (0317), 13 percent; Ochlockonee (0312), 10 percent; Mobile-Tombigbee (0316), 5 percent; Lower Mississippi (0809), 4 percent; Lower Mississippi-Lake Maurepas (0807), 3 percent; and Pearl (0318), 2 percent. Reaches of four rivers in the part of this area in Louisiana have been designated as National Wild and Scenic Rivers. These are the Amite, Tangipahoa, Tchefuncte, and Bogue Chitto Rivers. The Pearl River forms the boundary between Louisiana and Mississippi in this area. The Escatawpa River joins the Pascagoula River just before it empties into the Gulf of Mexico in the part of this area in Mississippi. The Tombigbee and Alabama Rivers join just outside this area to form the Mobile River in Alabama. The Perdido River forms the boundary between Alabama and Florida in this area. The major rivers that cross the part of this area in Florida on their way to the Gulf of Mexico are the Escambia, Yellow, Choctawhatchee, Apalachicola, Ochlockonee, and Suwannee Rivers.

Geology

Pleistocene-age terraces consisting of ancient Mississippi River deposits of unconsolidated fine sand, which grades to coarser sand and gravel at depth, are at the surface in the western end of this area, in Louisiana and Mississippi. The Citronelle Formation is at the surface in most of the parts of this area in Mississippi, Alabama, and the western panhandle of Florida. This formation is a thin layer of silt, sand, and gravel deposited by an ancient predecessor of the Mississippi River during Pliocene time. A thin veneer of Pleistocene-age sand covers the surface of this area farther to the east in Florida. Limestone and dolomite of the Floridan aquifer lie just beneath the sand in the rest of the area in Florida. Karst topography is common in Florida. Recent silt, sand, and gravel deposits fill the valleys along most of the major rivers in the area.

Climate

The average annual precipitation is 60 to 68 inches (1,525 to 1,725 millimeters) in most of the central part of this area. It is 47 to 60 inches (1,195 to 1,525 millimeters) in much of the area in Louisiana and Florida. The minimum precipitation usually occurs in the early and middle parts of autumn, increasing moderately in winter and early spring. Lesser amounts occur in May. The maximum precipitation usually occurs in summer. At the eastern end of this area, in Florida, rainfall usually occurs as high-intensity, convective thunderstorms in summer. In the rest of the area, it typically occurs as moderate-intensity, tropical storms that produce large amounts of rain in winter. The average annual temperature is 64 to 71 degrees F (18 to 21 degrees C). The freeze-free period averages 300 days and ranges from 250 to 350 days. It is longer closer to the Gulf of Mexico and to the south in Florida.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 1.8%; ground water, 15.3%
Livestock—surface water, 0.5%; ground water, 1.4%
Irrigation—surface water, 0.1%; ground water, 0.0%
Other—surface water, 74.0%; ground water, 6.9%

The total withdrawals average 1,030 million gallons per day (3,899 million liters per day). About 24 percent is from ground water sources, and 76 percent is from surface water sources. The abundant rainfall and the many perennial streams are important sources of water. Generally, river water is suitable for most uses with some treatment. Surface waters have been polluted by municipal and industrial wastewater discharges and fecal coliform bacteria. Some improvement in water quality has occurred as communities and industries strive to clean their wastewater before discharging it into nearby rivers or lakes. Most of the surface water is used for municipal and industrial supply and for cooling thermoelectric power plants.

Ground water is plentiful in this area but is affected by salt in many areas near the coast. Soft ground water is obtained from the Pleistocene terraces in Louisiana, Mississippi, and Alabama. This water is generally low in total dissolved solids, but it may be contaminated by septic systems. Where faults occur, brine from salt-dome deposits can move up into the surface aquifers, making the water too salty for most uses. Where the ground water is not suitable, better quality water can be obtained from river valley alluvium. River flows tend to recharge these aquifers annually, so this water is usually suitable for most uses with some treatment. Ground water is plentiful in the Citronelle and Floridan aquifers, in the middle and eastern parts of this area. This water is soft and hard, respectively, and is suitable for most uses. Since these aquifers are close to the Gulf of Mexico, intrusion of seawater is a constant problem.

Soils

The dominant soil orders in this MLRA are Alfisols, Ultisols, Entisols, Spodosols, and Histosols. The soils in the area dominantly have a thermic or hyperthermic soil temperature regime, an aquic or udic soil moisture regime, and siliceous mineralogy. They generally are deep or very deep; are somewhat poorly drained to very poorly drained; and are loamy, mucky, or sandy. Alaquods (Chaires and Leon series) and Psammaquents (Scranton series) formed in sandy marine sediments on flats and in depressions. Haplosaprists formed in organic deposits in swamps and depressions (Dorovan and Pamlico series) and in marshes and swamps (Lafitte and Maurepas series). Sulfihemists (Handsboro series) and

Sulfaquents (Axis series) formed in saltwater and brackish water marshes. Quartzipsamments (Newhan and Corolla series) and Psammaquents (Duckston series) formed on dunes and in interdunal swales on barrier islands. Glossaqualfs (Guyton series) and Hydraquents (Arat and Levy series) formed in alluvium on flood plains. Endoaqualfs (Meadowbrook and Wekiva series) and Albaqualfs (Tooles series) formed in loamy marine sediments on flats and flood plains and in depressions. Endoaquults (Myatt series) and Paleudults (Stough series) formed in mixed fluvial and marine sediments on flats and stream terraces. Paleaquults (Plummer and Bayou series) and Paleudults (Escambia and Ocilla series) formed in loamy and sandy sediments on marine terraces.

Biological Resources

This area supports pine forest vegetation and freshwater, brackish water, and saltwater marsh vegetation. Longleaf pine and slash pine are the major trees. Chalky bluestem, Indiangrass, and several species of panicum make up the understory. Palmetto, gallberry, and waxmyrtle are the dominant woody shrubs. Roseau, common reed, bulltongue, maidencane, cutgrass, and alligatorweed characterize the freshwater and intermediate water vegetation. Marshhay cordgrass, saltgrass, and Olney bulrush characterize the brackish water vegetation. Saltgrass, marshhay cordgrass, smooth cordgrass, and black needlerush are included in the saltwater vegetation.

Some of the major wildlife species in this area are white-tailed deer, feral hog, gray fox, red fox, bobcat, raccoon, skunk, opossum, otter, rabbit, squirrel, turkey, bobwhite quail, and mourning dove. The species of fish in the area include largemouth bass, channel catfish, bullhead catfish, bluegill, redear sunfish, spotted sunfish, warmouth, black crappie, chain pickerel, gar, bowfin, sucker, spotted trout, croaker, striped mullet, flounder, and red drum.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 1.3%
Grassland—private, 1.9%
Forest—private, 55.6%; Federal, 11.5%
Urban development—private, 10.4%
Water—private, 12.0%; Federal, 3.0%
Other—private, 4.3%

Very little of this dominantly forested area is in farms. Much of it is in large holdings owned by pulp and paper companies. Pulpwood and lumber are the principal forest products. Some of the forestland is grazed. Some areas are in State and national forests or are used as game refuges or as military training sites. Only a very small acreage is cropped or pastured. Corn, peanuts, tobacco, and soybeans are the major crops.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and productivity of the soils, surface compaction, and management of soil moisture. Conservation practices on forestland generally include forest stand improvement, forest trails and landings, prescribed burning, riparian forest buffers, forest site preparation, bedding, establishment of trees and shrubs, and management of upland wildlife habitat. The most important conservation practice on pasture is prescribed grazing. Over-seeding of pastures with small grains and/or legumes during winter commonly supplements forage production. Haying also provides additional feed during the long winters. Conservation practices on cropland generally include systems of crop residue management, cover crops, crop rotations, water disposal, subsoiling or deep tillage, pest management, and nutrient management. Critically eroding areas and areas where animals congregate must be monitored regularly and treated promptly. ■

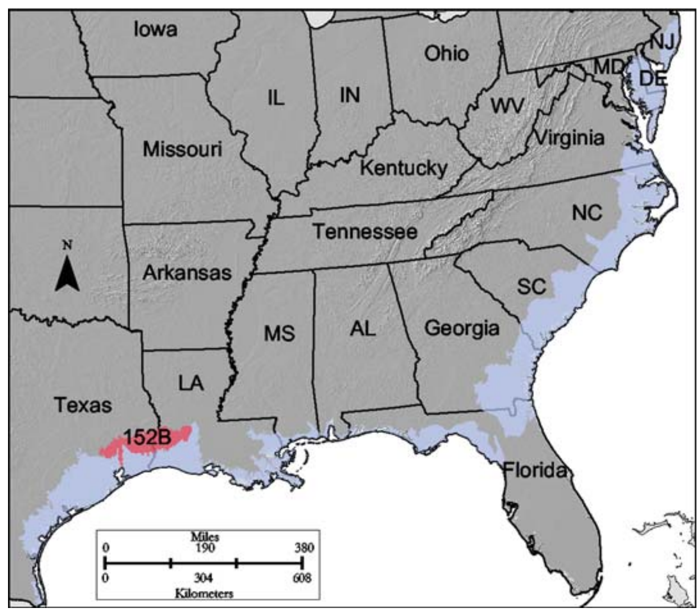

Figure 152B-1: Location of MLRA 152B in Land Resource Region T.

152B—Western Gulf Coast Flatwoods

This area (shown in fig. 152B-1) is in Texas (59 percent) and Louisiana (41 percent). It makes up about 5,880 square miles (15,240 square kilometers). It is just northeast of Houston, Texas, and north of Lake Charles, Louisiana. The towns of Kingwood, Texas, and Singer, Sulfur, and Oberlin, Louisiana, are in this MLRA. Interstate 10 is just south of this area. The Sam Houston National Forest and the Big Thicket National Preserve are in the part of this area in Texas. The Sam Houston Jones State Park is in the part in Louisiana.

Physiography

This area is in the West Gulf Coastal Plain Section of the Coastal Plain Province of the Atlantic Plain. The area is nearly level to gently sloping and has low local relief. Elevation ranges from 80 to 330 feet (25 to 100 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Louisiana Coastal (0808), 35 percent; Neches (1202), 25 percent; Sabine (1201), 19 percent; Galveston Bay-San Jacinto (1204), 11 percent; and Trinity (1203), 10 percent. This area is bisected by many small streams and rivers that run toward the Gulf of Mexico. From west to east, these include the San Jacinto, Trinity, Neches, Sabine, Beckwith, Calcasieu, and Mermentau Rivers. The Calcasieu River, in the eastern part of the area, has been designated as a National Wild and Scenic River.

Geology

The entire area is underlain by unconsolidated clay, silt, sand, and gravel deposited by ancient rivers in late Tertiary and Quaternary time. Recent silt, sand, and gravel deposits fill the valleys along most of the major rivers in the area.

Climate

The average annual precipitation in this area generally ranges from 46 to 60 inches (1,170 to 1,525 millimeters), increasing from west to east. It is as much as 64 inches (1,625 millimeters) in the extreme northeast corner of the area. The precipitation is evenly distributed throughout the year but is slightly higher in the eastern part during winter. Rainfall usually occurs as moderate-intensity, tropical storms that can produce large amounts of rain during fall and winter. The average annual temperature is 66 to 68 degrees F (19 to 20 degrees C). The freeze-free period averages 290 days and ranges from 265 to 320 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 3.9%; ground water, 2.2%
Livestock—surface water, 2.6%; ground water, 1.6%
Irrigation—surface water, 1.3%; ground water, 7.2%
Other—surface water, 76.3%; ground water, 4.7%

The total withdrawals average 760 million gallons per day (2,875 million liters per day). About 16 percent is from ground water sources, and 84 percent is from surface water sources. Rainfall, perennial streams, and aquifers provide an abundance of water. Most of the soils must be drained for optimum growth of general farm crops. Reservoirs on the San Jacinto River provide industrial and public supply water to the eastern end of this area. Water diverted from the Sabine, Calcasieu, and Mermentau Rivers is used for irrigating rice, for cooling thermoelectric power plants, and for industrial purposes in the suburbs of Lake Charles, Louisiana. Because of high levels of fecal coliform bacteria, the Calcasieu River is one of Louisiana’s most polluted rivers.

The unconsolidated sediments in this area are the primary sources of ground water. The water is used as drinking water and for industry and irrigation. The Gulf Coast aquifer system in Texas has moderately hard water with 300 to 500 parts per million (milligrams per liter) total dissolved solids. Soft water can be found in this aquifer in wells deeper than 500 feet (150 meters). The Chicot aquifer in Louisiana is made up of numerous beds of unconsolidated sand and gravel separated by layers of clay. The water in this aquifer is hard and has a median level of 350 parts per million (milligrams per liter) total dissolved solids. High iron levels may require treatment before this water is used for public supply.

Soils

The dominant soil orders in this MLRA are Alfisols and Ultisols. The soils in the area dominantly have a thermic soil temperature regime, an aquic or udic soil moisture regime, and siliceous or smectitic mineralogy. They generally are very deep, moderately well drained to very poorly drained, and loamy or clayey. Glossaqualfs formed in loamy and clayey sediments on stream terraces (Caddo and Evadale series), in loamy marine sediments on uplands (Waller series), and in alluvium on flood plains and stream terraces (Guyton series). Glossudalfs (Messer series) formed in loamy marine sediments on mounds and ridges. Vermaqualfs (Sorter series) formed in old alluvium on uplands. Hapluderts (Kaman series) formed in alluvium on flood plains. Paleudults (Kirbyville and Malbis series) formed in loamy marine sediments on uplands.

Biological Resources

This area supports pine-hardwood forest vegetation characterized by longleaf pine. Sweetgum, blackgum, post oak, blackjack oak, and southern red oak are the principal hardwood species. Hawthorns, myrtle, and shining sumac make up the woody understory. Mid and tall grasses are dominant in open areas. Little bluestem, pinhole bluestem, big bluestem, switchgrass, and Indiangrass are the principal grasses. Longleaf uniola, Virginia wildrye, Florida paspalum, beaked panicum, and several low-growing panicums and paspalums are the principal grasses in shady areas. Lespedezas, tickclover, wildbeans, and several composites are the principal forbs in the area.

Some of the major wildlife species in this area are white-tailed deer, coyote, fox, nutria, raccoon, skunk, cottontail, gray squirrel, fox squirrel, mink, armadillo, wood rat, white-footed mouse, eastern harvest mouse, cotton mouse, golden mouse, hispid cotton rat, hispid pocket mouse, marsh rice rat, turkey, quail, and mourning dove. Other major species include cottonmouth moccasin, broad-banded water snake, coral snake, hognose snake, canebrake rattlesnake, pigmy rattlesnake, copperhead, Louisiana milk snake, speckled kingsnake, rough green snake, buttermilk snake, five-lined skink, broad-headed skink, green anole, smooth softshell turtle, three-toed box turtle, red-eared turtle, Mississippi mud turtle, marbled salamander, smallmouth salamander, Fowler's toad, East Texas toad, spring peeper, eastern tree toad, northern cricket frog, northern leopard frog, and bullfrog. The species of fish in the area include spotted bass, largemouth bass, crappie, catfish, bullhead, carp, and bluegill.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 1%
Grassland—private, 12%; Federal, 1%
Forest—private, 74%; Federal, 3%
Urban development—private, 7%
Water—private, 1%
Other—private, 1%

The forestland in this area consists principally of pine and pine-hardwood forests. Much of the forested acreage is owned by large corporations, and lumber and pulpwood are the chief forest products. Cleared areas are used mostly for pasture. The major pasture grasses are bahiagrass and coastal bermudagrass. Only a few small areas are used for crops. Many small subdivisions are being developed throughout the area, especially in the vicinity of Houston and Beaumont, Texas.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and productivity of the soils, and soil moisture management. When areas are bare after a tree harvest, water erosion is a hazard on sloping land. Conservation practices on forestland generally include forest stand improvement, forest trails and landings, prescribed burning, riparian forest buffers, forest site preparation, bedding, establishment of trees and shrubs, and management of upland wildlife habitat. The soils in this area are low in content of organic matter and productivity. Measures that increase the content of organic matter are needed. Applications of lime in areas of low pH help to maintain or improve productivity. Many of the soils remain wet or have a high water table for some or most of the time during the year. Measures that improve drainage or adapt the land use to the wet conditions are needed. ■

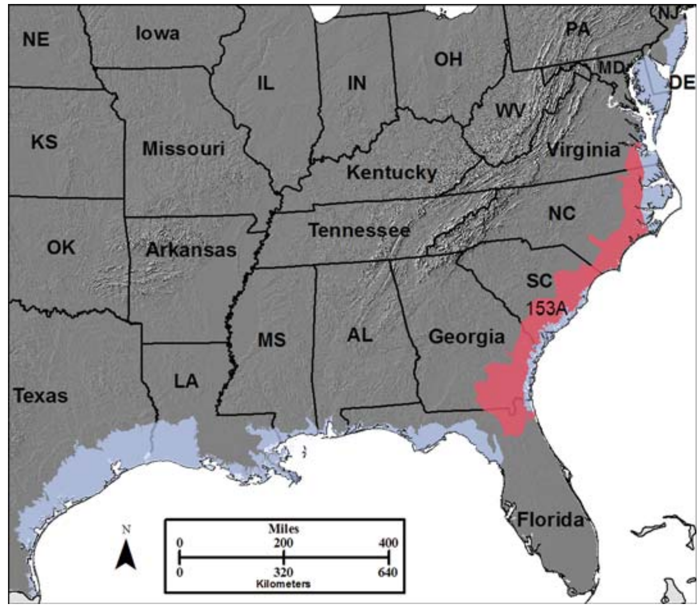

Figure 153A-1: Location of MLRA 153A in Land Resource Region T.

153A—Atlantic Coast Flatwoods

This area (shown in fig. 153A-1) is in South Carolina (30 percent), North Carolina (29 percent), Georgia (28 percent), Florida (10 percent), and Virginia (3 percent). It makes up about 28,720 square miles (74,420 square kilometers). It includes Suffolk and Franklin, Virginia; Greenville, Kinston, New Bern, Jacksonville, and Wilmington, North Carolina; Florence, Summerville, and Orangeburg, South Carolina; Fort Stewart, Hinesville, and Waycross, Georgia; and Lakeside and Jacksonville, Florida. Interstates 10, 16, 26, and 40 cross this area. The Green Swamp Private Preserve, the Croatan National Forest, Moores Creek National Military Park, and Camp Lejeune Marine Corps Military Reservation are in the part of this area in North Carolina. The Francis Marion National Forest is in the part in South Carolina. The Osceola National Forest and Camp Blanding, Cecil Field, and Jacksonville Naval Air Stations are in the part in Florida. The west edge of the Great Dismal Swamp in southeast Virginia and northeast North Carolina and parts of the Okefenokee Swamp in Georgia and Florida are in this MLRA.

Physiography

This area is in the Coastal Plain Province of the Atlantic Plain. Almost three-fourths of the area is in the Sea Island Section of the province, the northern end is in the Embayed Section, the extreme southern end is in the Floridian Section, and part of the southwest corner is in the East Gulf Coastal Plain Section. This area is a relatively flat coastal plain crossed by many broad, shallow valleys that have widely meandering stream channels. Some short, steep slopes border the stream valleys. Elevation ranges from 25 to 165 feet (8 to 50 meters). Local relief is mainly less than 35 feet (10 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Altamaha-St. Marys (0307), 18 percent; Pee Dee (0304), 17 percent; Edisto-Santee (0305), 16 percent; Suwannee (0311), 12 percent; Neuse-Pamlico (0302), 9 percent; Chowan-Roanoke (0301), 9 percent; Cape Fear (0303), 9 percent; Ogeechee-Savannah (0306), 6 percent; St. Johns (0308), 3 percent; and Lower Chesapeake (0208), 1 percent. Some of the major rivers that cross this area on their way to the Atlantic Ocean are, from north to south, the Blackwater, Nottoway, Chowan, Roanoke, Tar, Pamlico, Neuse, Cape Fear, Little Pee Dee, Pee Dee, Lynches, Black, Santee, Cooper, Edisto, Combahee, Coosawhatchie, Savannah, Ogeechee, Altamaha, Big Satilla, Satilla, and Suwanee Rivers.

Geology

Mostly unconsolidated Coastal Plain sediments occur at the surface throughout this area. These sediments are primarily Tertiary to Quaternary in age. They are a mixture of river-laid sediments in old riverbeds and on terraces, flood plains, and deltas. These young sediments are made up of combinations of clay, silt, sand, and gravel. From central North Carolina to Florida, Cretaceous marine, near-shore shale, sandstone, and limestone deposits occur beneath the surface. Swamps were common in this area prior to agricultural development. The present-day river valleys are extensive and are flat near the coast. The water table typically is close to the surface in these river valleys. Soils having restricted drainage are common throughout the area.

Climate

The average annual precipitation in this area is 44 to 57 inches (1,120 to 1,450 millimeters). The maximum precipitation occurs in summer. Rainfall usually occurs as moderate-intensity, tropical storms that can produce large amounts of rain during fall and winter. Snowfall may occur in the northern third of the area. The average annual temperature is 58 to 69 degrees F (15 to 21 degrees C), increasing to the south. The freeze-free period averages 290 days and ranges from 210 to 365 days, increasing in length to the south.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 3.7%; ground water, 7.6%
Livestock—surface water, 1.5%; ground water, 0.4%
Irrigation—surface water, 2.4%; ground water, 2.2%
Other—surface water, 68.5%; ground water, 13.6%

The total withdrawals average 2,695 million gallons per day (10,200 million liters per day). About 24 percent is from ground water sources, and 76 percent is from surface water sources. Rainfall, perennial streams, and aquifers provide an abundance of water. Many of the soils require artificial drainage before they can be used for crops, and some of the sandy soils require irrigation during droughty periods. Most of the surface water used in this area is for cooling thermoelectric power plants. The numerous rivers that flow across the area have good-quality water that is suitable for most uses with minimal treatment.

Water for domestic and some municipal and industrial uses is obtained primarily from wells in the unconsolidated sediments of the Coastal Plain aquifer system in the northern end of this area. This water is moderately hard or hard but is suitable for all uses. The median level of total dissolved solids is generally less than 250 parts per million (milligrams per liter). From central North Carolina to Florida, the principal source of ground water is Cretaceous marine sediments. Water from shale and sandstone aquifers is typically soft, and water from limestone aquifers (Castle Haynes in South Carolina and Floridan in South Carolina, Georgia, and Florida) is hard or very hard. The median level of total dissolved solids is higher than that in the water in the northern part of the area but is still well below the national standard for drinking water. Since the water in all of these aquifers is typically near the surface, nitrate contamination is a problem in some areas. Naturally high levels of fluoride and iron occur in some of the ground water throughout the MLRA.

Soils

The dominant soil orders in this MLRA are Spodosols and Ultisols. The soils in the area dominantly have a thermic soil temperature regime, an aquic or udic soil moisture regime, and siliceous or kaolinitic mineralogy. They generally are very deep, well drained to very poorly drained, and loamy or clayey. Paleaquults formed in marine sediments on flats and in depressions on the coastal plain (Coxville, Lynchburg, Pantego, and Pelham series) and on marine terraces (Rains series). Paleudults (Goldsboro series) and Kandiudults (Norfolk series) formed in marine sediments on uplands. Albaquults (Leaf series) formed in mixed alluvium and marine sediments on flats and terraces. Alaquods (Leon and Mascotte series) formed in marine sediments on flats and terraces and in depressions. Haplosaprists (Croatan series) formed in organic deposits over mixed marine and fluvial deposits on the coastal plain.

Biological Resources

This area supports pine-oak forest vegetation. Loblolly pine, sweetgum, red maple, blackgum, and oaks are dominant in the uplands. Water tupelo, swamp blackgum, bald cypress, sweetgum, and red maple are dominant on the bottom land.

Longleaf uniola, cutover muhly, toothachegrass, panicums, little bluestem, and associated grasses and forbs characterize the understory vegetation.

Some of the major wildlife species in this area are white-tailed deer, feral hog, gray fox, red fox, bobcat, raccoon, skunk, opossum, otter, rabbit, armadillo, squirrel, turkey, and bobwhite quail. The species of fish in the area include largemouth bass, channel catfish, bullhead catfish, bluegill, redear sunfish, spotted sunfish, warmouth, black crappie, chain pickerel, gar, bowfin, and sucker.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 15%
Grassland—private, 2%
Forest—private, 61%; Federal, 6%
Urban development—private, 8%
Water—private, 4%
Other—private, 4%

Most of this area is in farms, but some is in national forests or is used for game refuges or related purposes. Some of the forests are farm woodlots, but most are large holdings. Pulpwood is the main wood product. Lumber and naval stores are other wood products. The acreage of cropland is somewhat higher in the northern part of the area than in the southern part and is considerably lower in Florida. Vegetable crops, fruits, melons, sweet potatoes, and Irish potatoes are important crops. Large acreages are used for corn, soybeans, wheat, and tobacco. Some peanuts are grown on the sandy soils in Virginia, North Carolina, and Georgia. Poultry farming is an important enterprise in the northern part of the area and in some parts of Florida. Swine operations are of major importance in North Carolina and Virginia.

The major soil resource concerns are wind erosion and a low soil conditioning index resulting from surface compaction and a low content of organic matter in cultivated areas. Many areas of poorly drained and very poorly drained soils on uplands have been restored to wetland conditions. Wetland restoration improves water quality and provides wildlife habitat.

Conservation practices on forestland generally include forest stand improvement, forest trails and landings, prescribed burning, riparian forest buffers, forest site preparation, bedding, establishment of trees and shrubs, and management of upland wildlife habitat. Conservation practices on cropland generally include crop residue management, establishment of field borders, vegetative wind barriers, and nutrient and pest management. ■

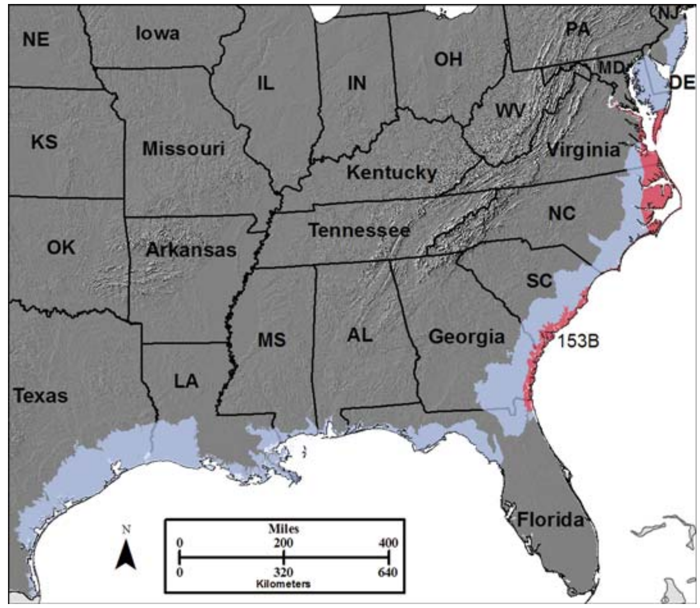

Figure 153B-1: Location of MLRA 153B in Land Resource Region T.

153B—Tidewater Area

This area (shown in fig. 153B-1) is in North Carolina (35 percent), South Carolina (22 percent), Georgia (21 percent), Virginia (17 percent), and Florida (5 percent). It makes up about 12,830 square miles (33,250 square kilometers). It includes the cities or towns of Norfolk, Hampton, Chesapeake, Virginia Beach, Chincoteague, and Kiptopeke, Virginia; Edenton, Elizabeth City, Kitty Hawk, and Morehead City, North Carolina; Socastee, Myrtle Beach, Mount Pleasant, Charleston, and Hilton Head Island, South Carolina; Savannah, Brunswick, and St. Simons Island, Georgia; and Yulee and Fernandina Beach, Florida. Small sections of Interstates 26 and 64 are in this area, and Interstate 95 parallels the coastline in the southern third of the MLRA. The Colonial National Historic Park, Oceana and Norfolk Naval Air Stations, Camp Peary, Fort Eustis, Wallops Flight Center, and Langley Air Force Base are in the part of this area in Virginia. The Croatan National Forest, Camp Lejeune Marine Corps Base, the Wright Brothers National Memorial, and the Cape Hatteras and Cape Lookout National Seashores are in the part in North Carolina. The Wright Brothers succeeded in the first powered flight near Kitty Hawk, North Carolina, on the Outer Banks. Parris Island Military Reservation, Fort Sumter and Fort Pulaski National Monuments, and the eastern portion of the Francis Marion National Forest are in the part of this area in South Carolina. The Kings Bay Submarine Support Base, Fort Frederica National Monument, and Cumberland Island National Seashore are in the part in Georgia. Numerous national wildlife refuges are throughout this MLRA.

Physiography

Most of this area is in the Sea Island Section of the Coastal Plain Province of the Atlantic Plain. The northern quarter is in the Embayed Section of the same province and division. The area is on a nearly level coastal plain crossed by many broad, shallow valleys that have meandering stream channels. Most of these valleys terminate in estuaries along the coast. Sea level is rising, creating tidal marshes at the edges of the estuaries. Elevation ranges from sea level to less than 25 feet (0 to 8 meters). Local relief is mainly about 3 feet (1 meter) or less.

The Suffolk Scarp is the upper (western) limit of this area. The scarp marks a point where the ocean shore extended prior to the Wisconsin period of glaciation. The eastern edge of the area is characterized by a system of barrier and sea islands. The barrier islands extend from the Eastern Shore of the Chesapeake Bay in Virginia to north of Charleston, South Carolina. The portion in North Carolina is referred to as the Outer Banks. Large bodies of brackish water, such as the Pamlico and Albemarle Sounds, are on the inland side of the barrier islands. The sea islands extend from north of Charleston, South Carolina, to Jacksonville, Florida.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Chowan-Roanoke (0301), 21 percent; Edisto-Santee (0305), 18 percent; Neuse-Pamlico (0302), 17 percent; Ogeechee-Savannah (0306), 13 percent; Altamaha-St. Marys (0307), 12 percent; Lower Chesapeake (0208), 12 percent; Pee Dee (0304), 5 percent; Cape Fear (0303), 1 percent; and St. Johns (0308), 1 percent. Some of the major rivers that cross this area on their way to the Atlantic Ocean are, from north to south, the Rappahannock, York, Rivanna, and Nottoway Rivers; Albemarle Sound (the Chowan and Roanoke Rivers); Pamlico Sound (the Pamlico and Neuse Rivers); and the Cape Fear, Pee Dee, Black, Santee, Cooper, Edisto, Combahee, Coosawhatchie, Savannah, Ogeechee, Altamaha, Satilla, and St. Marys Rivers. The headwaters of the St. Johns River are in this MLRA. The Great Dismal Swamp is in the parts of the MLRA in Virginia and North Carolina.

Geology

Mostly unconsolidated Coastal Plain sediments occur at the surface throughout this area. These sediments are primarily Tertiary to Quaternary in age. They are a mixture of river-laid sediments in old riverbeds and on terraces, flood plains, and deltas. These young sediments are made up of combinations of clay, silt, sand, and gravel. The islands and coastline in this area are covered with sand derived from these sediments. From central North Carolina to Florida, Cretaceous marine, near-shore shale, sandstone, and limestone deposits occur beneath the surface. Sea level has been rising since the last period of continental glaciation, drowning the mouths of estuaries. Swamps were common in this area prior to agricultural development. The present-day river valleys are extensive and are flat near the coast. The water table typically is close to the surface in these river valleys. Soils having restricted drainage are common throughout the area.

Climate

The average annual precipitation in this area is 40 to 58 inches (1,015 to 1,475 millimeters). The maximum precipitation occurs in summer, and the minimum occurs in autumn. Rainfall usually occurs as moderate-intensity, tropical storms that can produce large amounts of rain during fall and winter. Snowfall may occur in the northern end of the area. The average annual temperature is 58 to 69 degrees F (14 to 21 degrees C). The freeze-free period averages 295 days and ranges from 230 to 360 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 8.3%; ground water, 1.3%
Livestock—surface water, 0.4%; ground water, 0.2%
Irrigation—surface water, 0.2%; ground water, 0.1%
Other—surface water, 82.9%; ground water, 6.6%

The total withdrawals average 2,690 million gallons per day (10,180 million liters per day). About 8 percent is from ground water sources, and 92 percent is from surface water sources. Rainfall, perennial streams, and aquifers provide an abundance of water. Water for domestic, municipal, and industrial uses is obtained mainly from wells. Many soils require artificial drainage before they can be used for crops, but irrigation is needed on some of the sandy soils during droughty periods. Most of the surface water used in this area is for cooling thermoelectric power plants and for industry. The numerous rivers that flow into estuaries in the area have good-quality water that is suitable for most uses with minimal treatment.

Water for domestic and some municipal and industrial uses is obtained primarily from wells in the unconsolidated sediments of the Coastal Plain aquifer system in Virginia. This water is moderately hard or hard but is suitable for all uses. The median level of total dissolved solids is generally less than 250 parts per million (milligrams per liter).

The part of this area in northeast North Carolina obtains ground water from both a surficial aquifer and the Yorktown aquifer. The only source of freshwater in the Outer Banks is the surficial aquifer. The ground water in this aquifer is soft to hard and has the same median level of total dissolved solids as the water in the Coastal Plain aquifer in Virginia. Deeper wells or wells that are excessively pumped, however, can provide water that has high levels of total dissolved solids because of the encroachment of seawater. Water in the Yorktown aquifer has a median level of total dissolved solids of 319 parts per million (milligrams per liter) and is soft to hard.

From central North Carolina to Florida, the principal source of ground water in this MLRA is Cretaceous marine sediments. Water from shale and sandstone aquifers is typically soft, and water from limestone aquifers (Castle Haynes in South Carolina and Floridan in South Carolina, Georgia, and Florida) is hard or very hard. The median level of total dissolved solids is higher than that in the water in the northern part of the area but is still well below the national standard for drinking water.

Since the water in all these aquifers is typically near the surface, nitrate contamination is a problem in some areas. Naturally high levels of fluoride and iron occur in some of the ground water throughout this MLRA.

Soils

The dominant soil orders in this MLRA are Alfisols and Entisols. Histosols are of lesser extent. The soils in the area are characterized by restricted drainage, a thermic soil temperature regime, and an aquic soil moisture regime. The soils in the northern part of the area dominantly have mixed mineralogy, and those in the southern part dominantly have mixed clay and siliceous sand mineralogy. Very deep, loamy to clayey Endoaquults (Tomotley, Yeopim, Yemassee, and Wahee series), Umbraquults (Cape Fear and Portsmouth series), Endoaqualfs (Argent and Yonges series), and Albaqualfs (Meggett series) are extensive. Hapludults (Bertie and Tetotum series) are in the higher areas where drainage is better but is somewhat restricted. Other important soils are Alaquods (Leon and Lynn Haven series) and Psamments (Wando, Newhan, Corolla, and Fripp series). Histosols (Pungo and Belhaven series) are in large areas in North Carolina and Virginia, in the Great Dismal Swamp and in broad upland wetlands known as poquosins. Aquents (Bohicket and Capers series) are extensive throughout the brackish tidal marshes protected by the barrier islands and sea islands.

Biological Resources

Loblolly pine and some oaks are dominant in the uplands in this area, and blackgum, sweetgum, oaks, water tupelo, and bald cypress are dominant on the bottom land. Longleaf pine and slash pine are dominant in the southern part of the area. Longleaf uniola, switchcane, panicums, little bluestem, inkberry, large gallberry, greenbrier, waxmyrtle, cabbage palm, and associated grasses and forbs characterize the understory.

Some of the major wildlife species in this area are black bear, white-tailed deer, fox, raccoon, opossum, otter, muskrat, rabbit, mink, squirrel, quail, and mourning dove. The red wolf, an endangered species, is being reintroduced in several parts of the area.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 11%
Grassland—private, 1%
Forest—private, 22%; Federal, 5%
Urban development—private, 9%
Water—private, 37%; Federal, 5%
Other—private, 10%

Most of the northern part of this area is in farms, but some is in national forests or is used for game refuges, urban development, or related purposes. Some of the forests in the MLRA are in farm woodlots, but most are in large holdings. Pulpwood is the main wood product. Lumber and naval stores are other wood products. Large acreages are used for corn, soybeans, tobacco, and vegetables. Recreational enterprises are important in the area, and coastal marshes and open water in sounds make up more than 40 percent of the area.

The major soil resource concerns are a seasonal high water table and flooding. Measures that maintain drainage systems are needed. Conservation practices on cropland generally include crop residue management and control of the water table. In much of the area, the water table can be controlled by flashboard risers, which preserve water quality and utilize ground water in lieu of irrigation. ■

153C—Mid-Atlantic Coastal Plain

This area (shown in fig. 153C-1) is in Maryland (62 percent) and Delaware (38 percent). It makes up about 2,015 square miles (5,225 square kilometers). The town of Middletown, Delaware, the city of Dover, Delaware, and the towns of Chestertown and Easton, Maryland, are in this area. U.S. Highways 13, 113, and 301 cross the area. Dover Air Force Base is in this MLRA, and a number of national wildlife management areas are throughout the MLRA.

Physiography

This area is in the Embayed Section of the Coastal Plain Province of the Atlantic Plain. It is a nearly level to gently sloping coastal plain. Elevation ranges from sea level to about 80 feet (0 to 25 meters). Local relief is only 6 to 15 feet (2 to 5 meters), even where flood plains or coves from the bay are incised.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Chesapeake (0206), 72 percent, and Delaware (0204), 28 percent. The Chester and Choptank Rivers are both impounded

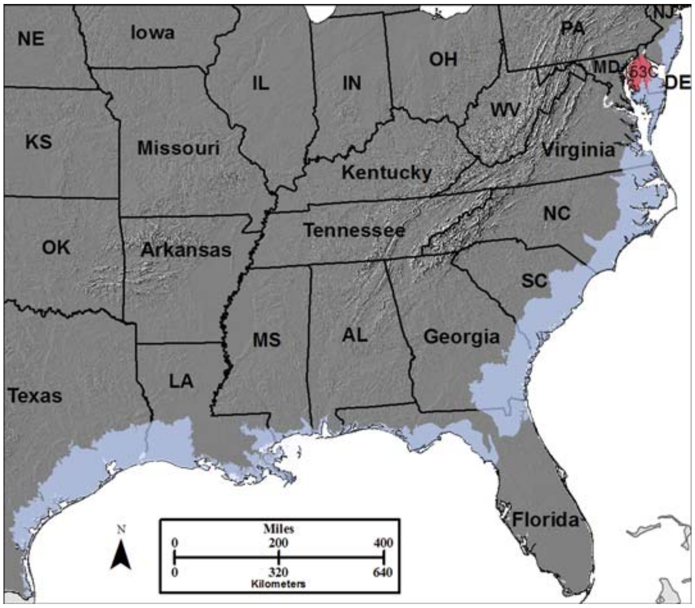

Figure 153C-1: Location of MLRA 153C in Land Resource Region T.

in the part of this area in Maryland. The Smyrna, Leipsic, Murderkill, and St. Jones Rivers are in the part in Delaware.

Geology

This area is underlain by unconsolidated sand, silt, and clay deposited by ancient rivers as continental sediments. Between glacial periods, when sea level was much higher than it is today, the river sediments were mixed with marine sediments. In the northern part of the area, 1 to 3 feet (less than 1 meter) of loess covers these sediments. Ocean levels are again rising, so extensive tidal marshes are in areas along the Chesapeake and Delaware Bays where the mouths of rivers are being further submerged.

Climate

The average annual precipitation in this area is 40 to 44 inches (1,015 to 1,120 millimeters). Convective summer thunderstorms provide a large amount of the total precipitation, but precipitation is relatively evenly distributed throughout the year. The average annual snowfall is typically about 6 inches (15 centimeters). The average annual temperature is 54 to 58 degrees F (12 to 14 degrees C). The freeze-free period averages 220 days and ranges from 205 to 235 days. It is shorter inland and longer along the bays.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 1.8%; ground water, 4.3%
Livestock—surface water, 0.1%; ground water, 0.5%
Irrigation—surface water, 2.2%; ground water, 4.5%
Other—surface water, 80.0%; ground water, 6.6%

The total withdrawals average 425 million gallons per day (1,610 million liters per day). About 16 percent is from ground water sources, and 84 percent is from surface water sources. Rainfall, perennial streams, and ground water sources provide an abundance of water. Many of the soils require artificial drainage before they can be used for crops. During droughty periods, however, irrigation is needed on some of the sandy soils. The surface water is suitable for most uses. Most of the surface water is used for cooling thermoelectric power plants.

Water for domestic, municipal, and industrial uses is obtained mainly from wells. One aquifer consists of the Quaternary and Tertiary alluvial deposits at the surface in eastern Maryland and from the center of this area and south in Delaware. The surficial sediments provide water that is soft and that has less than 100 parts per million (milligrams per liter) total dissolved solids. This water is used for domestic purposes and some public supplies and is heavily pumped for irrigation.

The Chesapeake Group and Rancocas aquifers are sources of ground water beneath the surficial aquifer. The water in these aquifers has low levels of total dissolved solids, typically less than 200 parts per million (milligrams per liter), but iron concentrations typically exceed the secondary drinking water standard of 300 parts per billion (micrograms per liter) and the water is hard or very hard. These aquifers provide water for public supply and for industry. The intrusion of seawater can be a problem near the shorelines of the Chesapeake and Delaware Bays.

Soils

The dominant soils in this MLRA are Ultisols. Entisols and Inceptisols are of lesser extent. The soils in the area have an aquic or udic soil moisture regime, a mesic soil temperature regime, and mixed or siliceous mineralogy. They are very deep, dominantly well drained to poorly drained, and generally loamy or sandy in the mineral horizons.

Well drained, loamy Hapludults (Sassafras, Downer, Hambrook, Unicorn, and Ingleside series) are on broad uplands. Moderately well drained Hapludults (Woodstown, Pineyneck, and Hammonton series) are in intermediate positions on the landscape. Poorly drained Endoaquults (Fallsington, Carmichael, and Hurlock series) are in low-lying areas. The soils generally formed in loamy or sandy coastal plain sediments. Significant areas of Hapludults (Matapeake, Nassawango, and Mattapex series) and Endoaquults (Othello and Elkton series) that formed in 1 to 3 feet (1 meter or less) of loess over sandy and loamy, stratified coastal plain deposits occur in the MLRA.

Small areas of sandy soils that formed in sandy terrace deposits or ancient dunes associated with rivers are throughout the MLRA. Somewhat poorly drained to excessively drained Quartzipsamments (Evesboro, Runclint, Galloway, and Klej series) and Hapludults (Galestown and Cedartown series) and poorly drained Psammaquents (Askecksy series) are the dominant soils in these small areas.

The flood plains, freshwater swamps, and low-lying flats are dominated by very poorly drained Humaquepts (Mullica, Indiantown, and Longmarsh series), Haplosaprists (Manahawkin and Puckum series), and Fluvaquents (Chicone and Zekiah series). The tidal marshes along the Chesapeake and Delaware Bays are dominated by very poorly drained Sulfihemists (Honga, Transquaking, Bestpitch, and Mispillion series) and Sulfaquents (Appoquinimink and Broadkill series).

Biological Resources

The natural vegetation in this area consists mostly of white oak, red oak, hickory, blackgum, red maple, black oak, scarlet oak, chestnut oak, blackjack oak, sweetgum, loblolly pine, beech, Virginia pine, scrub oak, highbush blueberry, sweet pepperbush, greenbrier, laurel, sassafras, lowbush blueberry, holly, and mountain laurel.

Some of the major wildlife species in this area are white-tailed deer, turkey, quail, raccoon, rabbit, squirrel, wading shore birds, and numerous species of ducks and geese. The Chesapeake and Delaware Bays provide habitat for diverse populations of aquatic animal species. The Chesapeake Bay provides extensive habitat for shellfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 40%
Grassland—private, 2%
Forest—private, 20%; Federal, 1%
Urban development—private, 7%
Water—private, 25%
Other—private, 5%

About one-half of this area is in farms. Farming is highly diversified. The main agricultural enterprise is the production of grain crops, such as soybeans and corn. Fruit and vegetable production and specialty crops, such as cranberries and blueberries, are important in the area. Many large-scale corporate farms produce the specialty crops. The production of poultry, truck crops, or fruit crops exceeds general farming in importance in some counties. Sod farms are important in some areas. Many large tracts of loblolly pine in areas of the wetter soils are managed for timber production. Native mixed pine and hardwood forests remain in large tracts or in areas of protected public lands in State forests and parks. Broad flats of marine and fluvial origin are drained by flat, wide, meandering, slow-moving streams. Ditch networks on large tracts have been developed to facilitate drainage for agricultural production. Rapid expansion of urban and suburban development is reducing the extent of farmland, particularly prime farmland, as well as forestland. The seafood industry is significant to the economy of the counties bordering the two bays.

Several major soil resource concerns affect this area. The most significant of these is the reduction in the acreage of farmland and forestland caused by urban and suburban development. Water erosion and the resultant degradation of stream quality commonly occur during construction activities associated with urbanization. Urbanization often changes the character of agricultural communities, some of which have histories dating back to the colonial era. Increased runoff associated with urban development and agriculture commonly causes stream downcutting and widening and the subsequent deposition of sandy material along streambanks. Development of residential lagoons along shorelines can severely impact the adjacent wetlands and estuaries.

Farmland preservation programs are vital to maintaining the agricultural resources in the area. Maintenance or improvement of water quality for recreation and fishing is critical to local economies, particularly in the shellfish habitat areas in the Chesapeake Bay. Conservation practices on cropland generally include systems of crop residue management (especially no-till and minimum-till systems), conservation cover crops, nutrient management, grassed waterways, filter strips, irrigation water management, and riparian buffers. Where livestock or poultry are part of the farm operation, management of animal waste, including storage of the waste, is important. ■

153D—Northern Tidewater Area

This area (shown in fig. 153D-1) is in New Jersey (46 percent), Maryland (35 percent), and Delaware (19 percent). It makes up about 5,045 square miles (13,075 square kilometers). The Chesapeake Bay and the Atlantic Ocean border this area. The Delaware Bay divides the area nearly in half. The MLRA includes Long Branch, Asbury Park, Lakewood, Hammonton, and Atlantic City, New Jersey; Cambridge, Salisbury, and Pocomoke City, Maryland; and Milford, Georgetown, and Seaford, Delaware. A short stretch of Interstate 195 crosses the northern tip of this area, in New Jersey. The Garden State Parkway parallels the coast in the part of this area in New Jersey, and the Atlantic City Expressway connects Atlantic City to Philadelphia, Pennsylvania. U.S. Highway 13 connects most of the rest of the area outside of New Jersey. Lakehurst Naval Air Station and most of Fort Dix are in the part of this area in New Jersey, and a number of national wildlife refuges and State forests are throughout the area. The Assateague Island National Seashore, consisting of most of Assateague Island, is in the part of the area in Maryland.

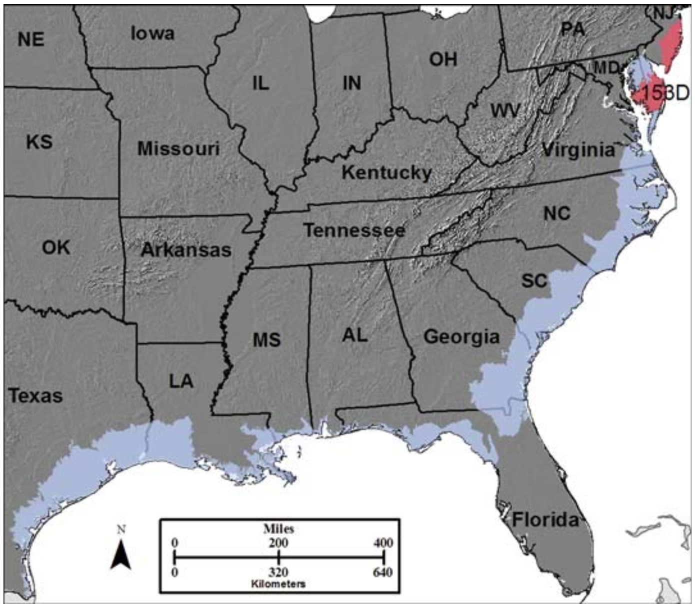

Figure 153D-1: Location of MLRA 153D in Land Resource Region T.

Physiography

This area is in the Embayed Section of the Coastal Plain Province of the Atlantic Plain. It is a nearly level to gently sloping coastal plain with dunes and beaches on the ocean and bay sides. Large areas of tidally flooded marshes occur, particularly between the numerous barrier islands and the mainland along the Atlantic Coast and along the bays. Elevation typically ranges from sea level to about 80 feet (0 to 25 meters). In the Barnegate Bay watershed in the northern part of the MLRA, however, remnants of old Coastal Plain deposits have a maximum elevation of more than 200 feet (60 meters). Local relief is only 6 to 15 feet (2 to 5 meters), even where flood plains or coves from the bay are incised.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Chesapeake (0206), 50 percent; Delaware (0204), 49 percent; and Lower Hudson-Long Island (0203), 1 percent. From north to south, the major rivers in the area are the Shark, Manasquan, Toms, Yellow, Oswego, Wading, Mullica, Tuckahoe, Great Egg Harbor, and Maurice Rivers in New Jersey and the Mispillion, Broadkill, Gravelly, Indian, Nanticoke, Broad, Wicomico, Dividing, and Pokomoke Rivers in Delaware and Maryland. The Mullica River in New Jersey and the Pokomoke River in Maryland have been designated as National Wild and Scenic Rivers.

Geology

This nearly level to gently sloping coastal plain is made up of unconsolidated sand, silt, and clay deposited by ancient rivers as continental sediments. Between glacial periods, when sea level was much higher than it is today, the river sediments in this area were mixed with underlying marine sediments. During this period, major spits formed at the southern margin of both the New Jersey and the Delmarva peninsulas. The maximum elevation of these recently reformed areas is less than 20 feet (6 meters). In the part of this area in Maryland, 1 to 3 feet (1 meter or less) of loess covers these sediments. Ocean levels are again rising; therefore, extensive areas of tidal marsh are accreting and moving inland along the Chesapeake and Delaware Bays and the Atlantic Ocean, particularly at the mouths of rivers. Some areas of coastal beach dune sands are along the ocean.

Climate

The average annual precipitation in most of this area is 38 to 45 inches (965 to 1,145 millimeters). It is 47 inches (1,195 millimeters) at the northern end of the area, in New Jersey. Convective summer thunderstorms provide a large amount of the total precipitation, but precipitation is relatively evenly distributed throughout the year. The average annual snowfall is typically about 6 inches (15 centimeters). The average annual temperature is 52 to 59 degrees F (11 to 15 degrees C). The freeze-free period averages 220 days and ranges from 190 to 255 days. It is shorter in inland areas and longer along the Atlantic Ocean and the Chesapeake and Delaware Bays.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 3.4%; ground water, 43.2%
Livestock—surface water, 0.4%; ground water, 1.0%
Irrigation—surface water, 4.4%; ground water, 11.7%
Other—surface water, 7.9%; ground water, 27.9%

The total withdrawals average 265 million gallons per day (1,005 million liters per day). About 84 percent is from ground water sources, and 16 percent is from surface water sources. Rainfall and perennial streams provide an abundance of water. Ground water discharge from the surficial aquifer throughout this area contributes to the perennial streamflows. Many of the soils require artificial drainage before they can be used for crops, but irrigation is needed on the sandier soils. The surface water is generally suitable for most uses. Contamination from agricultural runoff and municipal and industrial wastewater discharges causes some local water-quality problems. Near the coast, the surface water is brackish and is not used.

Water for domestic, municipal, and industrial uses and for irrigation is obtained mainly from wells. The Coastal Plain aquifers in this MLRA are primarily Quaternary and Tertiary alluvial deposits at or very close to the surface. The surficial aquifers are the Columbia, Unconfined, and Kirkwood-Cohansey. They provide water that is soft or moderately hard and that typically has less than 100 parts per million (milligrams per liter) total dissolved solids. High levels of iron cause some problems for users throughout the MLRA. Since these are water-table aquifers, they are very susceptible to contamination from surface activities. Excessive withdrawals of ground water can result in the intrusion of seawater near the Delaware and Chesapeake Bays and on the coast of the Atlantic Ocean. These aquifers provide water for public supply and for industry.

Aquifers lying beneath the surficial aquifers are known as the Chesapeake Group. Their water has low levels of total dissolved solids (typically less than 200 parts per million (milligrams per liter), but iron concentrations typically exceed the secondary drinking water standard of 300 parts per billion (micrograms per liter). Also, the water is hard or very hard. These aquifers provide water for public supply and for industry.

Soils

The dominant soil orders in this MLRA are Ultisols. Entisols, Histosols, Spodosols, and Inceptisols are of lesser extent. The soils in the area have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed or siliceous mineralogy. They are very deep, very poorly drained to excessively drained, and generally loamy or sandy in the mineral horizons. A strip of coastal beach dune sand extends along the Atlantic Ocean in most of the MLRA.

Well drained, loamy Hapludults (Sassafras, Downer, Hambrook, Nassawango, and Ingleside series) are on broad uplands. Moderately well drained Hapludults (Woodstown and Hammonton series) are in intermediate positions on the landscape. Poorly drained Endoaquults (Fallsington and Hurlock series) are in low-lying areas. These soils generally formed in loamy or sandy coastal plain sediments. The parts of the MLRA in Maryland and Delaware have significant areas of Hapludults (Matapeake and Mattapex series) and Endoaquults (Othello and Elkton series) that formed in 1 to 3 feet (1 meter or less) of loess over sandy and loamy, stratified coastal plain deposits. Large areas of sandy soils that formed in sandy coastal plain sediments or ancient dunes are throughout the MLRA. Somewhat poorly drained to excessively drained Quartzipsamments (Evesboro, Runclint, Lakehurst, Lakewood, and Klej series) and Hapludults (Galestown and Cedartown series) and poorly drained and very poorly drained Alaquods (Atsion and Berryland series) are the dominant soils.

The flood plains, freshwater swamps, and low-lying flats are dominated by very poorly drained Humaquepts (Mullica series), Haplosaprists (Manahawkin and Puckum series), and Fluvaquents (Chicone series). The tidal marshes along the Chesapeake and Delaware Bays and between the barrier islands and the mainland are dominated by very poorly drained Sulfihemists (Honga, Transquaking, Bestpitch, and Mispillion series) and Sulfaquents (Appoquinimink, Broadkill, Purnell, and Boxiron series).

Along the Atlantic Ocean, a broken line of barrier islands consisting of primarily coastal beaches and dunes is dominated by Udipsamments (Acquango and Brockatonorton series) and Quartzipsamments (Hooksan series).

Biological Resources

The natural vegetation in this area consists mostly of pitch pine, blackgum, red maple, black oak, scarlet oak, chestnut oak, blackjack oak, Atlantic white cedar, sweetgum, white oak, hickory, shortleaf pine, Virginia pine, scrub oak, highbush blueberry, sheep laurel, sweet pepperbush, gallberry, greenbrier, laurel, sassafras, lowbush blueberry, holly, and mountain laurel.

Some of the major wildlife species in this area are white-tailed deer, turkey, quail, raccoon, rabbit, squirrel, wading shore birds, and numerous species of ducks and geese. The Chesapeake Bay provides extensive habitat for shellfish. Both the Chesapeake and Delaware Bays provide habitat for diverse populations of aquatic animal species.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 15%
Grassland—private, 1%
Forest—private, 31%; Federal, 2%
Urban development—private, 11%
Water—private, 28%; Federal, 1%
Other—private, 11%

This area consists mainly of forestland, open water, or farmland. A significant acreage is urban land. The agricultural products in the area are primarily grain crops, such as soybeans and corn. Fruits and vegetables also are grown, and tobacco is grown in some areas in Maryland. Cranberries and blueberries are grown in New Jersey. Poultry production is important in the parts of the area in Delaware and Maryland, and much of the locally grown corn is used for feed. Large forested areas occur throughout the MLRA, particularly in the wetter low-lying areas. Numerous national wildlife refuges, State forests, State parks, and wildlife management areas occur throughout the MLRA. Seasonal tourism is a large part of the local economy, particularly along or near the barrier islands.

Several major soil resource concerns affect this area. The most important is the loss of farmland and forestland to urban and suburban development. Water erosion and the resultant degradation of stream quality commonly occur during the construction activities associated with urbanization. Urbanization often changes the character of agricultural communities, some of which have histories dating back to the colonial era. Increased runoff associated with urban development and agricultural uses commonly causes stream downcutting and widening and the subsequent deposition of sandy material along streambanks. Development of residential lagoons along shorelines can have a severe impact on the adjacent wetlands and estuaries.

Farmland preservation programs are vital to maintaining the agricultural resources in this area. Maintenance or improvement of water quality for recreation and fishing is critical to local economies and is particularly important in the shellfish habitat areas in the Chesapeake Bay. Conservation practices on cropland generally include systems of crop residue management (especially no-till and minimum-till systems), conservation cover crops, nutrient management, grassed waterways, filter strips, and riparian buffers. Where livestock or poultry are part of the farm operation, management of animal waste, including storage of the waste, is important. ■

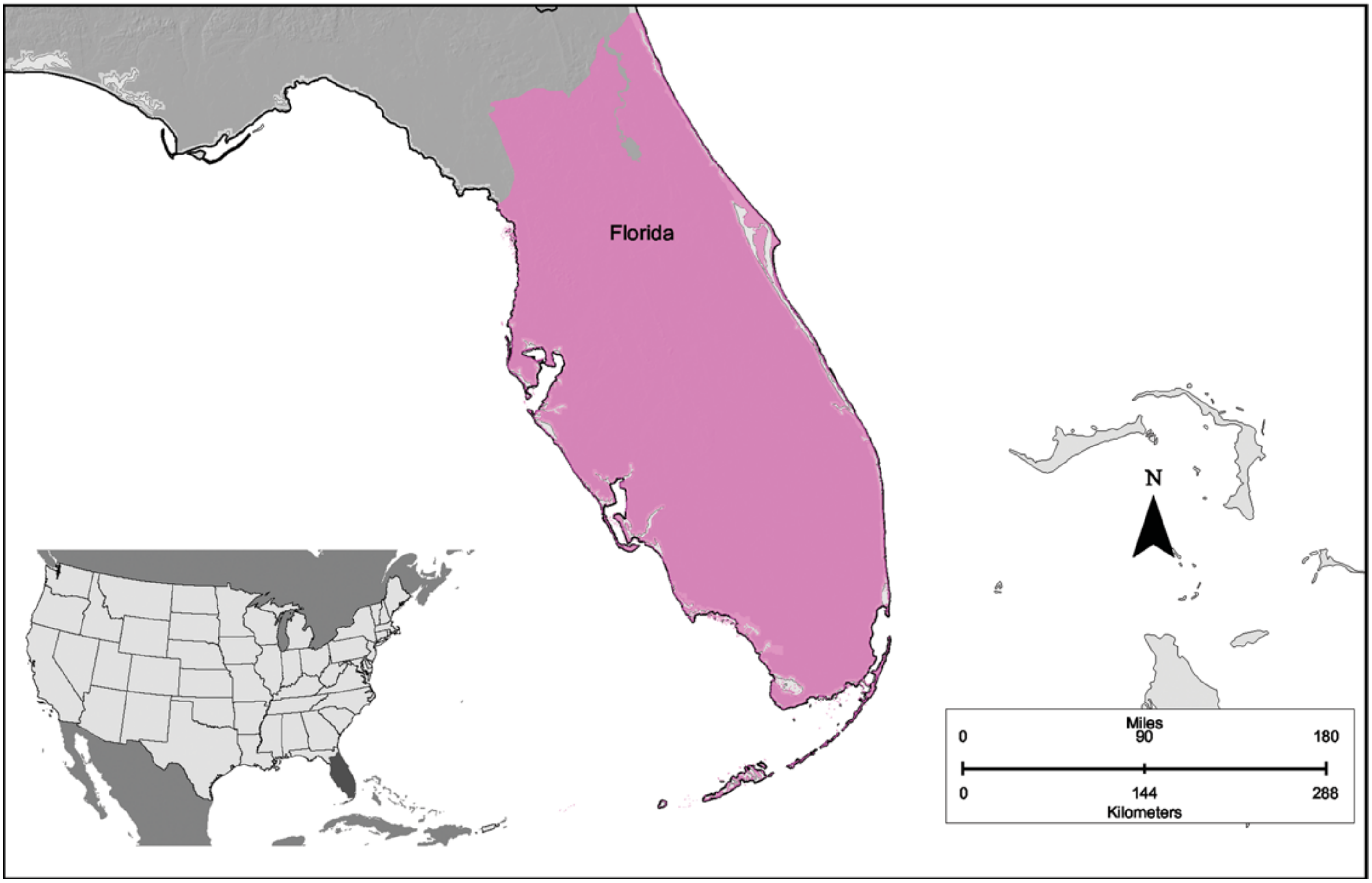

Figure U-1: Location of Land Resource Region U.

U—Florida Subtropical Fruit, Truck Crop, and Range Region

This region is entirely in Florida (fig. U-1). It makes up 35,610 square miles (92,275 square kilometers).

This is a region of low, flat coastal plains. The climate is hot and humid. The average annual precipitation is 44 to 59 inches (1,120 to 1,500 millimeters). About 60 percent of the annual precipitation occurs from June through September. Fall and winter are drier. The average annual temperature is 70 to 75 degrees F (21 to 24 degrees C). In most of the region, the freeze-free period ranges from 325 to 365 days.

The total withdrawals of freshwater in this region average about 6,880 million gallons per day (26,040 million liters per day). About 40 percent is from surface water sources, and 60 percent is from ground water sources. Abundant precipitation, some streams, and good aquifers provide ample supplies of good-quality water for all uses in this region. More than half of the water used in this region is irrigation water. The rest is about evenly split between public supply and municipal and industrial uses.

The soils in this region are dominantly Entisols. The region also has significant areas of Alfisols and Histosols. The dominant suborders are Aqualfs, Aquents, and Psamments. The soils in the region dominantly have a hyperthermic soil temperature regime, an aquic or udic soil moisture regime, and siliceous or carbonatic mineralogy.

About 90 percent of the land in this region is privately owned. More than half of the region consists of swamps and marsh. Only about 10 percent is cropland, which is used mainly for citrus fruits (fig. U-2). Truck crops and some sugarcane are important sources of income. Management of the water table is important during the summer, but many crops may require some irrigation during the generally dry fall and winter. The major resource concerns are wind erosion, maintenance of the content

Figure U-2: An orange grove in an area of Land Resource Region U.

of organic matter and productivity of the soils, and management of soil moisture. Water quantity can be a problem in a few parts of this region, and maintaining the quality of surface water and ground water is a concern. ■

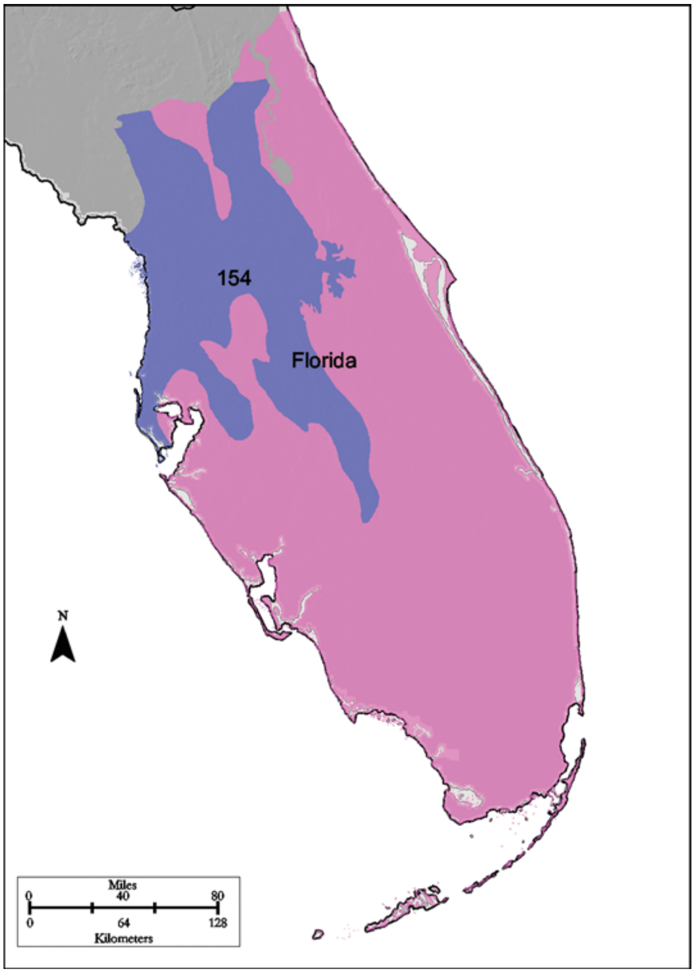

Figure 154-1: Location of MLRA 154 in Land Resource Region U.

154—South-Central Florida Ridge

This area is entirely in Florida (fig. 154-1). It makes up about 8,285 square miles (21,470 square kilometers). Parts of the east side of the city of Tampa Bay and the west half of Orlando are in this area. Interstate 75 parallels the north-south axis of the northern half of this MLRA, and Interstate 4 crosses the southern tip. The Ocala National Forest and the Withlacoochee State Forest are in this area.

Physiography

This area is in the Floridian Section of the Coastal Plain Province of the Atlantic Plain. The area is nearly level to gently rolling. The land surface is very irregular because of the many sinkholes that dot the area. Elevation is 80 to 165 feet (25 to 50 meters) in most of the area. It ranges from sea level along a narrow strip on the western edge of the area to 330 feet (100 meters) on some hills.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Peace-Tampa Bay (0310), 46 percent; St. Johns (0308), 36 percent; Southern Florida (0309), 14 percent; and Suwanee (0311), 4 percent. The Withlacoochee River is in this area.

Geology

This area is a young marine plain underlain by Tertiary-age rocks, including very fine grained shale, mudstone, limestone, and dolomite beds. A sandy marine deposit of Pleistocene age overlies the limestone in most of the area. Phosphate is mined from the limestone beds in the central part of the area.

Climate

The average annual precipitation in this area is 46 to 56 inches (1,170 to 1,420 millimeters). About 60 percent of the precipitation occurs from June through September. Most of the rainfall occurs as moderate-intensity, tropical storms that produce large amounts of rain from late spring through early autumn. Late autumn and winter are relatively dry. The average annual temperature is 68 to 73 degrees F (20 to 23 degrees C). The freeze-free period averages 335 days and ranges from 300 to 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 3.0%; ground water, 34.9%
Livestock—surface water, 0.1%; ground water, 0.7%
Irrigation—surface water, 9.8%; ground water, 23.8%
Other—surface water, 8.2%; ground water, 19.5%

The total withdrawals average 1,220 million gallons per day (4,620 million liters per day). About 79 percent is from ground water sources, and 21 percent is from surface water sources. Rainfall and surface and ground water sources provide an abundance of water. Many lakes are in the sinkholes throughout the area, but the area has few perennial streams. The risk of ground-water contamination is high because of the high water table and the karst topography in this area.

Almost all domestic, municipal, and irrigation water is obtained from wells in the Floridan aquifer in this MLRA. This aquifer is one of the most productive ground water sources in the United States. The water is hard but is of good quality. Wells yield large quantities of calcium bicarbonate type water. The Floridan aquifer is a thick sequence of Tertiary limestone and dolomite. The Eocene Avon Park Formation and Ocala Limestone are the thickest and most productive units in the aquifer system.

Soils

The dominant soil orders in this MLRA are Entisols and Ultisols. The soils in the area dominantly have a hyperthermic soil temperature regime, a udic soil moisture regime, and siliceous mineralogy. They generally are very deep, excessively drained to somewhat poorly drained, and loamy or sandy. Paleudults (Arredondo, Millhopper, and Sparr series) formed in loamy marine sediments on uplands. Quartzipsamments (Astatula, Candler, Lake, and Tavares series) formed in mixed sandy eolian and marine sediments on uplands.

Biological Resources

This area supports “sand hill” vegetation. Turkey oak, bluejack oak, and longleaf pine are the major species. Running oak, gopher apple, and such grasses as bluestems and panicums characterize the understory.

Some of the major wildlife species in this area are deer, feral hog, fox, raccoon, rabbit, gray squirrel, fox squirrel, turkey, bobwhite quail, and dove. The species of fish in the area include largemouth bass, shellcracker, catfish, bluegill bream, and crappie.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 7%
Grassland—private, 23%
Forest—private, 28%; Federal, 4%
Urban development—private, 23%
Water—private, 7%; Federal, 2%
Other—private, 6%

The agricultural enterprises in this area include the production of livestock, citrus, and truck crops. Forest products also are important. The forested areas include the Ocala National Forest. Pulpwood is the chief forest product, but some lumber also is produced. Some of the forests are grazed. Although less than one-tenth of the acreage is used for crops, this is the major citrus-producing area in Florida. Many kinds of winter vegetables also are grown. About half of the pastured areas in the MLRA are improved and intensively managed. Beef cattle are the principal kind of livestock, but dairying is an important enterprise near some of the large cities. Urban land makes up a large acreage in the area. Phosphate mines are a prominent feature in the central part of the area.

The major soil resource concerns are wind erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Additional resource concerns are water quality, water quantity (excess amounts), and plant and animal productivity and health.

Conservation practices on cropland generally include conservation crop rotations, cover crops, irrigation water management (including microirrigation systems), nutrient management, and pest management. Conservation practices on pasture and rangeland generally include prescribed grazing, brush management, pest management, prescribed burning, and watering facilities. Conservation practices on forestland generally include forest stand improvement, forest site preparation, prescribed burning, firebreaks, establishment of trees and shrubs, pest management, and management of upland wildlife habitat. ■

155—Southern Florida Flatwoods

This area is entirely in Florida (fig. 155-1). It makes up about 18,575 square miles (48,135 square kilometers). Numerous cities occur in this area. Gainesville and Ocala are in the isolated northern part of the area. Daytona Beach, West Palm Beach, and Fort Lauderdale are on the Atlantic coast, which forms the eastern boundary of the area. The cities of St. Petersburg and Fort Meyers and most of Tampa Bay are on the western edge of the area, along the coast of the Gulf of Mexico. The eastern half of the city of Orlando is in this MLRA. Interstate 75 parallels the Gulf coast in the western half of this MLRA, and Interstate 95 parallels the Atlantic coast in the eastern half. Interstate 4 crosses the northern end of both the eastern and western parts of this area. Cape Canaveral and the John F. Kennedy Space Center are in this MLRA.

Physiography

This area is in the Floridian Section of the Coastal Plain Province of the Atlantic Plain. It is on a nearly level coastal plain that has large areas of swamps and marshes. Streams and lakes are common. The northwestern half of Lake Okeechobee occurs in this area. Its surface is 14 feet (4 meters) above sea level. Most of the area is flat, but some hummocks rise 3 feet (1 meter) above the general level of the landscape and low beach ridges and dunes, on each coast, rise 6 to 10 feet (2 to 3 meters) above the lower inland areas. Elevation ranges from sea level to less than 80 feet (25 meters), increasing gradually from each coast inland.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Southern Florida (0309), 40 percent; St. Johns (0308), 32 percent; Peace-Tampa Bay (0310), 27 percent; and Suwannee (0311), 1 percent. The St. Johns, Kissimmee, and Caloosahatchee Rivers are in this area.

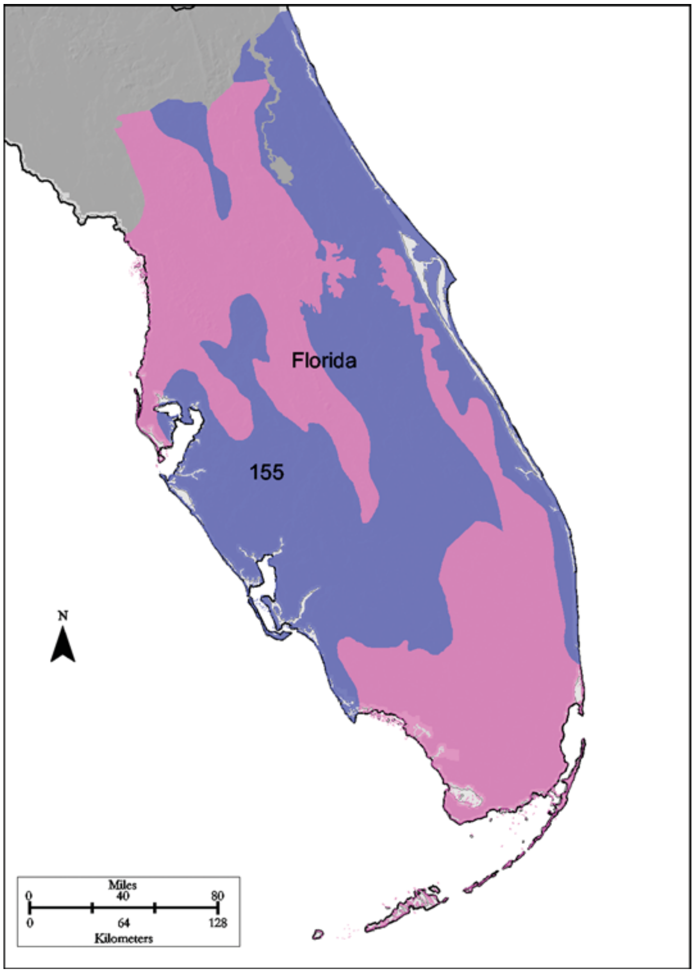

Figure 155-1: Location of MLRA 155 in Land Resource Region U.

Geology

This area is a young marine plain underlain by Tertiary-age rocks, including very fine grained shale, mudstone, and limestone beds. A sandy marine deposit of Pleistocene age occurs at the surface in most of the area.

Climate

The average annual precipitation in this area is 44 to 60 inches (1,120 to 1,525 millimeters). About 60 percent of the precipitation occurs from June through September. Most of the rainfall occurs as moderate-intensity, tropical storms that produce large amounts of rain from late spring through early autumn. Late autumn and winter are relatively dry. The average annual temperature is 68 to 75 degrees F (20 to 24 degrees C). The freeze-free period averages 335 days and ranges from 300 to 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 3.7%; ground water, 15.1%
Livestock—surface water, 0.2%; ground water, 1.4%
Irrigation—surface water, 21.4%; ground water, 35.6%
Other—surface water, 14.2%; ground water, 8.4%

The total withdrawals average 3,500 million gallons per day (13,250 million liters per day). About 60 percent is from ground water sources, and 40 percent is from surface water sources. Rainfall and surface and ground water sources provide an abundance of water. Canals and ditches control the ground water level for crops and pasture. Excess water is pumped out during the rainy season, and irrigation water is applied during the growing season. The surface water is of good quality.

Most of the domestic, municipal, and irrigation water in the area is obtained from wells in the artesian Floridan aquifer, which consists of deep limestone and dolomite beds. This aquifer is one of the most productive ground water sources in the United States. The water from this aquifer is a calcium bicarbonate type. It is hard, and it has high amounts of total dissolved solids in some areas.

A source of drinking water in this area is a nonartesian aquifer of sand, shells, and limestone that occurs in a belt across the southern and central parts of this MLRA. This shallow aquifer provides limited quantities of good-quality water. The water is a calcium bicarbonate type that is hard or very hard. It is highly susceptible to contamination from surface activities.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, and Spodosols. The soils in the area dominantly have a hyperthermic soil temperature regime, an aquic soil moisture regime, and siliceous mineralogy. They generally are deep or very deep, poorly drained or very poorly drained, and loamy or sandy. Endoaqualfs (Holopaw and Malabar series) and Glossaqualfs (Pineda and Riviera series) formed in loamy marine sediments on flats and flood plains and in depressions. Alaquods (Eaugallie, Immokalee, Myakka, Oldsmar, Smyrna, and Wabasso series) and Psammaquents (Basinger series) formed in sandy marine deposits on flats and flood plains and in depressions.

Biological Resources

This area supports “flatwood” forest vegetation. Slash pine, longleaf pine, cabbage palm, and live oak are the principal species. Saw palmetto, gallberry, and grasses, such as bluestems and wiregrasses, characterize the understory.

Some of the major wildlife species in this area are white-tailed deer, feral hog, bobcat, squirrel, snipe, raccoon, skunk, otter, bobwhite quail, woodpecker, and mourning dove. The species of fish in the area include black crappie, largemouth bass, bluegill, and catfish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 7%
Grassland—private, 36%
Forest—private, 19%; Federal, 3%
Urban development—private, 17%
Water—private, 13%
Other—private, 5%

The forestland in this area consists mainly of low-quality pine. It is grazed extensively. More than one-third of the area is improved pasture or native range grazed by cattle. The limited acreage of cropland in the area is used mainly for many kinds of winter vegetables. Some citrus fruits are grown in the area, and other subtropical fruits are grown in the southern part of the area.

The major soil resource concerns are wind erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include conservation crop rotations, cover crops, irrigation water management (including microirrigation systems), nutrient management, and pest management. Conservation practices on pasture and rangeland generally include prescribed grazing, brush management, pest management, prescribed burning, and watering facilities. Conservation practices on forestland generally include forest stand improvement, forest site preparation, prescribed burning, firebreaks, establishment of trees and shrubs, pest management, and management of upland wildlife habitat. ■

156A—Florida Everglades and Associated Areas

This area is entirely in Florida (fig. 156A-1). It makes up about 6,915 square miles (17,920 square kilometers). Miami and other cities are on the Atlantic coast, the eastern edge of the area. Interstate 75 bisects the northern half of the largest part of this MLRA, and Interstate 95 parallels the Atlantic coast. A small part of this MLRA is north of Florida's Turnpike and west of Interstate 95, in Brevard County. Everglades National Park, Big Cypress National Preserve, the Big Cypress Seminole Indian Reservation, and the southeast half of Lake Okeechobee occur in this area.

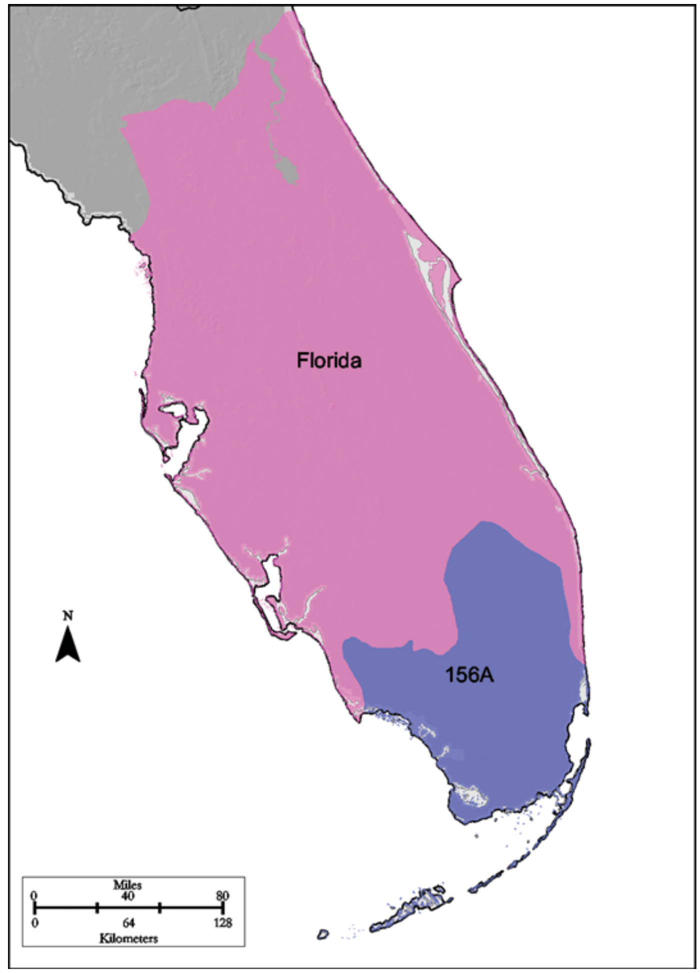

Figure 156A-1: Location of MLRA 156A in Land Resource Region U.

Physiography

This area is in the Floridian Section of the Coastal Plain Province of the Atlantic Plain. It is on a level, low coastal plain that has large areas of swamps and marshes. Poorly defined and broad streams, canals, and ditches drain the area to the ocean. Most of the area is flat, but in the interior, hummocks rise 3 to 6 feet (1 to 2 meters) above the general level of the landscape and low beach ridges and dunes, mainly in the eastern part of the area, rise 10 to 15 feet (3 to 5 meters) above the adjoining swamps and marshes. Elevation ranges from sea level to less than 80 feet (25 meters).

The only major Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is Southern Florida (0309). The area has no major rivers, but a number of canals cross the northern half of the area.

Geology

This area is a young marine plain underlain by Tertiary-age rocks, including very fine grained shale, mudstone, limestone, and dolomite beds. Limestone rock is the dominant subsurface material in this MLRA. A sandy marine deposit of Pleistocene age occurs at the surface in the northern part of the area and in the part in Brevard County.

Climate

The average annual precipitation in this area is 40 to 62 inches (1,015 to 1,575 millimeters). About 60 percent of the precipitation occurs from June through September. The center of the area is the driest part. Most of the rainfall occurs as moderate-intensity, tropical storms that produce large amounts of rain from late spring through early autumn. Late autumn and winter are relatively dry. The average annual temperature is 73 to 78 degrees F (23 to 25 degrees C). The freeze-free period averages 355 days and ranges from 345 to 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 2.7%; ground water, 22.9%
Livestock—surface water, 0.1%; ground water, 0.3%
Irrigation—surface water, 38.9%; ground water, 10.8%
Other—surface water, 11.4%; ground water, 12.8%

The total withdrawals average 1,850 million gallons per day (7,000 million liters per day). About 47 percent is from ground water sources, and 53 percent is from surface water sources. Rainfall and surface and ground water sources provide an abundance of water. Unless the water level in naturally wet areas is controlled, shallow water covers the surface during much of the rainy season. Canals and ditches control the ground water level for crops and pasture. Excess water is pumped out during the rainy season, and irrigation water is applied during the growing season. The surface water is generally of good quality.

Domestic water is obtained mainly from wells in a shallow, nonartesian aquifer of sand, shells, and limestone or from the Biscayne aquifer in the eastern half of this MLRA. The shallow aquifer provides limited quantities of good-quality water. The Biscayne aquifer is a “sole source” drinking water supply for much of Dade and Broward Counties and parts of Monroe and Palm Beach Counties. The aquifer consists of very permeable limestone that has good-quality water. Some high-capacity irrigation wells tap the Biscayne aquifer. All of the ground water is a calcium bicarbonate type and is hard or very hard. Some saline water problems occur in the Biscayne aquifer near the coast. These aquifers are susceptible to contamination from surface activities.

The northern part of this MLRA has abundant surface and ground water of good quality. The Floridan aquifer is the primary source of ground water in Brevard County. This aquifer consists of deep limestone and dolomite beds. The water in this aquifer is a calcium bicarbonate type and is hard.

Soils

The dominant soil orders in this MLRA are Entisols and Histosols. The soils in the area dominantly have a hyperthermic soil temperature regime, an aquic or udic soil moisture regime, and carbonatic mineralogy. They are very shallow to very deep, generally moderately well drained to very poorly drained, and loamy or sandy. Udorthents (Krome series) formed in residuum on flats. Fluvaquents (Biscayne and Perrine series) and Psammaquents (Hallandale series) formed in marine sediments on flats and in depressions and sloughs. Haplosaprists (Pahokee and Terra Ceia series) formed in organic deposits in marshes.

Biological Resources

This area supports freshwater marsh and swamp vegetation. Sawgrass, pickleweed, willow, buttonbush, and maidencane are the dominant marsh species. Bald cypress is the dominant swamp species. Mangrove trees grow in saltwater swamps along the eastern, southern, and southwestern coasts.

Some of the major wildlife species in this area are white-tailed deer, feral hog, snipe, bobcat, raccoon, skunk, otter, squirrel, bobwhite quail, and woodpecker. Alligators, turtles, and wading birds, including wood storks, white ibis, glossy ibis, egrets, and herons, are abundant in the swamps and marshes. The species of fish in the area include black drum, red drum, sea trout, sheepshead, snook, tarpon, and largemouth bass.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 11%
Grassland—private, 8%; Federal, 24%
Forest—private, 3%; Federal, 7%
Urban development—private, 12%
Water—private, 5%; Federal, 4%
Other—private, 26%

About one-third of this area is in Indian reservations, national parks, game refuges, or other large holdings. Cypress forests are extensive in the area, but mangrove forests are widespread along the eastern and southern coasts. A large part of the area is open marsh. Much of the area is used for hunting, fishing, and other recreational activities. The cropland in the area is used mainly for winter vegetables, but citrus fruits, avocado, and papaya are grown on the better drained soils. Sugarcane is an important crop on the organic soils south of

Lake Okeechobee. The acreage of improved pasture is increasing. Beef cattle are the principal kind of livestock, but dairying is an important enterprise locally. Urbanization is extensive along the eastern coast.

The major soil resource concerns are wind erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture and soil subsidence. Conservation practices on cropland generally include conservation crop rotations, cover crops, nutrient management, pest management, water-control structures, surface drainage systems (field ditches, mains, and laterals), pumping plants, and irrigation water management (including microirrigation systems and surface and subsurface irrigation systems). Conservation practices on pasture and rangeland generally include prescribed grazing, brush management, pest management, prescribed burning, and watering facilities. Conservation practices on forestland generally include forest stand improvement, firebreaks, pest management, prescribed burning, and management of upland and wetland wildlife habitat. ■

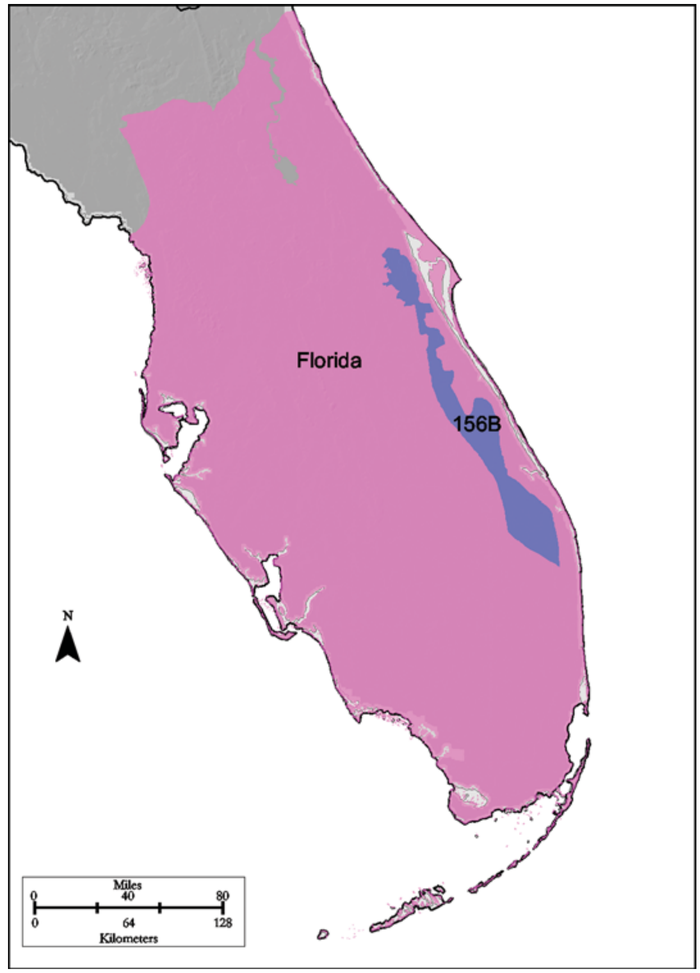

Figure 156B-1: Location of MLRA 156B in Land Resource Region U.

156B—Southern Florida Lowlands

This area is entirely in Florida (fig. 156B-1). It makes up about 1,835 square miles (4,750 square kilometers). It has no major cities or towns. It lies between Lake Okeechobee and the eastern coast. Interstate 95 parallels the eastern boundary of the area.

Physiography

This area is in the Floridian Section of the Coastal Plain Province of the Atlantic Plain. It is on nearly level lowlands. Agricultural canals drain this area. A few hummocks rise 3 to 6 feet (1 to 2 meters) above the general level of the landscape. Elevation is approximately 80 feet (25 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Southern Florida (0309), 56 percent, and St. Johns (0308), 44 percent.

Geology

This area is a young marine plain underlain by Tertiary-age rocks, including very fine grained shale, mudstone, limestone, and dolomite beds. A sandy marine deposit of Pleistocene age occurs at the surface in much of this area.

Climate

The average annual precipitation in this area is 46 to 60 inches (1,170 to 1,525 millimeters). About 60 percent of the precipitation occurs from June through September. Most of the rainfall occurs as moderate-intensity, tropical storms that produce large amounts of rain during the summer. Spring, fall, and winter are relatively dry. The average annual temperature is 71 to 74 degrees F (22 to 24 degrees C). The freeze-free period averages 360 days and ranges from 360 to 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.2%; ground water, 5.6%
Livestock—surface water, 0.1%; ground water, 0.4%
Irrigation—surface water, 49.0%; ground water, 32.7%
Other—surface water, 2.8%; ground water, 9.3%

The total withdrawals average 305 million gallons per day (1,155 million liters per day). About 48 percent is from ground water sources, and 52 percent is from surface water sources. Rainfall and surface and ground water sources provide an abundance of water. The surface water is of good quality. Unless the water level in naturally wet areas is controlled, shallow water covers the surface during much of the rainy season. Canals and ditches control the ground water level for crops and pasture. Excess water is pumped out during the rainy season, and irrigation water is applied during the growing season.

Domestic water is obtained mainly from wells in a shallow, nonartesian aquifer. This aquifer provides limited quantities of water that is hard but of good quality. The water is dominantly a calcium bicarbonate type. High-capacity irrigation wells are usually drilled down to the artesian Floridan aquifer, which consists of deep limestone and dolomite beds. The water in this aquifer is a calcium bicarbonate type but has high amounts of total dissolved solids in this area. In some areas the artesian water is too salty for direct application on salt-sensitive citrus crops. The shallow aquifer is susceptible to contamination from surface activities.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, and Histosols. The soils in the area dominantly have a hyperthermic soil temperature regime, an aquic soil moisture regime, and siliceous mineralogy. They generally are deep or very deep, poorly drained or very poorly drained, and loamy or sandy. Glossaqualfs (Pineda, Riviera, and Winder series), Endoaqualfs (Felda series), and Argiaquolls (Floridana series) formed in loamy marine sediments on flats and flood plains and in depressions. Psammaquents (Basinger series) formed in sandy marine sediments on flats and in depressions. Haplosaprists (Terra Ceia series) formed in organic deposits in marshes.

Biological Resources

This area supports "hummock and slough" swamp vegetation. Slash pine and cabbage palm are the dominant species. Saw palmetto, cordgrasses, and bluestems make up the understory.

Some of the major wildlife species in this area are white-tailed deer, feral hog, gray fox, raccoon, opossum, armadillo, rabbit, tree squirrel, wild turkey, bobwhite quail, mourning dove, Florida mallard, and woodpecker.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 24%
Grassland—private, 37%
Forest—private, 6%
Urban development—private, 15%
Water—private, 4%
Other—private, 14%

Most of this area is in farms or ranches. Citrus fruits, the chief crops, are planted in beds between shallow ditches that are part of the water-control system. The vegetation on the rangeland in the area consists of native grasses, forbs, sedges, and a few scattered pines. The forestland in the area consists of mixed pine and cabbage palm or cabbage palm and hardwoods.

The major soil resource concerns are wind erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include conservation crop rotations, cover crops, nutrient management, pest management, water-control structures, surface drainage systems (field ditches, mains, and laterals), pumping plants, and irrigation water management (including microirrigation systems and surface and subsurface irrigation systems). Conservation practices on pasture and rangeland generally include prescribed grazing, brush management, pest management, prescribed burning, and watering facilities. ■

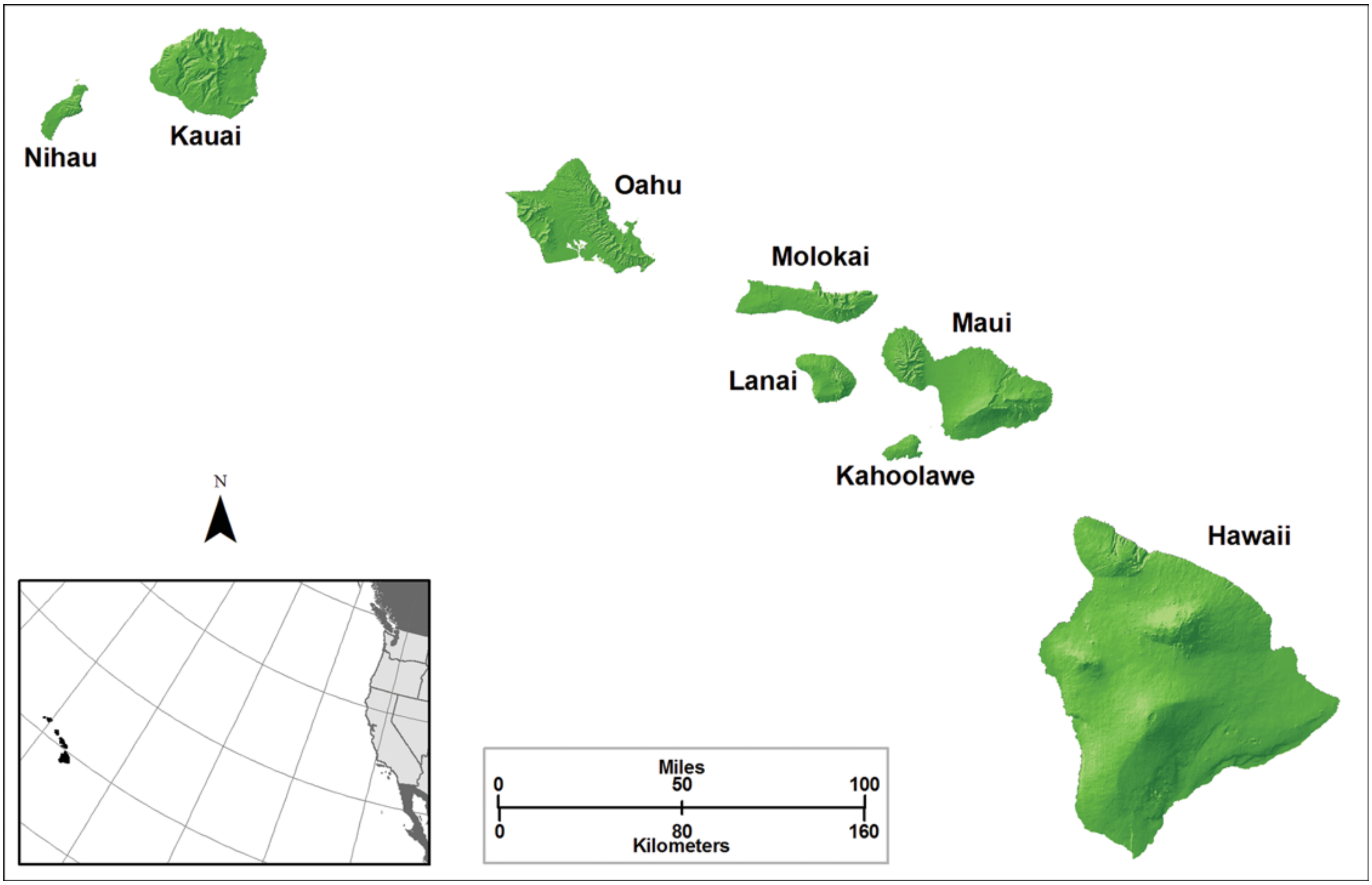

Figure V-1: Location of Land Resource Region V.

V—Hawaii Region

This region is in the Hawaiian Islands (fig. V-1). It makes up about 6,265 square miles (16,260 square kilometers).

This region consists of eight major islands (fig. V-2). These islands are of volcanic origin and consist of coastal plains, upland slopes, mountain ranges, plateaus, and summits. This is a region of warm to hot temperatures. Precipitation extremes are normal on each island. The windward (north and northeast) side of the islands receives heavy annual rainfall, mostly occurring from November to March or April. The leeward side receives little rainfall. It is subject to "kona" storms, which come from the leeward side of the islands and provide most of the annual precipitation in many areas. Winters are pleasantly warm. The average annual precipitation ranges from 60 to 220 inches (1,525 to 5,590 millimeters) on the windward side of the islands and from 30 to 60 inches (760 to 1,525 millimeters) on the leeward side. The average annual temperature ranges from 56 to 75 degrees F (14 to 24 degrees C). The freeze-free period is typically 365 days on all of the islands. Freezing temperatures occur annually at the tops of the higher volcanic peaks.

The total withdrawals of freshwater in this region average about 1,190 million gallons per day (4,505 million liters per day). About 50 percent is from surface water sources, and 50 percent is from ground water sources. About 64 percent of the water is used for irrigation, 20 percent is used for public supply, and 16 percent is used for municipal and industrial supply.

The soils in this region are dominantly Andisols. Mollisols, Aridisols, Histosols, Oxisols, and Inceptisols are of lesser extent. The region has a significant area of volcanic rock, which is classified as nonsoil. The dominant suborders are Ustands, Udands, and Ustolls that formed in weathered volcanic ash and basalt on uplands. Cambids also are common on uplands. Folists are common on wet mountain slopes. The soils in the region dominantly have an isohyperthermic or isothermic soil temperature regime, an ustic or udic soil moisture regime, and mixed mineralogy.

About 92 percent of the region is privately owned. The native vegetation ranges from desert shrubs and grasses to subtropical forest. Pineapples and coffee are the major export crops. Macadamia, papaya, and floral products are other important export crops. Truck crops, mainly tomatoes,

Figure V-2: An area of Kauai, one of the tropical islands making up Land Resource Region V.

cucumbers, head cabbage, lettuce, green peppers, snap beans, bananas, and such specialty crops as ginger and taro, also are important. Cattle ranching is important to the local economy. The forests in the region are used mainly for watershed, wildlife habitat, and recreation. Because of the pleasant climate and the tropical island scenery, tourism is an important industry. The most significant resource concern is the invasion of foreign plants and animals. Other concerns include water erosion and nutrient and pesticide runoff and leaching. ■

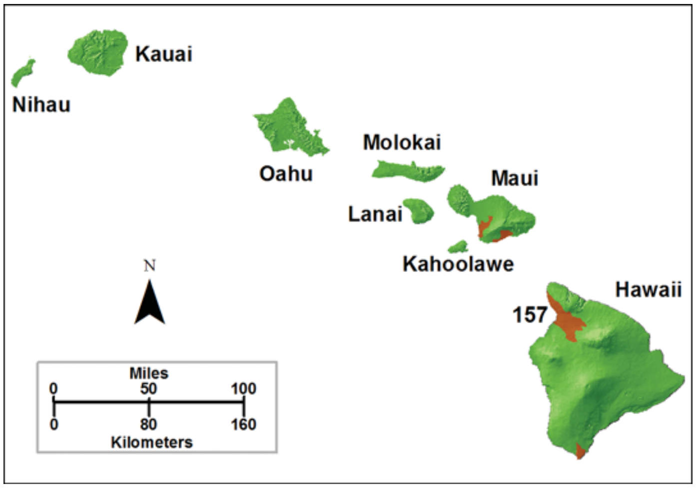

Figure 157-1: Location of MLRA 157 in Land Resource Region V.

157—Arid and Semiarid Low Mountain Slopes

This area is in the Hawaiian Islands (fig. 157-1). It makes up about 265 square miles (690 square kilometers). The town of Wailea and State Highway 31 are in the part of this area on Maui. Waikaloa Village and the Hapuna Beach Recreation Area are in the part on the Big Island of Hawaii. State Highways 19, 190, 200, and 270 cross the part on the Big Island.

Physiography

This area is on moderately dissected, gently sloping to steep, leeward mountain slopes on the geologically younger islands of Maui and Hawaii. Elevation ranges from near sea level to 6,000 feet (0 to 1,830 meters). Local relief ranges from 1,500 to 6,000 feet (455 to 1,830 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Hawaii (2001), 77 percent, and Maui (2002), 23 percent. The area has no perennial streams.

Geology

This MLRA is underlain dominantly by aa (basalt), which is covered by volcanic ash. The MLRA has minor areas of weathered andesite and basalt. Olivine sand is mixed with the ash deposits on the south- and east-facing slopes on the coastal uplands.

Climate

The average annual precipitation in most of this area is 10 to 35 inches (255 to 890 millimeters). It can exceed 45 inches (1,145 millimeters) on interior slopes at the higher elevations. Most of the rainfall occurs from October through May. Much of it occurs during kona storms, which occur in winter and usually bring rain for several hours to several days. They are called kona storms because they bring wind from the "kona" or leeward direction on the islands. The average annual temperature is 55 to 76 degrees F (13 to 24 degrees C). The average freeze-free period is 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.9%; ground water, 0.0%
Livestock—surface water, 0.9%; ground water, 0.9%
Irrigation—surface water, 68.6%; ground water, 27.5%
Other—surface water, 1.1%; ground water, 0.0%

The total withdrawals average 44 million gallons per day (165 million liters per day). About 28 percent is from ground water sources, and 72 percent is from surface water sources. The amount of rainfall is not adequate for crop production without irrigation. Because of the lack of perennial streams in this MLRA, water for public supply and almost all irrigation and livestock use is imported into this area from adjacent MLRAs with more plentiful water resources.

All three of the volcanic rock aquifers on the island of Hawaii and the two on Maui occur in this area. The ground water away from the Hawaiian coast is of good quality and is suitable for almost all uses. Near the coast, however, the water is of lower quality because of increased levels of salts from the intrusion of seawater. Some rural landowners still utilize these aquifers for domestic and livestock water, but the level of total dissolved solids typically exceeds 1,000 parts per million (milligrams per liter), so most of the ground water near the coast is used for irrigation.

Soils

The dominant soil orders in this MLRA are Andisols, Mollisols, and Aridisols. The soils in the area have an isohyperthermic or isothermic soil temperature regime, an ustic or aridic soil moisture regime, and dominantly amorphic mineralogy. They generally are moderately deep to very deep, well drained, and loamy. The soils are nonstony to extremely stony. Haplustands include the Kikoni, Kula, Pane, Puu Pa, and Waimea series; Haplotorrands include the Makena and Pakini series; and Vitritorrands include the Oanapuka series. Haplustolls (Kamaole series) formed in volcanic ash underlain by aa. Haplocambids (Kawaihae series) formed in volcanic ash on leeward coastal uplands. The MLRA has a significant acreage of miscellaneous (nonsoil) areas.

Biological Resources

This area is dominated by grass-shrub vegetation. The naturalized vegetation at the lower elevations includes kiawe, bermudagrass, lantana, fingergrass, and cactus. The native vegetation at the lower elevations includes ilima, piligrass, and uhaloa. At the higher elevations, naturalized kikuyugrass, white clover, and rattailgrass are common and the native species include the aiea tree, and on Maui, two rare species—ko´oloa ´ula (Chinese lantern) and pua aloalo (delicate yellow hibiscus). Yellow hibiscus is Hawaii's State flower.

The major wildlife species in the area include introduced game birds, such as pheasant, chukar, dove, and francolin. The upper elevations on Maui are designated as critical habitat for the Blackburn's sphinx moth.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—private, 85%
Forest—private, 3%
Urban development—private, 2%
Other—private, 10%

Most of this area is rangeland that is grazed primarily during the winter rainy season. Forage production is low during the dry summer months, so cattle are usually moved to wetter areas during that part of the year. Irrigated truck crops are grown in small areas at an elevation near 2,000 feet (610 meters). The local climate and soils are suitable for cool-season crops, such as head cabbage, head lettuce, celery, and round onions. Tomatoes are grown throughout the year. Some coastal areas are used for urban or resort development.

The major soil resource concerns are water erosion and wind erosion. Conservation practices on rangeland generally include prescribed grazing and brush management. Conservation practices on cropland generally include sprinkler irrigation and microirrigation, windbreaks, crop rotations, contour farming, and nutrient and pest management. ■

158—Semiarid and Subhumid Low Mountain Slopes

This area is in the Hawaiian Islands (fig. 158-1). It makes up about 520 square miles (1,340 square kilometers). It includes the towns of Kapaa, Hanamaula, and Lihue, Kauai; Waialua and Wahiawa, Oahu; Maunaloa, Molokai; Lanai City, Lanai; Honokahua, Paia, and Kahalui, Maui; and Hawi and Halaula, Hawaii. Interstate H2 terminates in the town of Wahiawa, Oahu, and numerous State highways cross the area. The Schofield

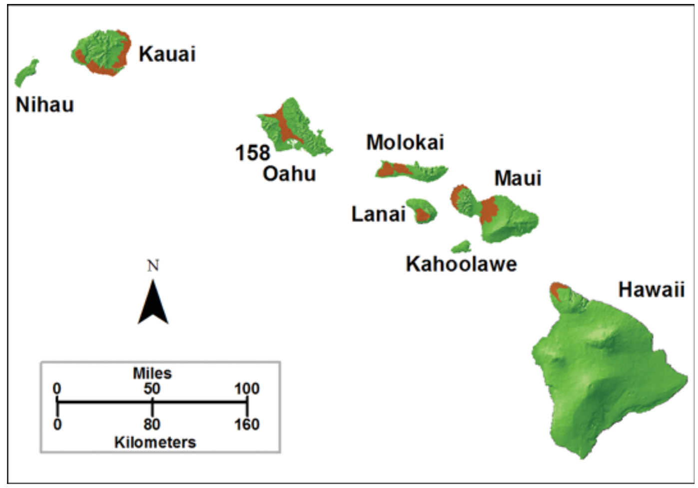

Figure 158-1: Location of MLRA 158 in Land Resource Region V.

Barracks Military Reservation and Wheeler Air Force Base are in the part of this MLRA on Oahu.

Physiography

This area primarily lies on the leeward, drier side of the older islands in the Hawaiian Islands chain. It is on nearly level to moderately steep slopes on plains that are dissected in places by gulches. Elevation ranges from near sea level to 1,600 feet (0 to 490 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Kauai (2007), 30 percent; Maui (2002), 24 percent; Oahu (2006), 18 percent; Molokai (2005), 15 percent; Hawaii (2001), 7 percent; and Lanai (2004), 6 percent. This area has no major rivers but has a number of perennial streams.

Geology

Most of the surface of this area is covered with highly weathered volcanic ash, which overlies basic igneous rocks. Alluvium derived from basic igneous rocks occurs in some moderately extensive areas of intermediate uplands.

Climate

The average annual precipitation in much of this area is 10 to 30 inches (255 to 760 millimeters). It can exceed 60 inches (1,525 millimeters) on the east and northeast sides of Kauai, in central Oahu, and on the north side of Hawaii. Most of the rainfall occurs from November through March. Much of it occurs during kona storms. The average annual temperature is 69 to 76 degrees F (21 to 24 degrees C). The freeze-free period averages 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.8%; ground water, 2.9%
Livestock—surface water, 0.1%; ground water, 0.1%
Irrigation—surface water, 65.1%; ground water, 23.0%
Other—surface water, 1.6%; ground water, 6.3%

The total withdrawals average 670 million gallons per day (2,535 million liters per day). About 32 percent is from ground water sources, and 68 percent is from surface water sources. Irrigation is required for the growth of crops in most of this area. Some parts of the MLRA are in high-rainfall (windward) zones on the islands where surface water is plentiful and irrigation is not necessary. Some surface water is trapped in these zones and piped to drier areas, where it is used for irrigation. A number of perennial streams occur in this area. The surface water in the area is used primarily for irrigation and for watering livestock. An exception is Maui, where almost all of the domestic water supply is surface water. The water has good chemical quality, but it typically requires treatment for physical and biological quality before it can be used as drinking water.

Little surface water is available in the part of this area on Molokai. In the 1960s, when pineapple production was at its height, a tunnel was constructed to bring water from the windward side of the island to the center of the island. The tunnel is still serviceable, but it is not being used at full capacity today.

Ground water of suitable quality for almost all uses can be obtained from three aquifers on Kauai—the Napali volcanic aquifer, the Koloa and Olokele volcanic aquifer, and the alluvial sediments in the river valleys. The median level of total dissolved solids is less than 500 parts per million (milligrams per liter) in the water in each of these aquifers, but the water in the volcanic aquifers is very hard and requires some treatment prior to use for domestic and public supplies.

Good-quality ground water for most uses also can be obtained from three aquifers on Oahu—the Koolau volcanic aquifer, the Waianae and Honolulu volcanic aquifer, and alluvial sediments. The median level of total dissolved solids is less than 200 parts per million (milligrams per liter) in the water in these aquifers, and the water in the volcanic aquifers is soft, so little treatment is required before the water is used as drinking water.

There are no available data on the quality of the water in the East Molokai volcanic rocks aquifer. Poor-quality ground water can be obtained from three aquifers on Maui—the Honolua volcanic aquifer, the Kula volcanic aquifer, and the sedimentary material in the isthmus area. The median level of total dissolved solids is close to 1,000 parts per million (milligrams per liter) in the water in each of these aquifers, and the water in the volcanic aquifers is very hard. Because of water-quality problems, ground water on Kauai and Maui is used primarily for irrigation.

The Kau volcanic rock aquifer on the Big Island has water with the lowest levels of total dissolved solids and the softest water of all the aquifers on all the islands, especially near the center of the island, where recharge occurs. The level of salts in the water may be higher than the median for this aquifer since this MLRA is located on the northwest coast of Hawaii. Pumping tends to increase the level of seawater intrusion into the “basal water.” Most of the ground water in this area floats as a lens of freshwater on the denser saltwater that occurs at depth in each aquifer. When freshwater is pumped out of the aquifer, the seawater tends to move higher into the aquifer, contaminating the freshwater. Seawater intrusion is most common near the coast, so the ground water may be limited for use as drinking water in this area.

The silica level in the water from all of the volcanic rock aquifers in the area exceeds 30 parts per million (milligrams per liter). The level of silica limits the industrial use of the ground water. At this concentration, silica combines with calcium and magnesium to form a scale that can create problems, especially in boilers and steam turbines.

Soils

The dominant soil orders in this MLRA are Oxisols, Mollisols, and Aridisols. The soils in the area have an isohyperthermic soil temperature regime, an ustic or aridic (torric) soil moisture regime, and dominantly kaolinitic mineralogy. They generally are very deep, well drained, and very fine textured. Haplocambids (Keahua series) formed in material weathered from basic igneous rocks. Eutrustox (Lahaina and Lihue series), Haplustolls (Makaweli and Paia series), and Eutrotorrox (Molokai series) formed in residuum on uplands from sea level to 1,500 feet (0 to 455 meters). Kandiustox (Puhi series) are in upland areas influenced by the higher amounts of average annual rainfall. Haplustox (Wahiawa series) formed in alluvium derived from basalt and ash on uplands with long slopes that have not been eroded. The MLRA has a significant acreage of miscellaneous (nonsoil) areas.

Biological Resources

The naturalized scrub-shrub and grassland species in this area include koa haole, bermudagrass, and guineagrass. The native species include ilima, piligrass, and uhaloa. Ohai, a rare shrub, grows along the coast of Molokai.

Some of the major wildlife species in this MLRA include nonnative game birds, such as francolins and doves. On Maui, Oahu, and Kauai, the endangered Hawaiian bat is known to occur. The endangered species in areas of reservoirs and wetlands include stilts and nene on Maui; stilts, nene, koloa duck, coots, and moorhen on Kauai; and stilts, coots, and moorhen on Oahu. The nene, a land bird and variety of Hawaiian goose, is the State bird of Hawaii. On Kauai, critical habitat has been designated for the endangered cave wolf spider and cave amphipod.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 23%
Grassland—private, 56%; Federal, 1%
Forest—private, 9%
Urban development—private, 7%; Federal, 1%
Water—private, 1%
Other—private, 2%

Farms and ranches make up nearly all of this area. Cultivated areas are used for irrigated sugarcane, pineapples, truck crops, or orchards. Also, some small areas are used for pasture. Some areas are used for urban development or military installations.

The major soil resource concerns include water erosion, wind erosion, and nutrient and pesticide runoff and leaching. The availability of irrigation water also is a concern. Conservation practices on cropland and grassland generally include nutrient and pest management, crop rotations, crop residue management, windbreaks, and cover crops. ■

159A—Humid and Very Humid Volcanic Ash Soils on Low and Intermediate Rolling Mountain Slopes

This area is in the Hawaiian Islands (fig. 159A-1). It makes up about 535 square miles (1,390 square kilometers). The towns of Honokaa, Hilo, Keaau, and Mountain View, Hawaii, and Hana, Maui, are in this MLRA. State Highways 11 and 19 cross the part of this area on the Big Island, and State Highway 360 (Hana Highway) crosses the part on Maui. The Hawaii Volcanoes National Park is on the western border of the part on the Big Island.

Physiography

This area lies on the windward, wetter side of the Islands of Hawaii and Maui. The area is on rolling mountain slopes that have been eroded by steep-sided gulches. Elevation ranges from near sea level to 6,000 feet (0 to 1,830 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Hawaii (2001), 91 percent, and Maui (2002), 9 percent. The area has no major rivers, but a few perennial streams drain the area.

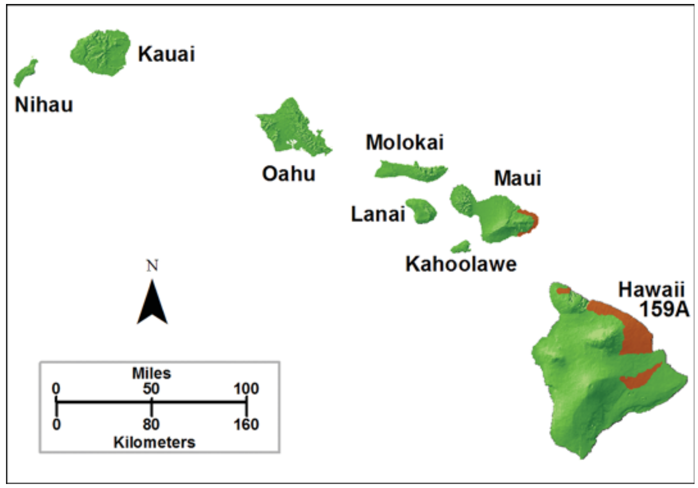

Figure 159A-1: Location of MLRA 159A in Land Resource Region V.

Geology

In most of this area, volcanic ash is underlain by basic igneous rocks. Some areas have volcanic ash over cinders.

Climate

The average annual precipitation in most of this area is 120 to 200 inches (3,050 to 5,080 millimeters). It can be as high as 300 inches (7,620 millimeters) in rain-forest zones and can be as low as 70 inches (1,780 millimeters) in the extreme north and west inland parts of the area. The average annual temperature is 54 to 73 degrees F (12 to 23 degrees C). The freeze-free period averages 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 5.3%; ground water, 26.4%
Livestock—surface water, 1.7%; ground water, 3.3%
Irrigation—surface water, 45.2%; ground water, 14.5%
Other—surface water, 3.6%; ground water, 0.0%

The total withdrawals average 30 million gallons per day (115 million liters per day). About 44 percent is from ground water sources, and 56 percent is from surface water sources. Almost all of this MLRA is in high-rainfall (windward) areas on the islands, so surface water typically is plentiful and irrigation is not needed. The western part of the Hamakua coast requires supplemental irrigation during the drier season. The area has a few perennial streams but no storage reservoirs or lakes. The surface water is used primarily for irrigation and for watering livestock. An exception is Maui, where almost all of the domestic water supply is surface water. The water has good chemical quality, but it typically requires treatment for physical and biological quality before it can be used as drinking water.

Poor-quality ground water is obtained primarily from the Honolua and Hana volcanic aquifer in the part of this area on Maui. The median level of total dissolved solids is close to 1,000 parts per million (milligrams per liter), and the water is very hard. Since this MLRA is on the coast of Maui, seawater intrusion can be a problem in the volcanic rock aquifer. Because of water-quality problems, the ground water on Maui is used primarily for irrigation.

All three volcanic rock aquifers on the island of Hawaii occur in this area. They include the Kau aquifer; the Puna, Hualalai, Kahuku, and Hamakua aquifer; and the Laupahoehoe and Hawi aquifer. Tests indicate that the ground water in the Kau aquifer has a median level of about 100 parts per million (milligrams per liter) total dissolved solids and is soft. The water is suitable for almost all uses with little or no treatment. The silica level in the water from all of the volcanic rock aquifers exceeds 30 parts per million (milligrams per liter). The level of silica limits the industrial use of the ground water. At this concentration, silica combines with calcium and magnesium to form a scale that can create problems, especially in boilers and steam turbines.

Soils

The dominant soils in this MLRA are Andisols. The soils in the area have an isothermic or isohyperthermic soil temperature regime, a udic or perudic soil moisture regime, and dominantly ferrihydritic mineralogy. They generally are very deep, well drained or moderately well drained, and hydrous. Hydrudands (Akaka, Hana, Honokaa, Kailua, and Kaiwiki series) formed in volcanic ash. Medial soil forms the upper part of some Hydrudands (Hilo series).

Biological Resources

This area supports forest vegetation and naturalized pasture grasses. The naturalized vegetation includes hilograss, California grass, kikuyugrass, and rattailgrass. It also includes eucalyptus and guava. Native forest and remnant patches include ohia leua, koa, treefern, and uluhe. *Stenogyne scrophulariodes* (no common name), a plant species of concern, occurs on the Big Island.

Some of the major wildlife species in the area include invasive feral pigs and mongooses and exotic birds, such as pheasants, chukars, meadowlarks, turkeys, and francolins. The native species on the Big Island include the endangered Hawaiian hawk and the endangered Hawaiian bat. On Maui, the upper elevations around Hana include critical habitat for numerous plant species, including `Oha wai.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 2%
Grassland—private, 37%; Federal, 1%
Forest—private, 48%; Federal, 11%
Urban development—private, 1%

Rangeland and woodland make up most of this area. Some areas are used intensively for orchards, eucalyptus plantations, or cropland. Some small areas are used for ornamentals. Forest reserves are maintained for the protection of rare, threatened, or endangered native plants.

The major resource concerns are water erosion, nutrient and pesticide leaching and runoff, surface compaction, plant disease, and excess moisture. Conservation practices on cropland and rangeland generally include erosion control, nutrient and pest management, and deep tillage. ■

159B—Subhumid and Humid Low and Intermediate Mountain Slopes

This MLRA is in the Kau area on the Big Island of Hawaii (fig. 159B-1). It makes up about 245 square miles (640 square kilometers). The towns of Naalehu and Pahala are in this MLRA. The total population in the area is low. State Highway 11 crosses the area from north to south. Part of the Hawaii Volcanoes National Park is in the southwestern portion of this area.

Physiography

This area is on low and intermediate slopes of Mauna Loa on the Big Island. It is on moderately dissected, gently sloping to rolling slopes on the side of a large shield volcano. Elevation ranges from near sea level to 6,000 feet (0 to 1,830 meters). Local relief ranges from 3,000 to 6,000 feet (915 to 1,830 meters).

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is Hawaii (2001). Few perennial streams are on the geologically young surface of this area.

Geology

Basic igneous rocks (basalt) underlie a mantle of basic weathered volcanic ash in this area. Some alluvial fans occur, and colluvium, typically a mixture of volcanic ash and cinders, occurs in places.

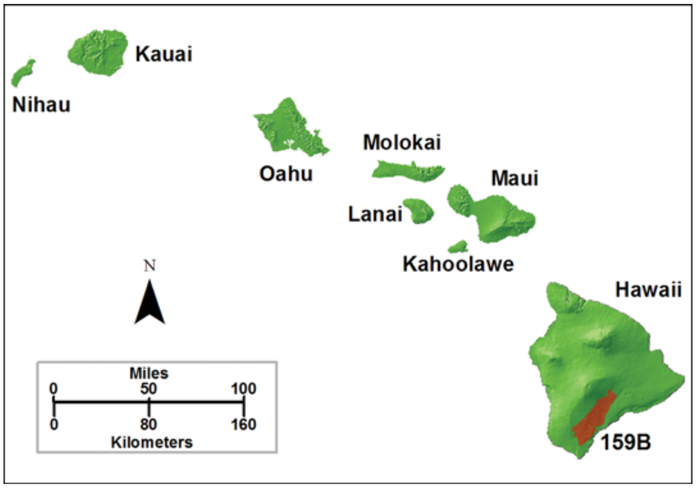

Figure 159B-1: Location of MLRA 159B in Land Resource Region V.

Climate

The average annual precipitation in this area is 50 to 100 inches (1,270 to 2,540 millimeters). Most of the rainfall occurs from November through March. The average annual temperature is 54 to 73 degrees F (12 to 23 degrees C). The freeze-free period averages 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0%; ground water, 0%
Livestock—surface water, 20%; ground water, 40%
Irrigation—surface water, 20%; ground water, 20%
Other—surface water, 0%; ground water, 0%

The total withdrawals average 0.5 million gallons per day (1.9 million liters per day). About 60 percent is from ground water sources, and 40 percent is from surface water sources. The amount of rainfall is generally adequate for crop production without full irrigation, but some small areas of cropland on the less steep slopes are irrigated. The area has few perennial streams. Springs are in the volcanic rocks. The surface water is typically suitable for irrigation and livestock but not as drinking water.

The Kau volcanic rock aquifer and the Laupahoehoe and Hawi volcanic rock aquifer occur in this area. The Kau volcanic rock aquifer on the Big Island has the lowest levels of total dissolved solids and the softest water of all the aquifers on all the islands, especially near the center of the island, where recharge occurs. The ground water from these aquifers is suitable for almost all uses in this area. The silica level in the ground water exceeds 30 parts per million (milligrams per liter). The level of silica limits the industrial use of the ground water. At this concentration, silica combines with calcium and magnesium to form a scale that can create problems, especially in boilers and steam turbines.

Soils

The soils in this MLRA are mainly Andisols or Histosols. They have an isothermic soil temperature regime, a udic soil moisture regime, and euic mineralogy. They are very deep to very shallow, well drained or moderately well drained, hydrous soils. Hydrudands (Akaka, Honokaa, and Kaiwiki series) formed in material weathered from volcanic ash. Keei and Kekake soils formed in volcanic ash over pahoehoe lava.

Biological Resources

The vegetation in this area consists of rain forest at the upper elevations and mixed trees, shrubs, and grasses at the lower elevations. The naturalized vegetation in the wetter areas includes hilograss, California grass, and guava. The naturalized vegetation in the drier areas includes Christmasberry, guineagrass, bermudagrass, and Natal redtop. Native forest and remnant patches include ohia leua, koa, and treefern. Two areas are designated as critical habitat for plant clusters, one 531 acres (215 hectares) and the other 1,351 acres (545 hectares). Kauila or kauwila is one of the keystone endangered plants in these protected areas.

Some of the major wildlife species in the area are feral pigs, mongoose, wild sheep, and exotic game birds. The native wildlife in the area includes the endangered Hawaiian hawk, the endangered Hawaiian bat, and the endangered akepa.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 3%
Grassland—private, 32%
Forest—private, 65%

Much of the land at the higher elevations in this area is in a forest reserve that provides watershed and habitat and protection for rare, threatened, and endangered plant species. Most of the land at the lower elevations is rangeland. Some small areas are used intensively for orchards, woodland, or irrigated cropland. A large part of this area was used for nonirrigated sugarcane for about 100 years, until the recent closing of the sugar plantation. Some of the areas once used for sugarcane are now used for cattle ranching, the production of macadamia nuts, trees for biomass, or small truck farms.

The major resource concerns are water erosion, nutrient and pesticide runoff and leaching, surface compaction, and plant disease. Conservation practices on cropland and rangeland generally include erosion and flood control and deep tillage. ■

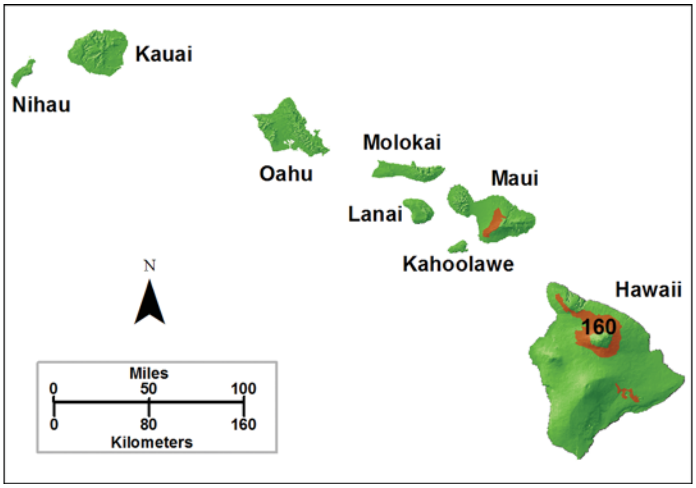

Figure 160-1: Location of MLRA 160 in Land Resource Region V.

160—Subhumid and Humid Intermediate and High Mountain Slopes

This area is in the Hawaiian Islands (fig. 160-1). It makes up about 500 square miles (1,290 square kilometers). The towns of Waimea, Man, and Keanakolu on the Big Island and Ulupalakua, Keokea, and Waiakoa on Maui are in this MLRA. Much of the Kula area of Maui also is in this MLRA.

Physiography

This area is on hilly, intermediate to high slopes of the Mauna Kea, Kohala, and Haleakala Mountains. The topography is gently sloping to hilly, and cinder cones are common. Elevation ranges from 1,000 to 9,000 feet (305 to 2,745 meters). Local relief ranges from 1,000 to 6,000 feet (305 to 1,830 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Hawaii (2001), 85 percent, and Maui (2002), 15 percent. This MLRA is a headwaters area for local streams.

Geology

Most of this area consists of material weathered from volcanic ash of different ages. At the higher elevations, some areas have common outcrops of aa. Some small areas are underlain by andesite or basalt bedrock. Alluvium in the area consists of volcanic sand and gravel.

Climate

The average annual precipitation in this area is 20 to 75 inches (510 to 1,905 millimeters). Most of the rainfall occurs during kona storms from November through March. Some supplemental moisture is derived directly from the clouds that typically occur above 2,000 feet (610 meters). The average annual temperature is 50 to 71 degrees F (10 to 22 degrees C). The freeze-free period averages 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 0.0%
Livestock—surface water, 16.7%; ground water, 16.7%
Irrigation—surface water, 50.0%; ground water, 16.7%
Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average about 0.6 million gallons per day (about 2.3 million liters per day). About 33 percent is from ground water sources, and 67 percent is from surface water sources. Some irrigation water is applied in most of the areas used for crops in the MLRA. Much of this water comes from rain catchments with storage tanks, from lined reservoirs, or from sources outside the MLRA. Most domestic and livestock water is from catchments that empty into storage tanks. The headwaters of a few perennial streams are in this area. The surface water is suitable for most uses. Treatment is required before the surface water that is not from catchments can be used as drinking water.

This area is near drainage divides on Maui and Hawaii. Any ground water at the higher elevations is probably trapped in the subsurface behind or between intrusive dikes. The quantities of water available depend on the geologic structure of a particular area. Poor-quality ground water is obtained from the Honolua and Kula volcanic aquifers in the part of this area on Maui. The median level of total dissolved solids is close to 1,000 parts per million (milligrams per liter) in other areas where this aquifer occurs, and the water is very hard. Because of water-quality problems, the ground water on Maui is used primarily for irrigation.

The Puna, Hualalai, Kahuku, and Hamakua volcanic rock aquifers and the Laupahoehoe and Hawi volcanic rock aquifer occur in the part of this area on the Big Island. The water in these aquifers typically has low levels of total dissolved solids and is soft. It is suitable for almost all uses with little or no treatment. The silica level in the water from all of the volcanic rock aquifers exceeds 30 parts per million (milligrams per liter). The level of silica limits the industrial use of the ground water. At this concentration, silica combines with calcium and magnesium to form a scale that can create problems, especially in boilers and steam turbines.

Soils

The dominant soil order in this MLRA is Andisols. The soils in the area have an isomesic soil temperature regime, an ustic or udic soil moisture regime, and dominantly amorphic or ferrihydritic mineralogy. They generally are deep, well drained, and medial in texture. Haplustands (Hanipoe, Kaipoioi, Laumaia, and Olinda series) and Hydrudands (Maile and Puu Oo series) formed in material weathered from volcanic ash. The MLRA has a significant acreage of miscellaneous (nonsoil) areas.

Biological Resources

The vegetation in this area consists of temperate grasses, shrubs, and trees. The naturalized vegetation, particularly in the pastured areas, includes bermudagrass, eucalyptus, gorse, kikuyugrass, Natal redtop, and rattailgrass. The native species include koa ohia, naio, mamani, pukiawe, a´ali´i, and treefern.

Some of the major naturalized wildlife species in the area are chickens, mongoose, numerous species of game birds, and feral pigs, goats, axis deer (only on Maui), and mouflon sheep (only on the Big Island). Part of the MLRA on the Big Island is designated critical habitat for some rare, threatened, or endangered plants and animals, including the endangered Hawaiian palila, akiapolaau, and Hawaiian hawk. On Maui, the upper elevations include an area designated as critical habitat for the Blackburn's sphinx moth.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—private, 75%; Federal, 3%
Forest—private, 14%; Federal, 2%
Urban development—private, 1%
Other—private, 3%; Federal, 2%

Most of this area is rangeland. Some small areas at elevations of 2,000 to 3,000 feet (610 to 915 meters) are used intensively for irrigated truck crops. The local climate and soils at that elevation are suitable for cool-season crops, such as head cabbage, head lettuce, celery, and round onions.

The major soil resource concern is water erosion. Conservation practices on rangeland generally include proper grazing use and brush management. Conservation practices on cropland generally include irrigation water management, windbreaks, crop rotations, contour farming, nutrient management, and pest management. ■

161A—Lava Flows and Rock Outcrops

This area is in the Hawaiian Islands (fig. 161A-1). It makes up about 1,580 square miles (4,100 square kilometers). This mountainous area has few towns and roads. It includes the Hawaii Volcanoes National Park; the Mauna Kea Observatory Complex; the Hualalai, Kilauea, and Mauna Loa volcanic craters; and the Haleakala National Park, near the Red Hill

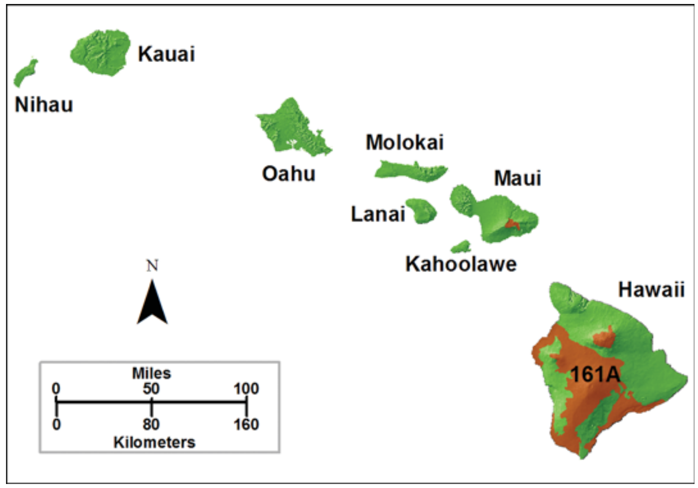

Figure 161A-1: Location of MLRA 161A in Land Resource Region V.

volcanic crater on Maui. The Pohakuloa Training Area, which is the largest military reservation in Hawaii, also occurs in this MLRA. It is between the Mauna Loa, Mauna Kea, and Hualalai Mountains.

Physiography

This area extends from sea level to the tops of the Mauna Kea, Mauna Loa, Haleakala, Kilauea, and Hualalai Mountains. It is on undulating to hilly, barren lava flows, rocky cliffs, rock outcrops, and steep cinder cones. Elevation ranges from sea level to 13,796 feet (0 to 4,206 meters). Mauna Kea is the highest point in Hawaii. Local relief ranges from 3,000 to 13,000 feet (915 to 3,965 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Hawaii (2001), 98 percent, and Maui (2002), 2 percent.

Geology

This area has young aa and pahoehoe lava that flowed from the top or flanks of volcanoes. The surface of the aa lava is fragmental, jagged, and rough. The surface of the pahoehoe is smooth but has many cracks. Cinder cones are near the summits of the volcanoes.

Climate

The average annual precipitation in this area is 10 to 100 inches (255 to 2,540 millimeters), generally increasing with elevation. Most of the rainfall occurs from October through March in most areas and from May through September in the Kona area. The average annual temperature is 38 to 76 degrees F (3 to 25 degrees C). The freeze-free period averages 365 days in most of the area but is shorter at the highest elevations.

Water

The withdrawals of freshwater by use are not estimated for this MLRA. The total withdrawals average much less than 1 million gallons per day (less than 3.8 million liters per day). The water used in this area is almost entirely surface water. The low rainfall limits agricultural production in the area. Much of the area is close to the craters of the large volcanoes on Maui and Hawaii, so the area has few streams. Water for almost all domestic uses and livestock is catchment water stored in tanks. Some resorts and urban areas along the coast of Hawaii rely on imported water from adjacent MLRAs. Very little or no ground water is available for development in this area.

Soils

The dominant soil orders in this MLRA are Andisols and Histosols. The soils in the area have an isohyperthermic to isofrigid soil temperature regime and an ustic or udic soil moisture regime. Most of the soils are organic. Mineral soils have medial texture. Shallow Ustifolists (Kekake and Punalu`u series) and shallow Udifolists (Keei, Kahaluu, and Kona series) formed in organic material over pahoehoe lava. Shallow soils in areas of volcanic ash include Haplustands (Kamawai and Pu`ukala series). Fulvudands (Hokukano series) and Ustivitrands (Nenenui series) formed in basic volcanic ash over pahoehoe lava. Deep Haplustands (Apakuie series) and Ustivitrands (Huikau and Kilohana series) formed on high mountain slopes. The MLRA dominantly consists of miscellaneous (nonsoil) areas, including lava flows, rock outcrop, and cinder land.

Biological Resources

The vegetation in this area includes naturalized dryland shrubs and grasses as well as rare dryland tree and shrub communities. The vegetation varies considerably, depending on the age of lava flow, rainfall, and elevation. Most areas, including recent lava flows and the tops of volcanoes, have no vegetation or have a sparse growth consisting of mosses, lichens, and ferns. The dry areas at low elevations support naturalized plants, such as kiawe, klu, and fountaingrass. The naturalized plants in wet areas include guava and molassesgrass.

The native vegetation in the area includes piligrass, ilima, uhaloa, ohia, and pukiawe. The vegetation in much of the area on the Big Island is classified as *Sophora chrysophylla* (no common name)-bastard sandalwood subalpine dry forest and lovegrass (*Eragrostis atropioides)* subalpine dry alpine vegetation. Two critical habitat areas for multiple plant species have been designated in this MLRA. One is about 70,000 acres (28,330 hectares), and the other is about 95,000 acres (38,445 hectares). The protected species include ka`u silversword in the first area and ohai and po´e in the larger area.

Some of the major wildlife species in the area are feral mouflon sheep (on the Big Island) and axis deer (on Maui). The native wildlife includes nene (the State bird of Hawaii) on both islands; the endangered Hawaiian palila, endangered Hawaiian hawk, and endangered Hawaiian bat on the Big Island; and the endangered pueo on Maui. In the area of Pu´u wa´a wa´a on the Big Island, critical habitat has been designated for the endangered Blackburn's sphinx moth.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—private, 28%; Federal, 6%
Forest—private, 10%
Other—private, 44%; Federal, 12%

The "other" category is dominantly barren lava flows and cinder cones. The current land uses in this area are dominantly recreation, wildlife habitat, rangeland, and some orchard production. Low-producing grazing land is in the medium rainfall belt. Some coastal areas are used for urban or resort development.

The major resource concerns are wildfire, wind erosion, drought, and flooding. Conservation practices on cropland and rangeland generally include prescribed grazing, firebreaks, and irrigation water management. ■

161B—Semiarid and Subhumid Organic Soils on Lava Flows

This MLRA is in the Kona coastal area on the leeward side of the Big Island of Hawaii (fig. 161B-1). It makes up about 385 square miles (1,000 square kilometers). The towns of Papua, Captain Cook, and Kealakekua are in this MLRA. Highway 11 is in the southern part of this area, and Highway 19 is in the far northern part.

Physiography

This area is on the western slopes of the Mauna Loa and Hualalai volcanoes. Slopes are undulating to very steep and follow the rugged topography of the lava flows. Elevation ranges from sea level to 6,000 feet (0 to 1,830 meters). Local relief ranges from 50 to 1,000 feet (15 to 305 meters).

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is Hawaii (2001). The MLRA has no perennial streams.

Geology

The surface of this area is dominated by organic material mixed with volcanic ash over aa and pahoehoe lava bedrock.

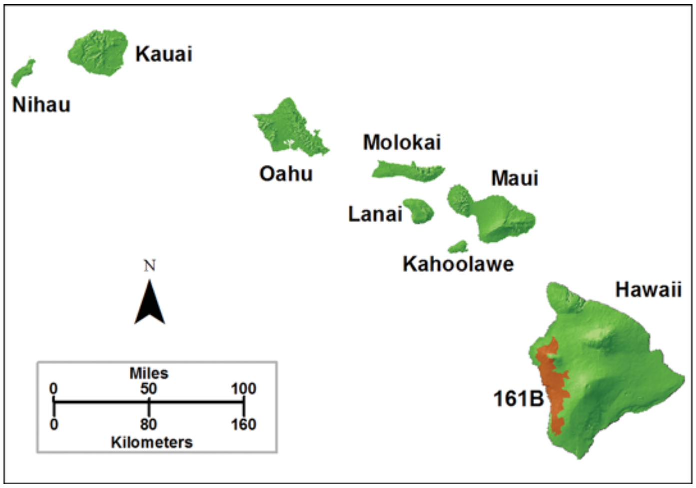

Figure 161B-1: Location of MLRA 161B in Land Resource Region V.

Climate

The average annual precipitation in this area is 30 to 80 inches (760 to 2,030 millimeters). Most of the rainfall occurs in spring and summer. The average annual temperature is 55 to 75 degrees F (13 to 24 degrees C). The freeze-free period averages 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 5.6%; ground water, 27.8%
Livestock—surface water, 11.1%; ground water, 0.0%
Irrigation—surface water, 27.8%; ground water, 27.8%
Other—surface water, 0.0%; ground water, 0.0%

The total withdrawals average 1.8 million gallons per day (6.8 million liters per day). About 56 percent is from ground water sources, and 44 percent is from surface water sources. This MLRA is a low-rainfall area with no perennial streams. Much of the irrigation water used in the area is imported from adjacent MLRAs. Catchments are used at the higher elevations to trap surface water, which is then piped to lower elevations for livestock use. Much of the public and domestic drinking water supply is distributed through pipelines from a few deep wells.

The Kau volcanic rock aquifer on the Big Island has the lowest levels of total dissolved solids and the softest water of all the aquifers on the islands, especially near the center of the island, where recharge occurs. The level of salts in the water may be higher than the median for this aquifer since much of this MLRA is near the southwestern coast of Hawaii. Pumping tends to increase the level of seawater intrusion into the “basal water.” Most of the ground water in this area floats as a lens of freshwater on the denser saltwater that occurs at depth in the volcanic rock aquifer. When freshwater is pumped out of the aquifer, the movement of seawater higher into the aquifer can cause contamination. The intrusion of seawater is most common near the coast, so the ground water can be limited for use as drinking water in parts of this area. Away from the coast, the ground water is suitable for almost all uses with little treatment.

The silica levels in the water from the volcanic rock aquifer exceeds 30 parts per million (milligrams per liter). The level of silica limits the industrial use of the ground water. At this concentration, silica combines with calcium and magnesium to form a scale that can create problems, especially in boilers and steam turbines.

Soils

The dominant soil orders in this MLRA are Histosols and Andisols. The soils in the area have an isohyperthermic to isomesic soil temperature regime, have an ustic or udic soil moisture regime, and generally are organic. They are dominantly very shallow to moderately deep and are well drained. Most of the soils are Folists that are well drained, organic soils in areas of aa or pahoehoe lava. Shallow Ustifolists (Kekake and Punalu`u series) and very shallow Udifolists (Kona series) formed in organic material over pahoehoe lava. Moderately deep or deep Ustifolists (Kaimu and Mawae series) and moderately deep or deep Udifolists (Puna and Kiloa series) formed in organic material in fragmental aa lava. Haplustands (Hanipoe series) and Hydrudands (Manaha`a series) formed in volcanic ash. The MLRA has a significant acreage of miscellaneous (nonsoil) areas.

Biological Resources

The vegetation in this area consists of shrubs, grasses, and trees. The dominant naturalized vegetation at the lower elevations includes kiawe, bermudagrass, tobacco tree, fountaingrass, and Natal redtop. A few native herbaceous species are dominant, including ilima and uhaloa. At the high-rainfall, intermediate elevations, naturalized hilograss is interspersed with native ohia and treefern. At the upper elevations, kikuyugrass and rattailgrass are the dominant grazed pasture grasses and ohia and koa are the dominant native overstory trees. Five critical habitat areas have been designated within this MLRA for clusters of plants, including haha (both *Cyanea hamatiflora* and *Cyanea stictophylaa*), popolo ku mai, and hua kuahiwi.

Some of the major wildlife species in the area are feral mouflon sheep, feral pigs, and numerous species of game birds. The native wildlife species include the endangered nene, the endangered Hawaiian hawk, and the endangered Hawaiian bat.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 2%
Grassland—private, 53%
Forest—private, 37%; Federal, 2%
Urban development—private, 2%
Other—private, 4%

The "other" category is dominantly barren lava flows or cinder cones. Most of this area is rangeland, but forest dominates the wetter, higher elevation areas. Coffee, macadamia, avocado, and papaya are grown. Some coastal areas are used for urban or resort development.

The major resource concerns are the irrigation water supply, nutrient and pesticide runoff and leaching, and depletion of organic matter in the soils. Conservation practices on cropland generally include irrigation water management and nutrient and pest management. ■

162—Humid and Very Humid Organic Soils on Lava Flows

This area is on the Big Island of Hawaii (fig. 162-1). It makes up about 550 square miles (1,430 square kilometers). The towns of Hilo, Pahoa, and Kalapana are in this MLRA. Highways 11, 13, 19, 20, and 137 cross the area.

Physiography

This area is on the southeastern slopes of Mauna Loa and Kilauea volcanoes. Slopes are undulating to very steep and follow the rugged topography of the lava flows. Elevation ranges from sea level to 4,000 feet (0 to 1,220 meters). Local relief ranges from 20 to 100 feet (6 to 30 meters).

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is Hawaii (2001). The area has numerous streams. The Wailuku River empties into Hilo Bay in this area.

Geology

This area is covered dominantly by a shallow layer of organic material in or on basaltic aa or pahoehoe lava bedrock. Volcanic activity has covered some small areas with recent volcanic ash.

Climate

The average annual precipitation in this area is 60 to 235 inches (1,525 to 5,970 millimeters). It is higher in the northern part of the area than in the southern part, and it increases with

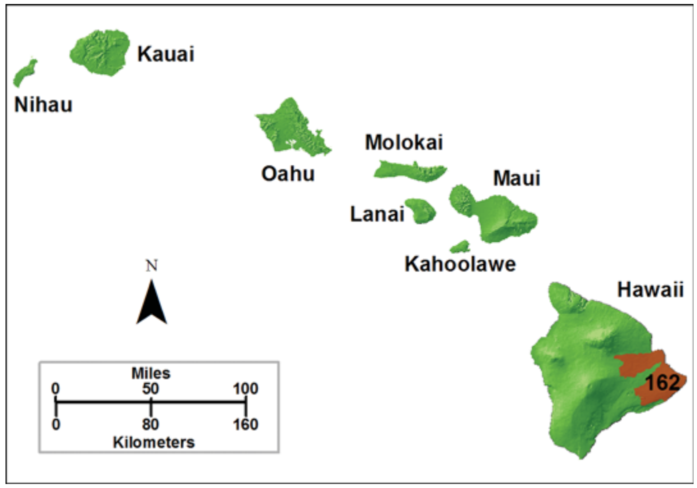

Figure 162-1: Location of MLRA 162 in Land Resource Region V.

elevation. The rainfall occurs from November through April in udic areas and is evenly distributed in perudic areas. The average annual temperature is 54 to 73 degrees F (12 to 23 degrees C). The freeze-free period averages 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 10%; ground water, 88%
Livestock—surface water, 1%; ground water, 1%
Irrigation—surface water, 0%; ground water, 0%
Other—surface water, 0%; ground water, 0%

The total withdrawals are about 10 million gallons per day (38 million liters per day). About 89 percent is from ground water sources, and 11 percent is from surface water sources. Because of the high amount of rainfall, irrigation is not needed for crop production. The area has a number of perennial streams. The chemical quality of the surface water is good, but physical and biological water quality can be a problem. Treatment is needed if the water is to be used as drinking water.

All three volcanic rock aquifers on the Big Island of Hawaii occur in this area. They include the Kau aquifer; the Puna, Hualalai, Kahuku, and Hamakua aquifer; and the Laupahoehoe and Hawi aquifer. Tests indicate that the ground water in the Kau aquifer has a median level of about 100 parts per million (milligrams per liter) total dissolved solids and is soft. In most of the area, this water is suitable for almost all uses with little or no treatment. The level of salts increases in water from these aquifers in areas near the coast, where the intrusion of seawater can be a problem if the aquifer is overused. The silica level in the water from all of the volcanic rock aquifers exceeds 30 parts per million (milligrams per liter). The level of silica limits the industrial use of the ground water. At this concentration, silica combines with calcium and magnesium to form a scale that can create problems, especially in boilers and steam turbines.

Soils

The dominant soils in this MLRA are Udifolists (Kiloa and Opihikao series) that have an isothermic or isohyperthermic soil temperature regime and a perudic or udic soil moisture regime. They are shallow over pahoehoe or a layer of aa clinkers. The layer of clinkers can extend to a depth of about 3 feet (1 meter). Hard, massive but fractured basalt underlies this layer. In some areas aa and pahoehoe lava flows or ash are too young to have obtained enough organic material for the formation of soils.

Biological Resources

This MLRA supports herbaceous plants, shrubs, and trees. The naturalized vegetation includes rose apple tree, African tuliptree, strawberry guava, and banana poka. The vegetation on coastal beaches includes coconut palms, ironwood, and other xerophytic and salt-tolerant plants. Native forests are dominated by ohia. Critical habitat for clusters of plants has been designated in the upper watersheds above Hilo and Saddle Road. The rare or endangered plants in the area include oha wai (*Cleremontia peleana*), haha (*Cyanea platyphylla*), and ha´iwale (*Cyrtandra tintinnabula*).

Some of the major wildlife species in this area are endangered waterfowl in wetlands and streams, such as the Hawaiian stilt, coot, moorhen, and duck. Nene, hoary bat, and Hawaiian hawk in pastures, abandoned areas formerly used for sugarcane, and lava fields are in unique anchialine pools (pools in marine caves) along the coastline. Rare shrimp species also occur in these areas.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 2%
Grassland—private, 25%; Federal, 1%
Forest—private, 54%; Federal, 2%
Urban—private, 2%;
Other—private, 12%; Federal, 2%

Naturalized forest makes up most of this area. The forestland is used for grazing, recreation, wildlife habitat, and watershed. Some areas are used for woodland with planted trees or for pasture or orchards.

The major resource concerns are the spread of invasive plant species, depletion of organic matter in the soils, and contamination caused by fertilizers, pesticides, and rural waste-disposal systems. Conservation practices on cropland and rangeland generally include mulching, crop residue management, and nutrient and pesticide management. Practices that reduce the extent of invasive species also are important. ■

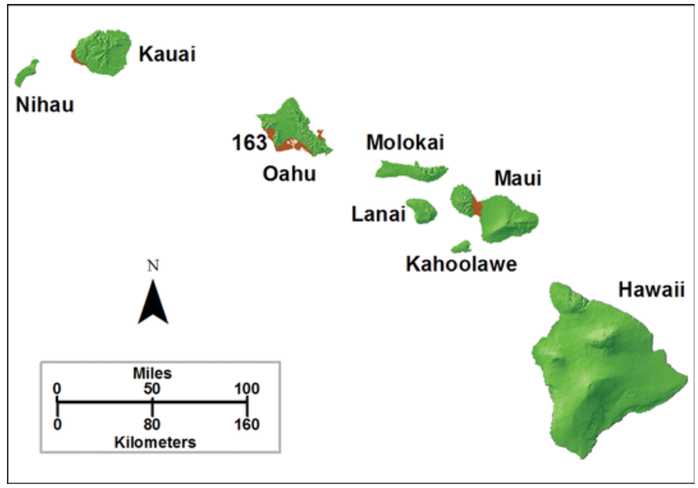

Figure 163-1: Location of MLRA 163 in Land Resource Region V.

163—Alluvial Fans and Coastal Plains

This area is in the Hawaiian Islands (fig. 163-1). It makes up about 140 square miles (365 square kilometers). It includes the towns or cities of Kahului, Maui; Kailua, Pearl City, and Honolulu, Oahu; and Mana, Kauai. There are numerous highways throughout these mostly heavily populated areas, including Interstate H1. Hickam Air Force Base, Pearl Harbor Naval Reservation, Kaneohe Bay Marine Corps Base, and the Pacific Missile Range Facility are some of the larger military installations in this MLRA. Captain James Cook landed near the mouth of the Waimea River in the part of this area on Kauai.

Physiography

This area is on nearly level and gently sloping coastal plains and the adjacent alluvial fans. Elevation ranges from sea level to 200 feet (0 to 60 meters). Local relief ranges from 50 to 100 feet (15 to 30 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Oahu (2006), 61 percent; Maui (2002), 27 percent; and Kauai (2007), 12 percent. Numerous streams cross the area as they empty into the ocean. Very few of the streams are perennial. The Waimea River is the only perennial stream in the part of this area on Kauai.

Geology

Alluvial fans and terraces grade into coastal plains throughout this area. Basalt, coral limestone, calcareous sand deposits, volcanic ash, coral sand, and fill lie beneath the unconsolidated sediments. Some small areas on coastal plains are underlain by marly lagoon deposits and marine clays.

Climate

The average annual precipitation in this area is 20 to 30 inches (510 to 760 millimeters). Most of the rainfall occurs from November through March. It occurs during kona storms that come in from the leeward side of the islands. The average annual temperature is 72 to 76 degrees F (22 to 24 degrees C). The freeze-free period averages 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 2.1%; ground water, 42.9%
Livestock—surface water, 0.0%; ground water, 0.0%
Irrigation—surface water, 18.2%; ground water, 6.3%
Other—surface water, 2.8%; ground water, 27.7%

The total withdrawals average 395 million gallons per day (1,495 million liters per day). About 77 percent is from ground water sources, and 23 percent is from surface water sources. The amount of rainfall is not adequate for crop production without irrigation. The area has only a few perennial streams. Some surface water is trapped in catchments in the higher and wetter parts of this MLRA and is piped to lower areas, where it is used for watering livestock and for irrigation. Some irrigation water is imported from the adjacent MLRAs. The surface water generally is not suitable for drinking unless it is treated.

Most of the water used in this area is ground water, which is of better quality than the surface water. Most of the water on Oahu is pumped from alluvial aquifers and the Waianae and Honolulu volcanic rock aquifer. This water typically has a median level of total dissolved solids of about 200 parts per million (milligrams per liter) and is moderately hard. Ground water is pumped from sedimentary deposits in the isthmus area of Maui for use in this MLRA. There are no water-quality test data reported for this aquifer. The intrusion of seawater is a potential problem in the aquifers on both of these islands.

Because of population increases, agricultural land has been converted to urban uses in southern Oahu. The improved drainage system in the urbanized areas carries runoff water away from recharge areas for the local aquifers. Also, recharge no longer occurs from the application of irrigation water after the agricultural land is developed for urban uses. Because of the lack of recharge and the heavy pumping near the coast, the level of ground water has dropped and the water has become more salty over time.

Soils

The dominant soil orders in this MLRA are Mollisols, Aridisols, Entisols, and Vertisols. The soils in the area have an isohyperthermic soil temperature regime, an aquic or arid (torric) soil moisture regime, and kaolinitic, carbonatic, parasesquic, smectitic, or mixed mineralogy. They are very deep to shallow, excessively drained to poorly drained, and clayey. Haplustolls (Ewa series) formed in alluvium derived from basaltic rocks. Ustipsamments (Jaucas series) formed in calcareous sand deposits in vegetated back-beach areas. Haplocambids (Kekaha series) and Gypsitorrerts (Lualualei) formed in fine textured alluvium derived from basic igneous rocks. Haplocambids (Mamala series) also formed in shallow alluvium over coral limestone on coastal plains. Haplustolls (Mokuleia series) formed in recent alluvium over coral sand. Near sea level, Endoaquolls (Nohili series) formed in alluvium underlain by marly lagoon deposits. The MLRA has some miscellaneous (nonsoil) areas.

Biological Resources

This area supports herbaceous and shrub vegetation and some trees. The naturalized vegetation consists of fingergrass, kiawe, koa-haoe, klu, lantana, and bermudagrass. The vegetation on coastal beaches includes coconut palms, ironwood, and other xerophytic and salt-tolerant plants. Wetlands support pickleweed, napiergrass, guava, and California grass.

Some of the major native wildlife species in this MLRA inhabit wetlands. They include the endangered stilts, the endangered coot, and the endangered moorhen. The Kaneohe Bay Marine Corps Base on Oahu has a refuge area for the endangered red-footed booby. The naturalized animals in the MLRA include numerous game bird species and chickens.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 20%
Grassland—private, 21%; Federal, 12%
Forest—private, 2%; Federal, 1%
Urban development—private, 27%; Federal, 8%
Water—private, 1%
Other—private, 7%; Federal, 1%

Most of the part of this MLRA on Oahu is in urban areas or military installations. The crops grown in the MLRA include irrigated sugarcane, truck crops, and orchards. Some small areas are used for dry-farmed pasture. Some coastal areas are used for resort development.

The major resource concerns are nutrient and pesticide leaching near shore environments, invasive plants and animals in wetlands, tillage-induced surface compaction, wind erosion, water erosion, and the supply and efficient use of irrigation water. Conservation practices on cropland and rangeland generally include nutrient and pest management, management of wildlife habitat, proper tillage, subsoiling, properly designed irrigation systems, windbreaks, and cover crops. Urban stormwater management in the heavily urbanized areas and on the military installations helps to protect streams, wetlands, and coastal zones. ■

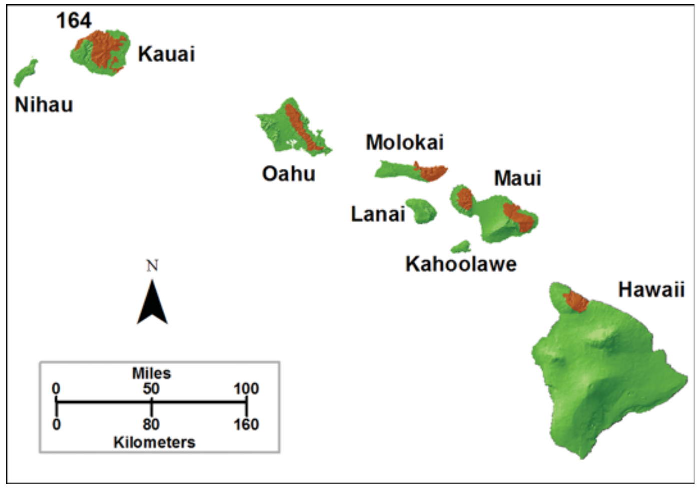

Figure 164-1: Location of MLRA 164 in Land Resource Region V.

164—Humid and Very Humid Steep and Very Steep Mountain Slopes

This area is in the Hawaiian Islands (fig. 164-1). It makes up about 760 square miles (1,970 square kilometers). It has only a few populated areas, including the coastal towns of Hanalei, Kauai; Kalaupapa and Halawa, Molokai; and Kahakuloa and Keanae, Maui. The part of the MLRA on Kauai includes Mt. Waialeale, noted as one of the highest rainfall areas on earth.

Physiography

This MLRA consists primarily of the deeply dissected mountainous areas of the older Hawaiian Islands. The topography is steep to precipitous and has many ridges, gulches, and canyons. Plateaus supporting montane bogs occur on the islands of Kauai, Molokai, Maui, and Hawaii. Elevation ranges from sea level to 7,000 feet (0 to 2,135 meters). Local relief is mostly 2,000 to 4,000 feet (610 to 1,220 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Kauai (2007), 33 percent; Maui (2002), 25 percent; Oahu (2006), 18 percent; Molokai (2005), 12 percent; and Hawaii (2001), 12 percent. The headwaters of many streams form in this steep area, and perennial streams are common.

Geology

This area is underlain by fractured basic igneous rock that is slightly weathered to highly weathered. Most of the bedrock is basalt. Volcanic ash and tropospheric dust are deposited in some areas. Organic deposits occur in wet forests at the higher elevations.

Climate

The average annual precipitation in most of this area is 75 to 250 inches (1,905 to 6,350 millimeters). It can be as low as 30 inches (760 millimeters) in some of the coastal areas below mountains and as much as 450 inches (11,430 millimeters) at the highest elevations. Most of the rainfall occurs from November through April. The average annual temperature is 53 to 75 degrees F (12 to 24 degrees C). The freeze-free period averages 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0%; ground water, 0%
Livestock—surface water, 50%; ground water, 0%
Irrigation—surface water, 0%; ground water, 0%
Other—surface water, 50%; ground water, 0%

The total withdrawals average 0.2 million gallons per day (0.8 million liters per day). All of the water is surface water. This high-rainfall area has many perennial streams. It is primarily an area of ground water recharge for all of the islands on which it occurs. This dominantly forested area has only a small acreage of agricultural land, and most of the water is used for domestic purposes or for watering livestock. Catchments are used to trap water, which is stored in tanks for future use.

Soils

The dominant soil orders in this MLRA are Inceptisols, Andisols, and Spodosols. The soils in the area have an isothermic or isomesic soil temperature regime, an aquic to ustic soil moisture regime, and mixed, amorphic, ferrihydritic, or parasesquic mineralogy. They generally are deep, are poorly drained to well drained, and have fine, very fine, medial, and hydrous textures. The soils on plateaus have an organic surface layer. The plateaus have unique montane bogs with perched water caused by an ironstone sheath within the soils. Petraquepts (Amalu and Hula series) and Placorthods (Kahanui series) formed in organic material, volcanic ash, and tropospheric dust over basic igneous rock. Poorly drained Epiaquands (Koolau series) and shallow, poorly drained Epiaquepts (Olokui series) also occur in the area. Hydrudands (Honomanu series) formed in weathered volcanic ash, which overlies fragmented basic igneous rock. The MLRA has a significant acreage of miscellaneous (nonsoil) areas.

Biological Resources

This area is dominated by the *Oreobolus furcatus* (no common name) montane rain forest, which has mixed plant species. Montane bog vegetation is common in the rain forests. The more common plants in the bogs are wet sedges, ohia, na´ene´e (*Dubautia waialealae*), and `uki. Numerous critical habitat plant cluster areas are in this MLRA. The rare and endangered plants in the part of the MLRA on Kauai include Domin’s club, mapele, heau, *Poa siphonoglossa* (no common name), *Alsidendron viscosum* (no common name), and haha (*Cyanea asarifolia*). The plants in the part of the area on Oahu include nanu, alani (*Melicope lydgatei*), `oha (*Delissea subcordata*), `anini or wanini, and nioi. The plants in the part on Molokai include alani (*Melicope reflexa*), haha (*Cyanea grimesiana*), ko`oko`olau, *Lysimachia maxima* (no common name), and *Stenogyne bifida* (no common name). The plants in the part on Maui include *Pteris lydgatei* (no common name), ha`iwale (*Cyrtandra munroi*), oha wai, and a variety of pauoa and haha species.

Some of the major wildlife species in the area include rare honeycreepers and other native Hawaiian forest birds (particularly on Kauai, which is inhabited by the `Akikiki Kaua´i elepaio, Kaua´i amakihi, `anianiau, and `akeke´e). The endangered animals in this MLRA include the Newcomb’s snail on Kauai, Blackburn’s sphinx moth on Molokai, Oahu elepaio and Oahu tree snails on Oahu, and *Achatinellid* land snails on Oahu and Maui. The naturalized species include exotic birds, feral pigs, deer, and goats.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—private, 50%; Federal, 2%
Forest—private, 43%; Federal, 3%
Urban development—private, 1%
Other—private, 1%

Most of this area is rangeland. Much of the area is naturalized rain forest. The forestland is used mainly for watershed, wildlife habitat, and recreation. Some small areas are used for crops or pasture.

The major soil resource concern is water erosion, including mass movement. Conservation practices on forestland include native forest restoration and fencing, which helps to control feral animals. ■

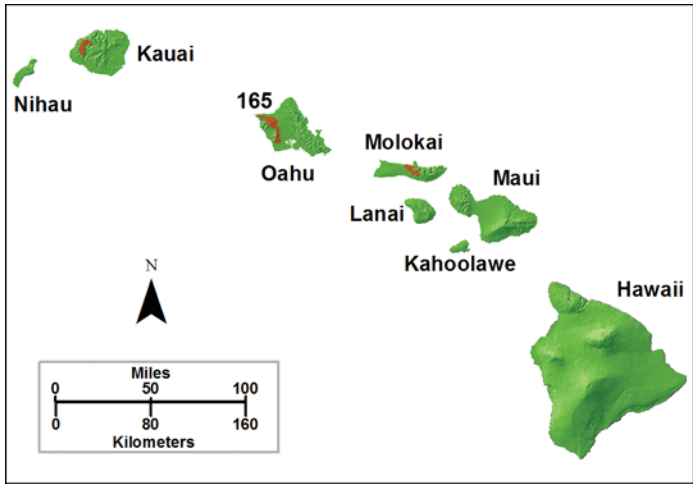

Figure 165-1: Location of MLRA 165 in Land Resource Region V.

165—Subhumid Intermediate Mountain Slopes

This area is in the Hawaiian Islands (fig. 165-1). It makes up about 110 square miles (290 square kilometers). It has very few populated areas. Highway 55 skirts the eastern edge of the west leg of this area on the island of Kauai. Highway 78 crosses the part of this area on Oahu, and Highway 47 ends in the part on Molokai.

Physiography

This area is on the leeward, drier, intermediate mountain slopes of the older Hawaiian Islands. Slopes are rolling and are dissected by many steep and very steep gulches. Elevation ranges from 400 to 3,700 feet (120 to 1,130 meters). Local relief ranges from 200 to 1,800 feet (60 to 550 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Oahu (2006), 49 percent; Kauai (2007), 29 percent; and Molokai (2005), 22 percent. The headwaters of many streams are in this area.

Geology

This area is dominated by basic igneous rock (primarily basalt). Interfluves are influenced by volcanic ash.

Climate

The average annual precipitation in this area is 25 to 60 inches (635 to 1,525 millimeters). Most of the rainfall occurs from November through March. The average annual temperature is 61 to 74 degrees F (16 to 23 degrees C). The freeze-free period averages 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 6.7%; ground water, 13.3%
Livestock—surface water, 13.3%; ground water, 0.0%
Irrigation—surface water, 13.3%; ground water, 33.3%
Other—surface water, 6.7%; ground water, 13.3%

The total withdrawals average 1.5 million gallons per day (5.7 million liters per day). About 60 percent is from ground water sources, and 40 percent is from surface water sources. The amount of rainfall is not adequate for crop production without irrigation. The streams that feed the Waimea River, the only perennial stream on Kauai, originate in this area. Water for almost all irrigation and livestock use is imported into this MLRA from wetter areas.

The Napali volcanic rock aquifer and the Waianae and Honolulu volcanic rock aquifer on Kauai and Oahu, respectively, provide good-quality ground water suitable for almost all uses in this area. Rural landowners use these aquifers for domestic and livestock water and for irrigation water. Some public supplies also are obtained from these aquifers.

Soils

The dominant soil orders in this MLRA are Inceptisols, Ultisols, Oxisols, Andisols, and Spodosols. The soils in the area have an isothermic soil temperature regime, a udic or ustic soil moisture regime, and parasesquic, ferrihydritic, or mixed mineralogy. They generally are deep, well drained, and fine textured or very fine textured. The soils that formed in volcanic ash include Haplustox (Mahana series). Haplustands (Oli series) formed in material weathered from basalt, and Hapludands (Kokee series) formed on dissected uplands. Placorthods (Kahanui series) formed in andesite residuum. Palehumults (Kalae series) formed in alluvium influenced by volcanic ash. Epiaquepts (Olokui series) are shallow, poorly drained soils that formed in material weathered from basic igneous rock. The MLRA has a significant acreage of miscellaneous (nonsoil) areas.

Biological Resources

This area supports forest, grassland, and scrub-shrub vegetation. The naturalized vegetation in the areas of lower rainfall includes kiawe, koa-haole, klu, lantana, and bermudagrass. Ohia, treefern, and uluhe dominate mesic to wet areas. Numerous critical habitat plant clusters occur on each island in this MLRA. On Kauai, the endangered plants that receive special protection include *Abutilon sandwicense* (no common name), alani (*Melicope pallida*), *Schiedea hookeri* (no common name), different species of haha, and aiea (*Nothocestrum pelitatum*). On Oahu, they include kulu´i, nioi, Ma`o hau hele (native yellow hibiscus), *Abutilon sandwicense* (no common name), alani (*Melicope pallida*), and various *Schiedea* species (no common names). The plants on Molokai include *Mariscus fauriei* (no common name), various *Schiedea* species (no common names), and *Silene alexandri* (no common name).

The naturalized wildlife species in this area include feral pigs, goats, chickens, and game birds. The endangered wildlife species include the Blackburn's sphinx moth, which has designated critical habitat in the part of this MLRA on Molokai. The hoary bat, Oahu tree snail, and Amastid land snail are endangered species in the part of the MRLA on Kauai.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 1%
Grassland—private, 65%; Federal, 6%
Forest—private, 25%; Federal, 2%
Urban development—private, 1%

Forest and rangeland make up nearly all of this area. Most of the area is used for watershed for the adjacent MLRAs. Some small areas are used for irrigated coffee or pineapple crops.

The major resource concerns are invasive species, feral animals, and water erosion. Conservation practices that are important in the area generally include restoration of native wildlife habitat, erosion control, and fencing, which helps to control feral animals. ■

166—Very Stony Land and Rock Land

This area is in the Hawaiian Islands (fig. 166-1). It makes up about 445 square miles (1,160 square kilometers). The part of this area on Kauai has no towns. On Kauai, Highway 55 is on the western edge of the MLRA, where the area shares a boundary with MLRA 165. The towns of Portlock and Aina Haina are in the eastern part of this area on Oahu, and Highway 72 connects these towns with Honolulu. Highway 78 crosses the middle of the western part of this area on Oahu. The town of Makua and Highways 90 and 99 also occur in the western part of this area, on the northwest tip of Oahu. The towns of Kamalo and Kaunakakai and Highway 45 are in the part of this area on

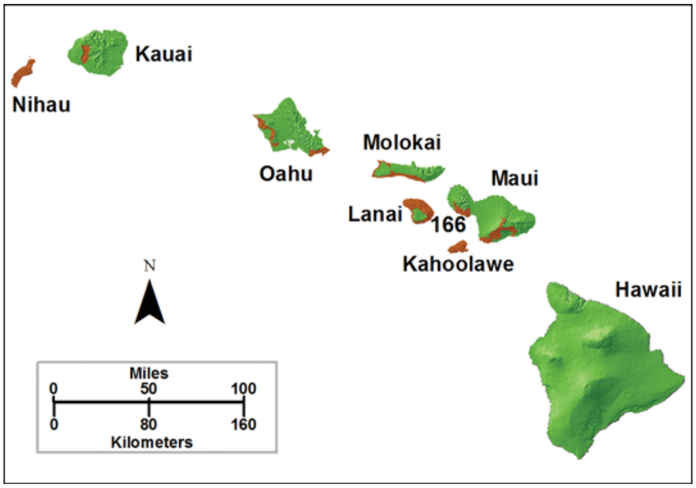

Figure 166-1: Location of MLRA 166 in Land Resource Region V.

the south coast of Molokai. The town of Kaumalapau Harbor and Highways 44 and 441 are in the part of this area on Lanai. The town of Olowalu and Highway 30 are in the western part of this area on Maui. The town of Keoneoio and Highway 31 are in the eastern part of this area on Maui. The U.S. Navy Bombing Range is in the part of this area on the uninhabited island of Kahoolawe.

Physiography

This area encompasses the stony complex slopes and rocky gulches in the arid and semiarid areas of the older Hawaiian Islands. Elevation ranges from sea level to 8,000 feet (0 to 2,440 meters). Local relief ranges from 200 to 2,000 feet (60 to 610 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Maui (2002), 23 percent; Lanai (2004), 22 percent; Oahu (2006), 15 percent; Niihau (2008), 13 percent; Molokai (2005), 12 percent; Kahoolawe (2003), 8 percent; and Kauai (2007), 7 percent. The Waimea River, the only perennial stream on Kauai, is in this area.

Geology

This area is covered by extrusive basic igneous rocks (primarily basalt) that are weathered in some areas. Some interfluves are mantled with weathered volcanic ash.

Climate

The average annual precipitation in this area is 10 to 60 inches (255 to 1,525 millimeters). Most of the rainfall occurs from November through March. Much of it occurs during kona storms. The average annual temperature is 50 to 76 degrees F (10 to 24 degrees C). The freeze-free period averages 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.6%; ground water, 42.9%
Livestock—surface water, 4.0%; ground water, 2.9%
Irrigation—surface water, 2.9%; ground water, 11.4%
Other—surface water, 0.0%; ground water, 35.4%

The total withdrawals average 17.5 million gallons per day (65 million liters per day). About 93 percent is from ground water sources, and 7 percent is from surface water sources. The amount of rainfall is not adequate for crop production without irrigation. The only perennial stream on Kauai, the Waimea River, is in this area. Because of the steep walls of the canyon through which the river flows, accessing the river water is difficult. Water for almost all irrigation and livestock use is imported into this MLRA.

Almost all of the water used in this area is for domestic, public, municipal, or industrial supplies. This water comes from volcanic rock aquifers. All of the volcanic rock and alluvial or sedimentary aquifers on Kauai, Oahu, Molokai, Maui, and the minor islands occur in this area. Some rural landowners use these aquifers for domestic and livestock water and some limited irrigation, but most of the ground water is used for public supply or for municipal or industrial purposes.

Soils

The dominant soil orders in this MLRA are Aridisols, Mollisols, and Entisols. The soils in the area have an isohyperthermic soil temperature regime, an aridic or ustic soil moisture regime, and dominantly mixed mineralogy. They dominantly are shallow, well drained, and clayey. They formed in material weathered from basic igneous rocks. Stony, shallow Haplocambids (Waiawa series) and Haplustolls (Waikomo series) and shallow Ustorthents (Uma series) occur in many areas. The MLRA has a significant acreage of miscellaneous (nonsoil) areas. Rock outcrops or stones cover the surface in about 40 to 50 percent of the area.

Biological Resources

The lower elevations of all of the islands in this MLRA support naturalized grass and scrub-shrub vegetation. These plants include Christmasberry, guineagrass, bermudagrass, and Natal redtop. Many areas in the MLRA are designated as critical habitat for endangered plants. Critical area plant clusters include *Panicum beechey* (no common name), *Schiedea spergulina spergulina* (no common name), `akoko

(*Chamaesyce halemanui*), nehe (*Lipochaeta faurei*), kaula, and *Gouania meyernii* (no common name) on Kauai; kio´ele, *Bonamia menzesii* (no common name), `awiwi, `anaunau, and *Silene lanceolata* (no common name) on Oahu; Wahine noho kula, `ohai, and ma`o hau hele on Molokai; *Tetramolopium remyi* (no common name), ma`o hau hele, and `ohai on Lanai; and ko`oko`olau (*Bidens micrantha kalealaha*), *Bobea sandwicensis* (no common name), *Bonamia menziesii* (no common name), and a´e (*Zanthoxylum hawaiiense*) on Maui.

Naturalized game birds, feral pigs, deer, and goats inhabit this MLRA. Many pelagic bird species, such as the Laysan albatross, shearwaters, and petrels, are along the coast and on nearby islets. Some of the major endangered wildlife species in the area are pueo and hoary bat on Oahu and Blackburn's sphinx moth and nene on Maui.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—private, 77%; Federal, 2%
Forest—private, 4%
Urban development—private, 3%
Water—private, 1%
Other—private, 13%

Most of this MLRA is used for rangeland, watershed, and wildlife habitat. More than one-fifth of the area is forestland. A small acreage is used for urban development.

The major resource concerns are control of flooding, fire, wind erosion, water erosion, and feral animals and restoration of native plant species. Conservation practices on rangeland generally include prescribed grazing, fencing, watering facilities, and firebreaks. ■

167—Humid Oxidic Soils on Low and Intermediate Rolling Mountain Slopes

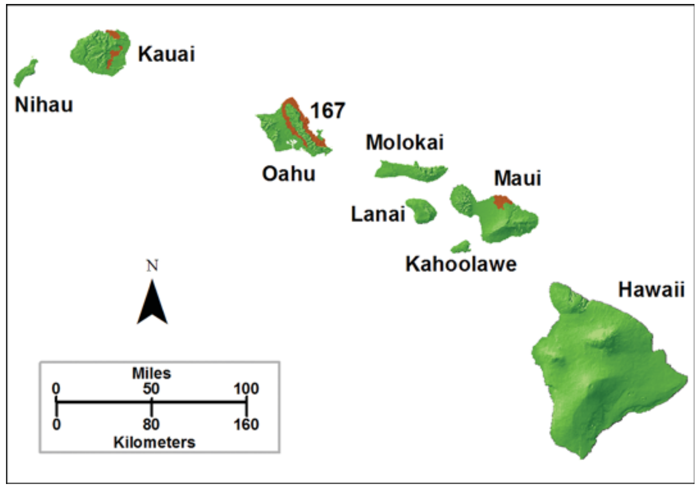

Figure 167-1: Location of MLRA 167 in Land Resource Region V.

This area is in the Hawaiian Islands (fig. 167-1). It makes up about 230 square miles (595 square kilometers). The part of this area on Kauai has no towns. Highway 55 crosses the northern part of the MLRA on this island, Highway 581 skirts the eastern edge of the southern part, and Highway 50 crosses the southernmost end. Highway 83 connects the many towns in the part of this area on the east coast of Oahu. The towns of Pauwela and Kokomo and Highways 36 and 40 are in the part on Maui.

Physiography

This area is dominantly on windward, low and intermediate mountain and hill slopes of the older Hawaiian Islands. Many steep and very steep gulches dissect the rolling mountain slopes. Elevation ranges from sea level to 2,000 feet (0 to 610 meters). Local relief ranges from 100 to 700 feet (30 to 215 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Oahu (2006), 60 percent; Kauai (2007), 21 percent; and Maui (2002), 19 percent. The headwaters of many streams occur in this area.

Geology

This area is covered dominantly by highly weathered ash and basic igneous rock. Alluvial sediments occur on bottom lands and low terraces along streams. In some small areas, the dominant geology is influenced by tropospheric dust.

Climate

The average annual precipitation in this area is 35 to 120 inches (890 to 3,050 millimeters). It increases with elevation. Most of the rainfall occurs from November through April. The average annual temperature is 66 to 76 degrees F (19 to 24 degrees C). The freeze-free period averages 365 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 0.0%; ground water, 42.5%
Livestock—surface water, 3.9%; ground water, 3.3%
Irrigation—surface water, 3.3%; ground water, 5.9%
Other—surface water, 2.6%; ground water, 38.6%

The total withdrawals average 15 million gallons per day (55 million liters per day). About 90 percent is from ground water sources, and 10 percent is from surface water sources. The amount of rainfall is not adequate for crop production without irrigation. The area has a few perennial streams but has no natural storage areas for surface runoff. Because of physical and biological contamination, rural landowners use the surface water only as livestock water and for some irrigation.

Almost all of the water used in this area is for domestic, public, municipal, and industrial supplies. Ground water of suitable quality for almost all uses on Kauai can be obtained from the Koloa and Olokele volcanic aquifer and the sedimentary rocks. The median level of total dissolved solids is generally less than 500 parts per million (milligrams per liter) in each of these aquifers, but the water in the volcanic aquifer is very hard and requires some treatment prior to use for domestic and public supplies. Good-quality ground water for most uses can be obtained from the Koolau volcanic aquifer, alluvial sediments, and sedimentary rocks on Oahu. The median level of total dissolved solids is less than 200 parts per million (milligrams per liter) in these aquifers, and the water in the volcanic aquifers is soft, so little treatment is required before the water is used as drinking water. Poor-quality ground water can be obtained from the Kula volcanic aquifer on Maui. The median level of total dissolved solids is close to 1,000 parts per million (milligrams per liter), and the water is very hard. Because of the poor water quality, the ground water on Maui is used primarily as livestock and irrigation water.

Soils

The dominant soil orders in this MLRA are Ultisols, Oxisols, and Inceptisols. The soils in the area have an isohyperthermic soil temperature regime, a udic or ustic soil moisture regime, and dominantly ferritic, ferruginous, mixed, parasesquic, kaolinitic, or sesquic mineralogy. They generally are very deep, well drained, and very fine textured. The soils on bottom land are well drained to poorly drained. The soils that formed in alluvial material include Endoaquepts (Hanalei series), Natraquerts (Kaena series), and Haplustolls (Waialua series). The soils that formed in areas influenced by tropospheric dust include Palehumults (Haiku series) and Acrudox (Makapili series). The soils that formed in material weathered from basic igneous rock include very deep and deep Palehumults (Honolua, Ioleau, and Kalapa series), Kanhaplohumults (Pauwela series), and Acrudox (Kapaa and Pooku series). The soils that formed in material weathered from basic igneous rock with admixtures of volcanic ash and ejecta include Acroperox (Halii series). The MLRA has a significant acreage of miscellaneous (nonsoil) areas.

Biological Resources

This area supports mesic to wet grass and forest vegetation and wetland plants. The naturalized plants include hilograss, California grass, java plum, and guava. Some areas are designated as critical habitat for endangered plants. Critical area plant clusters include *Awaous guamensis* (no common name), *Atyoida bisulcata* (no common name), and *Hedyotis littoralis* (no common name) on Kauai and different species of haha, aupaka (*Isodendrion longifolium*), and *Schiedea kaalae* (no common name) on Oahu. Critical habitat for *asplenium-leaved Diellia* is in the part of this MLRA on Maui.

Some of the major wildlife species in the area are hoary bat on all three islands and Oahu elepaio on Oahu. The endangered Hawaiian coot, stilt, and moorhen are on wetlands in the parts of this area on Kauai and Oahu. Small colonies of the endangered Newell shearwater and the endangered Hawaiian duck are in the part on Kauai.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 7%
Grassland—private, 41%; Federal, 4%
Forest—private, 37%; Federal, 2%
Urban development—private, 7%
Water—private, 1%
Other—private, 1%

Rangeland and woodland make up most of this area. About one-third of the area is used for bananas, pineapples, sugarcane, pasture, taro, orchards, or other crops. Some coastal areas are used for urban or resort development.

The major resource concerns are the spread of invasive plant species, flooding, and beach and water erosion. Wind erosion is a concern in the Kahuku area on Oahu. Conservation practices on rangeland and cropland generally include nutrient and pest management, restoration of native plants, prescribed grazing, crop rotations, and windbreaks. ■

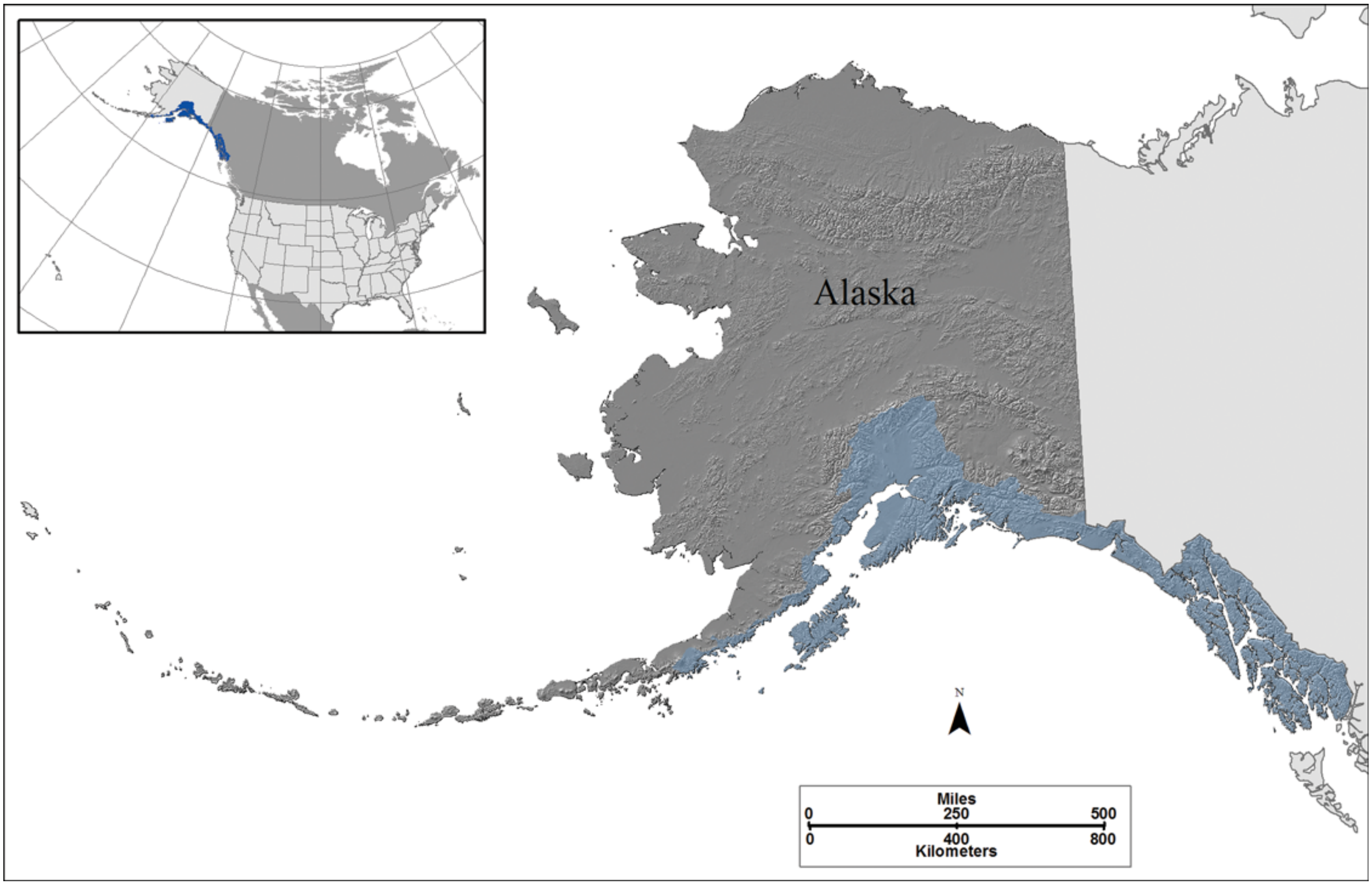

Figure W1-1: Location of Land Resource Region W1.

W1—Southern Alaska

This region is in the southern part of Alaska (fig. W1-1). It includes the arc of coastal lowlands and mountains along the Gulf of Alaska from the Alexander Archipelago in the southeast to Kodiak Island and the southern portion of the Alaska Peninsula in the west. It also includes the lowlands and mountains of Cook Inlet. The region makes up 95,210 square miles (246,710 square kilometers).

Rolling hills, glacial moraines, alluvial fans, and large outwash plains extend from the mountains to the commonly rugged coastline. All of the rivers in the region drain into the Gulf of Alaska and the North Pacific. Broad flood plains, terraces, and deltas flank the numerous glacial and freshwater drainages. Elevation ranges from sea level along the coast to 20,320 feet (6,195 meters) at the summit of Mount McKinley. The higher elevations are in areas of rugged mountains with bare rock, talus, glaciers, and ice fields. Some permafrost occurs in small isolated depressions and on north-facing slopes in the northern portion of the region.

The climate in this region ranges from maritime at the lower elevations along the coast to transitional maritime-continental at the higher elevations and in the northern Cook Inlet Lowlands. The average annual precipitation ranges from about 15 inches (380 millimeters) in the central Cook Inlet Lowlands to more than 275 inches (6,985 millimeters) in the coastal mountains. The average annual snowfall ranges from 30 to 70 inches (75 to 180 centimeters) along the coast and is as much as 800 inches (205 centimeters) in the high mountains. The average annual air temperature ranges from 27 to 46 degrees F (-3 to 8 degrees C). Temperatures are warmer near the coast and in the Cook Inlet Basin. Daily and seasonal temperature variations are highest in the mountains. The freeze-free period ranges from less than 60 days to more than 140 days.

The total withdrawals of freshwater in this region average about 230 million gallons per day (870 million liters per day). About 78 percent is from surface water sources, and 22 percent is from ground water sources. About 80 percent of the freshwater used in Alaska is used in this region, which is the most densely populated area in Alaska. About 65 percent of the water is used to meet the needs of the seafood industry, pulp mills, and mines or is used for cooling thermoelectric power plants. The rest of the freshwater is used primarily for public supply.

Figure W1-2: Agricultural development in an area of Land Resource Region W1.

The soils in this region dominantly have a cryic soil temperature regime, an aquic or udic soil moisture regime, and mixed or amorphic mineralogy. Gelepts and Cryepts occur on steep mountain slopes. Cryods, Cryands, Aquands, and Cryepts are on the lower slopes, foothills, and moraines. While Spodosols and Andisols intergrade in some areas, Andisols are dominant in the areas closer to volcanic sources. These areas include the Alaska Peninsula, Kodiak Island, the southern Kenai Peninsula, Kruzof Island, and Baranof Island. The Cryepts on the younger surfaces include Eutrocryepts and Dystrocryepts. Fluvents and Aquents are dominant on flood plains and low terraces. Histosols and Histic subgroups of other orders occur throughout the region. They are on level and depressional landforms and even on the steeper slopes along the coast and in the southeast. The Histosols include Fibrists, Hemists, Saprists, and Folists.

Alpine and subalpine vegetation occurs on the mountain slopes in this region. The vegetation transitions into subalpine grasslands and tall scrub at the lower elevations. The lower elevations of the Cook Inlet Lowlands have mixed forests of white spruce, black spruce, paper birch, and willow. Stunted black spruce grades into scrub and herbaceous communities in fens and bogs. Coastal forests dominated by Sitka spruce are along the northern and northwestern parts of the Gulf of Alaska. Western hemlock and Sitka spruce forests are dominant in the southeastern part of the region, and red cedar and Alaska cedar occur in the area farthest south. Land use is very diverse and includes urban and rural development, agriculture (fig. W1-2), forestry, commercial fishing, mining, livestock grazing, subsistence hunting and fishing, recreation, and wildlife habitat. ■

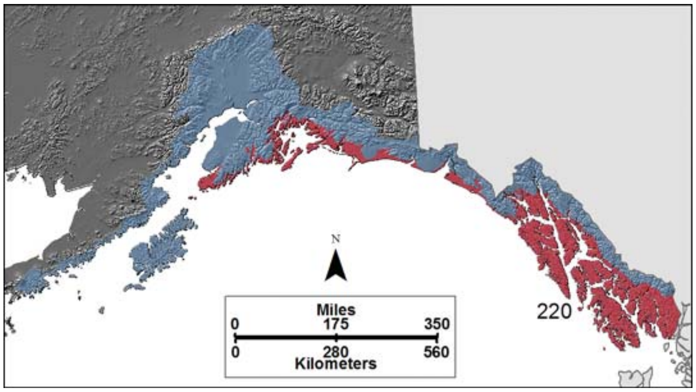

Figure 220-1: Location of MLRA 220 in Land Resource Region W1.

220—Alexander Archipelago-Gulf of Alaska Coast

This area is in the Southern Alaska Region (fig. 220-1). It includes the narrow arc of islands and low coastal mountains from the Alexander Archipelago in southeastern Alaska, north and west along the coast of the Gulf of Alaska and Prince William Sound, to the southern tip of the Kenai Peninsula. The area makes up about 27,435 square miles (71,085 square kilometers). The municipality of Juneau, Alaska's capital, and Ketchikan and Sitka are in the eastern part of the area. A number of smaller coastal towns and villages also are in the area. The Admiralty Island National Monument and part of Misty Fjords National Monument, Tongass National Forest, Chugach National Forest, and Glacier Bay, Wrangell-St. Elias, and Kenai Fjords National Parks and Preserves are in this MLRA. The southern terminus of the Trans-Alaska Pipeline is in this area, in Valdez.

Physiography

This area lies within the Pacific Border Ranges, Coastal Mountains, and Coastal Trough Provinces of the Pacific Mountains System. The Alexander Archipelago, Prince William Sound, and the southern Kenai Peninsula have dominantly low to moderate relief and deeply incised mountains. Throughout the area glaciers, rivers, and streams have cut deep, narrow to broad valleys. The broader valleys have nearly level to strongly sloping flood plains and stream terraces. Alluvial and colluvial fans and short footslopes are common in the valleys along the base of the mountains. Rocky headlands and sea cliffs are common along the coast. In the central portion of the area, the terrain consists primarily of strongly sloping to moderately steep outwash plains, alluvial fans, long footslopes, and flood plains. Formed by meltwaters of glaciers and ice fields from the adjoining MLRA 222, the flood plains in this part of the area are generally broad, have a high gradient, and are braided. Elevation ranges from sea level to 4,665 feet (1,420 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Southeast Alaska (1906), 83 percent, and South Central Alaska (1905), 17 percent. Surface water in this area drains to the Gulf of Alaska and the North Pacific by way of numerous short, high-gradient rivers that originate in glaciers, ice fields, mountain uplands, and the interior of Alaska and British Columbia. The major rivers are the Copper, Alsek, Taku, and Stikine Rivers. Lakes make up less than 2 percent of the area. Glaciers make up less than 1 percent and are limited to the higher elevations on Baranof Island in the Alexander Archipelago.

Geology

During the late Pleistocene epoch, the entire area was covered with glacial ice. The numerous fjords of the Alexander Archipelago and Prince William Sound were formed along faults or joints, chiefly as a result of glacial scouring and deepening of preglacial river valleys. Most glacial deposits have been eroded away or buried by mountain colluvium and alluvium, which cover about 90 percent of the present landscape. The remaining glacial and glaciofluvial deposits are generally restricted to coastal areas. During the Holocene epoch, volcanic activity within and adjacent to this area deposited a layer of volcanic ash of varying thickness on much of the landscape in the southeastern and northwestern parts of the area. Paleozoic, Mesozoic, and Lower Tertiary stratified sedimentary rocks and Cretaceous and Tertiary intrusive rocks underlie much of the area and are exposed on steep mountain slopes and ridges.

Climate

The average annual precipitation in most of this area is 60 to 120 inches (1,525 to 3,050 millimeters). It is 15 to 25 inches (380 to 635 millimeters) at the lower elevations on the small part of the Cook Inlet Lowlands in the southwest corner of the area. It can be as much as 200 inches (5,080 millimeters) at the highest elevations. Cloudy skies, moderate temperatures, and abundant rainfall characterize the temperate maritime climate of this area. Winter storms, accompanied by heavy rainfall at the lower elevations and snow at the higher elevations, are frequent. Moderate to strong, south and southeast winds are common before and during the storms. The average annual snowfall ranges from about 30 to 70 inches (75 to 180 centimeters) along the coast and is as much as 200 inches (510 centimeters) at the higher elevations. The average annual temperature at the lower elevations ranges from about 37 degrees F (3 degrees C) in the northwestern part of the area to 46 degrees F (8 degrees C) in the southeastern part. The freeze-free period averages about 120 to 190 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 15.3%; ground water, 13.2%
Livestock—surface water, 0.2%; ground water, 0.0%
Irrigation—surface water, 0.4%; ground water, 0.0%
Other—surface water, 50.4%; ground water, 20.5%

The total withdrawals average 53 million gallons per day (200 million liters per day). About 34 percent is from ground water sources, and 66 percent is from surface water sources. In most years precipitation is adequate for crops, but in some years yields are reduced by short dry periods in summer. Permanent streams, originating in the mountainous regions on the inland side, carry water to nearly all parts of the area. Some outlets for natural lakes in this area have been dammed. The stored water is used for limited irrigation, public supply, pulp mills in Sitka and Ketchikan, and fish-processing plants. The surface water is generally suitable for all uses. Rivers fed by glacial meltwater typically carry high loads of suspended sediment. The development of small local streams around Juneau is being considered. These streams would supplement the public water supply in developing areas outside Juneau. Flooding from ice dams that form during the spring thaw is a concern in this area.

Ground water is used for some public supply, pulp mills in Sitka and Ketchikan, and fish-processing plants in the central part of the area and in the vicinity of Juneau. The water is pumped primarily from unconsolidated sediments in river valleys (alluvium) or from buried glacial outwash deposits in the river valleys or on uplands. It is hard or very hard but is otherwise of excellent quality. Wells in this aquifer generally are shallow, and the aquifer is being constantly recharged with freshwater (rainfall and runoff). As a result, the median level of total dissolved solids is fairly low, about 130 parts per million (milligrams per liter). The level of iron may exceed the secondary standard for drinking water of 300 parts per billion (micrograms per liter). This standard is for esthetics. The iron can stain ceramic and porcelain and precipitate in pipes. Since this aquifer is close to the surface and water moves through it quickly, it is highly susceptible to contamination from runoff. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination. The intrusion of seawater can be a problem along the coast.

Small amounts of ground water can be obtained from the bedrock aquifer in the western and eastern parts of this area. This water is similar in quality to that in the unconsolidated sediments.

Soils

The dominant soil orders in this MLRA are Spodosols, Histosols, and Entisols. The soils in the area have a cryic soil temperature regime. Most have a udic soil moisture regime and mixed mineralogy.

Some Humicryods (Partofshikof and Sitka series) on mountains and hills formed in silty volcanic ash over loamy and gravelly or cobbly colluvium and glacial till. Other Humicryods (Tolstoi and Kupreanof series) and Haplocryods (Remedios series) on mountains and hills formed in colluvium and glacial till. These Spodosols range from shallow to deep and from well drained to somewhat poorly drained. Cryosaprists (Maybeso series), Cryohemists (Kina series), and Cryofibrists (Staney series) on footslopes, discharge slopes, and valley floors and in areas directly above timberline formed in thick deposits of organic material. These soils are generally deep and are poorly drained or very poorly drained. Cryofolists (McGilvery series) are on steep mountainsides and are well drained. Cryaquents (Ashmun series) and Cryofluvents (Tonowek series) on flood plains, stream terraces, and outwash plains formed in silty, sandy, and gravelly to cobbly alluvium. These soils are generally deep and range from well drained to somewhat poorly drained.

Miscellaneous (nonsoil) areas make up about 23 percent of this MLRA. The most common miscellaneous areas are chutes, rock outcrop, rubble land, beaches, riverwash, and water.

Biological Resources

This MLRA consists primarily of the lower elevation forested and subalpine zones. Western hemlock and Sitka spruce are the dominant trees on mountains and hills at the lower elevations. Red cedar and Alaska cedar are more prevalent in the southern part of the area. Black cottonwood and mixed forest types occur on flood plains. Areas of peat and other sites that are too wet for forest growth support sedge-grass meadows and low scrub. Tall alder scrub is on steep mountain slopes and in the subalpine zone. Grasslands of bluejoint reedgrass are common in the subalpine zone. Dwarf alpine scrub, herbaceous communities, and barren ground dominate the landscape at elevations of about 2,500 to 3,000 feet (760 to 915 meters) or more.

Some of the major species of mammals in the area are brown bear, black bear, Sitka black-tailed deer, moose, wolf, and mountain goat. Many species of migratory waterfowl and shore birds pass through the area. Extensive coastal meadows in the Yakutat area are especially important as resting and feeding sites during migration. Peregrine falcons and bald eagles nest in the area. Southeast Alaska supports the largest concentration of bald eagles in the world. The streams and rivers in the area support healthy populations of wild salmon and freshwater fish.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—20%
Forest—57%
Water—2%
Other—21%

For many decades, logging, commercial fishing, and mining have been the primary enterprises throughout much of the area. In recent years changes in public interests, land use policies, and timber economics have contributed to a significant decline in the timber industry. Commercial fishing continues to be an important industry, and most communities support a fleet of boats and fishing-related facilities. A number of mines operate in the area, and others have been prospected and proposed. Tourism and wild-land recreation are becoming increasingly important in the MLRA. During the summer, one or more cruise ships are likely to be docked in Juneau and other ports in the area. Flight-seeing, guided fishing, and other recreational tours are available out of Juneau and other major communities. Less than 1 percent of the area is urban. Juneau and a number of smaller communities are experiencing significant growth and urban development. Subsistence hunting, fishing, and gathering provide food and a variety of other resources to local residents and remain the principal economy for the residents of remote villages.

The major soil resource concerns are water erosion and mass wasting. Mass wasting induced by earthquakes and erosion can take the form of creep, earthflow, rockfall, slump, debris avalanche, and debris flow. Undercutting or overloading slopes, vibrations from earthquakes, and increased soil moisture content can trigger mass movements. Mass wasting can be a natural phenomenon or the result of human activities, such as logging and road construction.

Conservation practices on forestland generally include forest stand improvement and properly constructed roads, landings, and stream crossings. ■

221—Kodiak Archipelago

This area is in the Southern Alaska Region (fig. 221-1). It includes Kodiak Island, Afognak Island, and nearby islands in the western Gulf of Alaska. It makes up about 5,015 square miles (12,995 square kilometers). For the most part, the area is undeveloped wild land and is sparsely populated. The principal community is the city of Kodiak. A number of small villages are along the coast. The only roads are in and around the city of Kodiak and along nearby coastal areas. The Kodiak National Wildlife Refuge and a small part of the Chugach National Forest are in this MLRA.

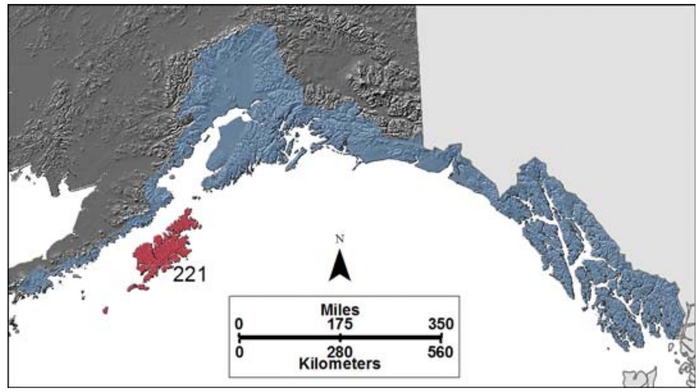

Figure 221-1: Location of MLRA 221 in Land Resource Region W1.

Physiography

This area lies within the Pacific Border Ranges Province of the Pacific Mountains System. The area is on low to moderately high, rolling mountains. Broad, nearly level valleys bordered by low, rolling hills are common at the lower elevations. The complex, irregular coastline has many prominent headlands, sea cliffs, and narrow, steep-walled bays. Elevation ranges from sea level along the coast to 4,405 feet (1,343 meters) at the summit of Mt. Glottof, near the center of Kodiak Island.

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is South Central Alaska (1905). Surface water in the area drains into the Shelikof Strait and the Pacific Ocean through a number of short rivers and streams originating in the mountainous uplands. The major rivers are the Karluk and Uganik Rivers on Kodiak Island. The largest lakes in the area are Karluk, Frazer, and Red Lakes on Kodiak Island. Numerous small and medium-size lakes are on coastal lowlands and the bottoms of broad river valleys. Lakes make up about 2 percent of the area.

Geology

During the middle to late Pleistocene epoch, all of the Kodiak Archipelago was covered by glacial ice originating in the mountains of the Alaska Peninsula and extending 50 to 100 miles (80 to 160 kilometers) or more into the North Pacific. No glaciers remain today. During the Holocene epoch, colluvium and slope alluvium accumulated across about 85 percent of the present-day landscape. Slightly modified glacial moraines and drift are on hills, in the lower valleys, and on coastal plains. Most of the present landscape is blanketed by a moderately thick or thick layer of ash, which originated from volcanoes on the Alaska Peninsula. The 1912 eruption of Mt. Novarupta deposited 1 to 2 feet (30 to 60 centimeters) of ash on the northern half of the islands. Kodiak Island and the adjacent islands are underlain mainly by Cretaceous and Lower Tertiary stratified sedimentary rocks. Older marine sedimentary and volcanic rocks occur locally. The Trinity Islands and the southeastern coast of Kodiak Island formed in younger Tertiary marine and continental rocks. This MLRA is seismically active. Faults extend across the length of the major islands. Land subsidence on Kodiak Island, as a result of the 1964 Good Friday earthquake, has been estimated at 5.4 feet (1.6 meters).

Climate

The average annual precipitation is mostly 23 to 60 inches (585 to 1,525 millimeters) in the northern half of this area. It is mostly 60 to 98 inches (1,525 to 2,490 millimeters) on the Pacific Ocean side. Cloudy conditions, moderate temperatures, and abundant rainfall characterize the temperate maritime climate of the area. The average annual snowfall ranges from about 30 inches (75 centimeters) in the southwestern part of the area to 100 inches (255 centimeters) in the northeastern part and at the higher elevations. The average annual temperature ranges from 40 to 44 degrees F (4 to 7 degrees C). The freeze-free period averages 85 to 200 days at the lower elevations but is much shorter at the highest elevations.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 22.2%; ground water, 44.4%
Livestock—surface water, 0.0%; ground water, 0.0%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 11.1%; ground water, 22.2%

The total withdrawals average about 1 million gallons per day (3.8 million liters per day). About 67 percent is from ground water sources, and 33 percent is from surface water sources. In most years precipitation is adequate for crops, but in some years yields are reduced by short dry periods in summer. Permanent streams, originating in the mountainous regions in the center of the island, carry water to nearly all parts of the area. The surface water is generally suitable for all uses. Flooding from ice dams that form during the spring thaw is a concern in this area.

Unconsolidated sediments along the coast of the island have some ground water. This water occurs as a lens of freshwater floating on saltwater. Most of the ground water used in this area is from the bedrock aquifer. The water is typically similar in quality to that in the unconsolidated sediments on the island. Some ground water is obtained from unconsolidated sediments in the larger river valleys (alluvium) or from buried glacial outwash deposits in the river valleys or on uplands. This water is hard or very hard but is otherwise of excellent quality. Wells in this aquifer generally are shallow, and the aquifer is being constantly recharged with freshwater (rainfall and runoff). As a result, the level of total dissolved solids is fairly low unless seawater has intruded. The median level of total dissolved solids is about 130 parts per million (milligrams per liter). The level of iron may exceed the secondary standard for drinking water of 300 parts per billion (micrograms per liter). The secondary standard is for esthetics. The iron can stain ceramic and porcelain and precipitate in pipes. Since this aquifer is close to the surface and water moves through it quickly, it is highly susceptible to contamination from runoff. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil orders in this MLRA are Andisols, Histosols, and Inceptisols. The soils in the area have a cryic soil temperature regime, a udic or aquic soil moisture regime, and dominantly amorphic mineralogy. Haplocryands and Vitricryands (Kodiak and Pyramid series) on mountain slopes and hills formed in silty volcanic ash over loamy and gravelly glacial till or bedrock residuum. These soils range from shallow to deep and are well drained. Cryaquepts (Ugak and Pasagshak series) on broad valley bottoms and in glacially scoured depressions formed in silty volcanic ash over loamy and gravelly glacial till and colluvium. These soils generally are deep and somewhat poorly drained. Cryofibrists (Saltery series) on broad valley bottoms and in depressions formed in thick deposits of organic material. These soils are somewhat poorly drained to very poorly drained.

Miscellaneous (nonsoil) areas make up about 18 percent of this MLRA. The most common miscellaneous areas are rock outcrop, chutes, rubble land, riverwash, and beaches.

Biological Resources

Sitka spruce forests are dominant at the lower elevations on uplands in the northeastern part of this area. To the south, the forests gradually give way to tall alder scrub and grasslands of bluejoint reedgrass. Flood plains support black cottonwood and mixed spruce-cottonwood forests, tall and low willow scrub, tall alder scrub, and various herbaceous plant communities. At the higher elevations and on Chirikof, Trinity, and Semidi Islands, the vegetation consists of dwarf scrub and herbaceous communities.

Some of the major species of mammals in the area are Kodiak brown bear, Sitka black-tailed deer, Roosevelt elk, and mountain goat. Many species of waterfowl migrate through the area or breed or winter in the area. There is a major migration route through Shelikof Strait and along the Alaska Peninsula. The coasts provide important wintering habitat for scoters, eiders, oldsquaws, mallards, and black brant. Other waterfowl in the area include loons, geese, ducks, and grebes. The rocky shorelines are excellent habitat for bald eagles and peregrine falcons. The area has many major seabird colonies. The streams and rivers in the area support healthy populations of wild salmon and freshwater fish.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—68%
Forest—14%
Water—2%
Other—16%

Commercial fishing and fish processing are the primary enterprises in this area. Most communities support a fleet of boats and fishing-related facilities. Logging in the northeastern part of the area provides raw materials for a small-scale wood products industry. A number of cattle, bison, and game ranches operate in the area. The meat and other products of these ranches are consumed locally. Tourism and wild-land recreation are becoming increasingly important in the area. During the summer, cruise ships are likely to be docked in the city of Kodiak. A number of local companies provide opportunities for flight-seeing, guided fishing and hunting, and a variety of other recreational activities. The Kodiak Islands are world famous for the huge Kodiak brown bears that inhabit them. Brown bears and other local game species attract visitors from around the world for hunting and wildlife viewing. Subsistence hunting, fishing, and gathering provide food and a variety of other resources to local residents and continue to be the principal economy in many villages. Less than 1 percent of the area is urban.

The major soil resource concerns are the erodibility of the soils on steep slopes and slope failures. The slope failures can be either naturally occurring or accelerated by human activity. Maintaining a good plant cover on the slopes can minimize erosion. Conservation practices on the forestland in the northeastern part of the area generally include forest stand improvement and properly constructed roads, landings, and stream crossings. ■

222—Southern Alaska Coastal Mountains

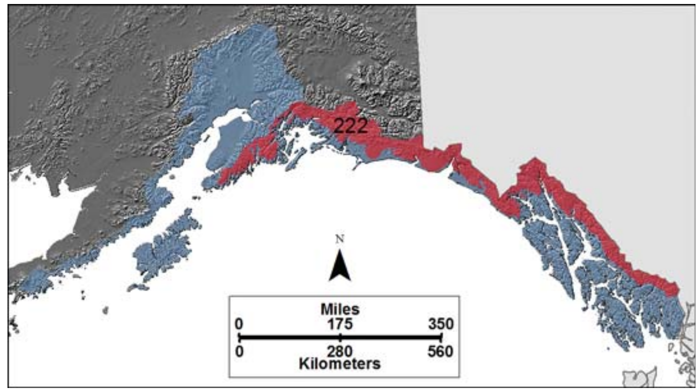

Figure 222-1: Location of MLRA 222 in Land Resource Region W1.

This area is in the Southern Alaska Region (fig. 222-1). It includes the higher elevations of the Coast, St. Elias, Chugach, and Kenai Mountains. It makes up about 26,335 square miles (68,235 square kilometers). The area is almost entirely undeveloped wild land. Small rural communities along the road system are the only permanent settlements. Part of the Wrangell-St. Elias Bay National Park and Preserve, the Glacier Bay National Park and Preserve, the Misty Fjords National Monument, the Chugach National Forest, and the Tongass National Forest are in this area.

Physiography

This area lies within the Coastal Mountains and Pacific Border Ranges Provinces of the Pacific Mountains System. The terrain consists of steep, rugged, high-relief mountains; massive glaciers; and ice fields. Glaciers and ice fields make up about 54 percent of the area. Numerous arêtes and nunataks are throughout the ice fields. Medial and lateral moraines are common in the glaciers. Unglaciated areas are deeply incised with narrow to broad valleys. Flood plains and stream terraces on valley floors rapidly give rise to steep alluvial fans and mountain footslopes. Elevation ranges from sea level at the base of tidewater glaciers and ice fields to 18,008 feet (5,490 meters) at the summit of Mt. St. Elias.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Southeast Alaska (1906), 63 percent, and South Central Alaska (1905), 37 percent. Surface water in this area drains to the Gulf of Alaska and North Pacific by way of numerous short, high-gradient rivers that originate in the glaciers, ice fields, and mountainous uplands. Lakes make up less than 1 percent of the area.

Geology

During the Pleistocene epoch, the area was covered with glacial ice. Most glacial deposits have eroded away or have been buried by colluvium and slope alluvium, which covers more than 90 percent of the present unglaciated landscape. The remaining glacial and glaciofluvial deposits and recent fluvial deposits are generally restricted to the bottoms of the larger valleys. Paleozoic, Mesozoic, and Lower Tertiary stratified sedimentary rocks, and occasionally Paleozoic intrusive rocks, underlie much of the area and are exposed on steep mountain slopes and ridges.

Climate

The average annual precipitation throughout most of this area is 120 to 200 inches (3,050 to 5,080 millimeters). It is 250 inches (6,350 millimeters) or more at the highest elevations. It is 25 to 50 inches (635 to 1,270 millimeters) in small areas northwest of Juneau, which is just outside this MLRA, and around and northeast of Copper Center. The precipitation usually is abundant throughout the year in most of the area. Cloudy conditions and moderate to cold temperatures characterize the climate of the area. The average annual snowfall ranges from about 200 to 800 inches (510 to 2,030 centimeters). It greatly exceeds the annual snowmelt in many places, as evidenced by the abundance and extent of glaciers and ice fields. The average annual temperature and length of the freeze-free period are not known. At the higher elevations, freezing temperatures are likely to occur during any month of the year.

Water

There are very limited withdrawals of freshwater for use in this sparsely populated MLRA. Most of the communities in the area are along the major rivers. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers either are frozen for much of the year or flow little during winter. Also, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. If surface water is available, treatment for removal of the suspended sediment would normally be required. For these reasons, most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners probably obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash). There are seldom any test data available on ground water in sparsely populated areas. If these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil orders in this MLRA are Spodosols and Histosols. The soils in the area have a cryic soil temperature regime or a subgelic soil temperature class, a udic or aquic soil moisture regime, and mixed or amorphic mineralogy. Humicryods (Nanwalek and Tutka series) and Haplocryods on mountains and hills formed in loamy and gravelly colluvium and glacial till. These soils range from shallow to deep and from well drained to somewhat poorly drained. Cryosaprists, Cryohemists (Koyuktolik and Nuka series), and Cryofibrists on footslopes, discharge slopes, and valley floors formed in thick deposits of organic material. These soils generally are deep and somewhat poorly drained to very poorly drained.

Miscellaneous (nonsoil) areas make up more than 90 percent of this MLRA. The most common miscellaneous areas are rock outcrop, rubble land, chutes, and glaciers.

Biological Resources

Most of this MLRA is in the true alpine zone. The vegetation consists of a variety of dwarf scrub and herbaceous communities. Low willow scrub is common in drainages. Lichens, scattered herbs, and dwarf shrubs dominate bedrock exposures and very shallow soils. In general, there is little or no plant growth at elevations above about 7,500 feet (2,285 meters). Along the boundary with MLRA 220, there are stringers and inclusions of tall alder scrub and grasslands of bluejoint reedgrass, which are characteristic of the subalpine zone.

Some of the major species of mammals in the area are brown bear, Dall sheep, mountain goat, moose, wolf, coyote, fox, snowshoe hare, arctic ground squirrel, and hoary marmot. Ptarmigan, American golden plovers, golden eagles, and a wide variety of other birds are common in many places.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—7%
Forest—3%
Other—90%

Remote wild-land recreation is the principal land use in this area. The rugged, high mountains, extensive glaciers and ice fields, and wilderness qualities of the area attract visitors from around the world. Most visitors are served by air taxi, guiding, and outfitting companies operating out of the major Alaska communities. Less than 1 percent of this area is urban. There are no major resource concerns in the area. ■

223—Cook Inlet Mountains

This area is in the Southern Alaska Region (fig. 223-1). It includes the higher mountains of the Aleutian and Alaska Ranges and the Talkeetna, Kenai, and Chugach Mountains. It makes up about 19,700 square miles (51,050 square kilometers). The area is primarily undeveloped wild land and is

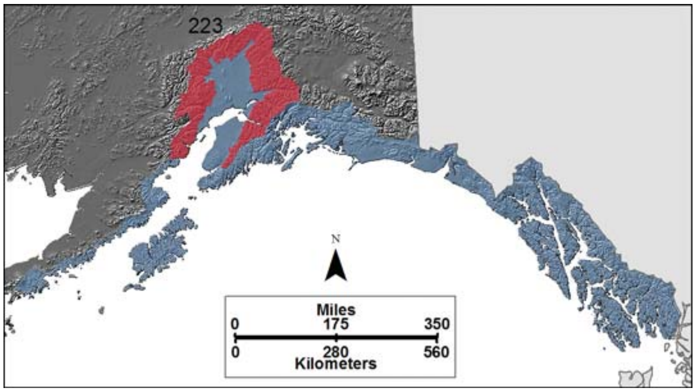

Figure 223-1: Location of MLRA 223 in Land Resource Region W1.

sparsely populated. A number of small communities, the largest of which is Cantwell, are along the road system. Parts of Denali National Park and Preserve, Lake Clark National Park and Preserve, Kenai National Wildlife Refuge, and Chugach National Forest are in this area.

Physiography

The part of this area in the Alaska and Aleutian Ranges lies within the Alaska-Aleutian Province. The part in the Kenai and Chugach Mountains lies within the Pacific Border Ranges Province. The part in the Talkeetna Mountains lies within the Coastal Trough Province. All of these provinces are within the Pacific Mountains System. The terrain throughout the area consists primarily of rugged, moderate to high mountains. Massive valley glaciers and ice fields are prominent at the higher elevations. Many of the larger valley glaciers extend down to an elevation of about 1,000 feet (305 meters) and into the upper edge of the Cook Inlet Lowlands. Glaciers and ice fields make up about 15 percent of the area. The mountains throughout the area are deeply incised with narrow to broad valleys that have braided, high-gradient flood plains. Coalescing alluvial fans and long footslopes are common on the lower mountain slopes in broad valleys. Elevation generally ranges from about 2,500 feet (760 meters) along the boundary with the Cook Inlet Lowlands to 20,320 feet (6,195 meters) at the summit of Mt. McKinley, the highest point in North America. Also, the elevation extends down to sea level in small areas along the Turnagain Arm of Cook Inlet.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: South Central Alaska (1905), 97 percent; Southwest Alaska (1904), 2 percent; and Yukon (1903), 1 percent. All of the rivers in the area drain into the Cook Inlet Lowlands and Cook Inlet. The Matanuska, Little Susitna, Knik, Kenai, and Chakachatna Rivers and major tributaries of the Susitna River, including the Yentna, Skwenta, Chulitna, Talkeetna, and Kashwitna Rivers, originate in glaciers and mountainous uplands in the area. The largest lakes are Chakachamna and Chelatna Lakes in the Alaska Range and Eklutna and Kenai Lakes in the Chugach Mountains. Lakes make up about 2 percent of the area.

Geology

The entire area, except for the highest peaks and the steep upper ridges, was covered by glacial ice during the late Pleistocene epoch. Most of the glacial deposits have eroded away or were buried by colluvium and slope alluvium during the Holocene epoch. Colluvial and alluvial deposits cover about 65 percent of the present landscape. Slightly modified to highly modified glacial moraines and outwash deposits are extensive on the lower mountain slopes and in valleys at the lower elevations. Holocene eolian deposits, consisting of an admixture of loess and volcanic ash and ranging in thickness from a few inches to 24 inches (60 centimeters) or more, have accumulated on the mid and lower mountain slopes. Valley bottoms are buried with recent fluvial deposits. The bedrock geology consists primarily of late Paleozoic and early Mesozoic stratified sedimentary rocks. Tertiary intrusive rocks are common.

Climate

The average annual precipitation in this area ranges from about 15 to 30 inches (380 to 760 millimeters) along the boundary with the Cook Inlet Lowlands (MLRA 224) to more than 100 inches (2,540 millimeters) in the highest mountains. Later summer and fall are generally the rainiest periods. Cloudy conditions, short summers, and moderate to cold temperatures characterize the climate of the area. The average annual snowfall ranges from about 80 to 400 inches (205 to 1,015 centimeters) or more. The average annual temperature at Puntilla Lake in the Alaska Range is 27 degrees F (-3 degrees C). The freeze-free period averages about 60 to 80 days. At the higher elevations, freezing temperatures can occur during every month.

Water

There are very limited withdrawals of freshwater for use in this sparsely populated MLRA. Most of the communities in the area are along the major rivers. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Also, the rivers are typically fed by glacial meltwater, which carries a high load of suspended sediment. If surface water is available, treatment for removal of the suspended sediment would normally be required. For these reasons, most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners probably obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash). There are seldom any test data available on ground water in sparsely populated areas. If these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil orders in this MLRA are Spodosols, Inceptisols, Gelisols, and Entisols. The soils in the area have a cryic soil temperature regime or a subgelic soil temperature class, a udic or aquic soil moisture regime, and amorphic or mixed mineralogy. Eutrocryepts and Dystrocryepts on strongly sloping to steep slopes formed in gravelly colluvium over fractured bedrock of varied lithology. They range from shallow to very deep and generally are well drained. Histoturbels and Aquiturbels are on landforms similar to those of the Eutrocryepts and Dystrocryepts but have finer textures and are poorly drained. Haplocryods, Humicryods, and Cryaquods on mid-mountain slopes formed in a surface layer of silty loess and volcanic ash over gravelly glacial drift or colluvium. These soils are generally deep and range from well drained to poorly drained. Cryofluvents, Cryorthents, and Cryaquents on flood plains formed in loamy and gravelly alluvium. They generally are deep and range from very poorly drained to excessively drained.

Miscellaneous (nonsoil) areas make up about 70 percent of this MLRA. The most common miscellaneous areas are rock outcrop, rubble land, and glaciers.

Biological Resources

For the most part, this MLRA includes only the true alpine zone. The vegetation consists of a variety of dwarf scrub and herbaceous communities. Low willow scrub is common in drainages. Lichens and scattered herbs and dwarf shrubs dominate bedrock exposures and very shallow soils. In general, there is little or no plant growth at elevations above about 7,500 feet (2,285 meters). Along the boundary with the Cook Inlet Lowlands, there are stringers and inclusions of tall alder scrub and grasslands of bluejoint reedgrass, which are characteristic of the subalpine zone.

Some of the major species of mammals in the area are brown bear, Dall sheep, mountain goat, caribou, moose, wolf, coyote, fox, snowshoe hare, arctic ground squirrel, and hoary marmot. Ptarmigan, American golden plovers, golden eagles, and a wide variety of other birds are common in many places.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—22%
Forest—8%
Water—2%
Other—68%

Remote wild-land recreation is the principal land use in this area. The rugged mountains, extensive glaciers, ice fields, and wilderness qualities of the area attract hikers and wilderness enthusiasts from around the world. Every summer, hundreds of climbers attempt to climb Mt. McKinley and other high peaks in the area. More people visit Denali National Park than any other park in Alaska. Hunters pursue moose, caribou, Dall sheep, brown bear, and black bear. Back-country recreationists and hunters are served by air taxi, guiding, and outfitting companies operating out of the major Alaska communities. Many extractable minerals and other commodities occur in this MLRA. Mining was historically a major land use that helped to support development on nearby lowlands. Less than 1 percent of this area is urban. There are no major resource concerns in the area. ■

224—Cook Inlet Lowlands

This area is in the Southern Alaska Region (fig. 224-1). It includes the lowlands and lower mountain slopes of the Susitna and Matanuska Valleys, the western Kenai Peninsula, and the west side of Cook Inlet. It makes up about 10,635 square miles (27,565 square kilometers). It includes the most densely populated areas of Alaska and has the most extensive network of highways and secondary roads in the State. It includes the municipality of Anchorage, the cities of Palmer and Wasilla in the lower Matanuska Valley, and the cities of Kenai and Soldotna on the western Kenai Peninsula. Most of the Kenai National Wildlife Refuge and parts of the Chugach National Forest and Denali National Park and Preserve are in this area.

Physiography

This area lies within the Coastal Trough Province of the Pacific Mountains System. The terrain is dominantly a broad expanse of gently sloping to rolling plains and low- or moderate-relief hills bordered by the lower slopes of the surrounding mountains. Depressions and shallow basins on plains are dotted with thousands of small and medium-size

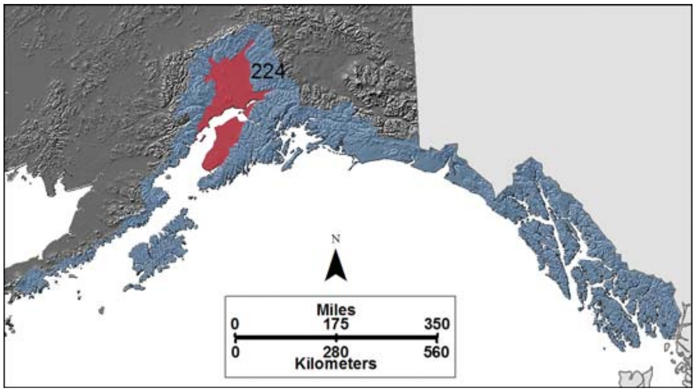

Figure 224-1: Location of MLRA 224 in Land Resource Region W1.

lakes and interconnecting wetlands. Lakes also are common in low areas between hills. Rivers have relatively high gradients, and braided flood plains and low to high stream terraces are common along the rivers. The area includes the Caribou Hills, Mt. Susitna, Beluga Mountain, and the Yenlo Hills. These are isolated, low to moderately high, rounded mountains that protrude above the surrounding terrain. Coalescing alluvial fans are common on the lower mountain slopes. Elevation ranges from sea level to 4,396 feet (0 to 1,340 meters).

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is South Central Alaska (1905). Numerous rivers, which originate in the surrounding Cook Inlet Mountains (MLRA 223), pass through the area. All of the rivers and streams drain into Cook Inlet. The major rivers are the Susitna and Yentna Rivers in the Susitna Valley, the Little Susitna River and Matanuska River in the Matanuska Valley, and the Kenai River and Deep Creek on the Kenai Peninsula. Other important rivers or tributaries include the Kustatan River on the west side of Cook Inlet, Ship Creek and Eagle River in the municipality of Anchorage, and Willow Creek, Montana Creek, Lake Creek, and the Deshka River in the Susitna Valley. The largest lakes are Tustumena Lake and Skilak Lake on the Kenai Peninsula and Beluga Lake on the west side of Cook Inlet. Small and medium-size lakes are in scattered areas throughout the rolling plains and hills in the Susitna Valley, the western Matanuska Valley, and the northern Kenai Peninsula. Lakes and other areas of surface water make up about 15 percent of the MLRA.

Geology

The area has a complex history of repeated glaciation. During the late Pleistocene epoch, the entire area was covered by glacial ice originating from the surrounding mountains. At times during the early and middle Pleistocene, ice dams at the lower end of Cook Inlet caused much of the area to be covered with a large proglacial lake. Surficial deposits on plains and hills consist of a complex mixture of glacial till and outwash. Fine textured glaciolacustrine deposits and sand dunes are in a few areas, primarily near the coast in the southern Susitna Valley, in the municipality of Anchorage, and on the western Kenai Peninsula. Recent fluvial deposits cover modern flood plains and stream terraces. During the Holocene epoch, winds blowing sediments from unvegetated flood plains and volcanic activity in the Alaska and Aleutian Ranges deposited a layer of mixed loess and volcanic ash across much of the area. In the vicinity of the city of Palmer, along the lower Matanuska and Knik Rivers, the layer of loess is many meters thick.

Climate

The average annual precipitation in this area ranges from 15 to 60 inches (380 to 1,525 millimeters). It generally is higher on the southern Kenai Peninsula, in the northern Susitna Valley, and at the higher elevations along the mountains. The average annual snowfall is about 60 to 120 inches (150 to 305 centimeters). The climate of this area is considered to be transitional from temperate maritime to subarctic continental. Most weather systems originate in the North Pacific and the Gulf of Alaska. In winter, particularly in the northern part of the area, arctic weather systems are more common. In the Matanuska Valley, seasonal winds pick up fine-earth material from unvegetated flood plains and create extensive dust clouds that can reach an altitude of 5,000 feet (1,525 meters) or more. The average annual temperature is about 27 to 36 degrees F (-3 to 2 degrees C). The freeze-free period averages 65 to 160 days, decreasing in length with elevation.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 24.8%; ground water, 12.1%
Livestock—surface water, 0.1%; ground water, 0.1%
Irrigation—surface water, 0.1%; ground water, 0.0%
Other—surface water, 56.3%; ground water, 6.6%

The total withdrawals average 175 million gallons per day (660 million liters per day). About 19 percent is from ground water sources, and 81 percent is from surface water sources. In most years precipitation is adequate for crops, but in some years yields are reduced by short dry periods in summer. Permanent streams carry water to nearly all parts of the area. Some outlets for natural lakes in this area have been dammed. The stored water is used for limited irrigation, public supply, and the needs of seafood-processing plants. Anchorage obtains supplemental surface water for public supply in developing areas from a pipeline from Lake Eklutna. The surface water generally is suitable for all uses. Rivers fed by glacial meltwater typically carry high loads of suspended sediment, and water in the lakes can require treatment. Flooding from ice dams that form during the spring thaw is a concern in this area.

Ground water is used for public supply and for the needs of seafood processing and a large petrochemical industrial complex on the Kenai Peninsula. It is pumped primarily from the Anchorage, Matanuska-Susitna, and Kenai Peninsula aquifers. These aquifers are either unconsolidated sediments in river valleys (alluvium) or buried glacial outwash deposits in river valleys or on uplands. This water is hard or very hard but is otherwise of excellent quality. Wells in these aquifers generally are shallow, and the aquifers are being constantly recharged with freshwater (rainfall and runoff). As a result, the median level of total dissolved solids is fairly low, ranging from 150 to 200 parts per million (milligrams per liter). The median level of iron approaches 2,000 parts per billion (micrograms per liter) in the Anchorage aquifer. The level of iron may exceed the secondary standard for drinking water of 300 parts per billion (micrograms per liter) in the Kenai Peninsula aquifer but not in the Matanuska-Susitna aquifer. The secondary standard for iron is for esthetics. The iron can stain ceramic and porcelain and precipitate in pipes. Since the aquifers are close to the surface and water moves through them quickly, they are highly susceptible to contamination from runoff. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination. The intrusion of seawater can be a problem along Cook Inlet.

Small amounts of ground water can be obtained from the bedrock aquifer in the higher parts of this area. This water is typically similar in quality to that in the unconsolidated sediments.

Soils

The dominant soil orders in this MLRA are Spodosols, Histosols, Entisols, and Inceptisols. The soils in the area have a cryic soil temperature regime, a udic or aquic soil moisture regime, and dominantly mixed mineralogy. Haplocryods (Estelle and Kenai series), Humicryods (Talkeetna series), Eutrocryepts (Bodenburg series), and Dystrocryepts (Smithfha series) on plains and hills formed in silty loess and volcanic ash over loamy, sandy, and gravelly glacial till and outwash. These soils generally are deep and well drained. Cryaquepts (Slikok and Disappear series) on plains and hills also formed in silty loess and volcanic ash over loamy, sandy, and gravelly glacial till and outwash. They are poorly drained or very poorly drained. Cryofibrists (Salamatof series) and Cryohemists (Starichkof series) in broad shallow basins and drainageways formed in thick deposits of organic material. These Histosols are poorly drained or very poorly drained. Cryofluvents (Niklason series) and Cryaquents (Killey series) on flood plains and stream terraces formed in stratified silty and sandy alluvium over gravelly alluvium. They generally are deep and range from well drained to very poorly drained.

Miscellaneous (nonsoil) areas make up about 15 percent of this MLRA. The most common miscellaneous areas are beaches, riverwash, and water.

Biological Resources

This MLRA primarily includes the lower lying forested and subalpine zones. The vegetation on upland sites is dominated by white spruce, paper birch, and quaking aspen. Lutz spruce is dominant on the southern Kenai Peninsula. On flood plains and in seepage areas on mountain slopes, cottonwood and mixed cottonwood forests are common. Extensive lowlands and areas of peat support stunted white and black spruce, low scrub of ericaceous shrubs and willow, and a variety of sedge and grass meadows. Halophytic sedge and sedge-grass meadows are along the coast of Cook Inlet. At the higher elevations in the subalpine zone, forest gradually gives way to grasslands of bluejoint reedgrass, tall alder scrub, and low willow scrub. Dwarf scrub and herbaceous communities characteristic of the alpine zone are above elevations of about 1,800 to 2,500 feet (550 to 760 meters) in the Caribou Hills on the southern Kenai Peninsula, on Mt. Susitna and the Yenlo Hills in the Susitna Valley, and along the boundary with the Cook Inlet Mountains (MLRA 223).

Since the mid 1980s, spruce bark beetles have infested tens of thousands of acres of white spruce, Lutz spruce, and mixed spruce forests on the Kenai Peninsula, in the southern Matanuska and Susitna Valleys, and along the west side of Cook Inlet. Across this area, and in particular on the Kenai Peninsula, the vast majority of large-diameter spruce trees have been killed by bark beetles. On the southern Kenai Peninsula, the dominant forest canopy has been entirely killed off by the bark beetles.

Some of the major species of mammals in the area are moose, brown bear, black bear, wolf, coyote, fox, beaver, and lynx. Caribou are common in a few places. Tundra swans, Canada geese, a wide variety of ducks, and sandhill cranes use the wetlands and lakes in the area for nesting and as stop-over sites during migration. Spruce grouse are common throughout the forests. Throughout much of the year, bald eagles are evident along rivers and streams.

Most of the rivers and streams in the area are important spawning grounds for salmon. Thousands of visitors are attracted to the area each year for sport fishing for Chinook, coho, and red salmon. Rivers on the Kenai Peninsula support anadromous steelhead fisheries. Rainbow trout are in many streams and lakes. The Alaska Department of Fish and Game stocks many lakes throughout the area with rainbow trout. Introduced northern pike are in most of the lakes in the Susitna Valley. They are a major predator of small fish and waterfowl.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—1%
Grassland—24%
Forest—59%
Urban development—1%
Water—15%

Agriculture has been important in this area since the beginning of European settlement and particularly since 1935, when the Matanuska Colony was established near the city of Palmer. Other agricultural areas in the MLRA are in the Susitna Valley, at Point Mackenzie, and around the cities of Sterling, Soldotna, and Homer on the Kenai Peninsula. The principal crops grown in the area are hay, potatoes, and other hardy vegetables. A few dairy farms are still operating in the Palmer area, at Point Mackenzie, and on the Kenai Peninsula. Cattle graze native rangeland and pasture on the southern Kenai Peninsula. Logging and personal-use firewood cutting are locally significant. In response to the bark beetle infestation, salvage logging and other management activities on the Kenai Peninsula have resulted in the construction of hundreds of miles of roads and in clear-cut logging on thousands of acres. The other major industries in the area include commercial fishing, fish processing, and oil and gas extraction.

Tourism and wild-land recreation are becoming increasingly important in the area. The recreation and tourism industries include hunting, fishing, back-country guiding, bus tours, and flight-seeing. Many local residents participate in hunting for moose and other game and fishing for salmon, halibut, trout, and northern pike. In winter, snowmobile trails crisscross the Susitna Valley. Extensive ATV trails provide summer and fall access to much of the area. Recreational cabins have been constructed beside many lakes and in other areas. Subsistence hunting, fishing, and gathering provide food and a variety of other resources for many residents.

Urban development, particularly along the road system, is a significant land use. Most of the land available for development within the municipality of Anchorage has already been developed. Rapid urbanization is occurring in the vicinity of Palmer and Wasilla in the lower Matanuska Valley and in the cities of Kenai and Soldotna on the Kenai Peninsula. In all parts of the area, agricultural lands are being converted to residential and small industrial developments. Extraction of sand and gravel in support of construction, road building, and road maintenance impacts thousands of acres in the lower Matanuska Valley and in other locations along the road system.

The major resource concerns are water erosion and water quality. Off-road vehicle use is an increasing problem throughout much of the MLRA, contributing locally to the destruction of the existing vegetation and causing surface compaction, erosion (sheet and rill, concentrated flow, and gully), damage to stream channels and fisheries, and changes in access and land use. Conservation practices that minimize ground disturbance and maintain an adequate plant cover are needed. Conservation practices on forestland generally include forest stand improvement; proper construction of roads, landings, and stream crossings; and road closures. Critical-area stabilization is important in many areas disturbed or damaged by off-road vehicles. ■

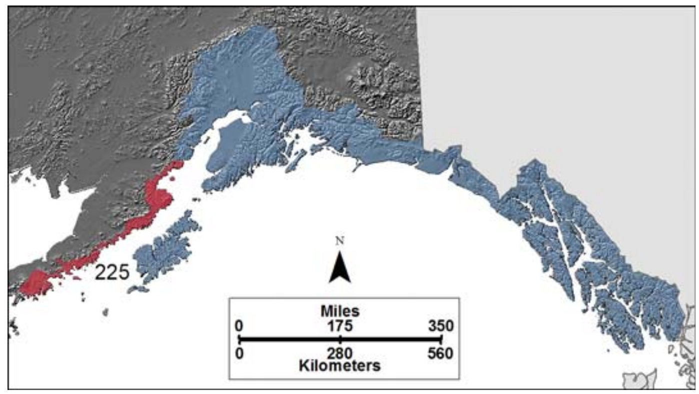

Figure 225-1: Location of MLRA 225 in Land Resource Region W1.

225—Southern Alaska Peninsula Mountains

This area is in the Southern Alaska Region (fig. 225-1). It includes the southeast-facing slopes of the southern Aleutian Mountains, where drainage is into the lower Cook Inlet, Shelikof Strait, and the North Pacific. The area makes up about 6,090 square miles (15,780 square kilometers). It is mostly undeveloped wild land. The only permanent settlements in the area are a few small coastal villages. The Becharof National Wildlife Refuge and parts of the Alaska Maritime Wildlife Refuge, Alaska Peninsula Wildlife Refuge, Lake Clark National Park and Preserve, and Katmai National Park and Preserve are in this area.

Physiography

This area lies within the Alaska-Aleutian Province of the Pacific Mountains System. The terrain consists primarily of rugged, low to moderately high mountains deeply dissected with narrow, high-gradient valleys. Glaciers and small ice fields are common at the upper elevations on the highest peaks in the area. Glaciers and permanent ice and snow make up about 7 percent of the area. In steep, narrow valleys, coalescing fans and steep footslopes continue down to the stream channel. Flood plains and stream terraces are of limited extent, except in the broader valleys at the lower elevations. A narrow, discontinuous zone of gently sloping to moderately steep outwash plains, flood plains, and low-relief hills is along the coast of Cook Inlet. Elevation ranges from sea level along the coast to 7,090 feet (2,160 meters) at the summit of Snowy Peak.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: South Central Alaska (1905), 87 percent, and Southwest Alaska (1904), 13 percent. All of the rivers and streams in the area originate in glaciers, ice fields, and mountainous uplands and drain directly into Cook Inlet. Lakes make up less than 2 percent of the area.

Geology

Except for the highest peaks and steep upper ridges, the entire area was covered with glacial ice during the late Pleistocene epoch. During the Holocene epoch, glacial deposits across much of the area eroded away or were buried by mountain colluvium and alluvium, which cover about 60 percent of the present landscape. Slightly modified to highly modified glacial moraines and outwash deposits and recent alluvium are extensive on the lower mountain slopes and in valleys at the lower elevations. Volcanic activity in Mt. Katmai and other volcanoes in the area has deposited a layer of volcanic ash across much of the landscape. The dominant geologic formations underlying most of the area are upper Jurassic, lower Tertiary, and some Cretaceous stratified sedimentary rocks. Undifferentiated volcanic rocks of Quaternary and Tertiary age are common near Mt. Katmai and other volcanoes.

Climate

The average annual precipitation in most of this area is 60 to 90 inches (1,525 to 2,285 millimeters). It ranges from about 30 inches (760 millimeters) in spots along the coast to more than 100 inches (2,540 millimeters) at the higher elevations. The precipitation is usually abundant throughout the year. Cloudy conditions and moderate to cold temperatures characterize the climate of the area. The average annual snowfall is about 50 to 200 inches (125 to 510 centimeters). It greatly exceeds annual snowmelt in many places, as evidenced by the abundance of glaciers and ice fields. The average annual temperature and length of the freeze-free period are not known. Freezing temperatures are likely to occur during any month of the year, particularly at the higher elevations.

Water

There are very limited withdrawals of freshwater for use in this sparsely populated MLRA. Most of the communities in the area are along the major rivers. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Also, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. If surface water is available, treatment for removal of the suspended sediment would normally be required. For these reasons, most of the water used for domestic purposes in this area is probably obtained from private wells.

Small communities and rural landowners probably obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash). There are seldom any test data available on ground water in sparsely populated areas. If these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil orders in this MLRA are Andisols, Histosols, and Inceptisols. The soils in the area have a cryic soil temperature regime or a subgelic soil temperature class, a udic or aquic soil moisture regime, and dominantly amorphic mineralogy. Haplocryands and Dystrocryepts on mountain slopes and hills formed in a layer of silty volcanic ash of varying thickness over gravelly and loamy colluvium, slope alluvium, and glacial till. These soils range from shallow to deep and generally are well drained. Cryaquepts on valley bottoms, in depressions, and on benches on mountains formed in silty volcanic ash over loamy glacial till and colluvium. They generally are deep and somewhat poorly drained. Cryofibrists on valley bottoms and in depressions formed in thick deposits of organic material. They are poorly drained or very poorly drained.

Miscellaneous (nonsoil) areas make up about 51 percent of this MLRA. The most common miscellaneous areas are rock outcrop, rubble land, glaciers, riverwash, and beaches.

Biological Resources

At the lower elevations, the vegetation is mostly tall scrub dominated by alder and willow. Balsam poplar forests, with tall shrub and herbaceous understory, are on flood plains and on some south-facing mountain slopes. With increasing elevation, tall scrub rapidly gives way to low scrub dominated by willow, ericaceous shrubs, and various graminoids and forbs. Scattered grasslands of bluejoint reedgrass are throughout the scrub. Dwarf scrub is the dominant vegetation at the highest elevations and on exposed ridges and steep slopes where the soils are shallow over bedrock. Crowberry, ericaceous shrubs, willow, bryophytes, and lichens generally dominate dwarf shrub communities. Poorly drained areas and areas of peat support low scrub and sedge-grass meadows.

Some of the major species of mammals in the area are brown bear, Dall sheep, moose, wolf, and coyote. Ptarmigan, American golden plovers, golden eagles, and a wide variety of other birds are common in many places.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—47%
Forest—2%
Water—2%
Other—49%

Remote wild-land recreation is the principal land use in this area. The rugged mountains, extensive glaciers and ice fields, and wilderness qualities of the area attract visitors from around the world. Most visitors are served by air taxi, guiding, and outfitting companies operating out of the major Alaskan communities. There are no major resource concerns in this area. ■

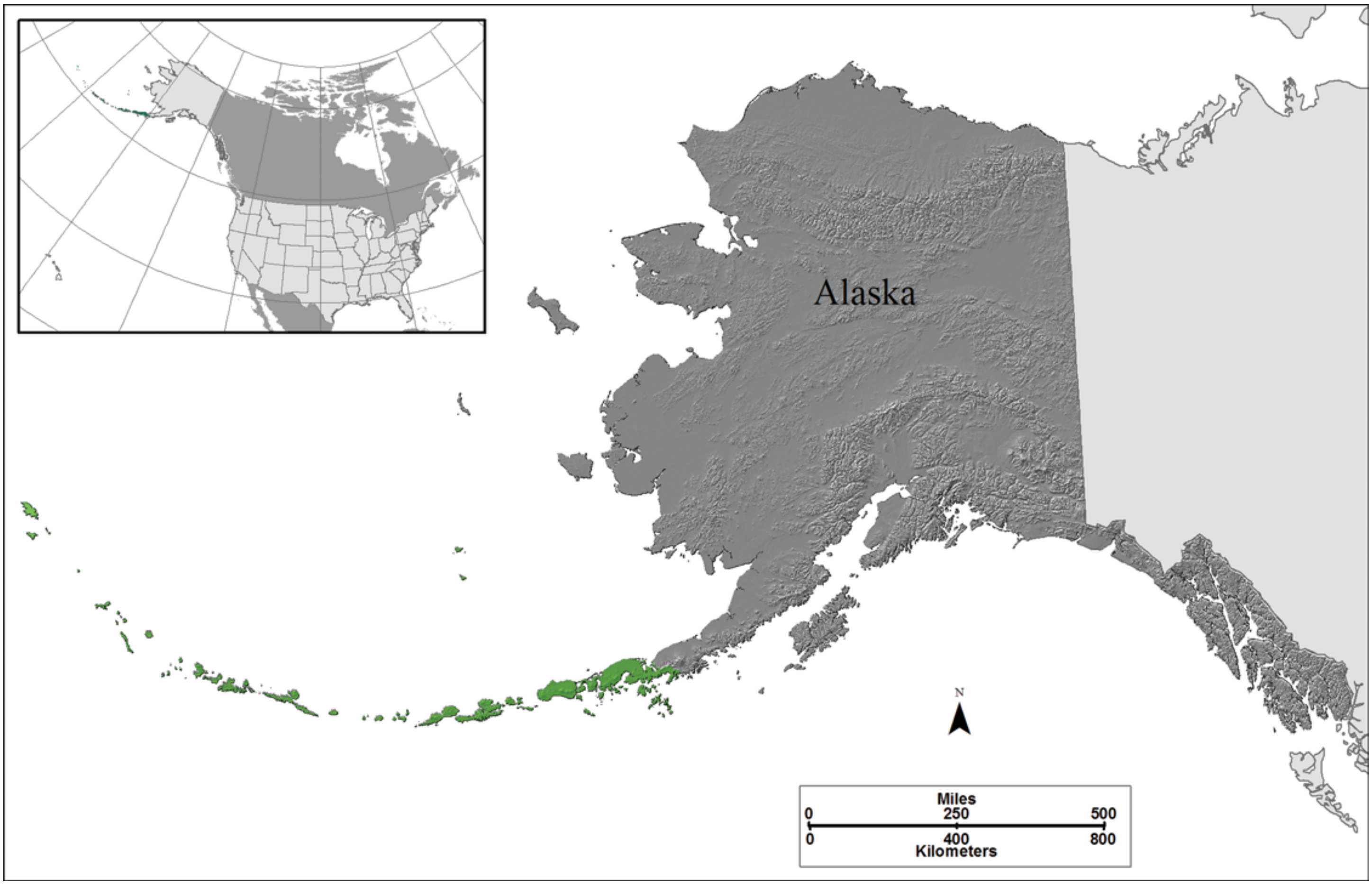

Figure W2-1: Location of Land Resource Region W2.

W2—Aleutian Alaska

This region includes the southwest part of the Alaska Peninsula, the Aleutian Islands, and the Pribilof Islands (fig. W2-1). It makes up 10,670 square miles (27,645 square kilometers).

This region is made up of volcanoes (many of which are active), lava flows, and tilted fault blocks of volcanic-derived sediments. Landforms include steep mountain slopes, rolling hills, and steep-walled fjords and sea cliffs (fig. W2-2). The eastern part of the region has been glaciated. Elevation ranges from sea level to more than 4,000 feet (0 to 1,220 meters). The region is free of permafrost. Cool temperatures, strong winds, fog, overcast skies, and precipitation characterize the maritime climate of the region. The annual precipitation ranges from about 21 to more than 78 inches (535 to 1,980 millimeters). The average annual air temperature ranges from 36 to 39 degrees F (2 to 4 degrees C). The freeze-free period averages about 115 to 140 days. It typically occurs from May to mid-September.

The total withdrawals of freshwater in this region average about 1.3 million gallons per day (5 million liters per day). About 46 percent is from surface water sources, and 54 percent is from ground water sources. Almost 70 percent of the water is used for the needs of the seafood industry. The rest is used as public supply or livestock water.

The dominant soils are Andisols, primarily Cryands that formed in volcanic ash or scoria. The soils in the area have a cryic soil temperature regime, a udic or aquic soil moisture regime, and amorphic or mixed mineralogy. Soil texture grades from coarse scoria and cinders to fine sand with increasing distance from the volcanoes. Bare rock and rubble occur on the steep slopes of volcanic cones, peaks, and high ridges. Histosols, especially Fibrists, occur in depressions and on broad valley bottoms.

This region supports no trees. Dwarf scrub vegetation occurs at the higher elevations and in areas exposed to strong winds. The more protected areas support mesic graminoid herbaceous vegetation. The major land uses in the region are wildlife

Figure W2-2: Recent volcanic deposits in an area of Land Resource Region W2.

habitat and subsistence hunting, fishing, and gathering. Small communities with fishing operations are located in the few good harbors. A few areas are used for recreation or some livestock grazing. ■

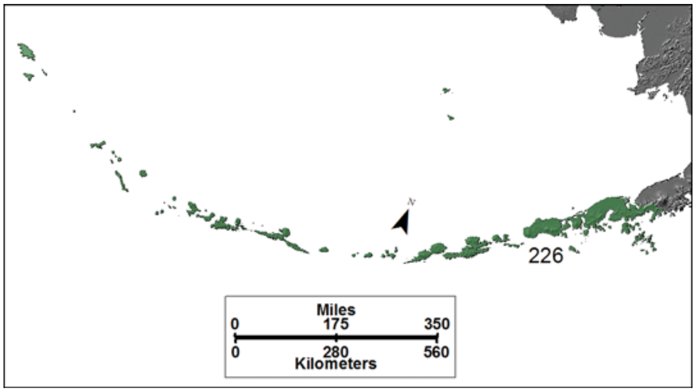

Figure 226-1: Location of MLRA 226 in Land Resource Region W2.

226—Aleutian Islands-Western Alaska Peninsula

This area is the only MLRA in the Aleutian Alaska Region (fig. 226-1). It includes the Aleutian Islands, the Pribilof Islands, and the southwest end of the Alaska Peninsula west of Port Moeller, Stepovak Bay, and Shumagin Island. It makes up about 10,670 square miles (27,645 square kilometers). The area is remote and consists primarily of undeveloped wild land, but a number of major towns, small villages, and military installations are across the area. The largest communities are Cold Bay, Unalaska, Dutch Harbor, and St. Paul. The Aniakchak National Monument and Preserve, the Izembek National Wildlife Refuge, and parts of the Alaska Maritime and Alaska Peninsula National Wildlife Refuges are in this area.

Physiography

This area lies within the Alaska-Aleutian Province of the Pacific Mountains System. It is dominantly on steep, low to moderately high, rounded mountains and isolated, moderately high volcanic cones. At the lower elevations on the larger islands and on the Alaska Peninsula, broad, moderately sloping valleys and rolling uplands bordered by low-relief hills are common. Valley features include gently sloping fans; narrow, meandering flood plains; and shallow basins dotted with small lakes and interconnecting wetlands. The complex, irregular coastline has many prominent headlands, sea cliffs, and narrow, steep-walled bays. Elevation ranges from sea level to more than 4,000 feet (1,220 meters) on many of the islands. The highest point in the Aleutian Islands is 9,372 feet (2,857 meters) at the summit of Shishaldin Volcano on Unimak Island.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Southwest Alaska (1904), 99 percent, and South Central Alaska (1905), 1 percent. Surface water in this area is drained into the North Pacific and the Bering Sea by numerous short, steep-gradient rivers and streams. Lakes make up less than 2 percent of the area.

Geology

This MLRA includes more than 50 volcanoes, most of which were active at some time during the Quaternary and Tertiary periods. The area is made up primarily of Quaternary and Tertiary volcanic rocks and unconsolidated deposits overlying a mostly submarine ridge of Tertiary sedimentary rocks. During the Pleistocene epoch, glacial ice covered the eastern part of the area to approximately Umnak Island. To the west, probably only the upper elevations were glaciated. Volcanic activity has mantled most of the area with thick deposits of silty volcanic ash, sandy and gravelly cinders, and volcanic rubble. Some slightly modified or moderately modified glacial landforms and deposits are at the lower elevations. Glaciers make up only about 1.5 percent of the present landscape and are restricted to the upper elevations of the highest volcanoes. Recent coastal and fluvial deposits occur in scattered areas along the coast and on flood plains at the lower elevations.

Climate

The average annual precipitation in this area ranges from 21 to about 78 inches (535 to 1,980 millimeters), generally increasing with elevation. The area has a cool maritime climate characterized by cloudy and foggy conditions, moderate temperatures, and abundant rainfall. Gale-force winds, occasionally approaching 100 miles per hour (160 kilometers per hour), are common during storms. The annual snowfall is 30 to 85 inches (75 to 215 centimeters) at the higher elevations. The average annual temperature is 36 to 39 degrees F (2 to 4 degrees C). The freeze-free period averages about 115 to 140 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 7.7%; ground water, 15.4%
Livestock—surface water, 7.7%; ground water, 0.0%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 30.8%; ground water, 38.5%

The total withdrawals average 1.3 million gallons per day (5 million liters per day). About 54 percent is from ground water sources, and 46 percent is from surface water sources.
In most years precipitation is adequate for crops in parts of this area, but in some years yields are reduced by short dry periods in summer. Some permanent streams, originating in the mountainous regions on the islands and the Alaska Peninsula, carry water to many parts of the area. The

surface water generally is suitable for all uses. The rivers fed by glacial meltwater typically carry high loads of suspended sediment.

The ground water used in this area is primarily from unconsolidated sediments in river valleys (alluvium or glacial outwash), but some is from bedrock aquifers. A significant area is underlain by the unconsolidated sediment aquifer on the northern side of the part of this MLRA on the Alaska Peninsula. This aquifer may also occur in the valleys along some of the larger streams. The ground water occurs as a lens of freshwater floating on saltwater near the coast. There are very little water-quality test data from either aquifer in this area. The results of tests in other areas indicate that the ground water is probably hard or very hard but otherwise is of excellent quality. Wells generally are shallow in the unconsolidated sediment aquifer, and this aquifer is being constantly recharged with freshwater (rainfall and runoff). As a result, the level of total dissolved solids is fairly low unless some intrusion of seawater has occurred. The level of iron may exceed the secondary standard for drinking water of 300 parts per billion (micrograms per liter). The secondary standard is for esthetics. The iron can stain ceramic and porcelain and precipitate in pipes. The water in the bedrock aquifer generally is very similar in quality to the water in the unconsolidated sediments. Shallow aquifers are highly susceptible to contamination from runoff. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil orders in this MLRA are Andisols and Histosols. The soils in the area have a cryic soil temperature regime, a udic or aquic soil moisture regime, and amorphic or mixed mineralogy. Haplocryands (Zolotoi series) and Vitricryands (Polovina series), the dominant soils on most landforms, formed in moderately thick or thick deposits of silty to sandy volcanic ash and coarse sandy to gravelly cinders over basalt bedrock. These soils range from shallow to deep and generally are well drained to excessively drained. Andic, Vitrandic (Tsammana series), and Aquandic subgroups of Dystrocryepts occur where coarse marine sediments underlie volcanic deposits. Along the margins of streams and lakeshores, poorly drained or very poorly drained Cryofibrists formed in thick deposits of organic material.

Miscellaneous (nonsoil) areas make up about 46 percent of this MLRA. The most common miscellaneous areas are cinder land, rock outcrop, water, riverwash, and beaches. Small valley glaciers are at the upper elevations on a few of the larger islands and on the Alaska Peninsula.

Biological Resources

At the higher elevations in this area, the vegetation consists of a mosaic of dwarf shrub scrub characteristic of the true alpine zone. At the lower elevations, wet and dry grasslands are dominated by mid-sized and tall grasses, sedges, and forbs. In areas of peat, the vegetation consists of low ericaceous shrub scrub. Aleutian shield-fern, the only endangered plant species currently listed for Alaska, is on Adak and Attu Islands. There are no naturally occurring forests in the area.

This MLRA is rich in marine and bird wildlife. Two species native to the Aleutian Islands, the Steller sea lion and the Aleutian Canada goose, are currently listed as threatened. The area is an important winter habitat for emperor geese and other waterfowl. It provides nesting habitat for a variety of birds, including green-winged teal, rock sandpiper, whiskered auklet, rock ptarmigan, song sparrow, rosy finch, and winter wren. The introduction of dogs, cats, and foxes has severely reduced the population of ground-nesting birds. Rats escaping from ships also are a hazard to these birds. Northern fur seals, Steller sea lions, and sea otters are common along the coast. Pink salmon and sockeye salmon are the most numerous fish species in the Aleutian Islands. Some of the eastern islands support small herds of caribou.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—54%
Water—2%
Other—44%

Commercial fishing in the North Pacific and Bering Sea is the primary enterprise in this area. Most of the communities in the area support a fleet of boats and related fishing facilities. Reindeer herding and harvesting of fur seals for pelts and meat occur on St. Paul Island. Small herds of reindeer and cattle are on Umnak Island. Tourism and wild-land recreation are becoming increasingly important. Subsistence hunting, fishing, and gathering provide food and a variety of other resources to local residents and are a major component of the local economy.

The major soil resource management concerns are water erosion and mass wasting of soils that formed in volcanic ash and cinders, particularly on steep slopes. Minimizing the degree and extent of surface disturbance during construction helps to control erosion. Overgrazing by reindeer is a local concern. Control of animal numbers and proper herd management can help to prevent overgrazing and allow natural restoration of depleted range. ■

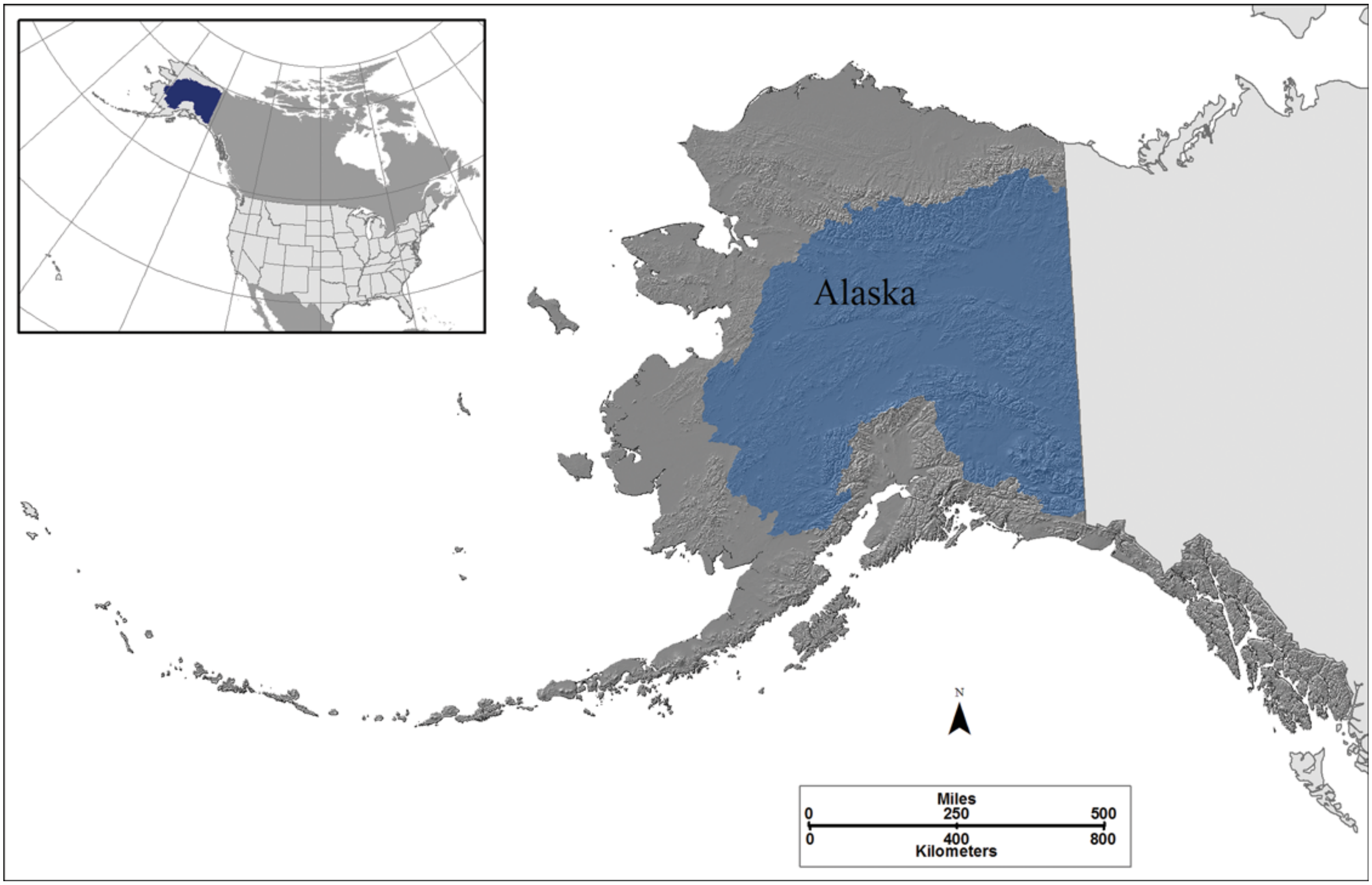

Figure X1-1: Location of Land Resource Region X1.

X1—Interior Alaska

This region includes the vast interior of Alaska, from the south slope of the Brooks Range to the north slope of the Alaska Range (fig. X1-1). It also includes the Copper River Basin and its surrounding mountains. The region makes up 259,260 square miles (671,835 square kilometers).

This region consists of flood plains, broad alluvial plains and terraces, hills, mountain slopes, and ridges. Elevation ranges from 100 feet (30 meters) in an area along the Yukon River in the western part of the region to 20,320 feet (6,195 meters) on the summit of Mt. McKinley. The mountains surrounding the region consist of folded and faulted strata that were extensively glaciated during the Pleistocene epoch. Almost all parts of the region below the highest mountain peaks are unglaciated. The intermountain basins of the Yukon Flats and Interior Alaska Lowlands are broad Pleistocene and Holocene flood plains and terraces. The Copper River Plateau, to the southeast, is a higher basin with broad alluvial and lacustrine terraces and glacial landforms. The Yukon, Tanana, and Kuskokwim Rivers drain most of this region to the west into the Bering Sea. In most of the Copper River Basin, drainage is into the Gulf of Alaska via the Copper River.

The subarctic continental climate in this region is dry and cold. It is characterized by short, warm summers and long, cold winters. The mean annual precipitation ranges from about 6 inches (150 millimeters) in the northwest lowlands to 100 inches or more (2,540 millimeters) in the Alaska Range. In summer, afternoon thunderstorms are common in valleys and at the lower elevations in the mountains. Lightning-caused wildfires often burn many thousands of acres. The mean annual temperature ranges from 8 to 28 degrees F (-13 to -2 degrees C). It varies most in the mountainous areas. Freezing temperatures may occur in any month in most of the region.

The total withdrawals of freshwater in this region average about 51 million gallons per day (195 million liters per day). About 79 percent is from surface water sources, and 21 percent is from ground water sources. Nearly 80 percent of the water is used for mining, agriculture, or the timber industry or for cooling thermoelectric power plants near Fairbanks. The rest generally is used for public supply in Fairbanks.

Figure X1-2: Agricultural development in an area of Land Resource Region X1.

This region is in the zone of discontinuous permafrost. Not all of the soils have permafrost in their profile. With a temperature near 30 degrees F (-1 degree C), the permafrost in this region is warmer than that in the Northern Alaska Region (LRR Y). Distribution of the permafrost-affected soils is determined by landform position, particle size, and moisture content of the soils. Much of the area on the flanks of the Brooks Range and Alaska Range is covered by rock, snow, and ice. Gelisols and Inceptisols are the dominant soils. The soils in the region have a cryic soil temperature regime or a subgelic soil temperature class, a udic or aquic soil moisture regime, and dominantly mixed mineralogy. In areas on mountain slopes, Orthels and Turbels are intermixed with Gelepts and Gelolls. In these areas, the soils that are not affected by permafrost formed in the coarser textured materials on the steeper slopes. Orthels and Turbels are intermixed with Cryepts on low hills and mountains. An even mixture of Gelisols and Inceptisols dominates the basins. The Inceptisols have a more recent history of fire than the Gelisols. Wildfires disturb the insulating organic material at the surface, lowering the permafrost layer and eliminating perched water tables from these former Gelisols. Depending on the frequency of the fires, landform position, and particle size, these Inceptisols may or may not revert back to Gelisols. Histosols are in depressions throughout the region. Organic soils include Histels with permafrost and Hemists without permafrost. Spodosols and Andisols are of limited extent in the region. Cryods are in scattered areas in some of the mountainous parts of the region. Cryands are in parts of the Yukon-Kuskokwim Highlands.

The native vegetation across the region ranges from boreal forests to alpine tundra. The southern Brooks Range and the flanks of the Alaska Range are dominated by alpine tundra with grasses, sedges, mosses, lichens, ericaceous shrubs, and willows. The low hills and mountains have a mixture of alpine tundra and boreal forests. The basins are dominantly boreal forests with black spruce, white spruce, paper birch, and quaking aspen.

Much of this region is sparsely populated wild land. Land use along the Yukon River and in some other parts of the region is diverse and includes urban development and rural settlement, agriculture (fig. X1-2), forestry, mining, subsistence hunting and fishing, and wildlife habitat. ■

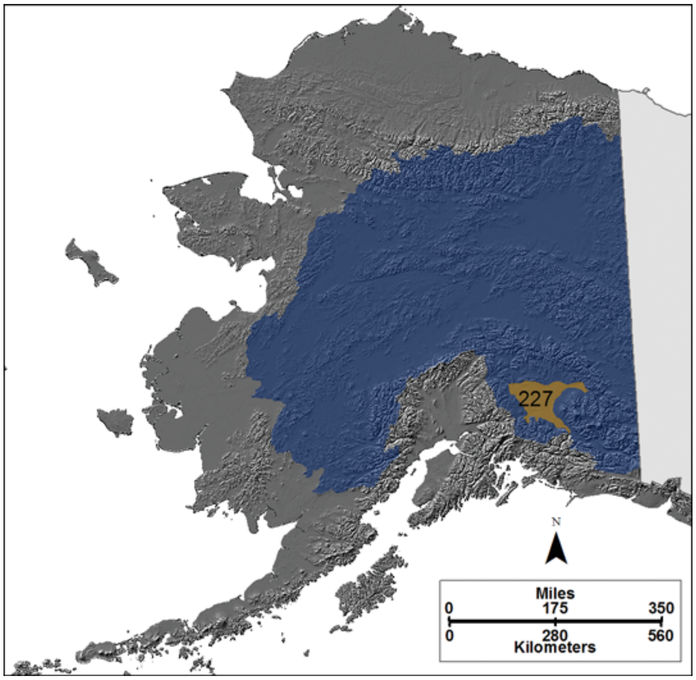

Figure 227-1: Location of MLRA 227 in Land Resource Region X1.

227—Copper River Basin

This area is in the Interior Region of Alaska (fig. 227-1). It includes the Talkeetna, Chugach, and Wrangell Mountains and the Copper River Plateau, a broad intermontane basin bordered by the Alaska Range. The MLRA makes up about 4,590 square miles (11,900 square kilometers). Although the area is traversed by the Richardson, Glenn, and Edgerton Highways, it is mostly undeveloped wild land and is sparsely populated. The largest community is Glennallen, at the intersection of the Richardson and Glenn Highways. The smaller communities in the area include Chitina, Copper Center, Gulkana, and Kenny Lake. Part of the Wrangell-St. Elias National Park and Preserve is in this area. The Trans-Alaska Pipeline parallels the Richardson Highway through the area.

Physiography

This area lies within the Coastal Trough Province of the Pacific Mountains System. It is mainly on nearly level to undulating plains and rolling hills. Many depressions and shallow basins on the plains have lakes and interconnecting wetlands, particularly in the western and northern parts of the area. Narrow flood plains and stream terraces are along the rivers and streams. In many areas the rivers are deeply incised with high escarpments and breaks between the river bottom and adjacent plains. Isolated, low- to moderate-relief mountains are in the northern and western parts of the area. Long footslopes are common at the base of the mountains. In general, elevation ranges from about 600 feet (185 meters) along the Copper River at Chitina to about 2,600 feet (795 meters) along the edge of the basin. The highest point in the area, at Windy Point on Slide Mountain, is 3,806 feet (1,160 meters).

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is South Central Alaska (1905). The Copper River drains most of the area through the Chugach Mountains to the Gulf of Alaska. The major tributaries of the Copper River are the Gulkana, Gakona, Tazlina, and Chitina Rivers. The largest lakes are Lake Louise, Susitna Lake, Crosswind Lake, and Ewan Lake. Lakes make up about 10 percent of the area.

This area is in the zone of discontinuous permafrost. Permafrost is commonly close to the surface in areas of the finer textured sediments on plains, stream terraces, and the more gently sloping footslopes and hills. Isolated masses of ground ice occur in thick deposits of loess on terraces and the lower side slopes of hills. Permafrost generally does not occur on flood plains and in close proximity to lakes and other water bodies.

Geology

During the latter part of the Pleistocene epoch, glacial ice dammed the Copper River drainage, forming a large proglacial lake in the center of the basin. Glaciers from the surrounding mountains extended into the basin, probably calving into the lake much of the time. At the onset of the Holocene epoch, the glaciers receded and the lake emptied, exposing a broad, nearly level to rolling plain. The central basin is filled with clayey lacustrine deposits that become progressively more silty toward the outer margins of the former lake. Slightly modified glacial moraines, drift, and occasional drumlins and eskers are above the level of the former lake. During the Holocene epoch, the rivers and streams in the area cut into the lacustrine deposits, creating low to high escarpments and depositing coarse textured alluvium on flood plains and stream terraces. A layer of calcareous, silty loess of varying thickness mantles much of the modern landscape. Quaternary and Tertiary volcanic rocks are exposed along river escarpments in the southeastern part of the area. Isolated mountains in the basin formed in stratified sedimentary rocks of Permian and Pennsylvanian age.

Climate

The average annual precipitation in this area ranges from about 10 inches (255 millimeters) in the central basin to more than 20 inches (510 millimeters) at the higher elevations in the northern and western parts of the area. Brief, warm summers and long, cold winters characterize the subarctic continental climate of the area. The average annual snowfall ranges from about 40 to 70 inches (100 to 180 centimeters). The average annual temperature ranges from about 23 to 28 degrees F (-5 to

-2 degrees C). The freeze-free period averages 35 to 90 days. Freezing temperatures are not unusual in summer, particularly at the higher elevations.

Water

There are very limited withdrawals of freshwater for use in this sparsely populated MLRA. The only measurable withdrawal is for agricultural and logging activities (0.1 million gallons, or 0.4 million liters, per day). Most of the communities in this area are along the three major roads crossing the area or along the major rivers or lakes. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Also, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. If surface water is available, treatment for removal of the suspended sediment would normally be required. For these reasons, most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners probably obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash). There are typically no test data available on ground water in sparsely populated areas. If these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination.

Soils

The dominant soil orders in this MLRA are Gelisols, Inceptisols, Spodosols, Entisols, and Mollisols. The soils in the area have a subgelic soil temperature class or a cryic soil temperature regime, an aquic or udic soil moisture regime, and dominantly mixed mineralogy.

Poorly drained Histoturbels (Dadina and Klawasi series) and Aquiturbels (Klanelneechena and Strelna series) are interspersed with well drained Eutrocryepts (Pippin and Gulkana series) and Haplocryolls (Kenny Lake and Tonsina series) on stream terraces, lacustrine terraces, till plains, and hills. These soils formed either in thick deposits of loess or in a mantle of loess over clayey lacustrine sediments or gravelly till and outwash. The Inceptisols and Mollisols in the area have a more recent history of fire than the Gelisols. Wildfires can disturb the insulating organic material at the surface, lowering the permafrost layer, eliminating perched water tables from Gelisols, and thus changing the classification. Depending on the frequency of the fires, landform position, and particle size, these soils may or may not revert back to Gelisols. Fibristels and Hemistels (Wrangell series) are in depressions. These organic soils are shallow or moderately deep to permafrost and are poorly drained or very poorly drained. Cryofluvents (Klutina series) and Cryorthents (Gakona series) formed in loamy alluvium over gravelly alluvium on flood plains and low terraces.

Miscellaneous (nonsoil) areas make up about 12 percent of this MLRA. The most common miscellaneous areas are riverwash and water.

Biological Resources

On productive, well drained soils in the uplands, forest vegetation includes white spruce, aspen, and paper birch. White spruce and white spruce-balsam poplar forests are on high flood plains and low stream terraces. Stunted black spruce and white spruce woodland of low productivity is on north-facing slopes, high stream terraces, and cold, wet sites with shallow permafrost. Following wildfires, willow, shrub birch, and ericaceous shrub scrub invade most sites until they eventually are replaced by forest vegetation. On most forest and woodland sites, post-fire succession leads to a relatively rapid accumulation of organic matter and mosses on the surface. This accumulation results in a decrease in soil temperature, biologic activity, and nutrient availability and a gradual decrease in site productivity. Nonforest vegetation in areas of peat, in drainageways, and above tree line includes low to tall willow, shrub birch, and ericaceous shrub scrub. Wet sedge meadows, sedge-grass meadows, and sedge-moss bog meadows are along the margins of lakes and on continuously ponded sites. Willow and alder scrub are on low flood plains.

The common species of mammals in the area include brown bear, black bear, caribou, moose, wolf, and a variety of rodents. Ponds and wetlands provide high-quality habitat for tundra swans and other waterfowl. Bald eagles are common along most rivers. The rivers and lakes in the area support lake trout, rainbow trout, grayling, burbot, northern pike, and whitefish.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—8%
Forest—80%
Water—10%
Other—2%

Several small farms are in the Kenny Lake area in this MLRA. Grasses, small grains, potatoes, and cool-season vegetables are grown on less than 1 percent of the MLRA. Small-scale timber harvesting occurs in a few places. Each year, hunting, fishing, boating, hiking, and other kinds of wild-land recreation attract thousands of visitors to the area. Subsistence hunting, fishing, and gathering provide food and a variety of other resources to both native and nonnative residents. Less than 1 percent of the area is urban.

The major soil resource concerns are wind erosion and water erosion in areas where the native vegetation has been removed.

Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities should include protection of the organic surface material and the thermal balance of the soils. ■

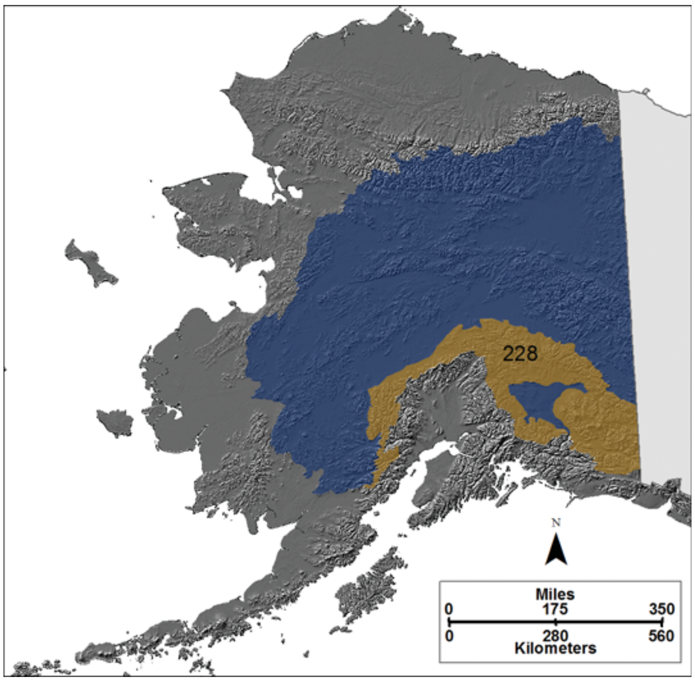

Figure 228-1: Location of MLRA 228 in Land Resource Region X1.

228—Interior Alaska Mountains

This area is in the Interior Region of Alaska (fig. 228-1). It includes the high mountain slopes and glaciated hills and plains of the Alaska Range, Talkeetna Mountains, Chugach Mountains, Wrangell Mountains, and the northern Aleutian Range. It makes up about 44,375 square miles (114,985 square kilometers). Except for some remote lodges and a few small communities along the Parks and Richardson Highways, which bisect the mountains in three places, this MLRA is primarily undeveloped wild land. Parts of Denali National Park and Preserve, Wrangell-St. Elias National Park and Preserve, and Tetlin National Wildlife Refuge are in this area. The Trans-Alaska Pipeline parallels the Richardson Highway from Paxson to Delta Junction.

Physiography

The part of this area in the Aleutian and Alaska Ranges lies within the Alaska-Aleutian Province of the Pacific Mountains System. The part in the Chugach and Wrangell Mountains lies within the Pacific Border Ranges Province of the same system, and the part in the Talkeetna Mountains lies within the Coastal Trough Province. The area consists of rugged, high mountains and low, rounded hills and extended footslopes along the base of the mountains. Throughout the area, the mountains are deeply dissected by narrow to broad, high-gradient valleys, typically with braided flood plains on the valley bottoms. Coalescing fans and steep footslopes are common in the valleys. Large valley glaciers occur throughout the area. Glaciers and permanent ice and snow make up about 15 percent of the area. Elevation ranges from about 1,500 feet (455 meters) near Paxson in the basin of the Copper River to 20,320 feet (6,195 meters) at the summit of Mt. McKinley.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: South Central Alaska (1905), 46 percent; Yukon (1903), 38 percent; and Southwest Alaska (1904), 16 percent. Surface water on the north slopes of the Aleutian and Alaska Ranges drains into the Bering Sea via the Tanana and Kuskokwim Rivers. The major tributaries of the Kuskokwim River are the Stony River and the North Fork of the Kuskokwim River. The major tributaries of the Tanana River are the Kantishna, Nenana, Delta, and Nabesna Rivers. Surface water in the mountains bordering the basin of the Copper River drains into the Copper River and the Gulf of Alaska and North Pacific. The major tributaries of the Copper River are the Gulkana, Tazlina, and Chitina Rivers. The headwaters of the Susitna River, which drains into the Cook Inlet Lowlands (MLRA 224) and Cook Inlet, are in this MLRA. Lakes and ponds make up less than 1 percent of the area. There are, however, a number of large lakes and lake systems in the area, including Tazlina, Klutina, and Tonsina Lakes in the Chugach Mountains and Paxson Lake and the Tangle Lakes system in the Alaska Range.

This area is in the zone of discontinuous permafrost. Generally, permafrost is close to the surface only in areas of the finer textured sediments on stream terraces and in swales on hills and footslopes. In the mountains, permafrost occurs only in gently sloping areas of rounded ridges, swales, and footslopes. Flood plains generally have no permafrost.

Geology

During the late Pleistocene epoch, all of this area was covered with glacial ice, except for the highest peaks and steep upper ridges. For the most part, glacial deposits eroded away or were buried by mountain colluvium and alluvium, which accumulated during the Holocene epoch across about 60 percent of the landscape. Slightly modified to highly modified glacial moraines, drift, and outwash deposits are extensive on the lower mountain slopes and in valleys at the lower elevations. Silty eolian deposits are limited to the lower mountain slopes and valleys. Valley bottoms are buried by recent fluvial deposits. The bedrock geology consists primarily of upper Paleozoic and Mesozoic sedimentary, metamorphic, and igneous rocks and Tertiary intrusive and volcanic rocks. The Usibelli Coal Mine and some commercial and recreational gold mines occur in this area.

Climate

The average annual precipitation ranges from about 15 to 20 inches (380 to 510 millimeters) at the lower elevations in this area. It is as much as 100 inches (2,540 millimeters) at the highest elevations in the Alaska Range and Wrangell Mountains. The amount of rainfall generally is highest in July, August, and early September. Brief, cool summers and long, cold winters characterize the subarctic continental climate of the area. The extreme variation in elevation in this MLRA results in a wide range of climatic conditions. The average annual snowfall ranges from about 70 to 400 inches (180 to 1,015 centimeters). The average annual temperature at McKinley Park headquarters in the Alaska Range is 27 degrees F (-3 degrees C). The freeze-free period averages about 50 to 80 days. At the higher elevations, freezing temperatures can occur during every month.

Water

There are very limited withdrawals of freshwater for use in this sparsely populated MLRA. The only measurable withdrawal is for mining operations (0.3 million gallons, or 1.1 million liters, per day). Most of the communities in the area are along the major rivers. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Also, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. If surface water is available, treatment for removal of the suspended sediment would normally be required. For these reasons, most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners probably obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash). There are typically no test data available on ground water in sparsely populated areas. If these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Septic systems, landfills, leaking fuel storage tanks, and industrial waste from coal and gold mining are all possible sources of contamination.

Soils

The dominant soil orders in this MLRA are Gelisols, Inceptisols, Spodosols, and Entisols. The soils in the area have a subgelic soil temperature class or a cryic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy.

Histoturbels and Aquiturbels on mountain slopes, hills, and plains formed in loamy and gravelly glacial till. These soils are shallow or moderately deep to permafrost and generally are poorly drained. Gelepts and Cryepts on steep mountain slopes formed in gravelly colluvium over fractured bedrock. These soils do not have permafrost, are shallow to very deep, and are well drained. Haplocryods on outwash plains, hills, and terraces formed in a thin layer of silty eolian deposits over sandy and gravelly outwash and alluvium. These soils are somewhat excessively drained. Cryofluvents and Cryorthents on flood plains formed in loamy alluvium over sandy and gravelly alluvium. These soils are somewhat poorly drained to well drained.

Miscellaneous (nonsoil) areas make up about 58 percent of this MLRA. The most common miscellaneous areas are rock outcrop, rubble land, and glaciers.

Biological Resources

This MLRA includes the true alpine and the subalpine zones. Alpine vegetation consists of a variety of dwarf scrub and herbaceous communities. Black crowberry, ericaceous shrubs, dwarf willow, or dryas typically dominates dwarf scrub. Various sedges, grasses, and low forbs dominate in herbaceous communities. Low willow scrub is common in drainages. Lichens, scattered herbs, and dwarf shrubs dominate bedrock exposures and very shallow soils. In general, there is little or no plant growth above elevations of about 7,500 feet (2,285 meters). The vegetation in the subalpine zone generally is low and medium scrub dominated by shrub birch and ericaceous shrubs that grade into white spruce woodlands at the lower elevations. Tall alder scrub is common in many places.

Some of the major species of mammals in the area are brown bear, black bear, Dall sheep, caribou, moose, wolf, coyote, fox, snowshoe hare, arctic ground squirrel, and hoary marmot. Ptarmigan, American golden plovers, golden eagles, and a wide variety of other birds are common in many places.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—30%
Forest—12%
Water—1%
Other—57%

Remote wild-land recreation is the principal land use in this area. The rugged mountains, extensive glaciers, and wilderness qualities of the area attract hikers and wilderness enthusiasts from around the world. Every summer, hundreds of climbers attempt to climb Mt. McKinley and other high peaks in the area. More people visit Denali National Park than any other park in Alaska. Hunters pursue moose, caribou, Dall sheep, brown bear, and black bear. Back-country recreationists and hunters are served by air taxi, guiding, and outfitting companies operating out of the major Alaska communities. Mining formerly was a major land use that helped to support development on nearby lowlands. The Usibelli Coal Mine is a large-scale open-pit mine in the mountains near Healy. It provides fuel for electrical generator plants in Fairbanks and elsewhere in Alaska. Small-scale commercial and recreational gold mines operate along a number of streams. There are no major resource concerns in this area. ■

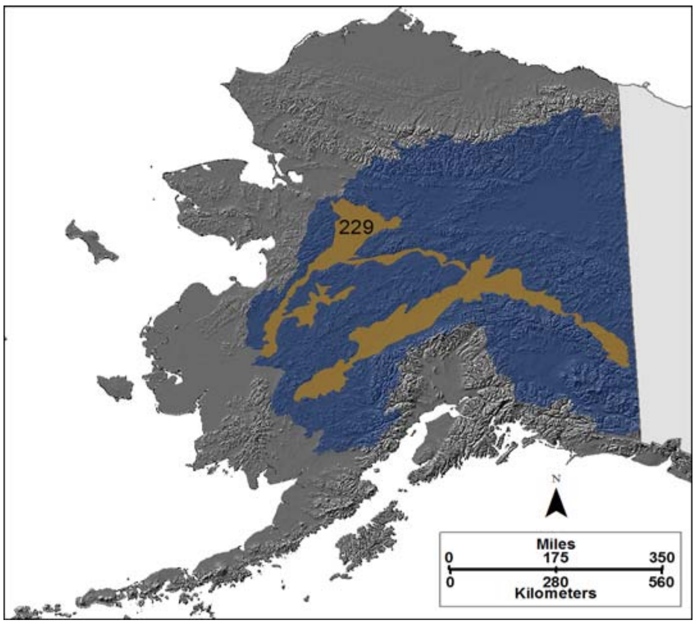

Figure 229-1: Location of MLRA 229 in Land Resource Region X1.

229—Interior Alaska Lowlands

This area is in the Interior Region of Alaska and includes the flood plains and terraces along the upper reaches of the Tanana and Kuskokwim Rivers and the middle reaches of the Yukon River (fig. 229-1). The area makes up about 36,320 square miles (94,120 square kilometers). The southwest part of this MLRA and nearby portions of the Interior Alaska Highlands (MLRA 231) are the second most densely populated areas in Alaska. The areas along the road system include the municipality of Fairbanks; the towns of Nenana, Delta Junction, and Tok; and parts of Fort Wainwright and Fort Greely, the two largest military reservations in Alaska. Elsewhere, the area is mostly undeveloped wild land and is sparsely populated. In the western part of the area, the communities of Tanana, Galena, and McGrath are accessible only by air or by river. Parts of the Denali National Park and Preserve and Tetlin National Wildlife Refuge are in this area. The Trans-Alaska Pipeline parallels the Alaska Highway from Delta Junction to Fairbanks.

Physiography

This area lies within the Western Alaska and Northern Uplands and Lowlands Provinces of the Intermontane Uplands and Lowlands System. The area is on broad, nearly level, braided to meandering flood plains, stream terraces, and outwash plains. In many places shallow basins and undulating stream terraces are dotted with hundreds of small and medium-size lakes and interconnecting wetlands. Sloughs, oxbow lakes, and low to high escarpments along river channels are features associated with the flood plains, terraces, and basins. Isolated bedrock-controlled hills and low- to moderate-relief mountains are in scattered areas throughout the MLRA. Extended footslopes are common at the base of hills and mountains and along the boundaries with adjoining mountainous MLRAs. Elevation ranges from about 100 feet (30 meters) in the southwestern part of the area, along the lower Yukon River, to about 1,900 feet (580 meters) in the upper Tanana Valley.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Yukon (1903), 75 percent, and Southwest Alaska (1904), 25 percent. Surface water in all of the area drains to the Bering Sea via the Tanana, Yukon, and Kuskokwim Rivers. The major tributaries of the Tanana River are the Kantishna, Nenana, Delta, and Nabesna Rivers. The major tributaries of the Yukon River, in addition to the Tanana River, are the Koyukuk and Innoko Rivers. The major tributaries of the Kuskokwim River are the Stony River and the North Fork of the Kuskokwim River. Lakes make up about 10 percent of the area.

This area is in the zone of discontinuous permafrost. Permafrost commonly is close to the surface in areas of the finer textured sediments on plains, stream terraces, and the more gently sloping footslopes and hills. Isolated masses of ground ice occur in thick deposits of loess on terraces and the lower side slopes of hills. Permafrost generally does not occur on flood plains and in areas near lakes and other water bodies.

Geology

Although never glaciated, this area is filled with a deep layer of Pleistocene glaciofluvial deposits. Additional fluvial sediments from the Alaska Range and the northern Aleutian Range accumulated along the Tanana and Kuskokwim Rivers during the Holocene epoch. The Koyukuk and lower Yukon River drainages have undergone several periods of deposition followed by erosion. In places old terraces are 33 to 250 feet (10 to 75 meters) above the flood plain. Quaternary glaciofluvial and fluvial sediments are estimated to be as much as 330 to 660 feet (100 to 200 meters) thick throughout the area. Much of the area, particularly along the Tanana and Kuskokwim Rivers, is mantled with a layer of silty micaceous loess originating from the unvegetated flood plains and outwash plains along the Alaska Range. Thick eolian deposits, including loess and sand dunes, make up about 12 percent of the area. Near the mountains are inclusions of glacial moraines and drift. Unconsolidated sediments bury the bedrock geology in this area, except for occasional structural hills.

Climate

The average annual precipitation ranges from 10 to 15 inches (255 to 380 millimeters) in the eastern and northern parts of this area and from 15 to 20 inches (380 to 510 millimeters) in the southern and western parts. The maximum precipitation occurs in late summer, mainly during thunderstorms. Short, warm summers and long, very cold winters characterize the subarctic continental climate of the area. The average annual snowfall ranges from 30 to 80 inches (75 to 205 centimeters). The average annual temperature ranges from about 22 degrees F in the eastern part of the area to 28 degrees F (-6 to -4 degrees C) in the western part. The freeze-free period averages about 70 to 120 days. The temperature usually remains above freezing from June through mid-September.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 10.6%; ground water, 8.7%
Livestock—surface water, 0.4%; ground water, 0.0%
Irrigation—surface water, 0.4%; ground water, 0.2%
Other—surface water, 68.3%; ground water, 11.4%

The total withdrawals average 48 million gallons per day (180 million liters per day). About 20 percent is from ground water sources, and 80 percent is from surface water sources. In most years precipitation is adequate for crops, but in some years yields are reduced by short dry periods in summer. Permanent streams, originating in the mountainous regions surrounding this area, bring water to nearly all parts of the MLRA. The area has numerous large natural lakes and some constructed reservoirs. The surface water is used for public supply, placer mining, cooling thermoelectric power plants, and some limited irrigation. It is generally suitable for all uses. Rivers fed by glacial meltwater streams below placer mines typically carry high loads of suspended sediment. Flooding from ice dams that form during the spring thaw is a concern in this area.

The ground water used in this area is primarily from unconsolidated sediments in river valleys (alluvium) or from buried glacial outwash deposits in the river valleys. This water is hard or very hard but is otherwise of excellent quality. Wells in these aquifers generally are shallow, and the aquifers are being constantly recharged with freshwater (rainfall and runoff). As a result, the median level of total dissolved solids is fairly low, about 190 parts per million (milligrams per liter). The level of iron greatly exceeds the secondary standard for drinking water of 300 parts per billion (micrograms per liter). This standard is for esthetics. The iron can stain ceramic and porcelain and precipitate in pipes. Since the aquifers are close to the surface and water moves through them quickly, they are highly susceptible to contamination from runoff. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination.

Some ground water can be obtained from the Fairbanks-North Star bedrock aquifer near Fairbanks and unnamed bedrock aquifers in other parts of the area. Except for lower levels of iron, the water in the unnamed bedrock aquifers is similar in quality to that in the unconsolidated sediments. The water in the Fairbanks-North Star aquifer is harder than that in the unconsolidated sediments, and its median level of total dissolved solids is about 400 parts per million (milligrams per liter). The level of iron is similar to that of the water in the alluvium or outwash. The median level of arsenic is 9 to 10 parts per billion (micrograms per liter) in water from both the unconsolidated sediments and the Fairbanks-North Star bedrock aquifer, but some tests indicate that the water from the bedrock aquifer can exceed the national drinking water standard of 50 parts per billion (micrograms per liter).

Soils

The dominant soil orders in this area are Gelisols, Inceptisols, Entisols, and Spodosols. The soils in the area have a subgelic soil temperature class or a cryic soil temperature regime, an aquic or udic soil moisture regime, and dominantly mixed mineralogy. Many of the soils have a significant content of mica that was derived from source parent materials.

Aquiturbels (Tanana series) and Histoturbels (Tanacross series) on nearly level stream terraces and outwash plains formed in silty loess of varying thickness over loamy, sandy, and gravelly alluvial deposits. On elongated footslopes, these soils formed in silty loess over loamy slope alluvium and colluvium. Hemistels (Bolio series) and Fibristels (Lemeta series) in depressions on stream terraces, outwash plains, and elongated footslopes formed in thick layers of organic material. All of the Gelisols are shallow or moderately deep to permafrost and are poorly drained or very poorly drained. Wildfires can disturb the insulating organic material at the surface, lowering the permafrost layer, eliminating perched water tables from Gelisols, and thus changing the classification. Depending on the frequency of the fires, landform position, and particle size, these soils may or may not revert back to Gelisols. Eutrocryepts (Volkmar series), Dystrocryepts (Zitziana series), Cryaquepts (Liscum series), and Haplocryods occur on the same landforms and formed in the same kind of material as the Gelisols. Unlike the Gelisols, they do not have permafrost within the soil profile. The Eutrocryepts, Dystrocryepts, and Haplocryods are well drained to excessively drained, and the Cryaquepts are poorly drained or very poorly drained. Cryorthents (Chena series) and Cryofluvents (Jarvis and Salchaket series) on flood plains and low stream terraces formed in stratified silty, sandy, and gravelly alluvium. These Entisols range from moderately well drained to excessively drained. Very poorly drained Cryofibrists along the margins of lakes and in shallow basins formed in floating fibrous peat.

Miscellaneous (nonsoil) areas make up about 19 percent of this MLRA. The most common miscellaneous areas are riverwash and water.

Biological Resources

Forests on productive, well drained soils in the uplands include white spruce and mixed white spruce, paper birch, and quaking aspen. White spruce and white spruce-balsam poplar forests are on high flood plains and low stream terraces. Stunted black spruce and white spruce woodland of low productivity occurs on north-facing slopes, high stream terraces, and cold, wet sites with shallow permafrost. On permafrost-affected flats, tamarack and paper birch occur in association with spruce. Lightning-caused wildfires are common, often burning many thousands of acres during a single fire. Following wildfires, willow, shrub birch, and ericaceous shrub scrub invade most sites until they eventually are replaced by forest vegetation. On all forest and woodland sites, post-fire succession leads to a relatively rapid accumulation of organic matter and mosses on the surface. This accumulation results in decreased soil temperature, biologic activity, and nutrient availability and a gradual decrease in site productivity. Nonforest vegetation includes low to tall willow, shrub birch, and ericaceous shrub scrub in areas of peat and in drainageways. Wet sedge meadows, sedge-moss bog meadows, and sedge-grass meadows are along the margins of lakes and on continuously ponded sites. Low to tall willow and alder scrub are on low flood plains.

The common species of mammals in the area include brown bear, black bear, caribou, moose, wolf, lynx, and a variety of rodents. Ponds and wetlands provide high-quality habitat for tundra swans, sandhill cranes, and other waterfowl. Bald eagles are common along most rivers. The rivers and lakes in the area support salmon, lake trout, rainbow trout, arctic grayling, burbot, northern pike, blackfish, and whitefish.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—1%
Grassland—20%
Forest—60%
Water—10%
Other—9%

Farming is a major land use in the Tanana Valley near Fairbanks and Delta Junction. Grasses, small grains, potatoes, and other cool-season vegetables are the principal crops. Some dairy cattle, beef cattle, and hogs are raised on this farmland. The flood plains and low stream terraces along the Tanana and Yukon Rivers are among the most productive forestlands in Interior Alaska. Logging provides important wood products for local use and export. Extractable minerals, dominantly gold and silver, occur in certain areas. Placer mining along the rivers and placer and hard rock mining in the adjacent Interior Alaska Highlands (MLRA 231) helped to support settlement and development in the area. Wild-land recreation, primarily hunting for moose and other game, is a significant land use in the area. Many residents rely on subsistence hunting, fishing, and gathering for a large part of their food. Urban development, particularly along the road system, has impacted less than 1 prcent of the area. Urban development and road construction require a significant quantity of construction material, and gravel pits of various sizes are along the major roads and near urban developments.

The major soil resource concerns are wind erosion and water erosion in areas where the native vegetation has been removed. Most urban and rural developments are adjacent to rivers, in areas where flooding is a severe hazard. Flooding is associated with spring snowmelt and runoff from the adjacent mountains and ice jamming at river bends during periods of ice breakup.

Conservation practices on forestland generally include timber stand improvement and proper construction of roads, landings, and stream crossings. Erosion- and sediment-control practices are important in the areas used for urban development. ■

230—Yukon-Kuskokwim Highlands

This area is in the Interior Region of Alaska and includes the mountains, hills, and valleys of the Lime Hills, the Kuskokwim Mountains, and the eastern side of the Nulato Hills (fig. 230-1). The area makes up about 59,860 square miles (155,115 square kilometers). It is mostly undeveloped wild land and is sparsely populated. The principal communities, which are along the banks of the major rivers, are Sleetmute, Lime Village, and Takotna. A number of other communities that supported past hard rock mining operations have been abandoned. Parts of the Nowitna National Wildlife Refuge and Lake Clark National Park and Preserve are in this area.

Physiography

This area lies within the Western Alaska Province of the Intermontane Uplands and Lowlands System. It is on moderate- to high-relief mountains and in narrow, flat-bottomed valleys. The highest local relief is in the Kuskokwim Mountains. Local relief in the Nulato, Nushagak, and Lime Hills is generally

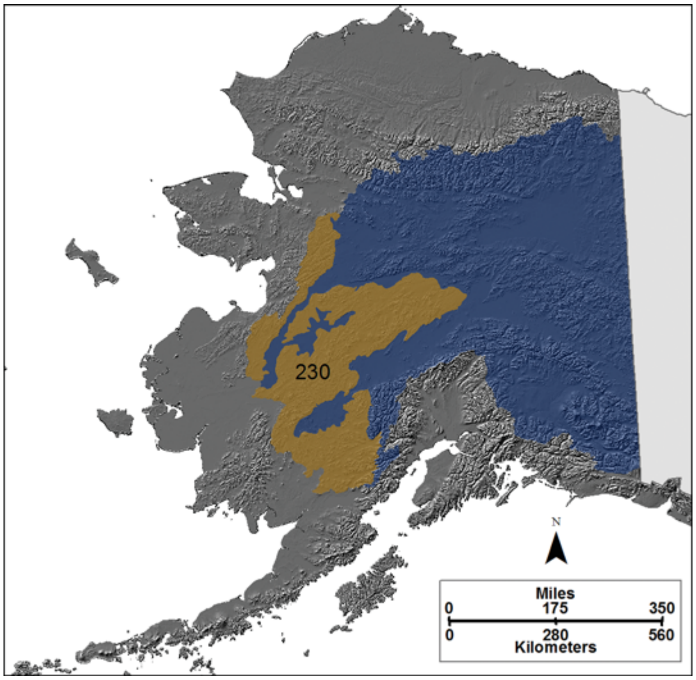

Figure 230-1: Location of MLRA 230 in Land Resource Region X1.

lower. Most of the mountains at the mid and higher elevations have gently sloping to strongly sloping, rounded summits. In a few places, particularly at the highest elevations in the Kuskokwim Mountains, the mountains are more rugged and have sharp ridges. Valley bottoms consist of nearly level flood plains and stream terraces, which give rise to moderately steep mountain footslopes and alluvial and colluvial fans at the base of the mountains. Elevation ranges from about 30 feet (9 meters) in the western part of the area, along the edge of the Yukon-Kuskokwim Coastal Plain (MLRA 238), to 4,508 feet (1,374 meters) at the summit of Von Frank Mountain, in the southeastern Kuskokwim Mountains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Yukon (1903), 54 percent; Southwest Alaska (1904), 44 percent; and Northwest Alaska (1902), 2 percent. Surface water on the eastern slope of the Nulato Hills, the Kuskokwim Mountains, and the western part of the Lime Hills drains into the Bering Sea via the Yukon, Innoko, and Kuskokwim Rivers. Surface water on the eastern and southern Lime Hills drains into the Mulchatna and Nushagak Rivers and Bristol Bay. Lakes make up about 7 percent of the area.

This area is in the zone of discontinuous permafrost. Permafrost commonly is close to the surface in areas of the finer textured sediments throughout the MLRA. Isolated masses of ground ice occur in thick deposits of loess on terraces and the lower side slopes of hills. The prevalence of permafrost decreases to the southwest. Permafrost generally does not occur on flood plains or on south-facing slopes on steep mountains.

Geology

During the Pleistocene epoch, the Lime Hills in the southeastern part of this area were covered extensively by glaciers originating in the Alaska Range and the northern Aleutian Range. Glacial moraines and drift are common in this part of the area. Elsewhere, the area generally was not glaciated and uplands are covered primarily by bedrock colluvium and slope alluvium originating from the underlying bedrock. Silty loess deposits of limited extent cover footslopes and the lower backslopes of hills near the major rivers. The bedrock geology consists primarily of Cretaceous and lower Paleozoic stratified sedimentary rocks and many, in places extensive, inclusions of Cretaceous and Tertiary intrusive and volcanic rocks. The area is cut by numerous northeast-trending faults. Quaternary fluvial and eolian deposits cover valley bottoms and the lower mountain slopes.

Climate

The average annual precipitation ranges from about 10 to 15 inches (255 to 380 millimeters) at the lower elevations in the eastern part of this area to 20 to 40 inches (510 to 1,015 millimeters) at the higher elevations in the western and southwestern parts. The climate is transitional from subarctic continental in the eastern part of the area to maritime in the southwestern part, along the boundary with the Western Region of Alaska. The average annual snowfall ranges from about 80 to 100 inches (205 to 255 centimeters). The average annual temperature is estimated to be about 20 to 25 degrees F (-7 to -4 degrees C). The freeze-free period at the lower elevations averages about 60 to 80 days. Freezing temperatures may occur in any month at the higher elevations.

Water

There are very limited withdrawals of freshwater for use in this sparsely populated MLRA. Most of the communities in the area are along the major rivers. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Also, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. If surface water is available, treatment for removal of the suspended sediment would normally be required. For these reasons, most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners probably obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash). There are typically no test data available on ground water in sparsely populated areas. If these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination.

Soils

The dominant soil orders in this MLRA are Gelisols, Inceptisols, Spodosols, and Entisols. The soils in the area have a subgelic soil temperature class or a cryic soil temperature regime, an aquic or ustic soil moisture regime, and dominantly mixed mineralogy.

Aquiturbels on long footslopes, on ridges above tree line, and on solifluction lobes formed in gravelly colluvium or in loess over gravelly colluvium. Histoturbels on north-facing slopes, footslopes, rolling uplands, and valley bottoms formed in moderately thick layers of organic material over loamy colluvium or loess. Fibristels and Hemistels in depressions (thermokarst depressions in places) on terraces and in swales on hillslopes formed in thick layers of organic material. Gelisols are shallow or moderately deep to permafrost and are poorly drained or very poorly drained. Wildfires can disturb the insulating organic material at the surface, lowering the permafrost layer, eliminating perched water tables from Gelisols, and thus changing the classification. Depending on the frequency of the fires, landform position, and particle size, these soils may or may not revert back to Gelisols. Dystrocryepts and Eutrocryepts on the upper slopes and on ridges formed in colluvium over fractured bedrock. Humicryods and Haplocryods on south-facing slopes and stream terraces formed in loess over loamy or gravelly alluvium. Inceptisols and Spodosols do not have permafrost within their soil profile and generally are well drained. Cryofluvents, Cryaquents, and Cryorthents on flood plains formed in stratified loamy, sandy, and very gravelly alluvium. These soils range from very poorly drained to excessively well drained.

Miscellaneous (nonsoil) areas make up about 10 percent of this MLRA. The most common miscellaneous areas are rock outcrop and rubble land. In many valleys placer mine tailings are common.

Biological Resources

The well drained soils on mountain slopes at low and mid-elevations are dominated by white spruce forests and woodlands, mixed spruce-hardwood forests, tall alder shrub, tall and low willow scrub, and low ericaceous scrub. Areas of peat and moderately well drained mineral soils have black spruce woodlands and low ericaceous and shrub birch scrub, commonly with tussock-forming sedges or various sedges and grasses in the ground layer. Drainages and lakeshores have wet sedge meadows, sedge-grass meadows, and sedge-moss meadows. Well drained soils on valley bottoms at the lower elevations have white spruce, balsam poplar, and mixed balsam poplar-white spruce forests. The higher elevations and the shallow soils on mountain slopes and ridges commonly have dwarf alpine scrub dominated by ericaceous shrub, dryas, and shrub birch. These communities often have a considerable amount of lichen cover and bare ground. Bedrock exposures with only lichens and scattered shrubs and herbs in pockets of fine earth dominate the highest elevations and ridges.

The common species of mammals in the area include brown bear, black bear, moose, caribou, wolf, and a variety of small mammals. Golden eagles and peregrine falcons nest on cliffs along the major rivers and on rock outcrops on ridges at the higher elevations. The rivers in the area support runs of salmon. Arctic grayling are common in clear-water streams.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—25%
Forest—65%
Water—7%
Other—3%

Most of this area still supports natural vegetation and is used primarily for subsistence hunting, fishing, and gathering by local residents. Mining for gold, silver, and other extractable minerals and commodities was a significant land use in the past. Most of the mines have ceased operation. People from outside the MLRA use the area for hunting and wild-land recreation.

The major soil resource concerns are erosion of the shallow soils on uplands and disturbance of the fragile permafrost-affected soils. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities should include protection of the organic surface material and the thermal balance of the soils. ■

231—Interior Alaska Highlands

This area is in the Interior Region of Alaska and includes the extensive hills, low to moderately high mountains, and valleys between the Tanana River to the south and the Brooks Range to the north (fig. 231-1). The area makes up about 69,175 square miles (179,255 square kilometers). It is traversed by a number of major roads, including the Taylor Highway in the eastern part of the area and the Steese, Elliott, and Dalton Highways north of Fairbanks. The area is mostly undeveloped wild land and is sparsely populated. The principal communities along the road system are part of the municipality of Fairbanks and the nearby communities of Eagle, Circle, Central, and Livengood. The northwestern part of the area has a number of remote villages, primarily along the major rivers. The Yukon-Charley

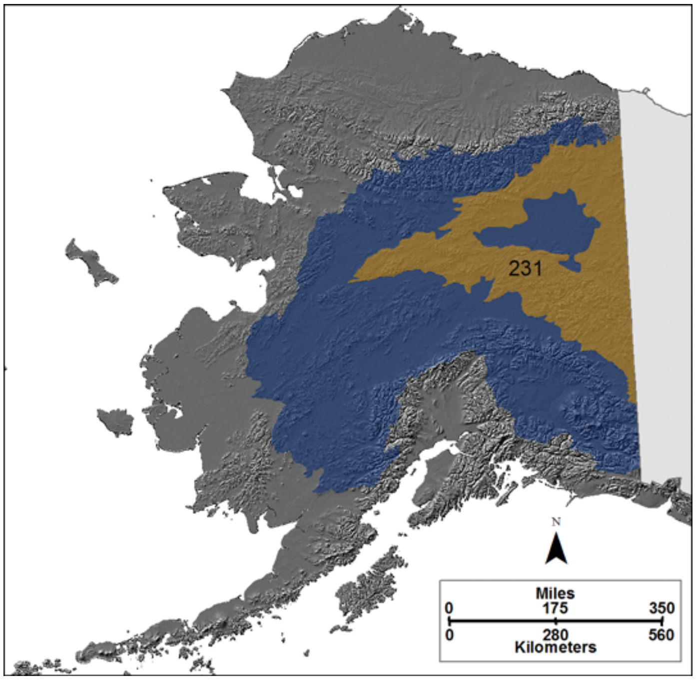

Figure 231-1: Location of MLRA 231 in Land Resource Region X1.

Rivers National Park and Preserve, the White Mountains National Recreation Area, part of the Yukon Flats National Wildlife Refuge, and the Arctic National Wildlife Refuge are in this MLRA. The Trans-Alaska Pipeline parallels the Elliott and Dalton Highways from Fairbanks north to the Brooks Range.

Physiography

This area lies within the Northern Uplands and Lowlands Province of the Intermontane Uplands and Lowlands System. It is mostly on moderately steep or steep, moderate- to high-relief hills and mountains and in narrow to broad, flat-bottomed valleys. The mountains are generally rounded at the lower elevations and sharp-ridged at the higher elevations. The Davidson Mountains, in the northwestern part of the area, are rounded to flat-topped at the higher elevations. Elevation ranges from about 400 feet (120 meters) in the western part of the area, along the boundary with the Interior Alaska Lowlands (MLRA 229), to 6,583 feet (2,007 meters) at the summit of Mt. Harper, in the southeastern part of the area.

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is Yukon (1903). Surface water in this MLRA drains into the Bering Sea via the Yukon, Tanana, and Koyukuk Rivers. The major tributaries of the Yukon River are the Porcupine, Chandalar, Fortymile, and Charley Rivers. The major tributaries of the Tanana River are the Goodpaster, Salcha, Chatanika, and Melozitna Rivers. The upper Kanuti River is the major tributary of the Koyukuk River in this area. Lakes make up less than 2 percent of the area.

This area is in the zone of discontinuous permafrost. Permafrost commonly is close to the surface in areas of the finer textured sediments throughout the MLRA. Isolated masses of ground ice occur in thick deposits of loess on terraces and the lower side slopes of hills. Permafrost generally does not occur on flood plains and south-facing slopes on steep mountains. Periglacial features, such as pingos, thermokarst pits and mounds, ice-wedge polygons, and earth hummocks, are on the lower slopes and in upland valleys, particularly in the Davidson Mountains, in the northwestern part of the area.

Geology

This MLRA generally was glaciated during the Pleistocene epoch only in the highest mountains and in the northern part of the area, where glaciers extended into the area from the Brooks Range. For the most part, glacial moraines and drift are limited to the upper elevations of the highest mountains. Most of the landscape is mantled with bedrock colluvium and slope alluvium originating from the underlying bedrock. Valley bottoms are filled with Holocene fluvial deposits and slope alluvium from the adjacent mountain slopes. Silty loess, which originated from unvegetated flood plains in and adjacent to this area, covers much of the surface. On low hills near the major river valleys, the loess is many feet thick. On high ridges, it is less than 1 foot thick. Bedrock is exposed on the highest ridges. The dominant bedrock types are Paleozoic sedimentary and Permian through Jurassic igneous rocks in the northeastern part of the area, Permian and lower Cretaceous sedimentary and metamorphic rocks in the eastern part, and Precambrian and Paleozoic metamorphic and sedimentary rocks with common Cretaceous intrusives in the southwestern and western parts.

Climate

The average annual precipitation is less than 10 inches (255 millimeters) on valley bottoms and lowlands in the northeastern part of this area and ranges from 20 to 40 inches (510 to 1,015 millimeters) at the higher elevations. The maximum rainfall occurs in late summer, mainly as a result of thunderstorms. Short, warm summers and long, cold winters characterize the subarctic continental climate of the area. The average annual snowfall ranges from about 45 to 100 inches (115 to 255 centimeters). The average annual temperature is about 10 to 16 degrees F (-12 to -9 degrees C) in the northern part of the area and 20 to 25 degrees F (-7 to -4 degrees C) in the southern part. The freeze-free period at the lower elevations averages about 60 to 100 days, and the temperature usually remains above freezing from June through mid-September.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 20%; ground water, 15%
Livestock—surface water, 0%; ground water, 0%
Irrigation—surface water, 0%; ground water, 0%
Other—surface water, 40%; ground water, 25%

The total withdrawals average 2 million gallons per day (7.5 million liters per day). About 40 percent is from ground water sources, and 60 percent is from surface water sources. In most years precipitation is adequate for crops at the lower elevations, but in some years yields are reduced by short dry periods in summer. Permanent streams carry water to nearly all parts of the area. The area has some natural lakes. The surface water in the area is used primarily for public supply and the needs of the forest products industry. It is generally suitable for all uses. Rivers fed by glacial meltwater typically carry high loads of suspended sediment. Flooding from ice dams that form during the spring thaw is a concern in this area.

The ground water used in this area is primarily from unconsolidated sediments in river valleys (alluvium) or from buried glacial outwash deposits in river valleys or on uplands. Most of the measurable water use from these aquifers occurs along the southern edge of this area, near Fairbanks, and along the boundary with the Yukon Flats Lowlands (MLRA 232). This water is hard or very hard but is otherwise of excellent quality. Wells in these aquifers generally are shallow, and the aquifers are constantly recharged with freshwater (rainfall and runoff). As a result, the median level of total dissolved solids is fairly low, about 130 parts per million (milligrams per liter). The level of iron may exceed the secondary standard for drinking water of 300 parts per billion (micrograms per liter). The secondary standard is for esthetics. The iron can stain ceramic and porcelain and precipitate in pipes. Since the aquifers are close to the surface and water moves through them quickly, they are highly susceptible to contamination from runoff. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination.

Small amounts of ground water can be obtained from the bedrock aquifer in this area. This water is similar in quality to that in the unconsolidated sediments.

Soils

The dominant soil orders in this MLRA are Gelisols, Inceptisols, Entisols, and Spodosols. The soils in the area have a subgelic soil temperature class or a cryic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. Many of the soils have a significant content of mica derived from micaceous parent materials.

Histoturbels (Ester and Goldstream series), Aquiturbels (Bradway and Chatanika series), and Haploturbels on north-facing slopes, on south-facing footslopes, and in valleys formed in thick deposits of silty loess or in loess over loamy and gravelly colluvium. On the steeper slopes, these soils commonly have fractured bedrock in their soil profile. The Gelisols on stream terraces formed in loamy alluvial deposits. Fibristels (Lemeta series) and Hemistels (Bolio series) are in depressions on stream terraces and footslopes and in swales on hills and mountains. All of the Gelisols are shallow or moderately deep to permafrost and are poorly drained or very poorly drained. Wildfires can disturb the insulating organic material at the surface, lowering the permafrost layer, eliminating perched water tables from Gelisols, and thus changing the classification. Depending on the frequency of the fires, landform position, and particle size, these soils may or may not revert back to Gelisols. Dystrocryepts (Brigadier and Gilmore series), Eutrocryepts (Fairbanks and Steese series), and Haplocryods formed in silty loess over loamy and gravelly colluvium or in loamy and gravelly colluvium over fractured bedrock on mountain slopes and hillslopes, especially south-facing slopes. On the lower slopes near the major rivers, these soils formed in deposits of loess many feet thick. The loess consists of both windblown material and colluvial silt that eroded and washed down from the adjacent slopes. Inceptisols and Spodosols do not have permafrost within their soil profile, generally are moderately deep or deep, and are well drained. Cryofluvents (Jarvis series) and Cryorthents (Chena series) on flood plains formed in stratified loamy, sandy, and very gravelly alluvium. These soils range from very poorly drained to excessively well drained.

Miscellaneous (nonsoil) areas make up about 2 percent of this MLRA. The most common miscellaneous areas are rock outcrop and rubble land. In many valleys placer mine tailings are common.

Biological Resources

Most of this area is forested below an elevation of about 1,800 to 2,000 feet (550 to 610 meters). White spruce, paper birch, quaking aspen, and mixed forests cover most slopes. White spruce forests and mixed white spruce-balsam poplar forests are common on high flood plains and low terraces. Black spruce woodlands are on steep north-facing slopes, high stream terraces, and other sites with poor drainage and shallow permafrost. Tussock-forming sedges commonly are dominant in the ground layer. Low to tall willow and alder scrub is extensive on low flood plains. Lightning-caused wildfires are common, often burning many thousands of acres during a single fire. Following wildfires, willow, shrub birch, and ericaceous shrub scrub invade most sites until they are eventually replaced by forest vegetation. With increasing elevation, the forests and woodlands give way to low scrub dominated by shrub birch and ericaceous shrubs. At even higher elevations and on shallow soils on mountain slopes and ridges, dwarf alpine scrub dominated by ericaceous shrub, dryas, and shrub birch is common. Many of these communities have a considerable amount of lichen cover and bare ground. Bedrock exposures with only lichens and scattered shrubs and herbs in pockets of fine earth dominate the highest elevations and ridges.

The common species of mammals in this area include moose, caribou, black bear, brown bear, wolf, wolverine, and a variety of small mammals. Dall sheep are in some of the higher mountains. Golden eagles are common at the higher elevations, and peregrine falcons nest in rocky canyons along many rivers. The wetlands in the area provide high-quality habitat for waterfowl, sandhill cranes, and other birds. Clear-water streams support runs of salmon and are important habitat for arctic grayling.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—28%
Forest—70%
Water—1%
Other—1%

Less than 1 percent of this area is used for hay, small grains, potatoes, or other cool-season vegetables. Logging provides important wood products for local use and export. Extractable minerals, particularly gold and silver, occur in certain areas. Mining in this area and in the adjacent Interior Alaska Lowlands (MLRA 229) helped to support settlement and development in the area. Less than 1 percent of the area is urban. Urban development near Fairbanks and wild-land recreation, primarily hunting for moose and other game, are significant land uses. The Alaska road system penetrates much of the area and provides good access for recreational activities. Subsistence hunting, fishing, and gathering provide food and a variety of other resources to local residents.

The major soil resource concerns are erosion of the shallow soils on uplands and disturbance of the fragile permafrost-affected soils. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities should include protection of the organic surface material and the thermal balance of the soils. ■

232—Yukon Flats Lowlands

This area is in the Interior Region of Alaska and includes the broad expanse of lowlands and low hills adjacent to the middle reaches of the Yukon River, known locally as the Yukon Flats (fig. 232-1). The area makes up about 12,785 square miles (33,130 square kilometers). It is not accessible by road, is mostly undeveloped wild land, and is sparsely populated. A number of villages are in scattered areas along the Yukon River and other major rivers. The largest of these villages are Ft. Yukon, Venetie, and Stevens Village. Many fishing and hunting camps, which are occupied seasonally by local residents, are along the rivers. Part of the Yukon Flats National Wildlife Refuge is in this area.

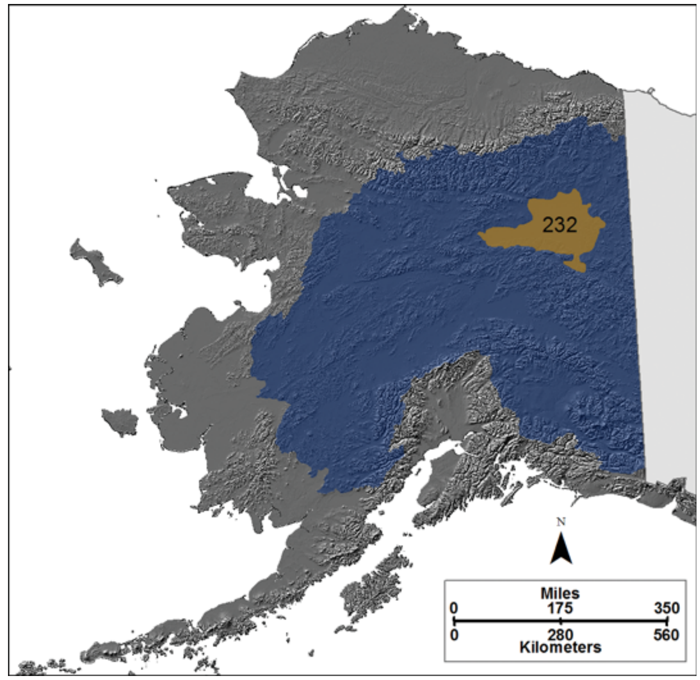

Figure 232-1: Location of MLRA 232 in Land Resource Region X1.

Physiography

This area lies within the Northern Uplands and Lowlands Province of the Intermontane Uplands and Lowlands System. The area consists primarily of a complex of nearly level to undulating, marshy stream terraces and flood plains adjacent to the Yukon River. Thousands of lakes, ponds, and interconnecting wetlands fill depressions, shallow basins, and abandoned river channels across the stream terraces. Flood-plain features include multiple channels and islands, meander scars, oxbow lakes, sloughs, and low escarpments. The water in the lakes and wetlands is maintained by the yearly flooding associated with spring breakup of ice on the Yukon River and its tributaries. Strongly sloping to rolling uplands surround the lowlands. These uplands, which consist of elongated footslopes and coalescing alluvial fans, are at the base of the hills and mountains of the Interior Alaska Highlands (MLRA 231). Elevation ranges from about 300 feet (90 meters) to about 1,000 feet (305 meters).

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is Yukon (1903). Surface water in all of the area drains into the Yukon River and the Bering Sea. On the Yukon Flats, the major tributaries of the Yukon River are the Porcupine, Sheenjek, Black, and Chandalar Rivers. Lakes make up approximately 20 percent of the area.

This area is in the zone of discontinuous permafrost. Permafrost commonly is close to the surface in areas of the finer textured sediments on plains, stream terraces, and the more gently sloping footslopes and hills. Isolated masses of ground ice occur in thick deposits of loess on terraces and the lower side slopes of hills. Permafrost generally does not occur on flood plains and near lakes and other water bodies.

Geology

This area is a broad intermontane tectonic basin filled with Quaternary and earlier glaciofluvial and fluvial sediments. In the central part of the basin, the glaciofluvial and fluvial deposits overlie lacustrine sediments. Unconsolidated sediments are estimated to be 300 to 400 feet (90 to 120 meters) or more thick near the center of the basin. Along the edge of the basin, much of the landscape is mantled with a thick layer of silty loess of Pleistocene and Holocene age. Sand dunes cover some areas. Fluvial and eolian sediments continue to be deposited today. The underlying bedrock geology is completely buried by unconsolidated sediments.

Climate

The average annual precipitation ranges from about 6 inches (150 millimeters) in the central basin to 15 inches (380 millimeters) along the boundary with the surrounding highlands. The maximum precipitation occurs in late summer, mainly as a result of thunderstorms. The average annual snowfall is about 45 to 55 inches (115 to 140 centimeters). Short, warm summers and long, very cold winters characterize the subarctic continental climate of the area. The surrounding hills and mountains of this MLRA partially isolate it from weather systems affecting other interior lowlands. As a result, temperatures are generally warmer in summer and colder in winter than is characteristic in other areas of comparable latitude. The average annual temperature ranges from about 20 to 25 degrees F (-7 to -4 degrees C). The freeze-free period averages 70 to 120 days. The temperature usually remains above freezing from early June through late August.

Water

There are very limited withdrawals of freshwater for use in this sparsely populated MLRA. Most of the communities in the area are along the major rivers or lakes. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Also, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. If surface water is available, treatment for removal of the suspended sediment would normally be required. For these reasons, most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners probably obtain ground water from the unconsolidated sediments in river valleys (alluvium or glacial outwash). There are typically no test data available on ground water in sparsely populated areas. These aquifers are open to the surface, so they are highly susceptible to contamination from surface activities. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination.

Soils

The dominant soil orders in this MLRA are Gelisols, Inceptisols, and Entisols. The soils in the area have a subgelic soil temperature class or a cryic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy.

Aquiturbels and Histoturbels formed in loamy, sandy, and gravelly alluvial deposits on nearly level stream terraces and in silty loess over loamy slope alluvium on elongated footslopes. Histoturbels have a moderately thick organic surface layer over mineral material. Fibristels and Hemistels in abandoned channels and depressions on stream terraces and on the margins of lakes formed in thick layers of organic material. The Gelisols are shallow or moderately deep to permafrost and are poorly drained or very poorly drained. Wildfires disturb the insulating organic material at the surface, lowering the permafrost layer and eliminating perched water tables from some Gelisols. Depending on the frequency of the fires, landform position, and particle size, these soils may or may not revert back to Gelisols. Eutrocryepts, Dystrocryepts, and Cryaquepts on nearly level stream terraces, rolling uplands, and bluffs along the major river channels formed in a moderately thick or thick layer of silty loess over alluvial material. Some of these soils formed in calcareous loess. Cryorthents and Cryofluvents on flood plains and low stream terraces formed in loamy, sandy, and gravelly alluvium. These soils range from very poorly drained to excessively drained. Very poorly drained Cryofibrists and Cryohemists along lake margins and in abandoned channels and depressions on stream terraces formed in thick layers of organic material.

Miscellaneous (nonsoil) areas make up about 20 percent of this MLRA. The most common miscellaneous areas are riverwash and water.

Biological Resources

The productive, well drained soils on uplands in this area have white spruce, paper birch, quaking aspen, and mixed white spruce-paper birch-quaking aspen forests. Balsam poplar and mixed white spruce-hardwood forests are on high flood plains and low stream terraces. Stunted black spruce and white spruce woodland of low productivity occurs on high stream terraces and on cold, wet sites with shallow permafrost. Tussock-forming sedges and mosses commonly are dominant in the ground layer. Paper birch and, in places, tamarack occur in association with spruce on permafrost-affected flats. Lightning-caused wildfires are common, often burning many thousands of acres during a single fire. Following wildfires, willow, shrub birch, and ericaceous shrub scrub invade most sites until they are eventually replaced by forest vegetation. On all forest and woodland sites, post-fire succession leads to a relatively rapid accumulation of organic matter and moss on the surface. This accumulation results in a decrease in soil temperature, biologic activity, and nutrient availability and a gradual decrease in site productivity. Tall and low scrub dominated by willow and alder is common on low flood plains. The wettest sites dominantly support tall to low alder and willow scrub, sedge-shrub meadows, sedge meadows, and sedge-moss bog meadows.

The common species of mammals in the area are moose, black bear, brown bear, wolf, caribou, wolverine, lynx, and a variety of small mammals. The wetlands in the area provide high-quality nesting habitat for tundra swans and a wide variety of geese and ducks. Sandhill cranes and a variety of raptors, grouse, and passerine birds inhabit the area. The important fish in the rivers and lakes include salmon, arctic grayling, whitefish, northern pike, blackfish, and burbot.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—8%
Forest—72%
Water—20%

Most of this area still supports natural vegetation and is used primarily for subsistence hunting, fishing, and gathering by local residents. Forests accessible from the villages provide timber for local use. People from outside the MLRA use the area for hunting and other kinds of wild-land recreation.

The major soil resource concern is flooding. Most communities are in areas on the banks of the major rivers and streams where flooding is a severe hazard. The flooding is associated with spring snowmelt and runoff from the adjacent mountains, with ice jamming on rivers during periods of breakup, and occasionally with high-intensity summer thunderstorms. On permafrost-affected soils, disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities should include protection of the organic surface material and the thermal balance of the soils. ■

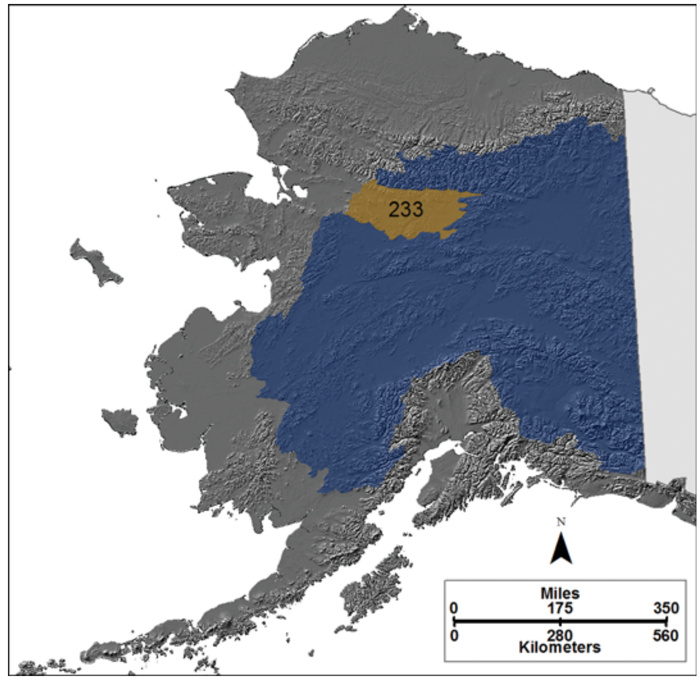

Figure 233-1: Location of MLRA 233 in Land Resource Region X1.

233—Upper Kobuk and Koyukuk Hills and Valleys

This area is in the Interior Region of Alaska and includes nearly level lowlands, rolling uplands, and isolated hills and low mountains along the upper Kobuk River from approximately its confluence with the Pau River east to the Kanuti Flats along the middle Koyukuk River (fig. 233-1). The area makes up about 12,910 square miles (33,455 square kilometers). It is primarily undeveloped wild land and is sparsely populated. The principal communities are the villages of Kobuk in the western part of the area and Bettles, Alatna, and Allakaket in the eastern part. A major part of Gates of the Arctic National Park and Preserve and the Kanuti National Wildlife Refuge are in this area.

Physiography

This area lies within the Western Alaska Province of the Intermontane Uplands and Lowlands System. The area is in broad, nearly level river valleys, in shallow basins, and on rolling uplands separated by isolated hills and low, rounded mountains. In the river valleys, nearly level flood plains and stream terraces gradually give rise to gently sloping to moderately steep slopes leading to the hills and mountains. Extensive, nearly level to undulating basins are on the Pau River Flats between the eastern Zane and Lockwood Hills, on the Kanuti Flats between the Kanuti and Koyukuk Rivers, and along the middle reaches of the Hogatza River. Shallow basins and depressions on stream terraces are dotted with hundreds of lakes and interconnecting wetlands. Elevation ranges from about 150 feet (45 meters) in the western part of the area, at the confluence of the Kobuk and Mauneluk Rivers, to 4,765 feet (1,453 meters) at the summit of Fritts Mountain, in the Angaycuham Mountains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Yukon (1903), 72 percent, and Northwest Alaska (1902), 28 percent. Surface water in the western third of this MLRA drains into the Kobuk River and eventually into Kotzebue Sound and the Chukchi Sea. The major tributaries of the Kobuk River are the Reed, Beaver, Mauneluk, and Pau Rivers. Surface water in the the eastern part of the MLRA drains into the Koyukuk River and eventually into the Yukon River and the Bering Sea. The major tributaries of the Koyukuk River are the Alatna, John, and Kanuti Rivers. The area has a complex of ponds and small lakes in basins and on stream terraces. Also, there are a number of large lakes within and on the edge of the area. The principal lakes are Walker Lake, Nutuvukti Lake, Naruak Lake, and Lake Shelby. Lakes make up about 5 percent of the area.

This area is in the zone of discontinuous permafrost. Permafrost is commonly close to the surface in areas of the finer textured sediments throughout the MLRA. Isolated masses of ground ice occur on terraces and the lower side slopes of hills. Permafrost generally does not occur on flood plains or on steep south-facing slopes. Periglacial features, such as pingos, thermokarst pits and mounds, ice-wedge polygons, and earth hummocks, are on the lower slopes and in upland valleys.

Geology

The northern part of this area was covered repeatedly by Pleistocene glaciers originating in the Brooks Range to the north. Slightly modified to highly modified moraines and drift cover many of the rolling uplands. Glacial ice flowed over most of the hills and low mountains, removing existing deposits and leaving a thin layer of glacial deposits. Today, the lower mountain slopes, hills, and valley bottoms are covered with a variety of material, including glacial drift, colluvium, slope alluvium, fluvial deposits, and silty loess. In the southern part of the area, basins and valleys are filled with Quaternary glaciofluvial and fluvial deposits. Hills and upland slopes are covered with bedrock colluvium and slope alluvium, which are mantled with loess in places. The bedrock geology underlying much of the area consists dominantly of Permian through lower Cretaceous stratified sedimentary and volcanic rocks.

Climate

The average annual precipitation ranges from 10 to 20 inches (255 to 510 millimeters) on valley bottoms and in basins and from 20 to 40 inches (510 to 1,015 millimeters) at the higher elevations in the hills and mountains. Most of the precipitation falls as rain between May and September. Short, warm summers and long, cold winters characterize the subarctic continental climate of the area. The average annual snowfall ranges from about 65 to 80 inches (165 to 205 centimeters). The average annual temperature is about 20 to 22 degrees F (-7 to -6 degrees C). The freeze-free period ranges from less than 30 days to about 90 days. Normally, the temperature remains above freezing from mid-June through August in river valleys and basins.

Water

There are very limited withdrawals of freshwater for use in this sparsely populated MLRA. Most of the communities in the area are along the major rivers or lakes. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Also, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. If surface water is available, treatment for removal of the suspended sediment would normally be required. For these reasons, most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners probably obtain ground water from bedrock aquifers or from the unconsolidated sediments in river valleys (alluvium or glacial outwash). There are typically no test data available on ground water in sparsely populated areas. The unconsolidated sediments aquifer is open to the surface, so it is highly susceptible to contamination from surface activities. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination.

Soils

The dominant soil orders in this MLRA are Gelisols, Inceptisols, and Entisols. The soils in the area have a subgelic soil temperature class or a cryic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy.

Aquiturbels and Haploturbels on stream terraces, hills, and upland slopes formed in silty loess or alluvium over very gravelly loamy alluvium and glacial drift. Hemistels are in areas of peat plateaus, palsas, and depressions on hills and upland slopes. Fibristels are in sloughs and depressions on stream terraces and on the margins of lakes. The Gelisols generally are shallow or moderately deep to permafrost and are poorly drained or very poorly drained. Wildfires can disturb the insulating organic material at the surface, lowering the permafrost layer, eliminating perched water tables from Gelisols, and thus changing the classification. Depending on the frequency of the fires, landform position, and particle size, the soils may or may not revert back to Gelisols. Eutrocryepts, Dystrocryepts, and Cryorthents on upland slopes, shoulders, and the crests of hills, and occasionally on stream terraces, formed in silty loess over very gravelly loamy colluvium, glacial till, and alluvium. These soils do not have permafrost within their soil profile, are deep, and are moderately well drained to excessively drained. Cryofluvents and Cryorthents on flood plains formed in stratified loamy, sandy, and very gravelly alluvium. These soils range from very poorly drained to excessively drained.

Miscellaneous (nonsoil) areas make up about 8 percent of this MLRA. The most common miscellaneous areas are rock outcrop and water.

Biological Resources

Most of this MLRA is in areas of open black spruce forests and black spruce woodland. Open white spruce forests and tall alder scrub with common white spruce are on active flood plains and steep mountain slopes with a southern aspect. On the drier sites and in areas of recent burns, paper birch and quaking aspen occur along with black spruce. Lightning-caused wildfires are common, often burning many thousands of acres during a single fire. Following wildfires, willow, shrub birch, and ericaceous shrub scrub invade most sites until they are eventually replaced by forest vegetation. On all forest and woodland sites, post-fire succession leads to a relatively rapid accumulation of organic matter and mosses on the surface. This accumulation results in a decrease in soil temperature, biologic activity, and nutrient availability and a gradual decrease in site productivity. Nonforest vegetation includes low to tall willow, shrub birch, and ericaceous shrub scrub in areas of peat, in drainageways, and in areas above an elevation of about 2,000 feet (610 meters). Moist sedge meadows, commonly with tussock-forming sedges, are on nearly level uplands. Wet sedge meadows and sedge-moss bog meadows are along the margins of lakes and on continuously ponded sites. Low to tall willow scrub with common balsam poplar is on low flood plains.

The common species of mammals in the area include brown bear, black bear, caribou, moose, wolf, beaver, and a variety of small mammals. The ponds and wetlands in the area provide high-quality habitat for tundra swans and other waterfowl. Bald eagles are common along most of the rivers. Arctic grayling, burbot, northern pike, sheefish, and whitefish are in the rivers and lakes in the area.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—16%
Forest—76%
Water—5%
Other—3%

Most of this area still supports natural vegetation and is used primarily for subsistence hunting, fishing, and gathering by local residents. The major soil resource concern is disturbance of the fragile permafrost-affected soils. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities should include protection of the organic surface material and the thermal balance of the soils. ■

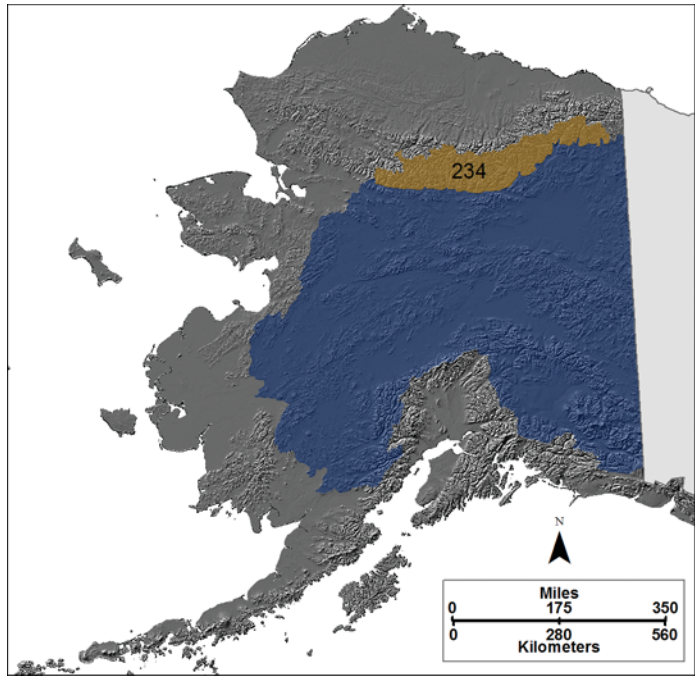

Figure 234-1: Location of MLRA 234 in Land Resource Region X1.

234—Interior Brooks Range Mountains

This area is in the Interior Region of Alaska and includes the high mountains and valleys on the southern side of the Brooks Range (fig. 234-1). The area makes up about 19,245 square miles (49,875 square kilometers). It is almost entirely remote wild land and is sparsely populated. The Dalton Highway (known locally as the Haul Road) bisects the Brooks Range at Atigun Pass. Anaktuvuk Pass and Arctic Village are two remote villages in this MLRA. Coldfoot, Wiseman, and Dietrich Camp, along the Dalton Highway, are the only other permanent settlements. Extensive portions of the Gates of the Arctic National Park and Preserve and the Arctic National Wildlife Refuge are in this area.

Physiography

This area lies within the Arctic Mountains Province of the Rocky Mountain System. The Brooks Range is the most northerly extension of the Rocky Mountains. The terrain consists dominantly of steep, rugged, high mountains and narrow, high-gradient valleys. At the upper elevations, the mountains are generally rocky and have sharp ridges. Small glaciers occur in some areas at the higher elevations. The lower mountain slopes are characterized by coalescing alluvial and colluvial fans and steep footslopes, many of which extend down and into the stream channels. Narrow, discontinuous flood plains are in the wider, more gently sloping parts of the valleys. The bottoms of valleys along the larger rivers and streams have nearly level flood plains and stream terraces. Elevation ranges from about 1,600 feet (490 meters) to nearly 8,000 feet (2,440 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Yukon (1903), 90 percent; Northwest Alaska (1902), 9 percent; and Arctic Slope (1901), 1 percent. Surface water in this MLRA drains entirely into the Yukon River system and the Bering Sea. The major rivers that have their headwaters in the area are the Sheenjek, Chandalar, Koyukuk, John, and Alatna Rivers. Lakes make up less than 5 percent of the area.

This area is in the zone of discontinuous permafrost. Permafrost generally is close to the surface only in areas of the finer textured sediments on stream terraces and in swales on hills and footslopes. Periglacial features include gelifluction lobes, polygons, and stripes.

Geology

During the early and middle Pleistocene epoch, glacial ice buried most of this area. By the late Pleistocene epoch, only the highest valleys and mountains were still glaciated. Most glacial deposits have eroded away or have been buried by mountain colluvium and slope alluvium, which accumulated during the Holocene epoch across about 95 percent of the landscape. Slightly modified to highly modified glacial moraines, drift, and outwash deposits occur in some areas on the lower mountain slopes and in valleys at the lower elevations. Recent and Pleistocene fluvial deposits are on flood plains, stream terraces, and alluvial fans. The underlying bedrock geology consists almost entirely of stratified sedimentary rocks of Paleozoic and Precambrian age. The eastern part of the area includes Paleozoic and early Jurassic volcanic and igneous rocks.

Climate

The average annual precipitation ranges from about 10 to 15 inches (255 to 380 millimeters) on valley bottoms at the lower elevations and from 20 to 30 inches (510 to 760 millimeters) at the highest elevations. The average annual snowfall is about 60 to 100 inches (150 to 255 centimeters). Short, cool summers and long, cold winters characterize the subarctic continental climate of the area. Strong winds are common at the higher elevations in mountain valleys. The average annual temperature ranges from 8 to 16 degrees F (-13 to -9 degrees C). The length of the freeze-free period is not known. Freezing temperatures can occur throughout the year, and extended periods of extreme cold are common during most winters.

Water

There are very limited withdrawals of freshwater for use in this sparsely populated MLRA. The few communities in the area are along the Haul Road. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Also, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. If surface water is available, treatment for removal of the suspended sediment would normally be required. For these reasons, most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities, rural landowners, and miners probably obtain ground water from the bedrock aquifer or the unconsolidated sediments in river valleys (alluvium or glacial outwash). There are typically no test data available on ground water in sparsely populated areas. The unconsolidated sediments aquifer is open to the surface, so it is highly susceptible to contamination from surface activities. Septic systems, landfills, leaking fuel storage tanks, and mine waste are all possible sources of contamination.

Soils

The dominant soil orders in this MLRA are Gelisols, Entisols, and Inceptisols. The soils in the area have a subgelic soil temperature class or a cryic soil temperature regime, a udic or aquic soil moisture regime, and mixed mineralogy.

Histoturbels and Aquiturbels on the lower mountain slopes, elongated footslopes, and stream terraces formed in loamy to cobbly colluvium, slope alluvium, and fluvial deposits. Many of these soils have a mineral surface layer of silty loess. Histoturbels have a moderately thick surface layer of organic material. Turbels, Gelepts, and Gelolls on mountain slopes, hillslopes, ridges, and fans formed in loamy and gravelly colluvium over fractured bedrock and loamy glacial drift. Fibristels and Hemistels in depressions and on the margins of lakes formed in thick layers of organic material. The Gelisols are shallow or moderately deep to permafrost and range from somewhat poorly drained to very poorly drained. Wildfires can disturb the insulating organic material at the surface, lowering the permafrost layer, eliminating perched water tables from Gelisols, and thus changing the classification. Depending on the frequency of the fires, landform position, and particle size, the soils may or may not revert back to Gelisols. Cryorthents, Eutrocryepts, and Dystrocryepts on south-facing slopes and ridges in the foothills and on the bottoms of narrow, steep valleys formed in loamy to very gravelly colluvium, fractured bedrock residuum, and glacial drift. Cryofluvents and Cryorthents on flood plains and natural levees along streams formed in loamy, sandy, and gravelly alluvium. Inceptisols and Entisols do not have permafrost within their soil profile and range from excessively drained to poorly drained.

Miscellaneous (nonsoil) areas make up about 63 percent of this MLRA. The most common miscellaneous areas are rock outcrop, rubble land, riverwash, and glaciers.

Biological Resources

Because of the shallow soils, strong winds, and harsh climate, vegetation is sparse in this area. It generally is limited to valleys and the lower mountain slopes. Dwarf scrub communities on mountain slopes and ridges are dominated by black crowberry, ericaceous shrubs, dryas, and dwarf willow. On shallow, rocky soils and exposed sites, lichens and scattered herbs dominate the ground layer. Bare soil and exposed bedrock generally are extensive. On the more mesic sites, sedges, forbs, and mosses cover most of the surface. The lower elevations and the deeper soils in basins and on terraces are dominated by white spruce and mixed spruce-hardwood forests and woodland, low willow and ericaceous shrub scrub, and mesic graminoid herbaceous communities. Black spruce woodlands, commonly with extensive areas of tussock-forming sedges, are common on high stream terraces and mountain footslopes. Depressions, drainageways, and other saturated areas have wet sedge meadows and wet sedge-moss meadows. Low and tall willow scrub is dominant on flood plains.

The most common species of mammals in the area include brown bear, black bear, wolf, caribou, and Dall sheep. The smaller mammals include marmot, red fox, arctic fox, wolverine, ground squirrel, lemming, and pika. The most common raptors are golden eagles, marsh hawks, and snowy owls in many areas.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—24%
Forest—13%
Water—5%
Other—58%

Most of this area still supports natural vegetation and is used primarily for subsistence hunting, fishing, and gathering by local residents. The area also is widely used for sport hunting and other kinds of wild-land recreation. Most visitors are served by air taxi, guiding, and outfitting companies operating out of the major Alaska communities. Mineral resources, including gold, silver, and copper, have been mined in a number of areas. Sand and gravel pits are along the Dalton Highway. The major resource concerns in this area are maintaining the protective plant cover and maintaining the thermal balance of permafrost-affected soils. ■

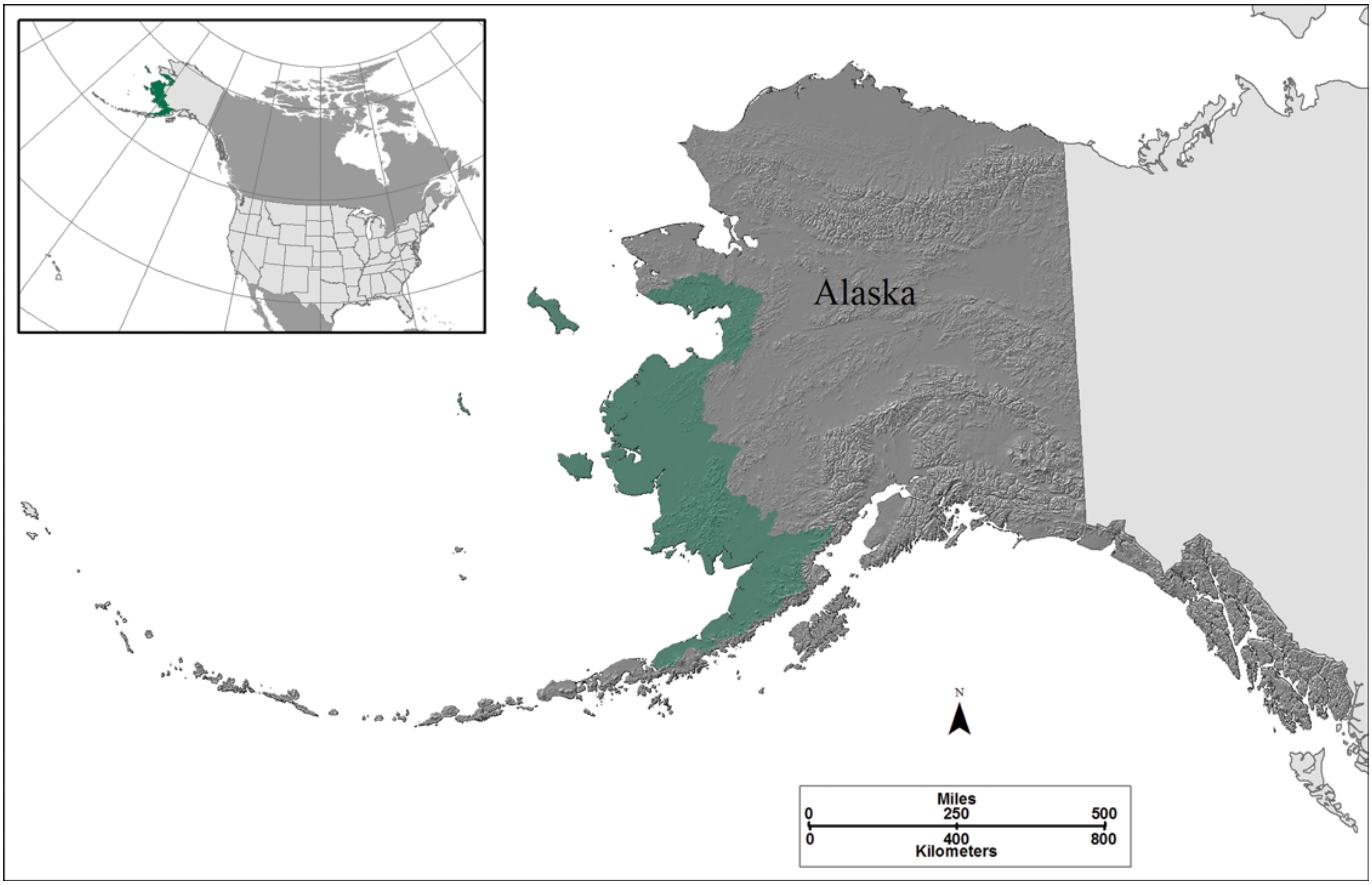

Figure X2-1: Location of Land Resource Region X2.

X2—Western Alaska

This region is in the western part of Alaska (fig. X2-1). It is near the Bering Sea from the Alaska Peninsula and Bristol Bay lowlands to the southern Seward Peninsula. The region includes the northern Bering Sea islands. It makes up 91,300 square miles (236,585 square kilometers).

This region consists of diverse landforms, including mountains, hills, coastal plains, outwash plains, stream terraces, volcanic cinder cones, and dunes. Elevation ranges from sea level to about 7,000 feet (2,135 meters). The Ahklun, Kilbuck, and Alaska Peninsula Mountains are generally steep and rugged. Rolling hills, low mountains, and broad valleys characterize the Nulato Hills, the Seward Peninsula, and the northern Bering Sea islands. The rest of the region consists of coastal lowlands and rolling uplands. Lakes and interconnecting wetlands cover as much as 80 percent of the coastal lowlands. Permafrost is discontinuous across the region. It is prevalent on coastal plains, terraces, and footslopes, but it normally does not occur on steep slopes or on flood plains. Patterned ground and gelifluction lobes are common in many of the permafrost-affected areas.

The climate ranges from maritime near the coast to subarctic continental away from the coast and at the higher elevations. In the northern part of the region, the winter climate becomes more continental as the icepack forms in the Bering Sea. Summers are short and warm, and winters are long and cold. In summer cloudy conditions are common along the coast. The annual precipitation throughout the region ranges from about 13 to 80 inches (330 to 2,030 millimeters). The amount of precipitation is lowest in lowland areas and the Nulato Hills and increases markedly at the higher elevations of the Ahklun and Alaska Peninsula Mountains. The average annual temperature ranges from 25 to 36 degrees F (-4 to 2 degrees C). It varies most in the mountainous areas. Frost may occur in any month. Strong winds are common, especially in winter. Snow covers the ground for approximately 7 to 9 months each year.

The total withdrawals of freshwater in this region average just under 1 million gallons per day (3.5 million liters per day). About 67 percent is from surface water sources, and 33 percent is from ground water sources. About 55 percent of the water is used for public supply in the coastal towns and communities. The rest is used mainly in mines and in some small-scale seafood-processing plants.

Figure X2-2: Reindeer grazing in an area of Land Resource Region X2.

Gelisols, which have permafrost in their profile, occur throughout the region and make up about 45 percent of the soil types. Orthels and Turbels are on level to sloping coastal plains and terraces as well as on footslopes and in swales in the hills and mountains. Mollorthels and Molliturbels are typical in the limestone uplands of the northern Bering Sea islands. Histels are in most of the depressions throughout the region. Coarse textured Gelepts and Gelolls with a cryic soil temperature regime are on steep slopes in the mountainous areas. Well drained Cryepts and Cryolls are on moraines and outwash plains. Cryands are in areas where volcanic ash and loess mantle older landforms and in areas along the flanks of cinder cones. Well drained Cryods are in scattered areas on uplands throughout the region. Fluvents are on flood plains and levees, and Psamments are in areas of dunes.

Arctic tundra and alpine tundra dominated by low and dwarf scrub and herbaceous communities are dominant throughout most of this region. Tussock tundra occurs across broad expanses of uplands. Wet sedge and sedge-grass meadows, sedge-moss meadows, and sedge-shrub meadows are on coastal wetlands and in poorly drained areas in drainageways. Of limited extent on valley bottoms, on well drained soils at the lower elevations, are open forests and woodland of white and black spruce and, in places, paper birch and balsam poplar. Low and tall scrub, dominated by alder and willow, is common on mid-mountain slopes and flood plains. Land use throughout the region includes reindeer herding (fig. X2-2), mining, wildlife habitat, and subsistence hunting, fishing, and gathering. ■

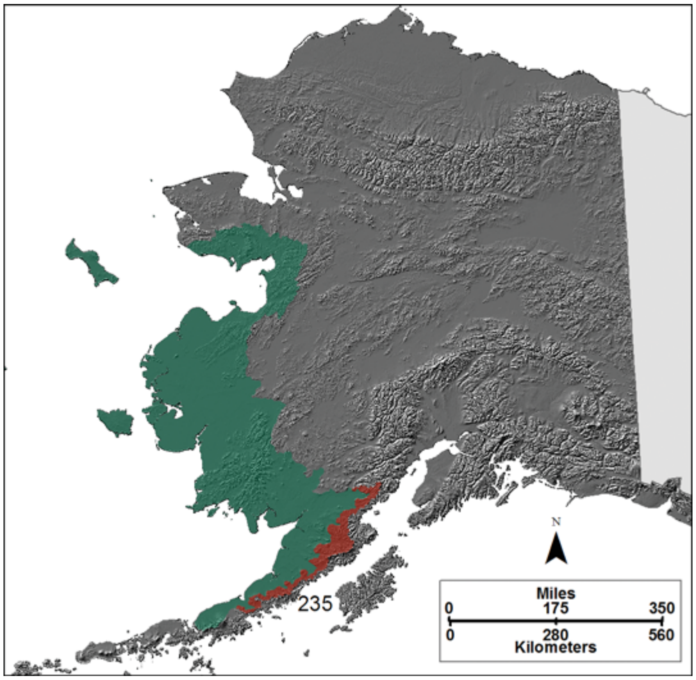

Figure 235-1: Location of MLRA 235 in Land Resource Region X2.

235—Northern Alaska Peninsula Mountains

This area is in the Western Region of Alaska and includes the northwest-facing slopes of the southern Aleutian Mountains (fig. 235-1). It makes up about 5,715 square miles (14,815 square kilometers). It is mostly undeveloped wild land and is sparsely populated. The only permanent settlements in the area are several small villages and remote recreational lodges. Parts of the Katmai National Park and Preserve, the Alaska Peninsula National Wildlife Refuge, and the Becharof National Wildlife Refuge are in this area.

Physiography

This area lies within the Alaska-Aleutian Province of the Pacific Mountains System. The terrain consists primarily of rugged, low to moderately high mountains deeply dissected with narrow, high-gradient valleys. On the highest peaks in the area, glaciers and small ice fields are common. Glaciers and permanent ice and snow make up about 2 percent of the area. In steep, narrow valleys, coalescing fans, footslopes, and small stream channels are contiguous downslope. At the lower elevations, along the boundary with the Bristol Bay-Northern Alaska Peninsula Lowlands (MLRA 236), flood plains and stream terraces are common on valley bottoms. Elevation ranges from about 14 feet (4 meters) along the shoreline of Becharof Lake to more than 7,000 feet (2,135 meters) at the summits of Mt. Veniaminof and Mt. Douglas.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Southwest Alaska (1904), 97 percent, and South Central Alaska (1905), 3 percent. Surface water in this MLRA drains into the Bristol Bay-Northern Alaska Peninsula Lowlands (MLRA 236) via numerous short, high-gradient streams and creeks that originate in the high basins and glaciers of the mountains. The headwaters of the Kvichak, Naknek, King Salmon, and Egegik Rivers originate in this MLRA. Lakes make up about 3 percent of the area.

Geology

Except for the highest peaks and steep ridges at the higher elevations, the entire area was covered by glacial ice during the late Pleistocene epoch. During the Holocene epoch, glacial deposits across much of the area eroded away or were buried by colluvium and slope alluvium. Mountain colluvium and alluvium cover about 50 percent of the present landscape. Slightly modified glacial moraines and drift and scattered areas of glaciofluvial deposits are extensive on the lower mountain slopes and in valleys at the lower elevations. Volcanic activity on Mt. Katmai and other volcanoes on the lower Alaska Peninsula and the Aleutian Islands has deposited a layer of volcanic ash across much of the landscape at the lower elevations. The dominant geologic formations underlying most of the area are upper Jurassic and some Cretaceous and lower Tertiary stratified sedimentary rocks. Jurassic intrusive rocks and Tertiary and Quaternary volcanic rocks are common locally, particularly in the vicinity of volcanoes.

Climate

The average annual precipitation ranges from 30 inches (760 millimeters) at the lower elevations in this area to more than 100 inches (2,540 millimeters) at the higher elevations. The climate in the area is influenced by the maritime conditions of Bristol Bay and the Bering Sea in the western part of the area, by spillover effects from the North Pacific to the southeastern part of the area, and by the orographic effects of the rugged mountainous environment. Summers are short, cool, and frequently cloudy and rainy. Windy conditions are common throughout the year. Winters are long and cold, generally with deep snow. The average annual snowfall is about 50 to 200 inches (125 to 510 centimeters). The average annual temperature and the length of the freeze-free period are not known. Freezing temperatures are likely to occur during any month of the year, particularly at the higher elevations.

Water

There are very limited withdrawals of freshwater for use in this sparsely populated MLRA. The few communities in the area and the recreational lodges are generally on the coast. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are probably frozen for much of the year or flow little during winter. Also, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. If surface water is available, treatment for removal of the suspended sediment would normally be required. For these reasons, most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners probably obtain ground water primarily from bedrock aquifers. Some wells may be in unconsolidated sediments in river valleys (alluvium or glacial outwash). There are typically no test data available on ground water in sparsely populated areas. If these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination.

Soils

The dominant soil orders in this MLRA are Andisols and Histosols. The soils in the area have a cryic soil temperature regime or a subgelic soil temperature class, a udic or aquic soil moisture regime, and amorphic or mixed mineralogy.

Haplocryands on the lower mountain slopes, fans, and stream terraces formed in a moderately thick or thick layer of silty volcanic ash over various materials, including loamy, gravelly, and cobbly colluvium, glacial drift, and slope alluvium. Haplocryands on the upper mountain slopes and ridges formed in a thin or moderately thick layer of volcanic ash over cobbly colluvium and slope alluvium over bedrock residuum. These soils generally are well drained. Cryofibrists on valley bottoms and in depressions formed in thick deposits of organic material. These soils are poorly drained or very poorly drained.

Miscellaneous (nonsoil) areas make up about 43 percent of this MLRA. The most common miscellaneous areas are riverwash, rock outcrop, rubble land, and glaciers.

Biological Resources

The lower elevations in this area generally support tall scrub dominated by alder and willow. Balsam poplar forests, with tall shrub and herbaceous understory, are on flood plains and some south-facing mountain slopes. With increasing elevation, tall scrub rapidly gives way to low scrub dominated by willow, ericaceous shrubs, and various graminoids and forbs. Grasslands of bluejoint reedgrass are in scattered areas throughout the scrub. At the highest elevations and on exposed ridges and steep slopes where the soils are shallow over bedrock, dwarf scrub is dominant. Crowberry, ericaceous shrubs, willow, bryophytes, and lichens generally dominate dwarf shrub communities. Poorly drained areas and areas of peat support low scrub and sedge-grass meadows.

Some of the major species of mammals in the area are brown bear, Dall sheep, moose, wolf, and coyote. Ptarmigan, American golden plovers, golden eagles, and a wide variety of other birds are common in many places.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—53%
Forest—4%
Water—3%
Other—40%

This area is mostly remote wild land and is used for recreation. Most visitors are served by air taxi, guiding, and outfitting companies operating out of the major Alaska communities. Subsistence hunting, fishing, and gathering provide food and a variety of other resources to local residents. ■

236—Bristol Bay-Northern Alaska Peninsula Lowlands

This area is in the Western Region of Alaska and includes the nearly level to rolling lowlands, uplands, and isolated hills adjacent to Bristol Bay (fig. 236-1). The area makes up about 19,575 square miles (50,725 square kilometers). It is mostly undeveloped wild land and is sparsely populated. The principal communities are Dillingham, Naknek, and King Salmon. Numerous other villages are in scattered areas throughout the MLRA, primarily along the major rivers and the shoreline of lakes. Parts of the Katmai and Aniakchak National Parks and Preserves and the Alaska Peninsula, Becharof, Togiak, and Alaska Maritime National Wildlife Refuges are in this area.

Physiography

This area lies within the Western Alaska Province of the Intermontane Uplands and Lowlands System. The terrain consists dominantly of a broad expanse of gently sloping to rolling plains and low- or moderate-relief hills bordered by moderately sloping, elongated mountain footslopes. Depressions and shallow basins on terraces and plains are dotted with small and medium-size lakes and interconnecting stream channels and wetlands. To the west, along the border

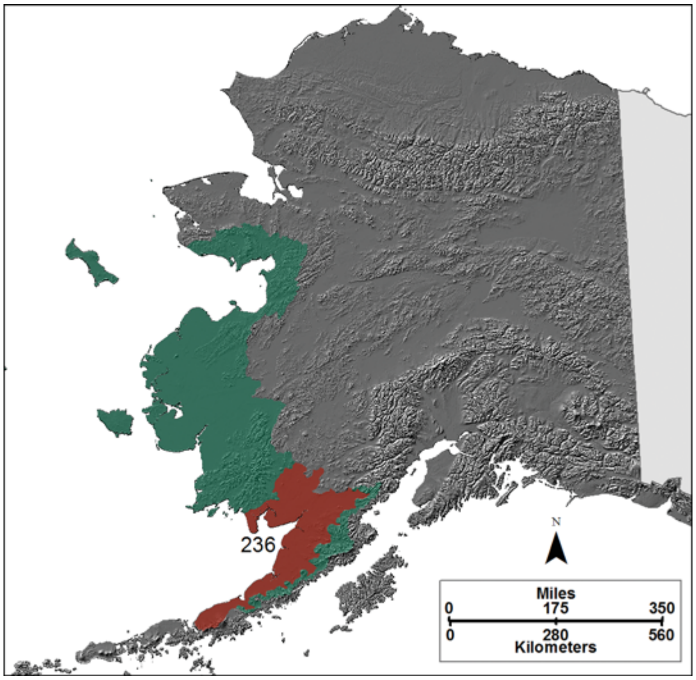

Figure 236-1: Location of MLRA 236 in Land Resource Region X2.

with the Ahklun Mountains (MLRA 237), and to the east, along the border with the Northern Alaska Peninsula Mountains (MLRA 235), large lakes behind terminal moraines extend from the mountain valleys out onto the plains. Narrow, low-gradient, meandering flood plains and low stream terraces are along the major rivers in the central part of the area. In the southwestern part of the area, short, high-gradient rivers and streams originating in the adjacent mountains have formed broad, braided alluvial fans and flood plains. Isolated hills and rounded, low-relief mountains are in scattered areas throughout the inland part of the MLRA. Elevation ranges from sea level along the coast of Bristol Bay to about 2,500 feet (760 meters) in the mountains.

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is Southwest Alaska (1904). Surface water in this MLRA drains entirely into Bristol Bay. The major rivers are the Egegik, Kvichak, Mulchatna, Naknek, Nushagak, Ugasik, and Wood Rivers. Most of the rivers and streams are meandering. The large lakes in the Aleutian Range include Lake Grosvenor and Iliamna, Kukaklek, Nonvianuk, Naknek, and Becharof Lakes. The Wood-Tikchik Lakes system is in the western part of the area, along the Ahklun Mountains. Lakes make up about 10 percent of the area.

This area is in the zone of discontinuous permafrost. Permafrost generally is at a considerable depth below the surface and occurs primarily in areas of the finer textured sediments on stream terraces, rolling uplands, and gently sloping footslopes. Isolated masses of ground ice occur in some areas of glacial drift and other unconsolidated materials. Permafrost generally does not occur on flood plains, near the coast, or in the southern part of the area.

Geology

During the early to middle Pleistocene epoch, the entire area was covered with glacial ice originating in the Aleutian Range to the east and the Ahklun Mountains to the west. Little glaciation remained by the late Pleistocene, except possibly in the higher hills and foothills near the mountains. Today, Pleistocene-age moraines, drift, and glaciofluvial deposits cover approximately 60 percent of the area. Elsewhere, mixed Holocene and Pleistocene fluvial and coastal deposits are dominant. Interlayered alluvial and marine sediments occur on the Nushagak Peninsula in the western part of the MLRA and in coastal areas in the eastern and southern parts. Much of the area has been mantled with a layer of silty volcanic ash and loess of varying thickness from regional volcanoes and unvegetated flood plains and outwash plains. The underlying bedrock geology consists primarily of Tertiary and Quaternary stratified sedimentary rocks. Tertiary volcanic rocks are of minor extent in scattered areas near the Aleutian Mountains.

Climate

The average annual precipitation in this area is 13 to 50 inches (330 to 1,270 millimeters), generally increasing with distance from the coast and with elevation. The climate of the area is strongly maritime near the coast of Bristol Bay. Continental weather systems from Interior Alaska probably have a significant influence farther inland, particularly in the winter. Summers are short and warm. Cloudy conditions and rain are common in summer. Winters are long and cold. The average annual snowfall is about 30 to 80 inches (75 to 205 centimeters). The average annual temperature ranges from 30 to 36 degrees F (-1 to 2 degrees C). The freeze-free period averages about 70 to 125 days.

Water

There are very limited withdrawals of freshwater for use in this sparsely populated MLRA. The only measurable withdrawal is for seafood-processing plants (0.2 million gallons, or 0.8 million liters, per day). Most of the communities in the area are on the coast or along the major rivers and lakes. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Also, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. If surface water is available, treatment for removal of the suspended sediment would normally be required. For these reasons, most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners probably obtain ground water primarily from unconsolidated sediments in river valleys (alluvium or glacial outwash). There are typically no test data available on ground water in sparsely populated areas. If these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soils in this MLRA are Gelisols, Andisols, and the andic subgroups of Spodosols, Histosols, Inceptisols, and Entisols. The soils have a subgelic soil temperature class or a cryic soil temperature regime, an aquic or udic soil moisture regime, and mixed or amorphic mineralogy.

Histoturbels and Aquiturbels on stream terraces and plains formed in loamy, sandy, and gravelly fluvial sediments. Many of these soils have a thin or moderately thick mineral surface layer of silty volcanic ash and loess. Fibristels, which are generally in depressions and shallow basins, formed in thick deposits of organic material. The Gelisols in the area are shallow or moderately deep to permafrost and are poorly drained or very poorly drained. Haplocryands, Haplocryods, Humicryods, and Dystrocryepts on rolling uplands and footslopes along the boundary with the adjacent mountains formed in a moderately thick or thick layer of silty volcanic ash over various glacial, fluvial, and colluvial sediments. Andisols and Spodosols do not have permafrost within their soil profile and generally are deep and moderately well drained or well drained. Cryofluvents and Cryaquents on flood plains, low stream terraces, and alluvial fans formed in stratified loamy, sandy, and gravelly alluvium. These soils are deep and range from poorly drained to excessively drained.

Miscellaneous (nonsoil) areas make up about 14 percent of this MLRA. The most common miscellaneous areas are water, riverwash (particularly in the southwestern part of the MLRA), and beaches.

Biological Resources

The moderately well drained soils on plains and rolling uplands in this MLRA generally support low and dwarf scrub dominated by ericaceous shrubs and herbs and in many areas by lichens and mosses. The somewhat poorly drained soils in bogs and other areas of peat generally support low and dwarf scrub dominated by shrub birch, ericaceous shrubs, tussock-forming sedges, and a thick, continuous layer of mosses. Poorly drained soils on lowlands, fens, and the margins of lakes are vegetated with wet herbaceous communities, including sedge marshes, sedge and sedge-moss meadows, and, near the coast, halophytic sedge meadows. Balsam poplar and mixed balsam poplar-white spruce forest communities, typically with an understory of tall and low shrubs, are on flood plains along the major rivers. Dwarf alpine scrub, lichens, and bare ground occur on convex slopes and ridges at the higher elevations of isolated hills and mountains.

The common species of mammals in the area include brown bear, black bear, wolf, wolverine, caribou, moose, and a variety of other furbearers. The lowlands have good-quality habitat for waterfowl. Many species of migratory waterfowl use the lowlands as staging and nesting areas. Nearly the entire population of Pacific black brant, numbering 250,000, and most of the world's population of the emperor goose use the coastal lagoons and wetlands in this area during their spring and fall migrations. Canada goose, ducks, tundra swans, and sandhill cranes also are common in the area. Many millions of shore birds use the same habitats and flyways as the migrating waterfowl. Most rivers and streams are important spawning areas for salmon, which provide world-class sport fishing during summer and fall for visitors and local residents. Many streams and lakes support rainbow trout. Introduced northern pike, a major predator of small salmon, other desirable fish, and waterfowl, are in many of the lakes in the area.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—66%
Forest—20%
Water—10%
Other—4%

Commercial fishing in Bristol Bay and the Bering Sea is the primary enterprise in this area. Most coastal communities support a fleet of boats and related fishing facilities. Many also have fish-processing plants. Less than 1 percent of the area is urban. Most inland areas still support natural vegetation and are used primarily for subsistence hunting, fishing, and gathering by local residents. The Mulchatna caribou herd in the area attracts subsistence and sport hunters from around Alaska and elsewhere. Wilderness recreation and sport fishing are increasingly popular in the area. Most visitors are served by air taxi and guiding services out of Dillingham, King Salmon, and other communities and by guest lodges in the area.

The major soil resource concern is disturbance of the fragile permafrost-affected soils. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities should include protection of the organic surface material and the thermal balance of the soils. ■

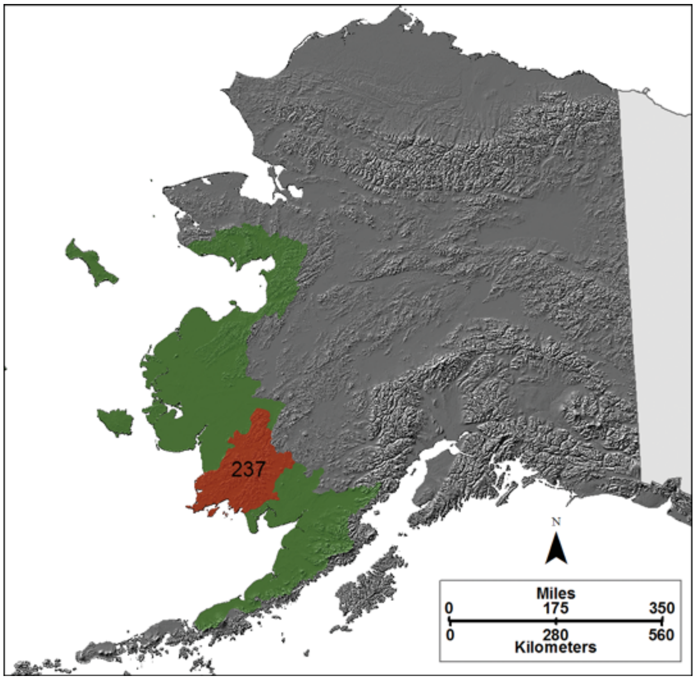

Figure 237-1: Location of MLRA 237 in Land Resource Region X2.

237—Ahklun Mountains

This area is in the Western Region of Alaska and includes the mountains, hills, and valleys of the Ahklun and Kilbuck Mountains (fig. 237-1). The area includes Hagemeister Island and the Walrus Islands in Bristol Bay. It makes up about 14,555 square miles (37,715 square kilometers). It is primarily undeveloped wild land and is sparsely populated. The principal communities, which are mainly along the coast of Bristol Bay and Kuskokwim Bay in the southwestern part of the area, are Goodnews Bay, Manokotak, and Togiak. Parts of the Togiak, Yukon Delta, and Alaska Maritime National Wildlife Refuges are in this area.

Physiography

This area lies within the Ahklun Mountains Province of the Intermontane Uplands and Lowlands System. The terrain consists of steep, rugged, low mountains cut throughout with narrow to broad valleys. Flood plains and terraces are common at the lower elevations in the valleys along the larger rivers. Alluvial and colluvial fans and steep mountain footslopes are common features of the valleys throughout the area. Along the coast, where the Togiak and Goodnews Rivers empty into the Bering Sea, nearly level to rolling deltas are dotted with numerous small lakes. To the east, along the border with the Bristol Bay-Northern Alaska Peninsula Lowlands (MLRA 236), are deep, east-west oriented, glacially carved valleys that include the Wood-Tikchik Lakes. Elevation ranges from sea level on the coast of the Bering Sea in the southern part of the area to 4,658 feet (1,420 meters) at the summit of Mt. Oratia.

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is Southwest Alaska (1904). All of the surface water in this area drains into the Bering Sea via numerous rivers emptying directly into the Bering Sea or into the Wood-Tikchik Lakes to the east or the Kuskokwim River to the north and west. The major rivers are the Goodnews, Togiak, Kanektok, Osviak, Eek, and Arolik Rivers. Lakes make up about 5 percent of the area.

This area is in the zone of discontinuous permafrost. Isolated masses of permafrost are in areas of deep, unconsolidated deposits in the mountains. On lowlands, permafrost occurs as isolated masses primarily in areas of the finer textured materials. It generally does not occur on flood plains and near the coast.

Geology

Throughout the Pleistocene epoch, all of the Ahklun Mountains were extensively glaciated, possibly except for the highest peaks and the upper ridges. The Kilbuck Mountains were unglaciated. Coastal lowlands were generally free of ice by the late Pleistocene. During the Holocene epoch, colluvium and slope alluvium accumulated across about 40 percent of the area. Glacial moraines and drift still cover approximately 45 percent of the area, primarily on the lower mountain slopes, valley bottoms, and coastal plains. Recent alluvial deposits are on flood plains and on interlayered alluvial and marine deposits on coastal lowlands. The bedrock geology underlying most of the area is dominantly Jurassic and Cretaceous stratified sedimentary rocks. Less common are Paleozoic sedimentary rocks. Exposed volcanic intrusive rocks that impart a ring-like structure to some of the isolated mountain groups are in scattered areas throughout the MLRA. Volcanic rocks are more common in the Kilbuck Mountains. The area is cut by numerous northeast-trending faults.

Climate

The average annual precipitation is 20 to 30 inches (510 to 760 millimeters) at the lower elevations in this area and can exceed 50 inches (1,270 millimeters) at the higher elevations. The climate of the area is under both maritime and continental influences, depending on the time of year and the proximity to the coast of Bristol Bay and the Bering Sea. Orographic influences also are likely important. Summers are short and variable. Winters are long and cold. The average annual snowfall ranges from about 80 to 200 inches (205 to 510 centimeters). The average annual temperature along the coast is about 33 degrees F (1 degree C). The length of the freeze-free period along the coast averages 110 to 135 days.

Water

There are very limited withdrawals of freshwater for use in this sparsely populated MLRA. Most of the communities in the area are on the coast. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Also, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. If surface water is available, treatment for removal of the suspended sediment would normally be required. For these reasons, most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners probably obtain ground water from bedrock aquifers or from the unconsolidated sediments in river valleys (alluvium or glacial outwash). There are typically no test data available on ground water in sparsely populated areas. The unconsolidated sediments aquifer is open to the surface, so it is highly susceptible to contamination from surface activities. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination. The intrusion of seawater can cause some problems along the coast.

Soils

The dominant soil orders in this MLRA are Gelisols, Inceptisols, Spodosols, Andisols, and Entisols. The soils in the area have a subgelic soil temperature class or a cryic soil temperature regime, an aquic or ustic soil moisture regime, and mixed or amorphic mineralogy.

Gelepts, Cryepts, Gelods, and Cryods on ridges, steep mountain slopes, hills, fans, footslopes, and plains formed in gravelly colluvium and slope alluvium. At the higher elevations, fractured bedrock is at a shallow or moderate depth in many of the soils. At the lower elevations, Andisols and andic subgroups of other orders have a thin or moderately thick surface layer of silty volcanic ash and loess. These soils range from shallow to deep and generally are well drained. Histoturbels and Aquiturbels in swales and depressions on hills, in seepage areas, and on footslopes and stream terraces formed in various colluvial and alluvial deposits. They are somewhat poorly drained or very poorly drained. Histoturbels have a moderately thick surface layer of organic material. Fibristels in depressions and shallow basins on stream terraces formed in thick deposits of organic material. Gelisols are shallow or moderately deep to permafrost and are poorly drained or very poorly drained. Cryaquents and Cryofluvents on flood plains, low stream terraces, and river deltas formed in stratified silty and sandy alluvium. They commonly have a substratum of gravelly and cobbly alluvium. They are deep and range from excessively drained to poorly drained. Many of these soils have an upper mineral layer of silty volcanic ash, loess, or a mixture of the two.

Miscellaneous (nonsoil) areas make up about 25 percent of this MLRA. The most common miscellaneous areas are rock outcrop, rubble land, and beaches.

Biological Resources

Well drained soils on mountain slopes at low and middle elevations in this area dominantly support tall alder shrub, tall and low willow scrub, and low ericaceous scrub. In areas of peat and moderately well drained mineral soils, low ericaceous shrub and shrub birch scrub occur along with tussock-forming sedges or various sedges and grasses in the ground layer. Wet sedge meadows, sedge-grass meadows, and sedge-moss meadows are in drainages and along lakeshores. Well drained soils at the lower elevations on valley bottoms support balsam poplar, white spruce, and mixed balsam poplar-white spruce forests. Balsam poplar and mixed forest types generally have an understory of tall and low shrubs and herbs. Spruce forest understory commonly is dominated by a nearly continuous layer of feather mosses with only scattered shrubs and herbs. On shallow soils at the higher elevations and on convex mountain slopes and ridges, the most common vegetation is dwarf alpine scrub dominated by ericaceous shrubs, dryas, and shrub birch. These communities commonly have a considerable amount of lichen cover and bare ground.

The major species of mammals inhabiting the area include brown bear, black bear, moose, caribou, wolf, wolverine, and various other furbearers. Walrus, spotted seals, and fur seals are in coastal areas. The sea cliffs provide important nesting habitat for murres, kittiwakes, fulmars, and cormorants. At the lower elevations, most of the rivers and streams are important spawning areas for salmon.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—67%
Forest—8%
Water—5%
Other—20%

Local residents use this remote area primarily for subsistence hunting, fishing, and gathering. A number of extractable minerals and other commodities formerly were mined in the area, but most of the mines have ceased operations. Wild-land recreation is an increasingly important land use, particularly in the Wood-Tikchik Lakes area. There are no major resource concerns in this area. ■

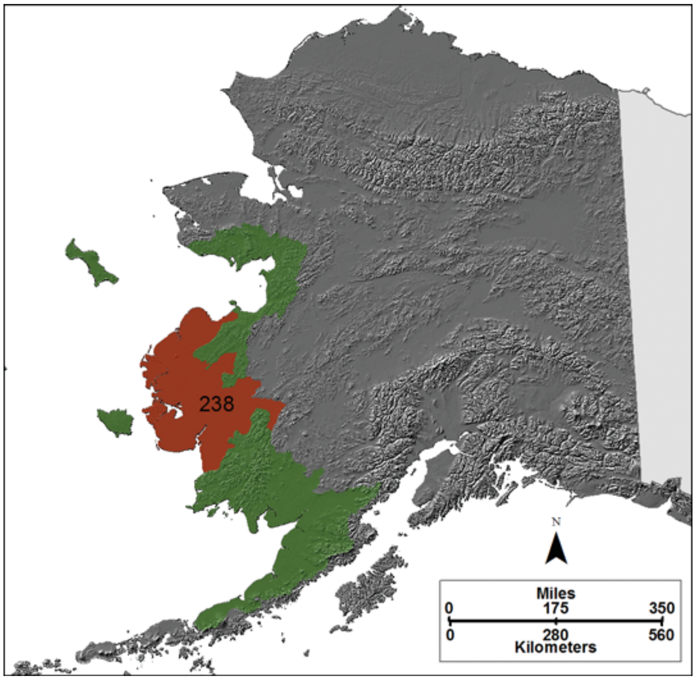

Figure 238-1: Location of MLRA 238 in Land Resource Region X2.

238—Yukon-Kuskokwim Coastal Plain

This area is in the Western Region of Alaska and consists of the broad, nearly level delta along the lower reaches of the Yukon and Kuskokwim Rivers, where the rivers empty into the Bering Sea (fig. 238-1). The area makes up about 29,960 square miles (77,640 square kilometers). Although the MLRA is mostly undeveloped wild land and is sparsely populated, there are approximately 42 villages in scattered areas along the coast or the banks of the Yukon and Kuskokwim Rivers. The principal communities are Aniak, Bethel, Hooper Bay, St. Marys, and Emmonak. This MLRA is entirely within the Yukon Delta National Wildlife Refuge. A few of the area's small coastal islands are included in the Alaska Maritime National Wildlife Refuge.

Physiography

This area lies within the Bering Shelf Province of the Intermontane Uplands and Lowlands System. The terrain consists of a level to rolling delta plain along the lower reaches of the Yukon and Kuskokwim Rivers. In a few areas, isolated low hills protrude above the surrounding plain. The Yukon River runs along the northern edge of the area, and the Kuskokwim River runs across the southern edge. The area is crossed by numerous low-gradient streams, many of which are tributaries or former channels of the Yukon and Kuskokwim Rivers. Depressions and shallow basins on the plain are dotted with interconnecting stream channels, wetlands, and thousands of small and medium-size lakes. The features of the flood plain include low escarpments, meander scars, oxbow lakes, sloughs, and multiple channels and islands. The coastline is broken by a number of large inlets and bays. Baird Inlet forms a large inland sea behind Nelson Island. Elevation ranges from sea level to about 300 feet (90 meters) in most of the area, but it is 2,342 feet (714 meters) at the summit of Towak Mountain, on Cape Romanzof.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Southwest Alaska (1904), 56 percent; Yukon (1903), 43 percent; and Northwest Alaska (1902), 1 percent. Surface water in the vast majority of interior and western Alaska drains into the Bering Sea through this MLRA. The major rivers are the Yukon, Kuskokwim, Tovers, Black, Azun, Kashunuk, and Izaviknek Rivers. Lakes make up about 40 percent of the area.

This area is in the zone of discontinuous permafrost. The layer of permafrost is thin or moderately thick and occurs primarily in fine textured deposits. The maximum depth to the bottom of the permafrost layer is about 600 feet (185 meters). Permafrost generally does not occur on flood plains and in areas near bodies of water.

Geology

This area was unglaciated during the Pleistocene epoch, except possibly along the extreme southeast edge, where glaciers from the Ahklun Mountains extended a small distance down onto the lowlands. Sediments across the vast majority of the area consist of fine textured, Holocene and Pleistocene deltaic deposits from the Yukon and Kuskokwim Rivers and loamy and sandy, Holocene fluvial deposits on flood plains and stream terraces. A number of low basalt hills and associated cinder cones and volcanic craters are in scattered areas throughout the western part of the MLRA. These features date to the Cretaceous and Tertiary period and are mantled by Holocene colluvium.

Climate

The average annual precipitation in this area is 15 to 30 inches (380 to 760 millimeters). The climate of the area is primarily maritime. In winter, when the Bering Sea icepack forms, however, the climate becomes more continental. Summers are short and variable. Cloudy and rainy conditions are common in summer. Windy conditions are common at any time of the year. Winters are long and cold. Fog and poor visibility are common, particularly in coastal areas during winter. The average annual snowfall ranges from about 40 to 90 inches (100 to 230 centimeters). The average annual temperature is 29 to 33 degrees F (-2 degrees to 1 degree C). The freeze-free period averages about 80 to 135 days. Freezing temperatures can occur in any month, but June, July, and August generally are freeze-free.

Water

There are very limited withdrawals of freshwater for use in this sparsely populated MLRA. The only measurable withdrawal is for public supply (0.2 million gallons, or 0.8 million liters, per day). Most of the communities in the area are on the coast or along the major rivers and lakes. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Also, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. If surface water is available, treatment for removal of the suspended sediment would normally be required. For these reasons, most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners probably obtain ground water primarily from unconsolidated sediments in river valleys or beneath the coastal plain (alluvium or glacial outwash). There are typically no test data available on ground water in sparsely populated areas. The unconsolidated sediment aquifers are open to the surface and are highly susceptible to contamination from surface activities. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination. The intrusion of seawater can be a problem near the coast.

Soils

The dominant soil orders in this MLRA are Gelisols, Inceptisols, and Entisols. The soils in the area have a subgelic soil temperature class or a cryic soil temperature regime, an aquic or udic soil moisture regime, and dominantly mixed mineralogy.

Fibristels, Hemistels, Histoturbels, and Aquiturbels are the most common soils across the broad expanse of the delta. Fibristels and Hemistels in depressions and shallow basins formed in thick deposits of organic material over shallow or moderately deep permafrost. They are very poorly drained. Mineral soil material, if it occurs, generally is within the permafrost layer. Historturbels are common in elevated and convex areas. They formed in a moderately thick layer of organic material over silty and loamy fluvial sediments. Aquiturbels on low terraces and in drainageways formed in stratified silty and sandy alluvial sediments. Histoturbels and Aquiturbels generally are shallow or moderately deep to permafrost and are very poorly drained to moderately well drained. Dystrocryepts on hills and elevated ridges formed in silty and sandy fluvial sediments. Cryofluvents on flood plains formed in silty and sandy alluvium. Excessively drained Cryopsamments on coastal dunes formed in thick deposits of sand. Very poorly drained Cryofibrists and Cryohemists on lakeshores formed in thick deposits of organic material. Inceptisols, Entisols, and Histosols do not have permafrost within their soil profile.

Miscellaneous (nonsoil) areas make up about 40 percent of this MLRA. The most common miscellaneous areas are water and beaches.

Biological Resources

Lakes, ponds, and other kinds of surface water are throughout most of this area. The vegetation near these bodies of water includes wet sedge meadows, sedge-shrub meadows, and sedge-moss meadows. Peat mounds and other low uplands support low and dwarf scrub dominated by ericaceous shrubs, tussock-forming sedges, other hydrophytic plants, and mosses. Sites with better drainage and higher local relief support low ericaceous scrub with mosses, lichens, low willows, and forbs. Dense stands of grasses grow on beds of drained thaw lakes. In the southern and eastern parts of the area, spruce forests and woodland occur on well drained soils on flood plains and the better drained soils on uplands. Both white spruce and black spruce are common. Low ericaceous shrubs, willow, alder, and mosses are dominant in the understory.

The common species of mammals in the area include brown bear, black bear, caribou, wolf, and various other furbearers. Walrus and seals are in some coastal areas. Most of this MLRA has good-quality habitat for waterfowl, and every year as many as 750,000 swans and geese use the lowlands as staging and nesting areas. More than 220 bird species use this MLRA at various times throughout the year. Among the significant species nesting in the area are tundra swans, emperor geese, black brants, spectacled eiders, bristle thighed curlews, white wagtails, dovekies, and McKays buntings. About 75 percent of the sandhill cranes in Alaska breed in this MLRA.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—55%
Forest—5%
Water—40%

Local residents use this remote area primarily for subsistence hunting, fishing, and gathering. Less than 1 percent of the area is urban. The major soil resource concern is disturbance of the fragile permafrost-affected soils. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities should include protection of the organic surface material and the thermal balance of the soils. ■

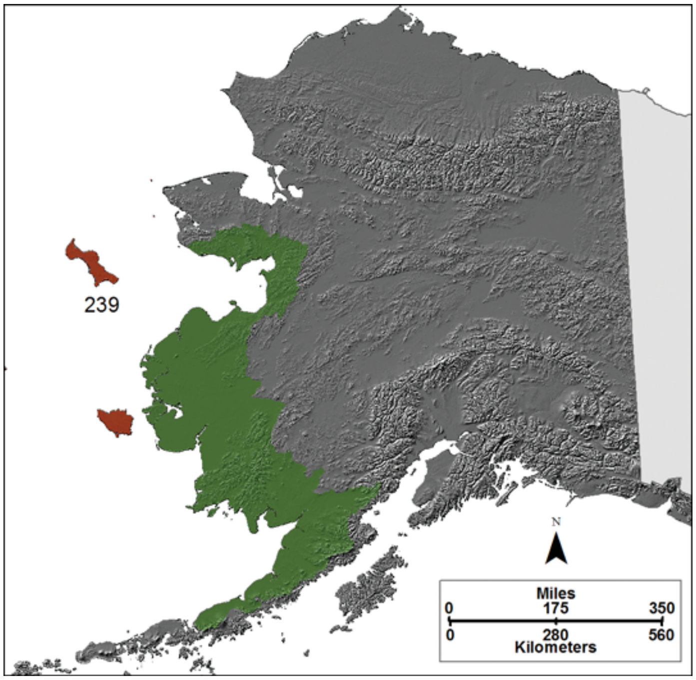

Figure 239-1: Location of MLRA 239 in Land Resource Region X2.

239—Northern Bering Sea Islands

This area is in the Western Region of Alaska and includes St. Lawrence, St. Matthew, and Nunivak Islands and a number of smaller islands in the northern Bering Sea (fig. 239-1). The area makes up about 3,575 square miles (9,260 square kilometers). The major villages in the area are Savoonga and Gambell on St. Lawrence Island and Mekoryuk on Nunivak Island. All of St. Matthew Island and a few small islands along the coast of St. Lawrence Island are included in the Alaska Maritime National Wildlife Refuge. Much of Nunivak Island is included in the Yukon Delta National Wildlife Refuge.

Physiography

This area lies within the Bering Shelf Province of the Intermontane Uplands and Lowlands System. The terrain consists of nearly level to rolling plains and highlands with mostly gentle slopes. Steep, low-relief volcanic cones, vents, and lava flows are common throughout Nunivak Island and are less common on St. Lawrence Island. Coastal lowlands dotted with numerous small and medium-size lakes make up a significant part of St. Lawrence Island. Narrow, discontinuous sand dunes and sand sheets are along many stretches of the coast. Elevation ranges from sea level along the coast to 2,207 feet (673 meters) at the summit of Atuk Mountain, on St. Lawrence Island.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Northwest Alaska (1902), 51 percent, and Southwest Alaska (1904), 49 percent. Numerous short, high-gradient streams drain the islands of this MLRA directly into the Bering Sea. On St. Lawrence Island, lakes make up about 10 percent of the area. Lakes are less extensive on Nunivak and St. Matthew Islands.

This area is in the zone of discontinuous permafrost. The layer of permafrost generally is thin or moderately thick and occurs primarily in fine textured deposits. Permafrost generally does not occur on flood plains, in coarse textured sediments on the steep slopes of volcanic cones, along the coast, or near lakes and other bodies of water. The common periglacial features in the area include solifluction lobes, frost boils, and patterned ground on plains and footslopes and in swales on hills.

Geology

The Northern Bering Sea Islands rise from the submarine Bering platform. St. Lawrence Island is the most geologically complex of the islands. It is made up primarily of Cretaceous, Tertiary, and Quaternary volcanic rocks and some Paleozoic stratified sedimentary rocks. Coastal lowlands are made up mostly of Quaternary alluvial and marine sediments. Nunivak and St. Matthew Islands are made up almost exclusively of Tertiary and Quaternary volcanic rocks. With the possible exception of a small area on the western end of St. Lawrence Island, the MLRA was unglaciated during the Pleistocene epoch. Most of the modern landscape is mantled with Quaternary alluvial, marine, and eolian deposits.

Climate

The average annual precipitation in this area is 10 to 25 inches (255 to 635 millimeters). The climate of the area is maritime much of the year and strongly continental in winter, when the Bering Sea icepack forms. Summers are short and cool. Cloudy, foggy, and rainy conditions are common in the summer. Strong winds are common throughout the year. Winters are long and cold. The average annual snowfall is about 50 to 80 inches (125 to 205 centimeters). The average annual temperature at Gambell on St. Lawrence Island is 25 degrees F (-4 degrees C). The freeze-free period at Gambell averages about 60 to 90 days.

Water

There are very limited withdrawals of freshwater for use in this sparsely populated MLRA. Most of the communities in the area are on the coast. Little surface water is available for use by island residents. Most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners on Nunivak and St. Matthew Islands obtain ground water from volcanic bedrock aquifers. The water is in joints, fractures, and rubble zones in the volcanic rocks. Unconsolidated sediments in river valleys and on the coastal plain (alluvium or some glacial outwash) provide ground water for residents of St. Lawrence Island. This ground water generally occurs as a lens of freshwater floating on saltwater near the coast. There are typically no test data available on ground water in sparsely populated areas. If these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination. The intrusion of seawater can be a problem since most residents live along the coast.

Soils

The dominant soil order in this MLRA is Gelisols. The MLRA also has small areas of Mollisols and Inceptisols. The soils in the area have a subgelic soil temperature class or a cryic soil temperature regime; an aquic, ustic, or udic soil moisture regime; and mixed mineralogy.

Histoturbels and Aquiturbels on plains, hills, and the lower mountain slopes formed in gravelly and sandy materials. Historthels on the same landforms have a moderately thick surface layer of organic material. The Gelisols are shallow or moderately deep to permafrost and are poorly drained to somewhat poorly drained. Dystrocryepts on plains, hills, and the lower mountain slopes formed in gravelly and sandy materials, do not have permafrost within their soil profile, and generally are well drained. Fibristels and Hemistels in depressions and swales on plains and hills formed in thick deposits of organic material, are shallow or moderately deep to permafrost, and are poorly drained. Mollorthels, Molliturbels, and Haplocryolls on limestone uplands formed in residuum. Mollorthels and Molliturbels are shallow or moderately deep to permafrost and are somewhat poorly drained or poorly drained. Haplocryolls do not have permafrost within their soil profile and generally are well drained.

Miscellaneous (nonsoil) areas make up about 10 percent of this MLRA. The most common miscellaneous areas are water, lava flows, rubble land consisting of volcanic rocks, and sandy and gravelly beaches.

Biological Resources

The areas of peat and the gentle mountain slopes, plains, and deeper soils in this MLRA generally support low and dwarf scrub and sedge-shrub meadows dominated by black crowberry, ericaceous shrubs, sedges, tussock-forming sedges, and a variety of forbs and mosses. Shallow soils on convex mountain slopes and ridges commonly support dwarf alpine scrub dominated by ericaceous shrubs, dryas, and dwarf willows. These communities commonly have a considerable amount of lichen and bare ground. Bedrock exposures with lichens and scattered shrubs and herbs in pockets of fine earth dominate the highest elevations and ridges and other windblown sites. Drainages and the shores of lakes support wet sedge meadows, sedge-grass meadows, and sedge-moss meadows. Well drained soils on flood plains commonly support low to tall willow scrub with dense grasses and forbs in the understory.

Various marine mammals and seabirds inhabit the coastal waters, rocky shorelines, and sea cliffs in the area. Waterfowl nest on coastal lowlands. The common marine mammals include northern fur seals, ribbon seals, sea lions, and walrus. Seabirds include eiders, cormorants, kittiwakes, puffins, auklets, oldsquaw, and murres. In winter, flocks of rare spectacled eiders congregate in openings in the sea ice south of St. Lawrence Island. Caribou, reindeer, musk ox, arctic fox, and other small mammals are on many of the islands.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—90%
Water—6%
Other—4%

Local residents use this remote area primarily for subsistence hunting, fishing, and gathering. Reindeer herding on Nunivak Island and St. Lawrence Island provides meat and other products to the residents. Tourism and wild-land recreation are minor but increasingly important land uses.

The major soil resource concerns are disturbance of the fragile permafrost-affected soils and erosion of the andic soils and the steeper soils. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities should include protection of the organic surface material and the thermal balance of the soils. ■

240—Nulato Hills-Southern Seward Peninsula Highlands

This area is in the Western Region of Alaska and consists primarily of the rolling hills, low mountains, and valleys on the southern Seward Peninsula and western slopes of the Nulato Hills. The area makes up about 17,920 square miles (46,430 square kilometers). It is primarily undeveloped wild land and is sparsely populated. The principal communities in the area are Nome and Unalakleet. A number of other small villages are along the coast of Norton Sound or the banks of the major rivers. Roads connect Nome with the villages of Council to the east, the central Seward Peninsula to the north, and Teller to the

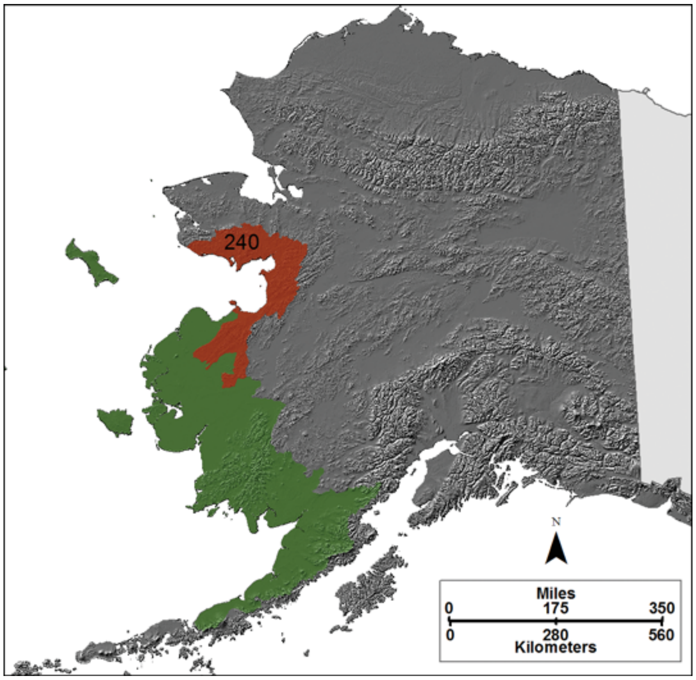

Figure 240-1: Location of MLRA 240 in Land Resource Region X2.

northwest. Part of the Yukon Delta National Wildlife Refuge is in this area.

Physiography

This area lies within the Seward Peninsula and Western Alaska Provinces of the Intermontane Uplands and Lowlands System. The terrain near the coast of Norton Sound consists of rolling hills and broad valleys. Rounded, low mountains occur farther inland. Narrow flood plains border the many clear-water streams in the area. Narrow, nearly level coastal plains are in a number of areas along the coast of Norton Sound. Elevation ranges from sea level to about 3,900 feet (1,190 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Northwest Alaska (1902), 74 percent, and Yukon (1903), 26 percent. Surface water in all of the area drains into Norton Sound and the Bering Sea by way of numerous short streams and rivers originating in the mountains. The principal rivers are the Unalakleet, Koyuk, and Fish Rivers. Lakes make up less than 1 percent of the area.

This area is in the zone of discontinuous permafrost. Permafrost is common on coastal plains, on gently sloping footslopes, and in swales on hills and mountains. It generally does not occur on flood plains or near lakes and other bodies of water. Isolated masses of permafrost are in deep, unconsolidated deposits in the mountains. In the vicinity of Nome, the base of the permafrost layer is at a depth of as much as 121 feet (37 meters).

Geology

Large areas of the Seward Peninsula were glaciated during the early and middle Pleistocene. By the late Pleistocene, glacial ice was limited to the upper elevations. Much of the MLRA is mantled with fine textured to coarse textured mountain colluvium and alluvium. Moderately modified or highly modified glacial moraines and drift and scattered glaciofluvial deposits are still in glaciated areas. Holocene deposits fill most of the coastal lowlands. Recent fluvial deposits are on flood plains and stream terraces. The bedrock geology of the area consists dominantly of Cretaceous, Precambrian, and Paleozoic stratified sedimentary rocks and Cretaceous through Tertiary volcanic rocks. Many coastal areas and areas at the lower elevations of hills and mountains are mantled with a thin layer of silty eolian deposits of Holocene age.

Climate

The average annual precipitation is about 15 to 20 inches (380 to 510 millimeters) at the lower elevations in this area and 20 to 40 inches (510 to 1,015 millimeters) at the higher elevations. Most of the precipitation falls as rain in late summer. The climate of the area is maritime much of the year and strongly continental in winter, when the Bering Sea icepack forms. Orographic influences are significant at the higher elevations. Summers are brief and cool. Cloudy and windy conditions are common throughout the year. Winters are long and cold. The average annual snowfall is 40 to about 100 inches (100 to 255 centimeters). The average annual temperature along the coast is about 26 degrees F (-3 degrees C). The freeze-free period along the coast averages about 55 to 90 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 40%; ground water, 20%
Livestock—surface water, 0%; ground water, 0%
Irrigation—surface water, 0%; ground water, 0%
Other—surface water, 20%; ground water, 20%

The total withdrawals average about 0.5 million gallons per day (2 million liters per day). About 40 percent is from ground water sources, and 60 percent is from surface water sources.

Permanent streams, originating in the mountainous regions surrounding this area, bring some surface water to villages and the town of Homer. The water from the rivers and natural lakes is used for some public supply, mining, and domestic purposes. It generally is suitable for all uses. Flooding from ice dams that form during the spring thaw is a concern in this area.

The ground water used for public supply, domestic purposes, and mining in this area is primarily from bedrock aquifers. Some unconsolidated sediments in river valleys or coastal plains (alluvium or glacial outwash) also provide some water. The ground water is hard or very hard but is otherwise of excellent quality. The level of total dissolved solids is fairly low, about 130 parts per million (milligrams per liter). The level of iron may exceed the secondary standard for drinking water of 300 parts per billion (micrograms per liter). The secondary standard is for esthetics. The iron can stain ceramic and porcelain and precipitate in pipes. Wells in this area generally are shallow, so these aquifers are highly susceptible to contamination from runoff. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil orders in this MLRA are Gelisols, Inceptisols, and Entisols. The soils in the area have a subgelic soil temperature class or a cryic soil temperature regime, an aquic or udic soil moisture regime, and dominantly mixed mineralogy.

Mollorthels, Aquiturbels, and Histoturbels are common on mountains, hills, and coastal plains. They formed in loamy and gravelly colluvium on mountains and hills and in mixed loamy and gravelly colluvium and slope alluvium on coastal plains. Many of the soils on mountains and hills are moderately deep or deep over fractured bedrock. Histoturbels and Aquiturbels have a moderately thick, in places discontinuous surface layer of organic material. The Gelisols in the area are shallow or moderately deep to permafrost and are poorly drained or somewhat poorly drained. On steep mountain slopes, particularly at the upper elevations, Dystrocryepts and Eutrocryepts formed in gravelly colluvium over fractured bedrock. These soils are shallow to deep over bedrock and are well drained. The soils on flood plains include Cryofluvents and Cryorthents that formed in stratified loamy alluvium over sandy and gravelly alluvium. These soils are deep and range from somewhat poorly drained to well drained.

Miscellaneous (nonsoil) areas make up about 5 percent of this MLRA. The most common miscellaneous areas are rock outcrop, rubble land, and beaches.

Biological Resources

Well drained soils on slopes at low and middle elevations in this area dominantly support tall alder shrub, tall and low willow scrub, and low ericaceous shrub scrub. Areas of peat and moderately well drained mineral soils support low ericaceous shrub and shrub birch scrub along with tussock-forming sedges or various sedges and grasses in the ground layer. Drainages support wet sedge meadows, sedge-grass meadows, and sedge-moss meadows. Well drained soils at the lower elevations on valley bottoms have open forests and woodland of mixed spruce and paper birch. The higher elevations and the shallow soils on convex mountain slopes and ridges commonly support dwarf alpine scrub dominated by ericaceous shrubs, dryas, and dwarf willows. These communities commonly have a considerable amount of lichen and bare ground. Bedrock exposures with lichens and scattered shrubs and herbs in pockets of fine earth dominate the highest elevations and ridges.

The common species of mammals in the area include brown bear, caribou, moose, wolf, and a variety of other furbearers. Golden eagles inhabit the areas at the higher elevations and nest in cliffs and other protected sites. Tundra swans and a variety of other waterfowl nest in the wetlands and ponds in the area. Coastal areas are inhabited by ribbon seals and walrus. The Unalakleet River and other rivers support summer runs of pink salmon.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—57%
Forest—38%
Other—5%

This remote area is used primarily for subsistence hunting, fishing, and gathering. Also, the Seward Peninsula is used for reindeer herding. Less than 1 percent of the area is urban. Mining, primarily placer mining and dredge mining, was once a major land use and played an important role in the growth and development of Nome. A number of mines throughout the area continue to operate.

The major soil resource concern is disturbance of the fragile permafrost-affected soils. Another concern is the suspended sediment load in rivers below areas of placer mines. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities should include protection of the organic surface material and the thermal balance of the soils. ■

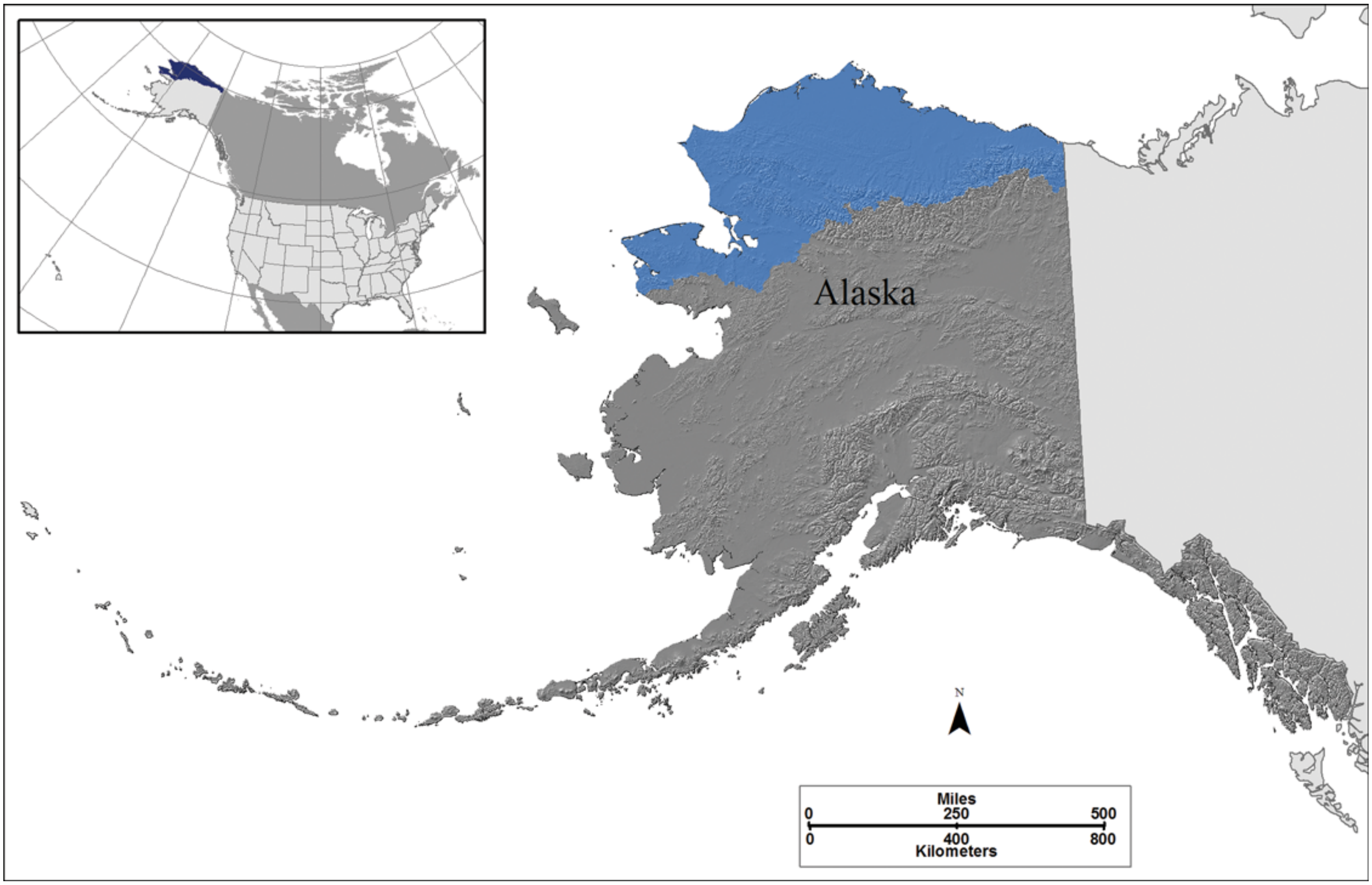

Figure Y-1: Location of Land Resource Region Y.

Y—Northern Alaska

This region is in the northern part of Alaska (fig. Y-1). It includes the northern slope of the Brooks Range, the western Brooks Range, and the northern and western Seward Peninsula. The region makes up 125,550 square miles (325,345 square kilometers).

This region consists of mountains, foothills, and extensive coastal plains and deltas. Elevation ranges from sea level on the coast to 8,570 feet (2,613 meters) at the summit of Mt. Igikpak, in the Brooks Range. The north flanks of the Brooks Range consist of folded and faulted strata uplifted during the Cretaceous period. The mountains were extensively glaciated during the Pleistocene epoch. To the north, the rolling hills, ridges, and plateaus extend to the gently rolling to level, unglaciated Arctic Coastal Plain. Periglacial features, such as patterned ground, pingos, beaded drainages, and gelifluction lobes, are common throughout the region. The southwest part of the region, extending into the Seward Peninsula, includes flood plains, rolling lowlands, and mountains. Surface water drains to the north and west into the Arctic Ocean and the Chukchi Sea in most of the region. On the western Seward Peninsula, however, it drains into the northern Bering Sea.

The arctic climate is dry and cold, characterized by very short summers and long winters. Most of the region is above the Arctic Circle and consequently receives continuous sunlight for several weeks in summer and continuous twilight for several weeks in winter. The mean annual precipitation ranges from about 4 to 10 inches (100 to 255 millimeters) at the lower elevations in the northern and western parts of the region and from 30 to 40 inches (760 to 1,015 millimeters) at the higher elevations in the Brooks Range and on the Seward Peninsula. The average annual temperature ranges from 8 to 22 degrees F (-13 to -6 degrees C). Freezing temperatures can occur in any month.

The total withdrawals of freshwater in this region average just under 2 million gallons per day (7 million liters per day). About 63 percent is from surface water sources, and 37 percent is from ground water sources. Almost 80 percent of the water is used for mineral and oil and gas extraction. The rest is used for

Figure Y-2: Wilderness recreation in an area of Land Resource Region Y.

public supply. The populated parts of the Seward Peninsula and the Arctic Slope account for almost all of the freshwater used in this region.

This area is in the zone of continuous permafrost. Permafrost is shallow or moderately deep, except on steep, coarse textured soils in the high mountains. Most of the soils in the region are Gelisols, having permafrost within their soil profile. Orthels and Turbels, the dominant suborders, occur on all landforms in the region. Aquorthels and Histoturbels are on the gentler slopes and on poorly drained hillsides. Glacic subgroups occur near the coasts. Mollorthels are on some well drained, south-facing slopes, and Psammorthels are on dunes. Fibristels formed in thick deposits of organic material in depressions throughout the region. Coarse textured Gelepts and Gelorthents are on some steep hillslopes and ridges. They have a mean annual soil temperature below 32 degrees F (0 degrees C) but do not have permafrost in their soil profile.

The native vegetation on foothills and lowlands is arctic tundra with grasses, sedges, mosses, lichens, ericaceous shrubs, and willows. The native vegetation in mountainous areas is dominantly alpine tundra with dwarf scrub communities. In these areas, sedges and lichens dominate the ground cover. Forested communities occur along the lower Noatak and Kobuk Rivers in the western part of the region. Reindeer grazing, wildlife habitat, mineral and petroleum extraction, and subsistence hunting, fishing, and gathering are the major land uses in this region. Some areas are used for wilderness recreation (fig. Y-2). ■

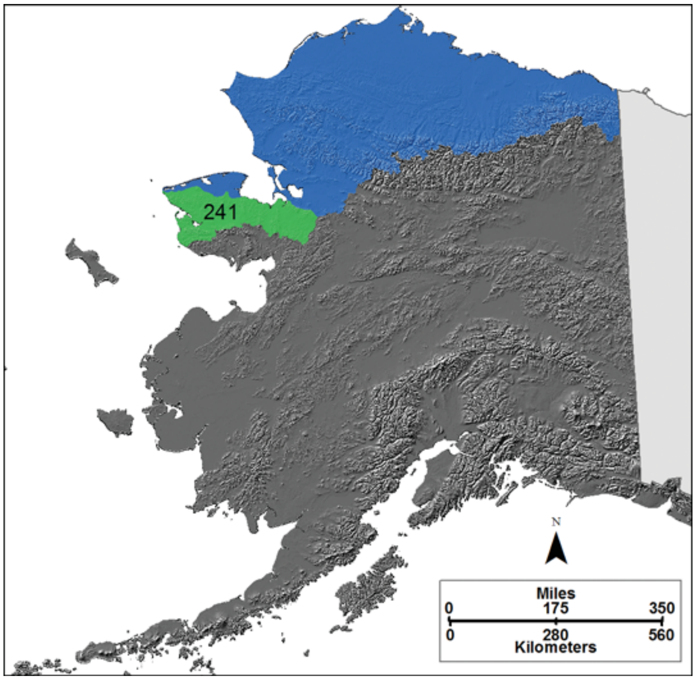

Figure 241-1: Location of MLRA 241 in Land Resource Region Y.

241—Seward Peninsula Highlands

This area is in the Northern Region of Alaska and includes the broad, rolling uplands and isolated high, rugged mountains of the central Seward Peninsula, from Cape Prince of Wales east to the Selawik Hills (fig. 241-1). The area makes up about 13,455 square miles (34,870 square kilometers). It is mainly undeveloped wild land and is sparsely populated. Teller, Wales, and a number of smaller villages are in the western part of the area, along the coast of the Bering and Chukchi Seas. Three roads, originating in Nome in the Nulato Hills-Southern Seward Peninsula Highlands (MLRA 240) to the south, provide access to small portions of the area. Part of the Bering Land Bridge National Preserve is in this area.

Physiography

This area lies primarily within the Seward Peninsula Province, but the eastern part is within the Western Alaska Province. Both of these provinces are within the Intermontane Uplands and Lowlands System. The terrain consists of extensive rolling hills, intervening lowlands, and isolated groups of rugged, moderately high mountains. Narrow flood plains and stream terraces are along the rivers. Elevation ranges from sea level along the coast to 4,714 feet (1,437 meters) at the summit of Mt. Osborn, in the Kigluaik Mountains.

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is Northwest Alaska (1902). Surface water in the northern part of the area drains into Kotzebue Sound and the Chukchi Sea via numerous relatively short rivers. The major rivers in this part of the area are the Buckland, Kiwalik, and Serpentine Rivers. Surface water in the western part of the area drains to the west into the northern Bering Sea. The principal rivers in this part of the area are the Agiapuk-American, Kougarok, and Kuzitrin Rivers. Lakes make up less than 2 percent of the area.

This area is in the zone of continuous permafrost. Moderately thick layers of permafrost are common in most unconsolidated materials, except along flood plains and in close proximity to lakes. Periglacial features are common. Bedrock structures have altiplanation terraces. Unconsolidated materials in the uplands have gelifluction sheets, benches, lobes, and high-center polygons. Wet lowlands have low-center polygons, thermokarst pits, thaw lakes, and pingos. Massive ice wedges and lenses occur throughout the area.

Geology

During the late Pleistocene epoch, this area was mostly unglaciated. The York Mountains in the western part of the area, the Kigluaik and Bendeleben Mountains along the southern edge, and the upper Kiwalik River drainage were glaciated in the early and middle Pleistocene. The modern landscape is mantled with coarse textured to fine textured colluvium, slope alluvium, and silty loess. Bedrock is at or near the surface in many upland areas. Recent alluvial and coastal sediments occur along rivers and near the coast. Slightly modified to highly modified glacial moraines and drift are in glaciated areas. The bedrock geology of the area consists of a complex mixture of rock ages and types. Stratified sedimentary rocks, ranging in age from Quaternary to Precambrian, are the dominant rock types. Tertiary or Quaternary volcanic rocks and inclusions of Cretaceous and Tertiary igneous rocks are in scattered areas throughout the MLRA.

Climate

The average annual precipitation ranges from about 10 to 15 inches (255 to 380 millimeters) in the northern and western parts of this area and from 20 to 40 inches (510 to 1,015 millimeters) in the mountains in the southern and eastern parts. Brief, cool summers and long, very cold winters characterize the arctic continental climate across much of the area. In summer, maritime conditions prevail along the coast of the Bering Sea. Strong winds are common throughout the area. The average annual snowfall is about 40 to 100 inches (100 to 255 centimeters). Exposed, windblown ridges generally are free of snow. The average annual temperature at Wales is 21 degrees F (-6 degrees C). The freeze-free period at Wales averages about 45 to 75 days. Freezing temperatures can occur in any month of the year, particularly in inland areas and at the higher elevations.

Water

There are very limited withdrawals of freshwater for use in this sparsely populated MLRA. An estimated 0.1 million gallons per day (0.4 million liters per day) is used in mining operations. Most of the communities in the area are along the major rivers or lakes or on the coast. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners probably obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash) or beneath the coastal plains. There are typically no test data available on ground water in sparsely populated areas. If these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil orders in this MLRA are Gelisols, Entisols, and Inceptisols. The soils in the area have a subgelic or pergelic soil temperature class or a cryic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy.

Histoturbels, Aquiturbels, Haplorthels, and Mollorthels on elongated toeslopes adjacent to coastal areas, on broad interior uplands and hills, and on mountain slopes formed in colluvium and slope alluvium. These soils are shallow or moderately deep to permafrost and are poorly drained or very poorly drained. Moderately well drained Gelepts and Gelorthents are on some steep hillslopes and ridges. These soils do not have permafrost within their soil profile. Fibristels on plains and in depressions, basins, and drainageways formed in thick deposits of organic material. They are shallow to permafrost and are very poorly drained. Mineral soil material, if it occurs in these organic soils, generally is within the permafrost layer. Cryofluvents on flood plains and stream terraces formed in sandy to gravelly alluvium. They generally do not have permafrost within their soil profile and range from poorly drained to excessively drained.

Miscellaneous (nonsoil) areas make up about 5 percent of this MLRA. The most common miscellaneous areas are rock outcrop, riverwash, and water.

Biological Resources

The uplands in this area generally support dwarf scrub dominated by dryas, black crowberry, ericaceous shrubs, and dwarf willow. On shallow, rocky soils and exposed sites, lichens and scattered herbs dominate the ground layer. Bare soil and bedrock generally are extensive. On the more mesic sites, sedges, forbs, and mosses cover most of the surface. The lower elevations and the deeper soils in the nearly level uplands and basins generally support low willow and ericaceous shrub scrub and mesic graminoid herbaceous communities, commonly with extensive areas of tussock-forming sedges. Depressions, drainageways, and other saturated areas support wet sedge meadows and wet sedge-moss meadows. The vegetation on flood plains consists of a mixture of tall and low scrub dominated by various willows, shrub birch, and alder.

The common species of mammals in the area include brown bear, caribou, moose, musk ox, black bear, wolf, red fox, a variety of other furbearers, and rodents. Reindeer were introduced to the area in the early 1900s to provide industry for local native residents. Many species of migratory waterfowl and shore birds nest in areas of wet tundra. Raptors in the area include gyrfalcon, peregrine falcon, golden eagle, hawks, and owls.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—88%
Forest—7%
Water—1%
Other—4%

This remote area is used primarily for reindeer herding or for subsistence hunting, fishing, and gathering. Reindeer provide meat for local and regional use and a number of other products for local use and export. Several highly mineralized areas can be mined. Most of the mining to date has been placer mining for gold. The largest mine is the Lost River Tin Mine, which has not operated since the 1960s. A number of mines throughout the area are still operating.

The major soil resource concern is disturbance of the fragile permafrost-affected soils. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities should include protection of the organic surface material and the thermal balance of the soils. ■

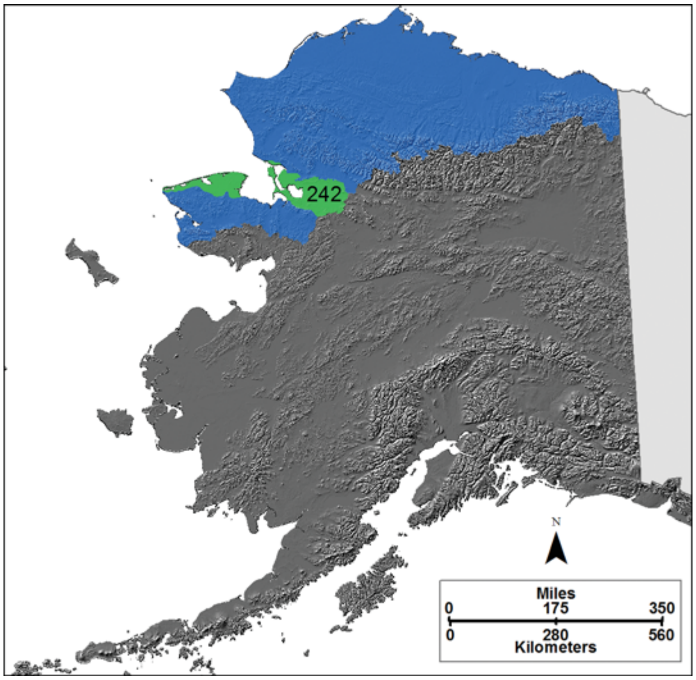

Figure 242-1: Location of MLRA 242 in Land Resource Region Y.

242—Northern Seward Peninsula-Selawik Lowlands

This area is in the Northern Region of Alaska and includes the mosaic of coastal lowlands, river deltas, gently sloping uplands, and isolated hills and low mountains along the northern Seward Peninsula and in the lower Selawik basin at the head of Kotzebue Sound (fig. 242-1). To the east, the area extends to the lower slopes of the Purcell Mountains, Zane Hills, and Sheklukshuk Range. The area makes up 8,165 square miles (21,155 square kilometers). It is mostly undeveloped wild land and is sparsely populated. A number of villages are in scattered areas throughout the MLRA. The largest of these are Noorvik, Kotzebue, and Shishmaref. Parts of the Bering Land Bridge National Preserve, a major portion of Selawik National Wildlife Refuge, and a small part of the Alaska Maritime National Wildlife Refuge are in this area.

Physiography

This area lies primarily within the Seward Peninsula Province, but the eastern part lies within the Western Alaska Province. Both of these provinces are within the Intermontane Uplands and Lowlands System. The terrain consists of nearly level to rolling plains, river deltas, and extended mountain footslopes. Depressions and shallow basins are dotted with hundreds of small lakes and interconnecting wetlands. Nearly level, meandering flood plains are along rivers. In a few areas the landscape is broken by rounded, low-relief hills protruding above the surrounding lowlands. In general, elevation ranges from sea level in the coastal lowlands to about 300 feet (90 meters) near the adjacent mountainous areas.

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is Northwest Alaska (1902). Surface water in the entire area drains into Kotzebue Sound and the Chukchi Sea. The major river systems that traverse the area are the Selawik and Buckland Rivers and the Kobuk and Noatak River deltas. Lakes make up about 25 percent of the area.

This area is in the zone of continuous permafrost. Thin or moderately thick layers of permafrost occur primarily in fine textured deposits. Near Kotzebue, the maximum depth to the bottom of the permafrost layer is as much as about 240 feet (75 meters). Permafrost generally does not occur on flood plains or near lakes and other bodies of water. Periglacial features, such as beaded drainages, patterned ground, thaw gullies, pingos, and frost boils, occur throughout the area.

Geology

The western part of this area was unglaciated during the Pleistocene epoch. Most of the eastern part was covered by glacial ice originating in the Waring Mountains and Brooks Range to the north. Sediments across the vast majority of the area consist of fine textured, Holocene and Pleistocene deltaic and fluvial deposits on coastal lowlands, Holocene fluvial deposits on flood plains and stream terraces, and mixed colluvium and slope alluvium on mountain footslopes. The underlying bedrock geology consists primarily of stratified sedimentary rocks and volcanic rocks of Cretaceous, Tertiary, and Quaternary age.

Climate

The average annual precipitation ranges from less than 10 inches (255 millimeters) in coastal lowland areas to 20 to 30 inches (510 to 760 millimeters) in the hills and mountains in the southern and eastern parts of this area. Brief, cool summers and long, very cold winters characterize the climate of the area. In summer, maritime conditions prevail near the coast, becoming more continental farther inland. In winter, when the icepack forms on Kotzebue Sound, arctic continental conditions prevail throughout the area. The average annual snowfall is about 40 to 60 inches (100 to 150 centimeters). The average annual temperature at Kotzebue is 22 degrees F (-6 degrees C). The freeze-free period at Kotzebue averages about 75 to 95 days. Freezing temperatures can occur in any month of the year, particularly at the higher elevations in inland areas.

Water

There are very limited withdrawals of freshwater for use in this sparsely populated MLRA. Most of the communities in the area are along the major rivers or lakes or on the coast. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners probably obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash) or beneath coastal plains. There are typically no test data available on ground water in sparsely populated areas. If these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil orders in this MLRA are Gelisols, Inceptisols, and Entisols. The soils in the area have a subgelic or pergelic soil temperature class or a cryic soil temperature regime and generally have an aquic soil moisture regime and mixed mineralogy.

Fibristels, Histoturbels, and Aquiturbels are the most common soils on coastal lowlands and deltas. Fibristels in depressions and shallow basins formed in thick deposits of organic material and are shallow or moderately deep to permafrost. Mineral soil material, if it occurs in these organic soils, generally is within the permafrost layer. These soils are very poorly drained. Histoturbels and Aquiturbels in elevated and convex areas on low terraces and long footslopes formed in silty and sandy material over a gravelly substratum. They are shallow or moderately deep to permafrost, commonly have surface microtopography of polygons and stripe hummocks, and generally are poorly drained or very poorly drained. Histoturbels have a moderately thick surface layer of organic material. Gelepts on hills and elevated ridges formed in silty and sandy fluvial sediments. They do not have permafrost within their soil profile and generally are well drained or moderately well drained. Cryorthents, Cryaquents, and Cryofluvents on flood plains and stream terraces formed in silty and sandy alluvium. Cryopsamments on coastal dunes formed in thick deposits of sand. All of these Entisols have no permafrost within their soil profile and range from very poorly drained to excessively drained.

Miscellaneous (nonsoil) areas make up about 25 percent of this MLRA. The most common miscellaneous areas are water and beaches.

Biological Resources

Lakes and ponds and saturated soils are throughout most of this area. Areas adjacent to lakes and ponds and areas where surface water generally occurs include wet sedge meadows, sedge-shrub meadows, and sedge-moss meadows. Peat mounds and other low uplands support low and dwarf scrub dominated by ericaceous shrubs, sedges, other hydrophytic plants, and mosses. Areas with better drainage and areas of higher local relief support low ericaceous shrub scrub with common mosses, lichens, low willows, and forbs. Dense stands of grasses grow on the beds of drained thaw lakes. Flood plains support low and tall willow scrub and alder scrub. In the eastern part of the area, spruce forests and woodland occur on well drained flood plains and the better drained uplands. Both white spruce and black spruce are common. Low ericaceous shrubs, willow, alder, and mosses are dominant in the understory.

The common species of mammals in the area include brown bear, caribou, wolf, and various other furbearers. Walrus and seals are in some coastal areas. Most of the area has good-quality habitat for waterfowl. Every year, thousands of swans, geese, and ducks use the lowlands as staging and nesting areas. Sandhill cranes and a variety of shore birds and passerine birds nest throughout the area.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—70%
Forest—5%
Water—24%
Other—1%

Local residents use this remote area primarily for subsistence hunting, fishing, and gathering. The major soil resource concern is disturbance of the fragile permafrost-affected soils. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities should include protection of the organic surface material and the thermal balance of the soils. ■

243—Western Brooks Range Mountains, Foothills, and Valleys

This area is in the Northern Region of Alaska and encompasses the southern slopes of the De Long Mountains, the Baird Mountains, the Noatak River drainage, and the lower Kobuk River drainage (fig. 243-1). The southern limit of the area includes the western Lockwood Hills, Sheklukshuk and Waring Mountains, and Kiana and Igichuk Hills. The area makes up 23,070 square miles (59,780 square kilometers). It is mostly undeveloped wild land and is sparsely populated. The villages of Noatak, along the lower Noatak River, and Ambler and Shungnak, along the lower Kobuk River, are the principal

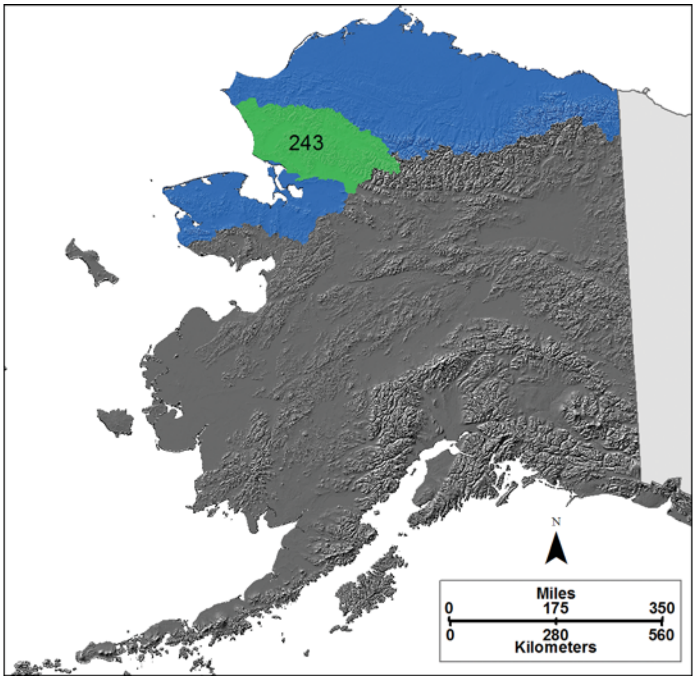

Figure 243-1: Location of MLRA 243 in Land Resource Region Y.

permanent settlements in the area. Parts of the Gates of the Arctic National Park and Preserve, Noatak National Preserve, Kobuk Valley National Park, and Cape Krusenstern National Monument are in this area.

Physiography

This area lies within the Arctic Mountains Province of the Rocky Mountain System. The terrain consists of a complex of flood plains, stream terraces, and rolling hills and upland slopes along the Noatak River and the lower Kobuk River. These features quickly give rise to moderately steep foothills and lower mountain slopes, eventually leading to steep, rugged, high-relief mountains. The upper mountain slopes generally are rocky, having extensive surface bedrock and rock rubble. Small glaciers and permanent snowfields are at the heads of some high-elevation valleys. Broad flood plains and extended mountain footslopes along the Kobuk, Squirrel, Ambler, and lower Noatak Rivers are dotted with numerous small and medium-size lakes and interconnecting wetlands. Elevation ranges from about 20 feet (6 meters) along the lower Noatak River in the western part of the area to 8,570 feet (2,613 meters) at the summit of Mt. Igikpak, in the eastern part.

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is Northwest Alaska (1902). Surface water in most of the area drains into the Noatak River via numerous other rivers. Surface water on the south slopes of the Baird Mountains drains into the Squirrel River, the Ambler River, and other tributaries of the Kobuk River. Both the Noatak and Kobuk Rivers empty into Kotzebue Sound and the Chukchi Sea. Lakes make up about 3 percent of the area.

This area is in the zone of continuous permafrost. In the mountains, permafrost is most evident in unconsolidated materials. In the valleys, thick layers of permafrost occur in both fine textured and coarse textured materials. Depth to the base of the permafrost layer may be 1,000 feet (305 meters) or more. In close proximity to water bodies, it may be 600 feet (185 meters) or more. Periglacial features, such as pingos, thermokarst pits, thaw lakes, gelifluction lobes, and high- and low-center polygons, are common on stream terraces, on the lower mountain slopes, and in swales on foothills.

Geology

The entire area was glaciated during the early and middle Pleistocene, except for possibly small portions of the Baird Mountains. By the late Pleistocene, glaciers had retreated from most of the area, except for the central, upper-elevation parts of the De Long Mountains in the northern part of the area. The valley of the upper Noatak River likely was covered by extensive proglacial lakes during parts of the Pleistocene epoch. In the mountains, glacial deposits have eroded away or have been buried by mountain colluvium and alluvium, which accumulated during the Holocene epoch across about 60 percent of the present landscape. Slightly modified to highly modified glacial moraines, drift, and outwash deposits are extensive on the lower mountain slopes and in valleys at the mid and lower elevations. These deposits cover about 18 percent of the area. Flood plains, stream terraces, and alluvial fans have recent and Pleistocene fluvial deposits. The underlying bedrock geology consists almost entirely of stratified sedimentary rocks of Paleozoic and Precambrian age and some of Cretaceous age.

Climate

The average annual precipitation ranges from about 10 to 15 inches (255 to 380 millimeters) at the lower elevations in the western part of this area and along the central Noatak River and from about 20 to 40 inches (510 to 1,015 millimeters) in the mountains. Short, generally cool summers and long, very cold winters characterize the arctic climate of the area. The average annual snowfall is about 35 to 100 inches (90 to 255 centimeters). The average annual temperature ranges from about 8 to 16 degrees F (-13 to -9 degrees C). The length of the freeze-free period is not known. Snow and freezing temperatures can occur in any month of the year, particularly at the higher elevations.

Water

There are very limited withdrawals of freshwater for use in this sparsely populated MLRA. Most of the communities in the area are along the major rivers or lakes or on the coast. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners probably obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash) or beneath coastal plains. There are typically no test data available on ground water in sparsely populated areas. If these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil orders in this MLRA are Gelisols, Entisols, Inceptisols, and Mollisols. The soils in the area have a subgelic or pergelic soil temperature class or a cryic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy.

Histoturbels, Aquiturbels, and Haploturbels formed in loamy to gravelly and stony colluvium, slope alluvium, and glacial drift on slopes, ridges, and fans in the mountains; on foothills, long upland slopes, and high terraces; and on flats in valleys. Histoturbels have a moderately thick surface layer of organic material. The soils on the upper mountain slopes and ridges generally are shallow to deep over fractured bedrock. The Histoturbels, Aquiturbels, and Haploturbels are shallow or moderately deep to permafrost and are poorly drained or very poorly drained. Fibristels in depressions, in shallow basins, and along lake margins formed in thick deposits of organic material. These soils are shallow or moderately deep to permafrost and are very poorly drained to somewhat poorly drained. Gelorthents, Gelepts, and Gelolls on the upper mountain slopes and ridges formed in loamy to stony colluvium and residuum. These soils are shallow to deep and generally are well drained. Cryofluvents on flood plains formed in stratified loamy, sandy, and gravelly alluvium and are well drained.

Miscellaneous (nonsoil) areas make up about 27 percent of this MLRA. The most common miscellaneous areas are rock outcrop, rubble land, and water.

Biological Resources

The mountain slopes and ridges in this area generally support dwarf scrub dominated by dryas, black crowberry, ericaceous shrubs, and dwarf willow. On shallow, rocky soils and exposed sites, lichens and scattered herbs dominate the ground layer. Bare soil and bedrock generally are extensive. On the more mesic sites, sedges, forbs, and mosses cover most of the surface. The lower elevations and deeper soils in areas of nearly level uplands, terraces, and basins generally support low willow and ericaceous shrub scrub and mesic graminoid herbaceous communities, commonly with extensive areas of tussock-forming sedges. Depressions, drainageways, and other saturated sites support wet sedge meadows and wet sedge-moss meadows. Flood plains support a mixture of tall and low scrub dominated by various willows, shrub birch, and alder. Along the lower Noatak and Kobuk Rivers, white spruce and mixed spruce-balsam poplar forests and woodland are associated with the scrub.

The common species of mammals in the area include brown bear, caribou, moose, musk ox, black bear, wolf, red fox, a variety of other furbearers, and rodents. Many species of migratory waterfowl and shore birds nest in the ponds and wetlands in the area. Raptors in the area include gyrfalcon, peregrine falcon, golden eagle, hawks, and owls. Arctic char and arctic grayling are in most of the rivers. Lake trout and northern pike are common in many lakes.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—59%
Forest—14%
Water—3%
Other—24%

Local residents use this remote area primarily for subsistence hunting, fishing, and gathering. Hunting and other kinds of wild-land recreation are increasingly important land uses. Most visitors are served by air taxi, guiding, and outfitting companies operating out of the major Alaska communities.

The major soil resource concern is disturbance of the fragile permafrost-affected soils. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities should include protection of the organic surface material and the thermal balance of the soils. ■

244—Northern Brooks Range Mountains

This area is in the Northern Region of Alaska and includes the high mountains and valleys on the northern side of the Brooks Range, where surface water drains into the Colville River and other Arctic Ocean drainage basins (fig. 244-1). The area makes up 15,695 square miles (40,675 square kilometers). It is entirely remote wild land and is sparsely populated. The only village in the area is Anaktuvuk Pass, along the boundary with the Interior Brooks Range Mountains (MLRA 234). The

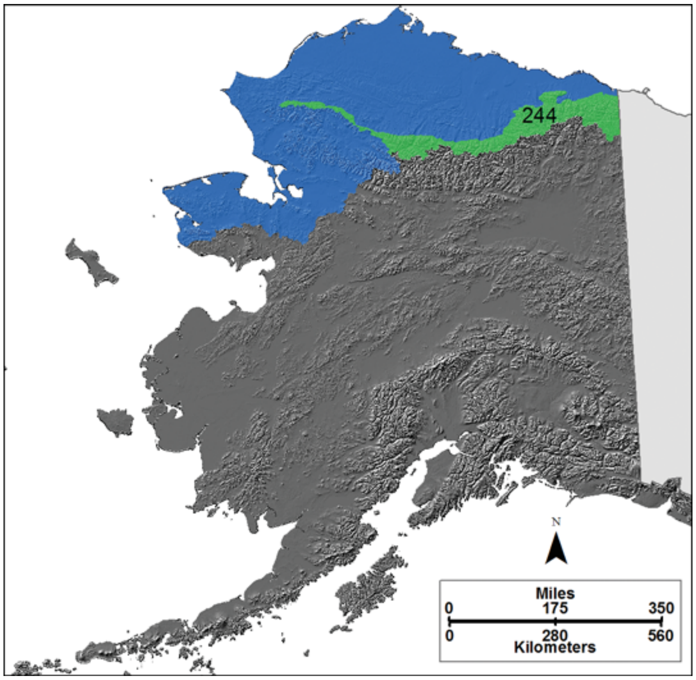

Figure 244-1: Location of MLRA 244 in Land Resource Region Y.

Dalton Highway (known locally as the Haul Road) and the Trans-Alaska Pipeline bisect the Brooks Range at Atigun Pass. Parts of the Gates of the Arctic National Park and Preserve and Arctic National Wildlife Refuge and the extreme southern part of the National Petroleum Reserve are in this area.

Physiography

This area lies within the Arctic Mountains Province of the Rocky Mountain System. The Brooks Range is the most northerly extension of the Rocky Mountains. The terrain consists of steep, rugged, high mountains and narrow valleys. In places small glaciers occur at the higher elevations, particularly in the Romanzof Mountains, in the eastern part of the area. The upper mountain slopes generally are rocky, having extensive surface bedrock and rock rubble. The lower slopes are characterized by coalescing fans and steep footslopes that extend to stream channels in narrow valleys. The bottoms of the valleys along the larger rivers and streams have nearly level flood plains and stream terraces and some rolling uplands. Elevation ranges from about 1,969 feet (600 meters) along the edge of the Arctic Foothills (MLRA 245) to 8,570 feet (2,613 meters) at the summit of Mt. Igikpak, in the western part of the area, along the border with the adjacent Brooks Range MLRAs.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Arctic Slope (1901), 98 percent, and Yukon (1903), 2 percent. Numerous rivers drain this MLRA through the Arctic Foothills and Coastal Plain to the Arctic Ocean. The major rivers are the Kongakut, Aichilik, Jago, Canning, Ivishak, Ribdon, Atigun, Anaktuvuk, and Killik Rivers. Lakes make up less than 2 percent of the area.

This area is in the zone of continuous permafrost. In the mountains, permafrost is most evident in areas of deep unconsolidated deposits. In valleys, thick layers of permafrost occur in both fine textured and coarse textured deposits. Periglacial features, including gelifluction lobes, polygons, and stripes, are common on stream terraces, on hills, and in gently sloping areas in the mountains.

Geology

Except for the highest peaks, the steep upper ridges, and occasional unglaciated valleys, most of this area was covered with glacial ice during the early and middle Pleistocene. In many places, the ice extended northward down onto the adjacent Arctic Foothills (MLRA 245). By the late Pleistocene, only the highest valleys and mountains remained glaciated. Most glacial deposits have eroded away or have been buried by mountain colluvium and alluvium, which accumulated during the Holocene epoch across about 75 percent of the present landscape. Slightly modified to highly modified glacial moraines, drift, and outwash deposits are extensive on the lower mountain slopes and in valleys at the lower elevations. These deposits cover about 20 percent of the area. Flood plains, stream terraces, and alluvial fans have recent and Pleistocene fluvial deposits. The underlying bedrock geology consists almost entirely of stratified sedimentary rocks of Paleozoic and Precambrian age. Inclusions of Paleozoic and early Jurassic volcanic and igneous rocks occur in the eastern part of the area.

Climate

The average annual precipitation throughout most of this area ranges from 15 to 40 inches (380 to 1,015 millimeters). Brief, cool summers and long, very cold winters characterize the arctic climate of the area. The average annual snowfall is about 50 to 100 inches (125 to 255 centimeters). The average annual temperature ranges from about 8 to 16 degrees F (-13 to -9 degrees C). The length of the freeze-free period is not known. Freezing temperatures can occur in any month of the year.

Water

There are very limited withdrawals of freshwater for use in this sparsely populated MLRA. Most of the communities in the area are along the major rivers at the lower elevations. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners probably obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash). There are typically no test data available on ground water in sparsely populated areas. If these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Septic systems, landfills, and leaking fuel storage tanks are all possible sources of contamination.

Soils

The dominant soil order in this MLRA is Gelisols. The soils in the area generally have a pergelic soil temperature class, an aquic or udic soil moisture regime, and mixed mineralogy.

Aquiturbels, Histoturbels, Molliturbels, and Haploturbels formed in loamy to stony colluvium, slope alluvium, and residuum. These soils are shallow or moderately deep to permafrost and are poorly drained or very poorly drained. Fibristels in depressions, drainageways, and basins formed in thick deposits of organic material, are shallow or moderately deep to permafrost, and are very poorly drained.

Miscellaneous (nonsoil) areas make up about 75 percent of this MLRA. The most common miscellaneous areas are rubble land, chutes, rock outcrop, and small glaciers.

Biological Resources

Because of the shallow soils, high winds, and harsh climate, the vegetation in this area is sparse and is generally limited to valleys and the lower mountain slopes. Dwarf scrub communities on mountain slopes and ridges are dominated by black crowberry, ericaceous shrubs, dryas, and dwarf willow. On shallow, rocky soils and exposed sites, lichens and scattered herbs dominate the ground layer. Bare soil and bedrock generally are extensive. On the more mesic sites, sedges, forbs, and mosses cover most of the surface. The lower elevations and deeper soils in basins and on terraces generally support low willow and ericaceous shrub scrub and mesic graminoid herbaceous communities, commonly with extensive areas of tussock-forming sedges. Depressions, drainageways, and other saturated sites support wet sedge meadows, sedge-shrub meadows, and wet sedge-moss meadows. Low and tall willow scrub is dominant on flood plains.

The common species of mammals in the area include brown bear, black bear, wolf, caribou, and Dall sheep. The smaller mammals include marmot, red fox, arctic fox, wolverine, ground squirrel, lemming, and pika. The common raptors in many areas include golden eagles, marsh hawks, and snowy owls.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—25%
Forest—2%
Other—73%

Residents of nearby villages use this remote area primarily for subsistence hunting, fishing, and gathering. The area also is used widely for sport hunting and other kinds of wild-land recreation. Most visitors are served by air taxi, guiding, and outfitting companies operating out of the major Alaska communities. Mineral resources have been prospected and mined in a number of places. Construction and maintenance of the Dalton Highway have led to development of numerous sand and gravel pits along the road corridor.

Generally, no major resource concerns affect land use in this sparsely populated area. Because of the highways and pipeline that cross the area, however, disturbance of the fragile permafrost-affected soils is a concern. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities should include protection of the organic surface material and the thermal balance of the soils. ■

245—Arctic Foothills

This area is in the Northern Region of Alaska and includes the broad, rounded hills and nearly level uplands at the base of the Brooks Range from Point Hope in the west to Demarcation Point in the east (fig. 245-1). The area makes up about 42,305 square miles (109,625 square kilometers). It is entirely undeveloped wild land and is sparsely populated. The only villages are Umiat, in the central part of the area, and Kivalina and Point Hope, along the coast of the Arctic Ocean in the western part of the area. The Dalton Highway (known locally as the Haul Road) and the Trans-Alaska Pipeline bisect this MLRA west of the Sagavanirktok River. Parts of the National Petroleum Reserve and Arctic National Wildlife Refuge are in this area.

Physiography

This area lies within the Arctic Foothills Province of the Rocky Mountain System. The northern part of the area consists of broad, rounded ridges and mesa-like uplands. The southern part, which is higher than the northern part, consists of irregular buttes, mesas, and linear ridges with intervening undulating plains and plateaus. Many streams and rivers are in swales and

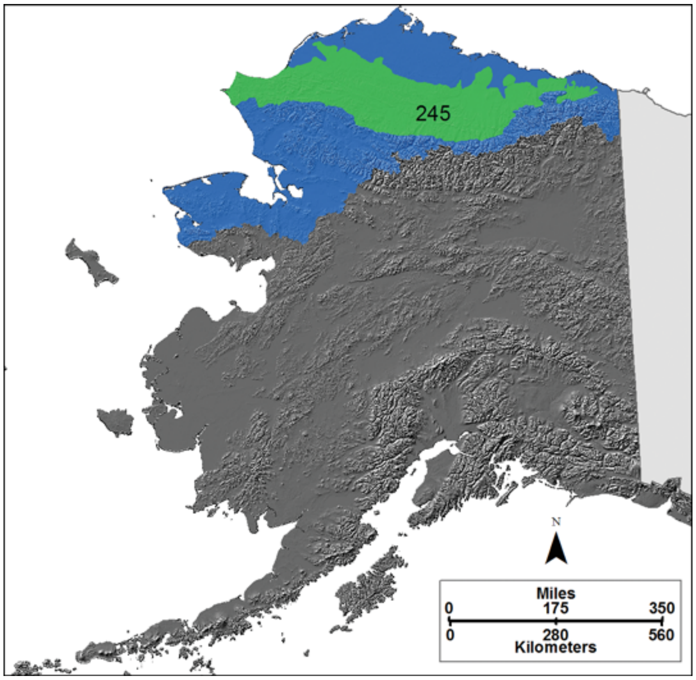

Figure 245-1: Location of MLRA 245 in Land Resource Region Y.

valleys between hills. Most rivers are confined to a single, moderate-gradient, slightly meandering channel. Braided sections occur across level areas. Elevation generally ranges from about 655 feet (200 meters) in the northern part of the area, along the border with the Arctic Coastal Plain (MLRA 246), to about 2,000 feet (610 meters) in the southern part, along the border with the Northern Brooks Range Mountains (MLRA 244). Some hills bordering the Brooks Range reach an elevation of 3,600 feet (1,100 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Arctic Slope (1901), 95 percent, and Northwest Alaska (1902), 5 percent. Numerous rivers originating in the Brooks Range drain through the Arctic Coastal Plain to the Arctic Ocean. The major drainage is that of the Colville River. Other major rivers are the Canning and Sagavanirktok Rivers. Lakes make up less than 2 percent of the area.

This area is in the zone of continuous permafrost. Thick layers of permafrost occur in both fine textured and coarse textured deposits. Depth to the base of the permafrost layer is as much as 2,100 feet (640 meters). Periglacial features, such as pingos, gelifluction lobes, and patterned ground, occur throughout the area.

Geology

This area remained unglaciated during the Pleistocene epoch, except possibly for the upper areas along the edge of the Northern Brooks Range Mountains (MLRA 244). Bedrock and coarse to fine rubble mantle the surface on convex uplands. Elsewhere, Quaternary surface deposits include various alluvial, eolian, or glaciofluvial materials. Slightly modified to highly modified moraines and drift occur in areas adjacent to the Brooks Range. The bedrock geology of the area consists primarily of Cretaceous and late Paleozoic to lower Mesozoic stratified sedimentary rocks. These rocks occur in about 67 percent of the area. The rest of the area consists of uplifted Cretaceous and Tertiary continental deposits.

Climate

The average annual precipitation is less than 10 inches (255 millimeters) at the lower elevations along the northern boundary of this area with the Arctic Coastal Plain (MLRA 246) and ranges from 15 to 20 inches (380 to 510 millimeters) at the higher elevations in the southern part of the area. Brief, cool summers and long, very cold winters characterize the arctic climate of the area. The average annual snowfall ranges from about 40 to 60 inches (100 to 150 centimeters). The average annual temperature ranges from 10 to 18 degrees F (-12 to -8 degrees C). The average freeze-free period is fewer than 10 days to 55 days.

Water

There are very limited withdrawals of freshwater for use in this sparsely populated MLRA. Most of the communities in the area are along the major rivers at the lower elevations or are on the coast. Some mining and oil and gas extraction operations use some surface water in this area. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Most of the water used for domestic supply in this area is probably obtained from private wells.

Most small communities, rural landowners, and mineral industries probably obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash). There are typically no test data available on ground water in sparsely populated areas. If these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Septic systems, landfills, leaking fuel storage tanks, and waste from mineral, oil, and gas extraction are all possible sources of contamination. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil order in this MLRA is Gelisols. Entisols and Inceptisols are of minor extent. Most of the soils in the area have a pergelic soil temperature class, an aquic soil moisture regime, and mixed mineralogy. The soils generally are shallow or moderately deep to permafrost, are poorly drained or very poorly drained, and are loamy and gravelly.

Aquiturbels, Histoturbels, and Molliturbels formed in loamy and gravelly colluvium and slope alluvium on ridges, gently sloping to steep hills, and valley bottoms and in gravelly alluvium on stream terraces. Moderately well drained Gelepts and Gelorthents are on some steep hillsides. These soils have a cryic soil temperature regime and do not have permafrost within their soil profile. Fibristels in depressions, on valley bottoms, and in drainageways formed in thick deposits of organic material.

Miscellaneous (nonsoil) areas make up about 4 percent of this area. The most common miscellaneous areas are rock outcrop, talus, and ice.

Biological Resources

The uplands in this area generally support dwarf scrub dominated by dryas, black crowberry, ericaceous shrubs, and dwarf willow. On shallow, rocky soils and exposed sites, lichens and scattered herbs dominate the ground layer. Bare soil and bedrock generally are extensive. On the more mesic sites, sedges, forbs, and mosses cover most of the surface. The mesic sites and deeper soils in valleys, in basins, and on terraces generally support low and dwarf willow and ericaceous shrub scrub and mesic graminoid herbaceous communities, commonly with extensive areas of tussock-forming sedges. Depressions, drainageways, and other saturated sites support wet sedge meadows and wet sedge-moss meadows. Flood plains support a mixture of tall and low scrub dominated by various willows, shrub birch, and some alder.

The common species of mammals in the area include brown bear, wolf, wolverine, caribou, arctic fox, snowshoe and tundra hare, hoary marmot, brown lemming, and northern bog lemming. Musk oxen, which were decimated by hunting in the late 1800s, are becoming more common in many places. The common birds in the area include willow ptarmigan, rough-legged hawk, American golden plover, short-eared owl, and snowy owl. Arctic char and arctic grayling are in most of the rivers.

Land Use

Following are the various kinds of land use in this MLRA:

Grassland—96%
Water—1%
Other—3%

Local residents use this area primarily for subsistence hunting, fishing, and gathering. Sport hunting and other kinds of wild-land recreation are becoming increasingly important land uses. Most visitors are served by air taxi, guiding, and outfitting companies operating out of the major Alaska communities. Some limited extraction of minerals, including oil and gas, occurs in local areas.

The major soil resource concern is disturbance of the fragile permafrost-affected soils. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities should include protection of the organic surface material and the thermal balance of the soils. ■

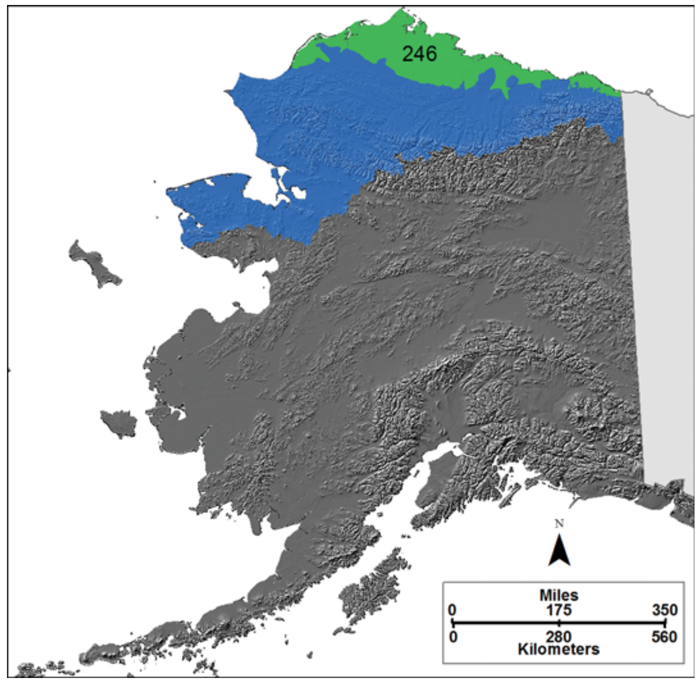

Figure 246-1: Location of MLRA 246 in Land Resource Region Y.

246—Arctic Coastal Plain

This area is in the Northern Region of Alaska and consists of a level to gently rolling plain along the coast of the Arctic Ocean (fig. 246-1). The area makes up about 22,860 square miles (59,240 square kilometers). It is mostly remote wild land and is sparsely populated. Permanent settlements include Point Lay, Wainwright, Barrow, Nuigsut, and Kaktovik. The Prudhoe Bay oil fields and the northern terminus of the Trans-Alaska Pipeline are in the central part of the area. The Dalton Highway (known locally as the Haul Road) and the Trans-Alaska Pipeline bisect the area west of the Sagavanirktok River, terminating at Deadhorse. The community of Deadhorse provides much of the industrial infrastructure and many of the residential facilities associated with the oil fields and pipeline. Parts of the National Petroleum Reserve and Arctic National Wildlife Refuge are in this area.

Physiography

This area lies within the Arctic Coastal Plain Province of the Interior Plains System. The terrain consists of a level to gently rolling plain rising from the Arctic Ocean to the Arctic Foothills (MLRA 245). The area is dotted by thousands of small and medium-size lakes and interconnecting wetlands. Many of the lakes are elongated thaw lakes, which are consistently oriented from north to northwest. Narrow, nearly level flood plains and stream terraces are along the many rivers that cross the area. In the central part of the area, near the coast, small sand dunes also occur along the rivers. Elevation ranges from sea level to about 655 feet (200 meters).

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is Arctic Slope (1901). Numerous rivers, mostly originating in the Brooks Range to the south, drain from this MLRA to the Arctic Ocean. The major rivers are the Canning, Colville, Jago, Kongakut, Kuk, Utukok, and Sagavanirktok Rivers. Lakes and other kinds of surface water make up about 20 percent of the area.

This area is in the zone of continuous permafrost. Thick layers of permafrost occur in both fine textured and coarse textured deposits. Depth to the base of the permafrost layer is as much as 2,100 feet (640 meters). Periglacial features, such as beaded drainages, patterned ground, thaw gullies, pingos, and frost boils, occur throughout the area.

Geology

This area was never glaciated. The bedrock geology consists of Cretaceous and Tertiary stratified sedimentary rocks and uplifted continental deposits. The modern landscape is mantled with Quaternary deposits of alluvial, eolian, or glaciofluvial origin.

Climate

The average annual precipitation in this area is 4 to 6 inches (100 to 150 millimeters). Brief, cool summers and long, very cold winters characterize the arctic climate of the area. The average annual snowfall is about 20 to 40 inches (50 to 100 centimeters). The average annual temperature ranges from 8 to 14 degrees F (-15 to -10 degrees C). The average freeze-free period is fewer than 5 days to 20 days. Freezing temperatures can occur in any month.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 5.9%; ground water, 17.6%
Livestock—surface water, 0.0%; ground water, 0.0%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 58.8%; ground water, 17.6%

The total withdrawals average less than 2 million gallons per day (6 million liters per day). About 35 percent is from ground water sources, and 65 percent is from surface water sources. Mineral and oil and gas extraction operations use most of the surface water in this area. Some communities along the major rivers or on the coast use some surface water for their public supply. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen or flow little during winter. Most of the water used for domestic supply in this area is probably obtained from private wells.

Most small communities, rural landowners, and mineral industries obtain ground water from unconsolidated sediments in river valleys (alluvium or glacial outwash) or beneath the coastal plain. There are typically no test data available on ground water in sparsely populated areas. If these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Septic systems, landfills, leaking fuel storage tanks, and waste from mineral, oil, and gas extraction are all possible sources of contamination. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil order in this MLRA is Gelisols. The soils in the area have a pergelic soil temperature class. Most have an aquic soil moisture regime and mixed mineralogy. All of the soils have permafrost. They are generally shallow or moderately deep to permafrost and are poorly drained or very poorly drained.

Aquiturbels, Histoturbels, and Haploturbels on nearly level to rolling plains, low hills, and pingos formed in loamy to gravelly sediments. Aquiturbels and Haplorthels on flood plains and stream terraces formed in sandy and gravelly alluvium. Psammoturbels on dunes formed in thick deposits of sandy material. Aquiturbels are in areas between the dunes. Fibristels in depressions, basins, and drainageways and along lake margins formed in thick deposits of organic material.

Miscellaneous (nonsoil) areas make up about 20 percent of this MLRA. The most common miscellaneous areas are water, riverwash, and beaches.

Biological Resources

Wet soil conditions are prevalent across much of this area. The vegetation in the area occurs primarily in a variety of mesic and wet sedge, sedge-grass, and sedge-moss meadows. The drier sites and low uplands support dwarf scrub dominated by dryas, black crowberry, ericaceous shrubs, and dwarf willow. On shallow, rocky soils and exposed sites, lichens and scattered herbs dominate the ground layer. Bare soil and bedrock generally are extensive. Flood plains support a mixture of low willow scrub and scattered herbs.

The common species of mammals in the area include brown bear, wolf, wolverine, caribou, arctic hare, mink, weasel, and lemming. Small herds of musk oxen are in scattered areas throughout the MLRA. This species was decimated by hunting in the late 1800s and reintroduced to the area in 1969. Pack ice and coastal areas are inhabited by polar bear, walrus, and arctic fox. Many species of migratory waterfowl, including lesser snow goose, tundra swans, brant, and common eider, nest in the lakes and ponds in the area. Sea birds, including the pomarine jaeger, glaucous gull, and black guillemot, are abundant along the coast. A wide variety of passerine birds and shore birds use the upland and wetland habitats throughout the area.

Land Use

Following are the kinds of land use in this MLRA:

Grassland—80%
Water—20%

Local residents use this area primarily for subsistence hunting, fishing, and gathering. Sport hunting and other kinds of wild-land recreation are becoming increasingly important land uses. Most visitors are served by air taxi, guiding, and outfitting companies operating out of the major Alaska communities. Less than 1 percent of the area is urban. Oil and gas extraction and the related industrial development occur in some areas.

The major soil resource concern is disturbance of the fragile permafrost-affected soils. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities should include protection of the organic surface material and the thermal balance of the soils. Oil spills and other kinds of industrial pollution are serious concerns in areas of oil extraction and industrial development. ■

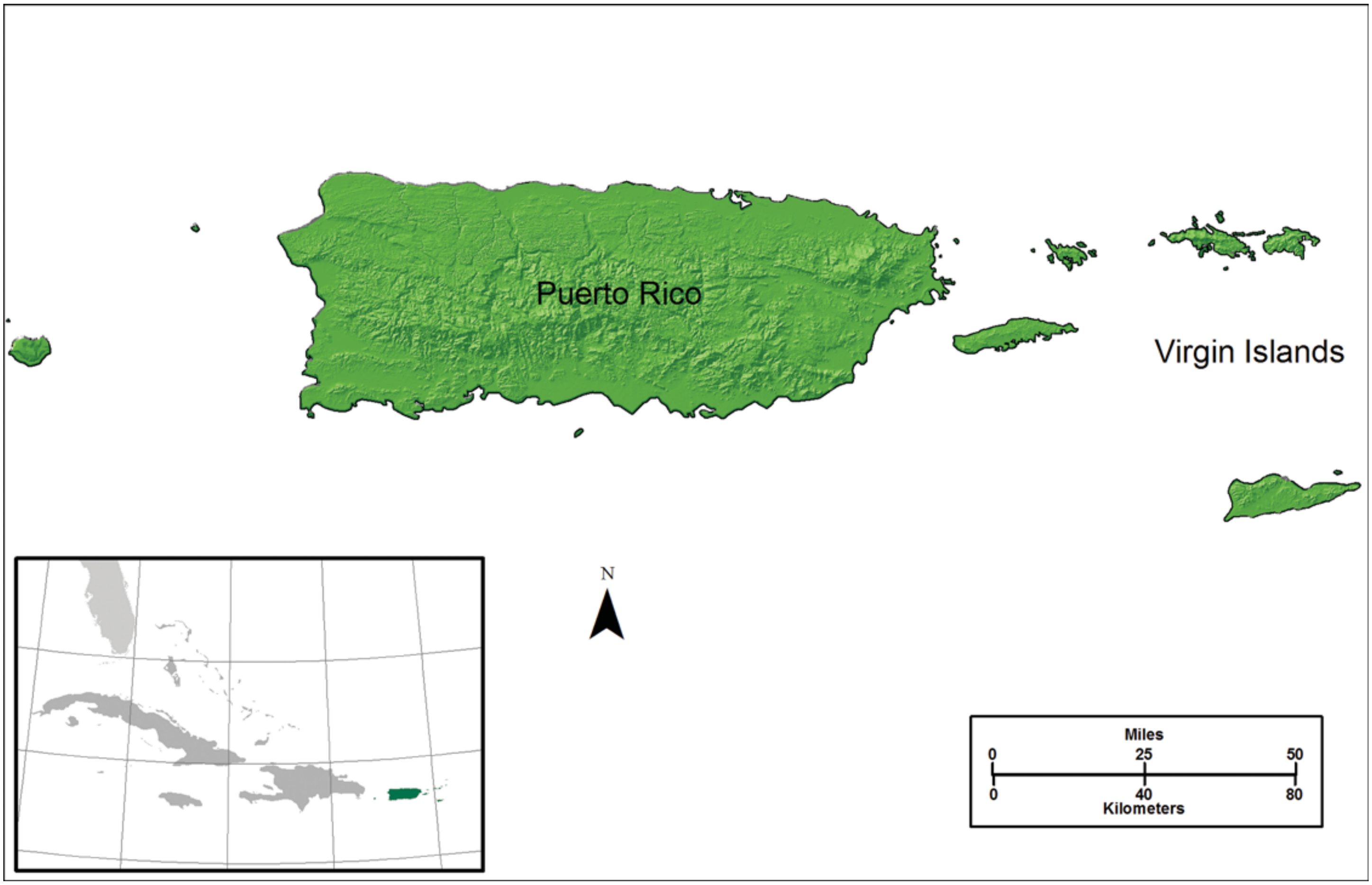

Figure Z-1: Location of Land Resource Region Z.

Z—Caribbean Region

This region (shown in fig. Z-1) includes Puerto Rico (94 percent); the U.S. Virgin Islands of St. Croix, St. Thomas, and St. John (4 percent); and the outlying islands of Vieques, Culebra, Desecheo, and Mona (2 percent). It makes up 3,595 square miles (9,310 square kilometers).

This is a region of humid and semiarid mountains, valleys (fig. Z-2), and coastal plains. It has a long, warm growing season. The average annual precipitation ranges from 60 to 90 inches (1,525 to 2,285 millimeters) in the humid uplands, 45 to 60 inches (1,145 to 1,525 millimeters) on the humid coastal plains, 30 to 45 inches (760 to 1,145 millimeters) in the semiarid mountains and valleys, and 10 to 45 inches (255 to 1,145 millimeters) on the semiarid coastal plains. The area of rain forest in northwest Puerto Rico has the highest average annual precipitation, 120 to 200 inches (3,050 to 5,080 millimeters). The average annual temperature is 70 to 74 degrees F (21 to 23 degrees C) in the humid uplands, 77 degrees F (25 degrees C) on the humid coastal plains, and 79 degrees F (26 degrees C) in the semiarid mountains and valleys and on the semiarid coastal plains. This region is freeze-free.

Puerto Rico is surrounded by the Atlantic Ocean to the north and by the Caribbean Sea to the south. Approximately three-fourths of the island consists of mountain ranges. Cerro de Punta, the highest peak, is at an elevation of 4,389 feet (1,338 meters), and El Yunque, in the rain forest, is at an elevation of 3,493 feet (1,065 meters). Other prominent physical features are limestone karst in the northwestern part of the region and coastal plains of varying width along the northern and southern coasts. Slopes are 15 percent or less in about 15 percent of this region, 16 to 45 percent in 25 percent of the region, and more than 45 percent in the rest of the region.

The total withdrawals of freshwater in this region average about 595 million gallons per day (2,250 million liters per day). About 72 percent is from surface water sources, and 28 percent is from ground water sources. Most of the surface water used in the region is from storage tanks or cisterns fed by rainwater catchments. About 71 percent of all the water used in this heavily populated region is for public supply. About 24 percent is used for irrigation.

The soils in this region include a wide range of Inceptisols, Ultisols, Oxisols, Mollisols, Entisols, Alfisols, and Histosols. The dominant suborders are Ustepts, Udepts, and Humults in

Figure Z-2: Valley and mountains in an area of Land Resource Region Z.

the mountainous areas and Udults and Udox on the coastal plains. Poorly drained Aquepts, Aquolls, and Aquents are common on flood plains, and Ustolls and Udolls are in the better drained areas. Rendolls and Udalfs occur in areas of limestone karst. Saprists occur in depressions. Generally, the soils have a thermic or isohyperthermic soil temperature regime, an ustic or udic soil moisture regime, and mixed or smectitic mineralogy.

About 96 percent of the land in this region is privately owned. Pasture of native and improved grasses grown for dairy and beef enterprises is the main land use. Forestland, mostly unimproved, is widespread, especially in the humid uplands. The climax vegetation consists of forest species. Food crops, such as plantains, bananas, yams, mangos, taniers, vegetables, and some citrus fruit and coconuts, are grown in the region. Some unique farmland is used for pineapples or rice. The importance of sugarcane, once the main cash crop in the region, has declined because many sugar mills have been closed. Coffee grown under shade was once a prosperous enterprise, but hurricanes and other problems have contributed to the decline of this enterprise. Urban developments, highways, and recreational areas are encroaching on the better farmland, especially near metropolitan areas. The main limitations of the soils in the region are shallowness to bedrock and steepness of slope. ■

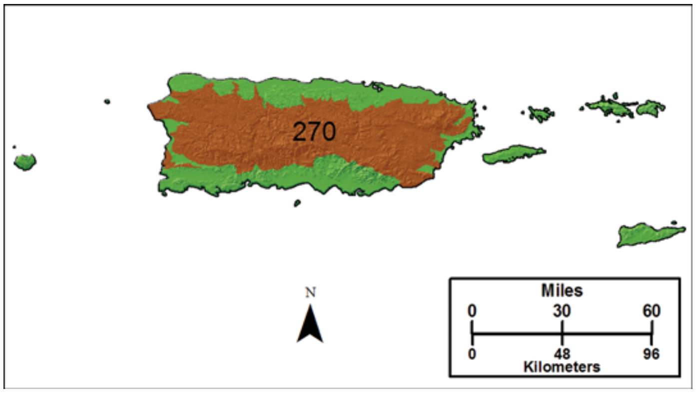

Figure 270-1: Location of MLRA 270 in Land Resource Region Z.

270—Humid Mountains and Valleys

This area is in central Puerto Rico (fig. 270-1). It makes up about 1,800 square miles (4,660 square kilometers), which is 53 percent of Puerto Rico. From west to east, the towns of Las Marías, Maricao, Adjuntas, Utuado, Jayuya, Villalba, Orocovis, Barranquitas, Comerío, Cidra, Caguas, San Lorenzo, and Las Piedras are in this area. A number of State parks and forest preserves are in the area. Examples are the "Monte del Estado," the "Bosque de Guilarte," and part of the "Bosque de Susúa." The Caribbean National Forest (El Yunque), a rain forest, is at the eastern end of the area.

Physiography

This mountainous area has very steep slopes and very narrow to indistinct valleys. Landslides are common in the area. Elevation ranges from 160 to 4,400 feet (50 to 1,340 meters).

Three different mountain ranges occur in the area. The Central Ridge, "Cordillera Central" as it is known locally, is the highest and largest of the three. It is truly in the center of the island and is oriented in a general east-west direction. Cerro de Punta, its highest peak, is 4,389 feet (1,338 meters) above sea level. Los Tres Picachos and Monte Guilarte are about 3,952 feet (1,205 meters) high.

Second in extent and elevation is the Sierra de Luquillo mountain range in the northeastern part of Puerto Rico. The three highest peaks in this range are El Toro, 3,523 feet (1,074 meters) above sea level; El Yunque, 3,493 feet (1,065 meters); and Pico del Este, 3,447 feet (1,051 meters). Because of its elevation and location on the island relative to the easterly trade winds, a rain forest (El Yunque) occurs on the higher parts of this range.

The third mountain range is the Sierra de Cayey, in the east-central part of Puerto Rico. The highest peaks in this range are Cerro La Santa, 2,962 feet (903 meters) high, and Cerro de la Tabla, 2,919 feet (890 meters) high.

Contrasting with the strongly dissected uplands are the small areas of undulating landscapes that occur at elevations of 1,640 to 1,970 feet (500 to 600 meters) near Barranquitas in east-central Puerto Rico. These landscapes are remnants of a Miocene geomorphic surface, known as the St. John Peneplain, that escaped erosion.

The only Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is Puerto Rico (2101). This MLRA includes the headwaters of almost all of the rivers and streams on the island.

Geology

Most of this MLRA consists of volcanic rocks that formed below sea level during the Cretaceous period (135 to 70 million years ago). The various formations consist mainly of volcaniclastic rocks (andesite, volcanic sandstone and siltstone, breccia, lava breccia, and pillow lava) of andesitic composition. Large intrusions of plutonic rocks into the volcanic strata occur in the Utuado area in west-central Puerto Rico and in the San Lorenzo area in southeastern Puerto Rico. These batholiths consist of granodiorite and quartz diorite. Plutonic rocks crop out in many small areas throughout the island. Ultrabasic rocks called serpentinite occur in the Cerro Las Mesas, Monte del Estado, and Bosque de Susúa areas in southwestern Puerto Rico. They formed in the late Jurassic period, probably 150 million years ago. The present area of the MLRA emerged from the sea during the early Tertiary period as a result of uplift caused by plate tectonics. The uplift of the island produced numerous fractures and fault zones and tilted the originally horizontal strata.

Climate

The average annual precipitation is 80 to 85 inches (2,030 to 2,160 millimeters) in most of this area. It can be as low as 60 inches (1,525 millimeters) along the northern and southern edges of the area and can be 120 to 200 inches (3,050 to 5,080 millimeters) at the highest elevations. Most of the rainfall occurs in the afternoons as frequent, trade-wind showers from May to October, but tropical storms and hurricanes can produce high amounts of rain that can result in local flooding and landslide problems. The area is typically drier from December to March, rainy during April and May, semidry in June and July, and wet from August to November. The average annual temperature is less than 70 degrees F (21 degrees C) at the higher elevations and 74 degrees F (23 degrees C) at the lower elevations. There is little difference in air temperature between the summer and winter seasons. This MLRA is freeze-free.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 88.9%; ground water, 7.2%
Livestock—surface water, 0.9%; ground water, 0.4%
Irrigation—surface water, 0.0%; ground water, 0.0%
Other—surface water, 0.9%; ground water, 1.6%

The total withdrawals average 30 million gallons per day (115 million liters per day). About 9 percent is from ground water sources, and 91 percent is from surface water sources. Rainfall, perennial streams, and lakes provide ample amounts of surface water. Manmade lakes are used to trap and store runoff for public supply and irrigation at the lower elevations outside this MLRA. The surface water generally meets the recommended standards for all uses. Fecal coliform contamination can occur at times in streams.

The ground water in this area is of good quality, but it is little used. The principal aquifer is the dense and massive volcanic rock underlying most of the area. Fractures and joints in the rock trap and hold the water. Another source of ground water consists of alluvial deposits of very limited extent in narrow valleys.

Soils

The dominant soils in this MLRA are Inceptisols, Ultisols, or Oxisols. The dominant suborders are Udepts, Humults, and Udox. Most of the soils have an isohyperthermic or isothermic soil temperature regime, a udic soil moisture regime, and mixed mineralogy and are clayey or loamy. The soil moisture regime in the Luquillo area is perudic. Shallow and moderately deep Eutrudepts (Caguabo, Mucara, Quebrada, and Morado series) are on steep side slopes, mainly in the east-central part of Puerto Rico. Deep, very fine textured Haplohumults (Humatas series) and Hapludox (Los Guineos series) are on steep side slopes in the west-central part of Puerto Rico. Deep, extremely weathered Acrudox (Nipe series) are of minor extent in the western part of Puerto Rico.

Biological Resources

The dominant plant species in this area are carpetgrass, whorled dropseed, pendejuelo, knotroot bristlegrass, creeping wheatgrass, St. Augustine grass, woodland grass, foxtail grass, beardgrass, matojito, flor de conchitas, bitterbrush, sensitive plant, tick trefoil, burbrush, albizia tree, false moneywort, black manzanilla, shepherdsneedle, black sage, rattleweed, wireweed, boton blanco, wild sage, guava, coconut tree, flame tree, white oak, turkey berry, camasey, higuillo, yagrumo hembra, yagrumo macho, guano, tabonuco tree, mango tree, treefern, palma de sierra, Christmas tree, Puerto Rico royal palm, palo de doncella, and basora prieta.

Some of the major wildlife species in this area are *Anolis* species, bananaquit, bridled quail dove, cattle egret, *Eleutherodactylus* species, green-throated carib, Antillean nighthawk, elfin woods warbler, gray kingbird, greater Antillean grackle, killdeer, mangose (invasive), merlin, plain pigeon, Puerto Rican boa, Puerto Rican bullfinch, Puerto Rican emerald hummingbird, Puerto Rican lizard cuckoo, Puerto Rican nightjar, Puerto Rican screech owl, Puerto Rican tanager, Puerto Rican tody, Puerto Rican woodpecker, Puerto Rico vireo, red-tailed hawk, rodents, ruddy quail dove, scaly-naped pigeon, sharp-shined hawk, smooth-billed ani, and West Indian whistling duck.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 23%
Grassland—private, 23%
Forest—private, 34%; Federal, 1%
Urban development—private, 14%
Water—private, 2%
Other—private, 3%

The grassland in the area is pasture that supports improved forage and native grasses. Approximately 7 percent of the area is used for the production of coffee beans. Most of the coffee beans are grown in the shade, but some are grown in sunlight. The food crops grown in the area include plantains, bananas, taniers, yams, and pigeon peas. Orchard crops also are grown. The climax vegetation in the area consists of forest species. Urban expansion is becoming a serious land use problem in the area.

The major soil resource concerns are water erosion (sheet and rill and ephemeral gully or concentrated flow) and mass movement of soil; maintenance of the content of organic matter, tilth, and fertility of the soils; and water infiltration. Water-quality concerns include surface water contaminants derived from organic and inorganic fertilizers.

Conservation practices on cropland generally include conservation crop rotations, contour farming, hillside ditches, grassed waterways, crop residue management systems (especially no-till systems), and nutrient and pest management. Conservation practices on pasture generally include fencing, pasture and hayland planting, watering facilities, and prescribed grazing. ■

271—Semiarid Mountains and Valleys

This area (shown in fig. 271-1) is in Puerto Rico (71 percent), the Virgin Islands (20 percent), and the outlying islands of Vieques and Culebra (9 percent). It makes up about 525 square miles (1,365 square kilometers). From west to east, the towns of Cabo Rojo, Lajas, Guanica, Yauco, Peñuelas, Juana Díaz, Coamo, Salinas, Guayama, and Arroyo, Puerto Rico, are in this area. All of St. John and St. Thomas and the towns of Christiansted and Frederiksted, St. Croix, are in the area.

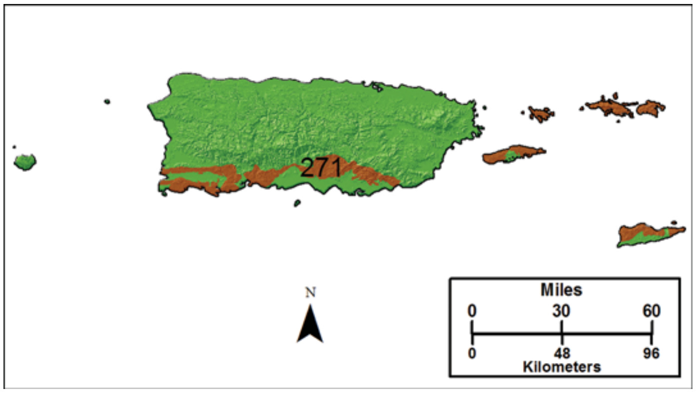

Figure 271-1: Location of MLRA 271 in Land Resource Region Z.

Physiography

The part of this area in Puerto Rico consists of semiarid mountains that form the southern slopes of the central mountain chain (Cordillera Central), which extends from east to west across the length of the island. Slopes generally range from moderately steep to very steep. They are nearly vertical in the northernmost part of the area. Elevation ranges from 160 to 1,300 feet (50 to 395 meters).

The part of this area in the Virgin Islands and in the two outlying islands is mountainous. A ridge of mountains characterizes the northeast and northwest corners of St. Croix. Mount Eagle, the highest peak in St. Croix, is 1,165 feet (355 meters) high. St. Thomas and St. John are characterized by irregular coastlines, many bays, steep slopes, and small drainage areas. Crown Mountain, the highest peak in St. Thomas, is 1,556 feet (474 meters) above sea level. Bordeaux Mountain, the highest peak in St. John, is 1,297 feet (395 meters) above sea level.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Puerto Rico (2101), 71 percent; Virgin Islands (2102), 20 percent; and Caribbean Outlying Islands (2103), 9 percent. All of the streams in the part of this area in Puerto Rico flow to the south; none are perennial.

Geology

The geology of this MLRA is very diverse. The part of the area in Puerto Rico consists of steep mountainsides composed mainly of Cretaceous rocks. The lower mountains consist of Tertiary limestone. Ultrabasic rocks (serpentinite) occur in Sierra Bermeja, in southwestern Puerto Rico. Together with the chert fragments in the same area, they constitute the oldest rocks on the island. They formed in the late Jurassic period, probably 150 million years ago. Most of the part of the MLRA in Puerto Rico has a mixture of limestone and volcanic rocks in the higher, steeper areas. Some igneous intrusives also occur in the parts of the MLRA in Puerto Rico and the outlying islands. Volcanic rocks are dominant, however, in the higher parts of the Virgin Islands and the other outlying islands around Puerto Rico.

Climate

The average annual precipitation in the part of this MLRA in Puerto Rico is 35 to 45 inches (890 to 1,145 millimeters) near the coast and is as much as 60 inches (1,525 millimeters) in the higher inland areas. Much of the rainfall is lost through evapotranspiration, and the year-round air temperatures are high. Thus, the climate is semiarid. Most of the rainfall occurs in the afternoons as frequent trade-wind showers from May to October, but tropical storms and hurricanes can produce high amounts of rain that can result in widespread flooding problems. This part of the MLRA is typically drier from December through March, rainy during April and May, semidry in June and July, and wet from August through November.

The average annual precipitation in the part of this MLRA on St. Croix is 40 to 50 inches (1,015 to 1,270 millimeters), decreasing nearer the coast. St. Thomas is the driest of the Virgin Islands. Its annual precipitation is 35 to 42 inches (890 to 1,065 millimeters). St. John is the wettest island. Its annual precipitation is 40 to 55 inches (1,015 to 1,395 millimeters). No records are kept on the annual precipitation in the outlying islands. The annual amount on these islands is probably similar to the amount on St. Croix.

The average annual temperature in this MLRA is about 79 degrees F (26 degrees C). The difference between the temperature in summer and that in winter is less than 8 degrees F (5 degrees C). This MLRA is freeze-free.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 53.6%; ground water, 33.4%
Livestock—surface water, 0.6%; ground water, 1.6%
Irrigation—surface water, 2.7%; ground water, 1.3%
Other—surface water, 0.8%; ground water, 6.0%

The total withdrawals average 75 million gallons per day (285 million liters per day). About 42 percent is from ground water sources, and 58 percent is from surface water sources. Rainfall provides an ample supply of surface water in the part of this area in Puerto Rico, but most of the precipitation is lost through evapotranspiration before it can reach streams or the ground water table. Manmade lakes are used to trap and store runoff water for public supply and some irrigation. The area has no perennial streams. Fecal coliform levels generally are high during periods when the streams are flowing. During dry periods, the effluent from sewage treatment plants typically makes up almost all of the flow in streams near population centers.

The South Coastal Plains aquifer, one of the two most important aquifers in Puerto Rico, underlies most of the southern half of this MLRA. This alluvial deposit generally holds calcium bicarbonate water. Along the coast, however, the intrusion of saltwater changes the ground water to a sodium chloride type. The surface water and ground water generally meet the recommended standards for all uses. The ground water is very hard, and the highest concentrations of nitrate on the island occur in the South Coastal Plains aquifer. Nitrate levels are still below the limit allowed in drinking water (10 parts per million or milligrams per liter).

Alluvial deposits in valleys and volcanic rocks are the primary sources of ground water in the northern half of the part of this MLRA in Puerto Rico. Narrow valley floors and steep volcanic rock slopes adjacent to the valleys limit the quantities of available ground water in these two aquifers. Most of the ground water used in this area is from the South Coastal Plains aquifer.

In the part of this MLRA on the Virgin Islands and on the outlying islands, streams do not flow throughout the year and the amount of available ground water in the volcanic rocks is low. Thus, the freshwater needs on these islands typically exceed the annual supplies. Rooftop catchments and seawater conversion plants are used to provide almost all of the potable water on the islands. Contamination from sewage effluent and septic systems creates water-quality problems.

The limited quantities of ground water in the volcanic rock aquifers on the Virgin Islands are primarily used for domestic purposes. This water is of better quality than the ground water in the calcareous sediments of the King's Hill aquifer underlying the center of St. Croix. The levels of total dissolved solids (especially chloride), nitrates, and bacteria from fecal sources are much lower in the volcanic rock aquifer.

Soils

The dominant soils in the part of this MLRA in Puerto Rico are Mollisols, Inceptisols, or Alfisols. The dominant suborders are Ustolls and Ustepts. The soils have an isohyperthermic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy. They are underlain by volcanic rocks. They generally are shallow or moderately deep and are clayey. Well drained, shallow Haplustolls (Descalabrado series) are dominant throughout this part of the MLRA. Well drained, moderately deep Dystrustepts (Callabo series) and Haplustolls (Jacana series) are on side slopes and footslopes. Of minor extent are shallow, well drained Haplustalfs (Guayama series) on steep side slopes.

The dominant soils in the part of this MLRA in the Virgin Islands are Mollisols or Inceptisols. The dominant suborders are Ustolls and Ustepts. The soils have an isohyperthermic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy. They are underlain by volcanic rocks. They generally are shallow or moderately deep, well drained clay loams. Haplustolls (Annaberg-Cramer complex and Fredriksdal-Susannaberg complex) and Haplustepts (Victory-Southgate complex) are dominant throughout this part of the MLRA.

Biological Resources

The dominant plant species in this MLRA are hurricanegrass, guineagrass, Mexican bluegrass, buffelgrass, southern sandbur, Egyptian grass, Kleberg's bluestem, flame tree, white oak, goosegrass, sprawling panic, wiregrass, threeawn, coconut tree, slender gramagrass, lovegrass, coconut paspalum, tamarind tree, sweet acacia, maga tree, whorled dropseed, para grass, pata conejo, knotroot bristlegrass, purslane, cockspur, sensitive plant, tautaba, mallow, butterfly pea, century plant, leucaena, giant milkweed, croton, black olive, turpentine, basora, rattlebox, mesquite, Christmas tree, damiana, guayacan tree, and tantan.

Some of the major wildlife species in this area are Adelaide's warbler, barn swallow, Caribbean elaenia, cattle egret, iguana, lesser Antillean pewee, lizards, Puerto Rican lizard cuckoo, mourning dove, northern mockingbird, ovenbird, prairie warbler, Puerto Rican nightjar, sparrow hawk, yellow-faced grassquit, West quail dove, Puerto Rican bullfinch, green-throated carib, brown pelican, common moorhen, masked duck, Puerto Rican woodpecker, Puerto Rican emerald hummingbird, Puerto Rican tody, Puerto Rico vireo (Bien-te-veo), Puerto Rican flycatcher (Juí), yellow-shouldered blackbird (Mariquita de Puerto Rico), and donkeys.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 4%
Grassland—private, 38%; Federal, 5%
Forest—private, 25%; Federal, 5%
Urban development—private, 16%
Water—private, 1%
Other—private, 5%; Federal, 1%

About 43 percent of the area is pasture, which supports mainly adapted native grasses. About 30 percent is natural forest; 8 percent supports improved species of such hardwoods as mahogany, teak, and eucalyptus.

The mountainous region in northwestern St. Croix, the largest of the Virgin Islands, supports a fairly dense tropical forest. The other parts of the MLRA support a dense growth of thorny bushes and cacti, which generally grow in semiarid regions having low rainfall and high evaporation rates.

Although the soils in the Virgin Islands have severe limitations that preclude their use as sites for dwellings, urban development is significant in this MLRA. Urban expansion is becoming a land use problem.

The major soil resource concerns are water erosion (sheet and rill and ephemeral gully or concentrated flow), maintenance of the content of organic matter and tilth of the soils, and water infiltration. Water-quality concerns include surface water contaminants derived from organic and inorganic fertilizers. Water-quantity concerns include water management on irrigated land.

Conservation practices on cropland generally include conservation crop rotations, contour farming, grassed waterways, crop residue management systems (especially no-till systems), and nutrient and pest management. Conservation practices on pasture generally include fencing, pasture and hay planting, watering facilities, and prescribed grazing. ■

272—Humid Coastal Plains

This MLRA is primarily on the northern coast of Puerto Rico, but it includes small areas on the east and west coasts (fig. 272-1). It makes up about 965 square miles (2,500 square kilometers). From west to east, the cities of Isabela, Quebradillas, Camuy, Hatillo, Arecibo, Barceloneta, Manati, Dorado, Toa Baja, Toa Alta, Bayamón, Guaynabo, San Juan, Carolina, and Loíza are in the part of this MLRA on the northern coast. The cities of Aguadilla and Mayagüez are in the part on the west coast, and the cities of Fajardo and Ceiba are in the part on the east coast. More than half of Puerto Rico's population lives in this MLRA. Puerto Rico State Road 2 connects San Juan and Mayagüez, and Puerto Rico State Road 3 connects San Juan and Ceiba. The "Expreso de Diego," Puerto Rico Highway 22, connects San Juan and Arecibo.

Physiography

This area is divided into two distinct zones. One zone consists of the flat alluvial plains and terraces along the coast, and the second consists of the irregular features of karst limestone in inland areas. In the northwest corner of the MLRA, limestone forms a sharp cliff rising almost 200 feet (60 meters) a short distance inland from the beach. In the rest of the area, the karst is eroded and is expressed as either low, rolling hills or steep-sided, isolated hills. Longitudinal depressions parallel the coast from Arecibo to Sabana Seca. Swamps and lagoons have developed in these depressions. Elevation ranges from sea level to 2,300 feet (0 to 700 meters).

The only major Hydrologic Unit Area (identified by a four-digit number) that makes up this MLRA is Puerto Rico (2101).

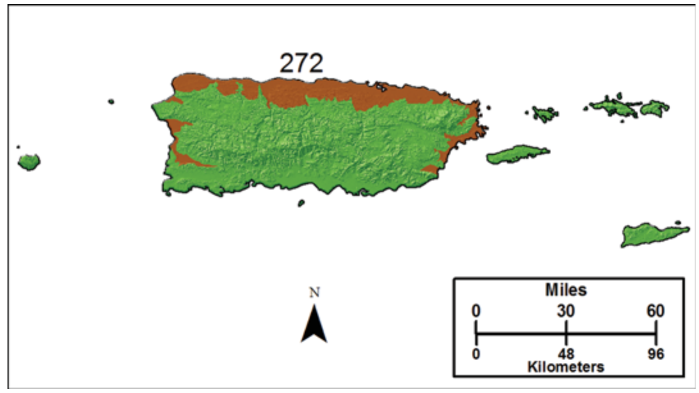

Figure 272-1: Location of MLRA 272 in Land Resource Region Z.

Streams generally flow to the north in this area. Most of the drainage in the karst zone is underground.

Geology

The mountainous part of this MLRA consists of a series of limestone formations that originated in a marine basin north of the island during the Oligocene to Miocene epoch of the Tertiary period (30 to 15 million years ago). After the uplift of these sediments to their present elevation, dissolution of the calcareous rocks produced a distinct karst topography. The limestones of the north coast account for nearly one-fifth of Puerto Rico's land area.

The flat part of this MLRA consists of various alluvial sediments of Quaternary age. The most extensive of these are the so-called "Blanket Deposits," which developed during the late Tertiary and early Quaternary as a result of the erosion of the interior of the island following the uplift. These deposits consist of sand, silt, and clay in various proportions.

The small areas on the east and west coasts are made up of alluvial flood plains and wave-cut coastal terraces that consist of river alluvium. Lower lying swamps and marshes are near the coast and adjacent to many of the larger rivers. An extensive swampy area is east of Arecibo on the north coast.

Climate

The average annual precipitation in most of this area is 60 to 65 inches (1,525 to 1,650 millimeters), increasing with elevation. Most of the rainfall occurs in the afternoons as frequent, trade-wind showers from May to October, but tropical storms and hurricanes can produce high amounts of rain that can result in local flooding and landslide problems. The area is typically drier from December through March, rainy during April and May, semidry in June and July, and wet from August through November. The average annual temperature is about 77 degrees F (25 degrees C). There is little difference in air temperature between the summer and winter seasons. This MLRA is freeze-free.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 66.8%; ground water, 15.3%
Livestock—surface water, 0.7%; ground water, 0.9%
Irrigation—surface water, 6.4%; ground water, 5.7%
Other—surface water, 0.7%; ground water, 3.6%

The total withdrawals average 265 million gallons per day (1,005 million liters per day). About 25 percent is from ground water sources, and 75 percent is from surface water sources. Rainfall and perennial streams provide ample supplies of surface water in this area. Manmade lakes are used to trap and store runoff water for cooling hydroelectric power plants and for public supply at the lower elevations in this area. The surface water generally is of good quality, meeting the recommended standards for drinking water. Most of the streams near population centers are contaminated with fecal coliform. Also, most sewage treatment plants discharge partially treated effluent into streams during most of the year. These discharges generally occur near the coast.

The North Coast Limestone is one of the most heavily used aquifers on the island. Ample supplies of ground water in this aquifer are generally of good quality. Both the water table and artesian water meet the recommended standards for drinking water. The calcium bicarbonate type of water in the water table aquifer can change to a sodium chloride type near the coast because of the intrusion of saltwater. The higher levels of chloride typically exceed the recommended limits for total dissolved solids for drinking water. The hydrodynamic pressure in the artesian aquifer provides a positive flow of freshwater into the ocean at some distance offshore, so there is no chloride contamination in this deeper aquifer.

The alluvial valley deposits on the east and west coasts are another source of ground water in this area. The level of total dissolved solids in the West Coast alluvial valley aquifer is much higher than the recommended level for drinking water. The intrusion of seawater is a major problem in this aquifer. The level of total dissolved solids in the East Coast alluvial valley aquifer is not much higher than the level in the North Coast limestone aquifer. The water in the East Coast alluvial valley aquifer is suitable only for irrigation and livestock, however, because of high levels of iron and manganese, from volcanic rocks and ancient swamp deposits.

Soils

The soils in this MLRA include a wide range of Ultisols, Inceptisols, Entisols, Histosols, Oxisols, Mollisols, and Alfisols. All of the soils in the area have an isohyperthermic soil temperature regime, most have an ustic soil moisture regime, and most are clayey and have mixed or kaolinitic mineralogy. There are four distinct geomorphic areas in this MLRA—coastal plains, flood plains along rivers, small lagoon-like depressions, and areas of limestone karst. On the coastal plains, the dominant soils are Ultisols or Oxisols and the dominant suborders are deep, well drained Udults or Udox. On the flood plains, the dominant soils are Mollisols or Inceptisols and the dominant suborders are poorly drained Aquolls, somewhat poorly drained Aquepts, or well drained Udolls. In the small depressions, the dominant soils are Histosols or Entisols and the dominant suborders are poorly drained Saprists or Aquents. Miscellaneous areas of swamps and marshes are in these depressions. In the extensive areas of limestone karst, the dominant soils are Mollisols or Alfisols and the dominant suborders are Rendolls, Udolls, or Udalfs.

Biological Resources

The dominant plant species in this area are Caribgrass, streambank millet, para grass, beach sedge, Durban crowfoot grass, Jamaica fingergrass, lovegrass, flame tree, white oak, beachgrass, St. Augustine grass, carpetgrass, southern sandbur, knotroot bristlegrass, albizia tree, bayhops, seapurslane, Puerto Rico royal palm, wireweed, coconut tree, stargrass, pangolagrass, Venezuela grass, Kleberg's bluestem, Tanner grass, Napier grass, signalgrass, and guineagrass. The dominant vegetation on wetlands includes red mangrove, white mangrove, black mangrove, button mangrove, southern cattail, leatherfern, and para grass.

Some of the major wildlife species in this area include bananaquit, zenaida dove, smooth-billed ani, Puerto Rican lizard cuckoo, lesser Antillean pewee, yellow warbler, cave swallow, white-crowned pigeon, barn swallow, cattle egret, great egret (Garza real), green heron (Martinete), little blue heron, northern waterthrush, West India whistling duck, white-rumped sandpiper, semipalmated sandpiper, least sandpiper, greater yellowlegs, Wilson's plover, yellow-crowned night-heron, blue-winged teal, and white-cheeked pintail.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 7%
Grassland—private, 24%
Forest—private, 27%; Federal, 2%
Urban development—private, 33%
Water—private, 2%
Other—private, 5%

Most of this area is in farms averaging 35 acres (14 hectares) in size. The pastures in the area support native and improved grasses. Many large dairy farms are in the area. The cropland in the MLRA includes about 3,000 acres (1,215 hectares) of farmland of statewide importance, which is planted to pineapples and is in areas of Oxisols. Many areas that formerly were used for sugarcane are now used for hayland or sod grasses. Orchards, consisting mainly of orange and grapefruit trees, are important in some areas. Urban development is significant, especially in areas adjacent to large metropolitan centers. It is a serious land use problem because it results in the loss of prime farmland.

The major soil resource concerns are water erosion (sheet and rill); maintenance of the content of organic matter, tilth, and fertility of the soils; crusting; and water infiltration. Water-quality concerns include surface water contaminants derived from organic and inorganic fertilizers. Water-quantity concerns include runoff, flooding, and water management on nonirrigated land.

Conservation practices on cropland generally include conservation crop rotations, bedding, deep tillage, grassed waterways, crop residue management systems (especially no-till systems), and nutrient and pest management. Conservation practices on pasture generally include fencing, pasture and hay planting, watering facilities, and prescribed grazing. ■

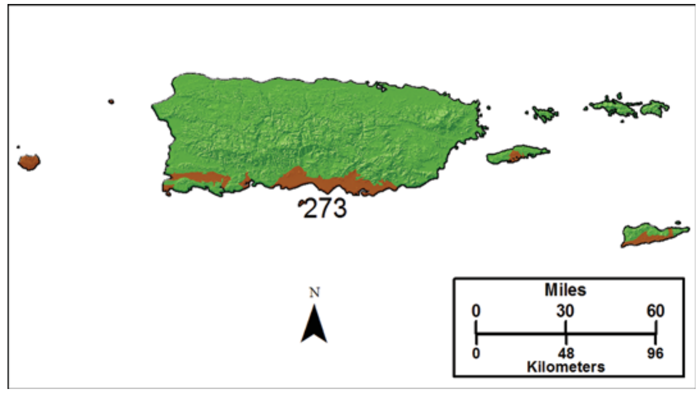

Figure 273-1: Location of MLRA 273 in Land Resource Region Z.

273—Semiarid Coastal Plains

This area (shown in fig. 273-1) is on the south coast of Puerto Rico (81 percent) and mostly on the southern side of St. Croix in the Virgin Islands (10 percent) and the outlying islands of Vieques, Desecheo, and Mona (9 percent). It makes up about 305 square miles (785 square kilometers). The part of the area on St. Croix is 28 square miles (72 square kilometers). The MLRA includes the towns of Cabo Rojo, Lajas, Guanica, Ponce, Juana Díaz, Salinas, Guayama, and Arroyo, Puerto Rico; Hamilton, St. Croix; and Isabel Segunda, Vieques. The Puerto Rico National Guard Camp (Campamento Santiago) is at the eastern end of the area, and a number of State parks are in the area, primarily on the coast in Puerto Rico.

Physiography

The coastal half of the part of this area in Puerto Rico gently slopes up from the Caribbean Sea. Most of the towns are at an elevation of 5 to 50 feet (2 to 15 meters). The inland half of the MLRA rises sharply to an elevation of 250 feet (75 meters). Steep foothills are at the base of the southern slopes of the central mountain chain (Cordillera Central), which extends from east to west across the length of the island. The part of the area in the "Valle de Lajas" is a flat coastal plain surrounded by steep foothills on three sides.

A rolling plain marks the part of this area on St. Croix. It generally is at an elevation of 10 to 140 feet (3 to 45 meters). It is flatter on the coast and more rolling in inland areas. The MLRA extends to the coast on both the south and north sides of the eastern end of St. Croix. Elevation rises to almost 200 feet (60 meters) in the area connecting the northern and southern parts of this MLRA. The MLRA separates two mountainous areas on the north side of the island.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Puerto Rico (2101), 81 percent; Virgin Islands (2102), 10 percent; and Caribbean Outlying Islands (2103), 9 percent. In the "Valle de Lajas," the main river flows west, but all of the other streams in the part of this MLRA in Puerto Rico flow south. None of the streams in the MLRA are perennial.

Geology

The geology of this MLRA is very similar to that of the low part of MLRA 271. An important feature is the Lajas Valley, which formed in a geosyncline. This low area was produced by a deeper lying graben or down-dropped block between two gravity faults. This valley is in the western part of the MLRA, south of the footslopes of the Cordillera Central and north of the Sierra Bermeja. It is filled with as much as 240 feet (75 meters) or more of clayey sediments.

Gravel, sands, silts, and clays deposited in the Quaternary period by rivers typically occur on the flatter parts of this MLRA near the coast. Limestone and volcanic rocks occur in the higher, steeper parts. The flatter alluvial deposits are not very extensive. Of all the Virgin Islands, St. Croix is the only one in which limestone occurs as parent material. Volcanic rocks form the interior and higher parts of the Virgin Islands and the other outlying islands around Puerto Rico.

Climate

The average annual precipitation in most of this area is 30 to 45 inches (760 to 1,145 millimeters). It is lower near the coast and higher on the inland hills. It is 10 to 30 inches (255 to 760 millimeters) in a few small, isolated areas. Almost all of the rainfall is lost through evapotranspiration, and the year-round air temperatures are high. Thus, the climate is semiarid. Most of the rainfall occurs in the afternoons as frequent, trade-wind showers from May to October, but tropical storms and hurricanes can produce high amounts of rain that can result in widespread flooding problems. The area typically is drier from December through March, rainy during April and May, semidry in June and July, and wet from August through November. The average annual temperature is about 79 degrees F (26 degrees C). The variation in mean monthly temperatures is only 5 to 8 degrees F (3 to 4 degrees C). This MLRA is freeze-free.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:

Public supply—surface water, 38.5%; ground water, 10.0%
Livestock—surface water, 0.5%; ground water, 0.6%
Irrigation—surface water, 30.4%; ground water, 17.0%
Other—surface water, 1.2%; ground water, 1.9%

The total withdrawals average 225 million gallons per day (850 million liters per day). About 30 percent is from ground water sources, and 70 percent is from surface water sources. Rainfall provides an ample supply of surface water in the part of this area in Puerto Rico, but 90 percent of the precipitation is lost through evapotranspiration before it can reach streams or the ground water table. Manmade lakes are used to trap and store runoff water for public supply and some irrigation. The area has no perennial streams. Fecal coliform levels generally are high during periods when the streams are flowing. During dry periods, the effluent from sewage treatment plants typically makes up almost all of the flow in streams near population centers.

The South Coastal Plains aquifer, one of the two most important aquifers in Puerto Rico, underlies this MLRA. This alluvial deposit generally holds calcium bicarbonate water. Along the coast, however, the intrusion of saltwater changes the ground water to a sodium chloride type. The surface water and ground water generally meet the recommended standards for all uses. The ground water is very hard, and the highest concentrations of nitrate occur in the South Coastal Plains aquifer. Nitrate levels are still below the limit allowed for drinking water (10 parts per million or milligrams per liter).

The West Coast alluvial valley aquifer underlies the "Valle de Lajas." The water from this aquifer is generally of good quality, except for very high levels of total dissolved solids. The water is normally a calcium bicarbonate type, but it is a sodium chloride type near the coast, where seawater intrusion is common.

The Virgin Islands use almost 11 million gallons of freshwater per day (42 million liters per day). About 90 percent of this water is used in the part of this MLRA on the island of St. Croix. Almost all of the water is used for public supply. Streams do not flow throughout the year, and the amount of available ground water is low. Thus, the needs for freshwater in the Virgin Islands typically exceed the annual supplies. Rooftop catchments and seawater conversion plants are used to provide almost all of the potable water on St. Croix and Vieques. Contamination from sewage effluent and septic systems can create water-quality problems.

Little ground water is used in the Virgin Islands. Most of the ground water that is used comes from the calcareous sediments of the King's Hill aquifer underlying the center of St. Croix. This alluvial deposit generally holds calcium bicarbonate water. Near the coast, however, the intrusion of saltwater changes the ground water to a sodium chloride type. The water in this aquifer exceeds the drinking water standards for total dissolved solids and chloride and is very hard. It is typically desalinized before it is used as potable water. The levels of nitrates, fecal coliform, and fecal streptococci bacteria commonly exceed drinking water standards. Limited quantities of ground water occur in the fractures and joints in the volcanic rocks on Vieques.

Soils

The soils in this MLRA are dominantly Mollisols or Vertisols. The soils in the part of the area in Puerto Rico have an isohyperthermic soil temperature regime and generally have an ustic soil moisture regime. They generally are clayey or loamy and have mixed or smectitic mineralogy. In a small area around Ensenada, the soils have an aridic soil moisture regime. The dominant suborders on the flood plains are very deep, somewhat poorly drained Aquolls and excessively drained and well drained Ustolls. The dominant suborders on high terraces are deep, expansive clayey Usterts and Aquerts.

The soils in the part of the area on St. Croix have an isohyperthermic soil temperature regime and an ustic soil moisture regime. They generally are clayey or gravelly loam and have mixed or carbonatic mineralogy. The dominant suborders on alluvial fans and terraces are well drained Ustolls and Usterts. The dominant suborders on marine terraces and in valleys in the limestone hills and mountains are clayey and loamy Ustolls.

Biological Resources

The dominant plant species in this area are beachgrass, southern sandbur, saltwort, bermudagrass, Mexican bluegrass, Egyptian grass, matojo de piramide, whorled dropseed, lovegrass, knotroot bristlegrass, sea purslane, heliotrope, chickweed, lechecillo, tautaba, tuna cactus, bayhops, sweet acacia, flame tree, white oak, leucaena, black olive, turpentine, catclaw blackbead, twisted grass, coconut tree, buffer grass, guineagrass, Kleberg's bluestem, and mesquite. The dominant vegetation on wetlands includes red mangrove, white mangrove, black mangrove, button mangrove, southern cattail, leatherfern, water panicum, and para grass.

Some of the major wildlife species in this area include yellow warbler, cattle egret, lesser woodpecker, Antillean nighthawk, bananaquit, black-bellied plover, Blackpoll warbler, black-whiskered vireo, blue-winged teal, brown pelican, cave swallow, clapper rail, common ground-dove, common moorhen, common yellowthroat, great blue heron, great egret, greater Antillean grackle, greater yellowlegs, green heron, killdeer, least sandpiper, lesser yellowlegs, little blue heron, mangrove cuckoo, northern mockingbird, ovenbird, prairie warbler, semipalmated plover, semipalmated sandpiper, snowy egret, snowy plover, stilt sandpiper, tricolored heron, white-cheeked pintail, white-crowned pigeon, Wilson's plover, and yellow-shouldered blackbird.

Land Use

Following are the various kinds of land use in this MLRA:

Cropland—private, 20%
Grassland—private, 27%; Federal, 8%
Forest—private, 6%; Federal, 1%
Urban development—private, 23%
Water—private, 5%
Other—private, 10%

The pastures in this area support native and improved grasses and are used mainly for beef production. The production of hay for racehorses is an important enterprise in some areas. About 38,000 acres (15,380 hectares) is irrigated by different systems and is used mainly for pasture, hay, plantains, or bananas. Several hundred acres are irrigated by drip systems and are used for the production of avocados, mangos, or oranges. The production of irrigated vegetables is of local economic importance. Rapid urban expansion is a land use problem near the larger cities of Puerto Rico. It has increased the need for new roads, schools, recreational developments, and agricultural land.

For many years, sugarcane grown on St. Croix was an important part of the economy, but the sugar mills have been closed. Finding a suitable cash crop has been difficult because of the scarcity of water for irrigation. Approximately 13,665 acres (5,525 hectares) in the Virgin Islands, or 16 percent of the total area, is used for agricultural purposes. Most of this acreage is on St. Croix. More than 78 percent of the acreage is pasture that is grazed by livestock. The main crops are herbs and spices, sugarcane, coconuts, sweet potatoes, yams, and cassava. The commonly grown vegetable crops include cucumbers, eggplant, okra, peppers, and tomatoes. Avocados, bananas, papayas, soursop, sugar apple, guavaberry, citrus fruits, and mangos are the main fruit crops grown on the islands.

The major soil resource concerns in this MLRA are water erosion (sheet and rill) induced by irrigation, surface compaction, maintenance of the content of organic matter and tilth of the soils, and water infiltration. Water-quality concerns include surface water contaminants derived from organic and inorganic fertilizers. Water-quantity concerns include runoff, flooding, and water management on irrigated land. In the Virgin Islands, limited supplies of soil moisture and ground water, drought, and poor water quality are serious concerns.

Conservation practices on cropland generally include conservation crop rotations, bedding, deep tillage, grassed waterways, crop residue management systems (especially no-till systems), nutrient and pest management, and irrigation water management. Conservation practices on pasture generally include fencing, pasture and hay planting, watering facilities, and prescribed grazing. ■

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Glossary

Aa. A Hawaiian term for lava flows that typically have a rough, jagged, spinose, clinkery surface.

Alluvial fan. A low, outspread mass of loose materials and/or rock material, commonly with gentle slopes. It is shaped like an open fan or a segment of a cone. The material was deposited by a stream at the place where it issues from a narrow mountain valley or upland valley or where a tributary stream is near or at its junction with the main stream. The fan is steepest near its apex, which points upstream, and slopes gently and convexly outward (downstream) with a gradual decrease in gradient.

Alluvium. Unconsolidated material, such as gravel, sand, silt, clay, and various mixtures of these, deposited on land by running water.

Aquifer. A geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells or springs.

Artesian well. A well tapping a confined aquifer in which the static water level is above the top of the aquifer; a flowing artesian well is a well in which the water level is above the land surface.

Aspect. The direction toward which a slope faces. Also called slope aspect.

Backslope. The position that forms the steepest and generally linear, middle portion of a hillslope. In profile, backslopes are commonly bounded by a convex shoulder above and a concave footslope below.

Backswamp. A flood-plain landform. Extensive, marshy or swampy, depressed areas of flood plains between natural levees and valley sides or terraces.

Badland. A landscape that is intricately dissected and characterized by a very fine drainage network with high drainage densities and short, steep slopes and narrow interfluves. Badlands develop on surfaces that have little or no vegetative cover overlying unconsolidated or poorly cemented materials (clays, silts, or sandstones) with, in some cases, soluble minerals, such as gypsum or halite.

Basal ground water. A term that originated in Hawaii and refers to a major body of fresh ground water in contact with underlying saline water (usually seawater in Hawaii and the Pacific Basin) in the lowermost part of the flow system.

Base flow. The sustained low flow of a stream. In some areas base flow is the ground-water inflow to the stream channel.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bedrock-controlled topography. A landscape where the configuration and relief of the landforms are determined or strongly influenced by the underlying bedrock.

Bolson. Extensive, flat, saucer-shaped, alluvium-floored basin or depression, almost completely or completely surrounded by mountains and from which drainage has no outlet; a term used in desert regions in the southwestern part of the United States.

Bottom land. An informal term loosely applied to various portions of a flood plain.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Breaks. A landscape or tract of steep, rough or broken land dissected by ravines and gullies and marking a sudden change in topography.

Butte. An isolated, generally flat-topped hill or mountain with relatively steep slopes and talus or precipitous cliffs and characterized by summit width that is less than the height of bounding escarpments; commonly topped by a caprock of resistant material and representing an erosion remnant carved from flat-lying rocks.

Caliche. A general term for a prominent zone of secondary carbonate accumulation in surficial materials in warm, subhumid to arid areas. Caliche is formed by both geologic and pedologic processes. Finely crystalline calcium carbonate forms a nearly continuous surface-coating and void-filling medium in geologic (parent) materials. Cementation ranges from weak in nonindurated forms to very strong in indurated forms. Other minerals (e.g., carbonates, silicate, and sulfate) may occur as accessory cements. Most petrocalcic horizons and some calcic horizons are caliche.

Canyon. A long, deep, narrow valley with high, precipitous walls in an area of high local relief.

Cirque. A steep-walled, semicircular or crescent-shaped, half-bowl-like recess or hollow, commonly situated at the head of a glaciated mountain valley or high on the side of a mountain. It was produced by the erosive activity of a mountain glacier. It commonly contains a small round lake (tarn).

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan. A dense, compact, slowly permeable subsoil layer that contains much more clay than the overlying materials, from which it is separated by a sharply defined boundary. A claypan is commonly hard when dry and plastic and sticky when wet.

Coarse textured soil. Sand or loamy sand.

Cobble (or cobblestone). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Colluvium. Unconsolidated, unsorted earth material being transported or deposited on side slopes and/or at the base of slopes by mass movement (e.g., direct gravitational action) and by local, unconcentrated runoff.

Conglomerate. A coarse grained, clastic sedimentary rock composed of rounded or subangular rock fragments more than 2 millimeters in diameter. It commonly has a matrix of sand and finer textured material. Conglomerate is the consolidated equivalent of gravel.

Conservation cropping system. Growing crops in combination with needed cultural and management practices. In a good conservation cropping system, the soil-improving crops and practices more than offset the effects of the soil-depleting crops and practices. Cropping systems are needed on all tilled soils. Soil-improving practices in a conservation cropping system include the use of rotations that contain grasses and legumes and the return of crop residue to the soil. Other practices include the use of green manure crops of grasses and legumes, proper tillage, adequate fertilization, and weed and pest control.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Crop residue management. Returning crop residue to the soil. This practice helps to maintain soil structure, organic matter content, and fertility and helps to control erosion.

Cropping system. Growing crops according to a planned system of rotation and management practices.

Cross-slope farming. Deliberately conducting farming operations on sloping farmland in such a way that tillage is across the general slope.

Delta. A body of alluvium having a surface that is fan shaped and nearly flat; deposited at or near the mouth of a river or stream where it enters a body of relatively quiet water, generally a sea or lake.

Depth, soil. Generally, the thickness of the soil over bedrock. Very deep soils are more than 60 inches deep over bedrock; deep soils, 40 to 60 inches; moderately deep, 20 to 40 inches; shallow, 10 to 20 inches; and very shallow, less than 10 inches.

Desert pavement. A natural, residual concentration or layer of wind-polished, closely packed gravel, boulders, and other rock fragments mantling a desert surface. It forms where wind action and sheetwash have removed all smaller particles or where rock fragments have migrated upward through sediments to the surface. It typically protects the finer grained underlying material from further erosion.

Domestic water use. Use of water for all indoor household purposes, such as drinking, food preparation, bathing, washing clothes and dishes, and flushing toilets, and for such outdoor purposes as watering lawns and gardens.

Drainage class (natural). Refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized—*excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained,* and *very poorly drained*. These classes are defined in the "Soil Survey Manual."

Drainage, surface. Runoff, or surface flow of water, from an area.

Drainageway. A general term for a course or channel along which water moves in draining an area. A term restricted to relatively small, linear depressions that at some time move concentrated water and either do not have a defined channel or have only a small defined channel.

Draw. A small stream valley that generally is shallower and more open than a ravine or gulch and that has a broader bottom. The present stream channel may appear inadequate to have cut the drainageway that it occupies.

Drift. A general term applied to all mineral material (clay, silt, sand, gravel, and boulders) transported by a glacier and deposited directly by or from the ice or transported by running water emanating from a glacier. Drift includes unstratified material (till) that forms moraines and stratified deposits that form outwash plains, eskers, kames, varves, and glaciofluvial sediments. The term is generally applied to Pleistocene glacial deposits in areas that no longer contain glaciers.

Drinking water standard. The level of a dissolved constituent in water that is deemed safe for human consumption. For example, the national standard for drinking water is less than 1,000 parts per million (milligrams per liter) total dissolved solids. The secondary standard is 500 parts per million (milligrams per liter). Secondary water quality standards are for esthetics. Water exceeding the secondary standard is safe but is less desirable for drinking and for many industrial uses.

Drumlin. A low, smooth, elongated oval hill, mound, or ridge of compact till that has a core of bedrock or drift. It commonly has a blunt nose facing the direction from which the ice approached and a gentler slope tapering in the other direction. The longer axis is parallel to the general direction of glacier flow. Drumlins are products of streamline (laminar) flow of glaciers, which molded the subglacial floor through a combination of erosion and deposition.

Dune. A low mound, ridge, bank, or hill of loose, windblown granular material (generally sand), either barren and capable of movement from place to place or covered and stabilized with vegetation but retaining its characteristic shape.

Eolian deposit. Sand-, silt-, or clay-sized clastic material transported and deposited primarily by wind, commonly in the form of a dune or a sheet of sand or loess.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature, such as a fire, that exposes the surface.

Escarpment. A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and resulting from erosion or faulting. Most commonly applied to cliffs produced by differential erosion. Synonym: scarp.

Esker. A long, narrow, sinuous, steep-sided ridge of stratified sand and gravel deposited as the bed of a stream flowing in an ice tunnel within or below the ice (subglacial) or between ice walls on top of the ice of a wasting glacier and left behind as high ground when the ice melted. Eskers range in length from less than1,000 feet to more than 100 miles (less than a kilometer to more than 160 kilometers) and in height from 10 to 100 feet (3 to 30 meters).

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grain is grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fan remnant. A general term for landforms that are the remaining parts of older fan landforms, such as alluvial fans, that have been either dissected or partially buried.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fine textured soil. Sandy clay, silty clay, or clay.

Firebreak. An area cleared of flammable material to stop or help control creeping or running fires. It also serves as a line from which to work and to facilitate the movement of firefighters and equipment. Designated roads also serve as firebreaks.

Flood plain. The nearly level plain that borders a stream and is subject to flooding unless protected artificially.

Fluvial. Of or pertaining to rivers or streams; produced by stream or river action.

Foothills. A region of steeply sloping hills that fringes a mountain range or high-plateau escarpment. The hills have relief of as much as 1,000 feet (300 meters).

Footslope. The concave surface at the base of a hillslope. A footslope is a transition zone between upslope sites of erosion and transport (shoulders and backslopes) and downslope sites of deposition (toeslopes).

Forb. Any herbaceous plant not a grass or a sedge.

Forest type. A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands.

Fracture. A break in rock units caused by structural stresses. Fractures may occur as faults, joints, and planes of fracture cleavage.

Fragipan. A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Freshwater. Water that contains less than 1,000 parts per million (milligrams per liter) total dissolved solids. This is the national standard for drinking water.

Geologic time scales. These are eras, periods, and epochs. The eras are as follows:

Cenozoic	present to 65 million years BP
Mesozoic	65 to 230 million years BP
Paleozoic	230 to 570 million years BP
Precambrian	570 million to 4.5 billion years BP

The periods are as follows:

Quaternary	present to 2 million years BP
Tertiary	2 to 65 million years BP
Cretaceous	65 to 140 million years BP
Jurassic	140 to 190 million years BP
Triassic	190 to 230 million years BP
Permian	230 to 280 million years BP
Pennsylvanian	280 to 310 million years BP
Mississippian	310 to 345 million years BP
Devonian	345 to 405 million years BP
Silurian	405 to 425 million years BP
Ordovician	425 to 500 million years BP
Cambrian	500 to 570 million years BP

The epochs are as follows:

Recent (Holocene)	present to 10,000 years BP
Pleistocene	10,000 to 2 million years BP
Pliocene	2 to 10 million years BP
Miocene	10 to 25 million years BP
Oligocene	25 to 40 million years BP
Eocene	40 to 55 million years BP
Paleocene	55 to 65 million years BP

Glaciofluvial deposits. Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur in the form of outwash plains, valley trains, deltas, kames, eskers, and kame terraces.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are bedded or laminated.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water. Generally, all subsurface water, as distinguished from surface water; specifically, that part of the subsurface water in the saturated zone (a zone in which all voids, large and small, ideally are filled with water under pressure greater than atmospheric).

Gully. A small channel with steep sides caused by erosion and cut in unconsolidated materials by concentrated but intermittent flow of water. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

High-residue crops. Such crops as small grain and corn used for grain. If properly managed, residue from these crops can be used to control erosion until the next crop in the rotation is established. These crops return large amounts of organic matter to the soil.

Hill. A generic term for an elevated area of the land surface, rising as much as 1,000 feet (305 meters) above surrounding lowlands, commonly of limited summit area and having a well defined outline. Slopes are generally more than 15 percent. The distinction between a hill and a mountain is arbitrary and may depend on local usage.

Hillslope. A generic term for the steeper part of a hill between its summit and the drainage line, valley flat, or depression floor at the base of a hill.

Hydrologic Unit Area. A natural drainage basin or hydrologic area that includes either the drainage area of a major river or the combined drainage areas of a series of rivers.

Igneous rock. Rock that was formed by cooling and solidification of magma and that has not been changed appreciably by weathering since its formation. Major varieties include plutonic and volcanic rock (e.g., andesite, basalt, and granite).

Industrial water use. Use of water for fabrication, processing, washing, and cooling in industries involved with chemical and allied products, food, mining, paper and allied products, petroleum refining, and steel.

Interfluve. A landform composed of the relatively undissected upland or ridge between two adjacent valleys containing streams flowing in the same general direction. An elevated area between two drainageways that sheds water to those drainageways.

Irrigation. Application of water to soils to assist in the production of crops and pasture or to maintain plant growth in recreational areas, such as parks and golf courses.

Kame. A low mound, knob, hummock, or short irregular ridge composed of stratified sand and gravel deposited by a subglacial stream as a fan or delta at the margin of a melting glacier; by a supraglacial stream in a low place or hole on the surface of the glacier; or as a ponded deposit on the surface or at the margin of stagnant ice.

Karst (topography). A kind of topography that formed in limestone, gypsum, or other soluble rocks by dissolution and that is characterized by closed depressions, sinkholes, caves, and underground drainage.

Lacustrine deposit. Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Lake plain. A nearly level surface marking the floor of an extinct lake filled by well sorted, generally fine textured, stratified deposits, commonly containing varves.

Lake terrace. A narrow shelf, partly cut and partly built, produced along a lakeshore in front of a scarp line of low cliffs and later exposed when the water level falls.

Landslide. A general, encompassing term for most types of mass movement landforms and processes involving the downslope transport and outward deposition of soil and rock materials caused by gravitational forces; the movement may or may not involve saturated materials. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Livestock water use. Use of water for livestock watering, feedlots, dairy operations, and other on-farm needs. The types of livestock include dairy cows and heifers, beef cattle and calves, sheep and lambs, goats, hogs and pigs, horses, and poultry.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Material transported and deposited by wind and consisting dominantly of silt-sized particles.

Mass movement. A generic term for the dislodgment and downslope transport of soil and rock material as a unit under direct gravitational stress.

Meander belt. The zone within which migration of a meandering channel occurs; the flood-plain area included between two imaginary lines drawn tangential to the outer bends of active channel loops.

Meander scar. A crescent-shaped, concave or linear mark on the face of a bluff or valley wall, produced by the lateral erosion of a meandering stream that impinged upon and undercut the bluff.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mesa. A broad, nearly flat topped and commonly isolated landmass bounded by steep slopes or precipitous cliffs and capped by layers of resistant, nearly horizontal rocky material. The summit width is characteristically greater than the height of the bounding escarpments.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement at depth in the earth's crust. Nearly all such rocks are crystalline.

Mine spoil. An accumulation of displaced earthy material, rock, or other waste material removed during mining or excavation. Also called earthy fill.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Mining water use. Use of water for the extraction of naturally occurring minerals, including solids, such as coal, sand, gravel, and ore; liquids, such as crude petroleum; and gases, such as natural gas. Also includes uses associated with quarrying, milling, and other preparations customarily done at the mine site or as part of a mining activity. Does not include water associated with dewatering of an aquifer that is not put to beneficial use or with processing, such as smelting, refining petroleum, or slurry pipeline operations. These processing uses are considered industrial water uses.

Miscellaneous area. A kind of map unit that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, or silty clay loam.

Moraine. In terms of glacial geology, a mound, ridge, or other topographically distinct accumulation of unsorted, unstratified drift, predominantly till, deposited primarily by the direct action of glacial ice in a variety of landforms. Also, a general term for a landform composed mainly of till (except for kame moraines, which are composed mainly of stratified outwash) that has been deposited by a glacier. Some types of moraines are disintegration, end, ground, kame, lateral, recessional, and terminal.

Mountain. A generic term for an elevated area of the land surface, rising more than 1,000 feet (305 meters) above surrounding lowlands, commonly of restricted summit area (relative to a plateau) and generally having steep sides. A mountain can occur as a single, isolated mass or in a group forming a chain or range. Mountains are formed primarily by tectonic activity and/or volcanic action but can also be formed by differential erosion.

Mudstone. A blocky or massive, fine grained sedimentary rock in which the proportions of clay and silt are approximately equal. Also, a general term for such material as clay, silt, claystone, siltstone, shale, and argillite and that should be used only when the amounts of clay and silt are not known or cannot be precisely identified.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash. Stratified and sorted sediments (chiefly sand and gravel) removed or "washed out" from a glacier by meltwater streams and deposited in front of or beyond the end moraine or the margin of a glacier. The coarser material is deposited nearer to the ice.

Outwash plain. An extensive lowland area of coarse textured glaciofluvial material. An outwash plain is commonly smooth; where pitted, it generally is low in relief.

Paleoterrace. An erosional remnant of a terrace that retains the surface form and alluvial deposits of its origin but was not emplaced by, and commonly does not grade to, a present-day stream or drainage network.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture.

Pedisediment. A layer of sediment, eroded from the shoulder and backslope of an erosional slope, that lies on and is being (or was) transported across a gently sloping erosional surface at the foot of a receding hill or mountain slope.

Permafrost. Ground, soil, or rock that remains at or below 32 degrees F (0 degrees C) for at least 2 years. It is defined on the basis of temperature and is not necessarily frozen.

Plateau (geomorphology). A comparatively flat area of great extent and elevation; specifically, an extensive land region that is considerably elevated (more than 330 feet, or 100 meters) above the adjacent lower lying terrain, is commonly limited on at least one side by an abrupt descent, and has a flat or nearly level surface. A comparatively large part of a plateau surface is near summit level.

Playa. The generally dry and nearly level lake plain that occupies the lowest parts of closed depressions, such as those on intermontane basin floors. Temporary flooding occurs primarily in response to precipitation and runoff. Playa deposits are fine grained and may or may not have a high water table and saline conditions.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Proper grazing use. Grazing at an intensity that maintains enough cover to protect the soil and maintain or improve the quantity and quality of the desirable vegetation. This practice increases the vigor and reproduction capacity of the key plants and promotes the accumulation of litter and mulch necessary to conserve soil and water.

Public water use. Use of water provided by a public supplier for such purposes as firefighting, street washing, flushing of water lines, and maintaining municipal parks and swimming pools. Generally, public-use water is not billed by the public supplier.

Public-supply water. Water withdrawn by public and private water suppliers that furnish water to at least 25 people or have a minimum of 15 connections. Public suppliers provide water for a variety of uses, such as domestic, commercial, industrial, thermoelectric power, and public water uses.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Red beds. Sedimentary strata that are mainly red and are made up largely of sandstone and shale.

Relief. The relative difference in elevation between the upland summits and the lowlands or valleys of a given region.

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as bedrock disintegrated in place.

Return flow. Water that reaches a ground or surface water source after release from the point of use, when it is available for further use.

Rill. A very small, steep-sided channel resulting from erosion and cut in unconsolidated materials by concentrated but intermittent flow of water. A rill generally is not an obstacle to wheeled vehicles and is shallow enough to be smoothed over by ordinary tillage.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Rural water use. Use of water in suburban or farm areas for domestic and livestock needs. The water generally is self-supplied and includes domestic water, drinking water for livestock, and water used for other purposes, such as dairy sanitation, cleaning, and waste disposal.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Saline water. Water that contains 1,000 parts per million (milligrams per liter) or more total dissolved solids. All water reported as used for public supply, livestock watering, and irrigation is considered to be freshwater even though the level of total dissolved solids may exceed 1,000 parts per million (milligrams per liter).

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-sized particles.

Sedimentary rock. A consolidated deposit of clastic particles, chemical precipitates, or organic remains accumulated at or near the surface of the earth under normal low temperature and pressure conditions. Sedimentary rocks include consolidated equivalents of alluvium, colluvium, drift, and eolian, lacustrine, and marine deposits. Examples are sandstone, siltstone, mudstone, claystone, shale, conglomerate, limestone, dolomite, and coal.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock that formed by the hardening of a deposit of clay, silty clay, or silty clay loam and that has a tendency to split into thin layers.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shoulder. The convex, erosional surface near the top of a hillslope. A shoulder is a transition from summit to backslope.

Side slope (geomorphology). A geomorphic component of hills consisting of a laterally planar area of a hillside. The overland waterflow is predominantly parallel. Side slopes are dominantly colluvium and slope-wash sediments.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. An indurated silt having the texture and composition of shale but lacking its fine lamination or fissility; a massive mudstone in which silt predominates over clay.

Sinkhole. A closed, circular or elliptical depression, commonly funnel shaped, characterized by subsurface drainage and formed either by dissolution of the surface of underlying bedrock (e.g., limestone, gypsum, or salt) or by collapse of underlying caves within bedrock. Complexes of sinkholes in carbonate-rock terrain are the main components of karst topography.

Slope alluvium. Sediment gradually transported down the slopes of mountains or hills primarily by nonchannel alluvial processes (i.e., slope-wash processes) and characterized by particle sorting. Lateral particle sorting is evident on long slopes. In a profile sequence, sediments may be distinguished by differences in size and/or specific gravity of rock fragments and may be separated by stone lines. Burnished peds and sorting of rounded or subrounded pebbles or cobbles distinguish these materials from unsorted colluvial deposits.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief and by the passage of time.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the material below the solum. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stream terrace. One of a series of platforms in a stream valley, flanking and more or less parallel to the stream channel, originally formed near the level of the stream; represents the remnants of an abandoned flood plain, stream bed, or valley floor produced during a former state of fluvial erosion or deposition.

Stripcropping. Growing crops in a systematic arrangement of strips or bands that provide vegetative barriers to wind erosion and water erosion.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum. The part of the soil below the solum.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Summit. The topographically highest position of a hillslope. It has a nearly level (planar or only slightly convex) surface.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer."

Surface water. An open body of water, such as a stream or lake.

Talus. Rock fragments of any size or shape (commonly coarse and angular) derived from and lying at the base of a cliff or very steep rock slope. The accumulated mass of such loose broken rock formed chiefly by falling, rolling, or sliding.

Terminal moraine. An end moraine that marks the farthest advance of a glacier. It typically has the form of a massive arcuate or concentric ridge, or complex of ridges, and is underlain by till and other types of drift.

Terrace (conservation). An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field generally is built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geomorphology). A steplike surface, bordering a valley floor or shoreline, that represents the former position of a flood plain, lake, or seashore. The term is usually applied both to the relatively flat summit surface (tread) that was cut or built by stream or wave action and to the steeper descending slope (scarp or riser) that has graded to a lower base level of erosion.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thermoelectric power water use. Use of water in the process of generating electricity with steam-driven turbine generators. The term describes the combined public-supply deliveries to thermoelectric power plants and self-supplied thermoelectric power withdrawals.

Till. Dominantly unsorted and nonstratified drift, generally unconsolidated and deposited directly by a glacier without subsequent reworking by meltwater, and consisting of a heterogeneous mixture of clay, silt, sand, gravel, stones, and boulders; rock fragments of various lithologies are embedded within a finer matrix that can range from clay to sandy loam.

Till plain. An extensive area of level to gently undulating soils underlain predominantly by till and bounded at the distal end by subordinate recessional or end moraines.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toeslope. The gently inclined surface at the base of a hillslope. Toeslopes in profile are commonly gentle and linear and are constructional surfaces forming the lower part of a hillslope continuum that grades to valley or closed-depression floors.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Total dissolved solids. The total amount of dissolved constituents (minerals and organic matter) in water.

Tuff. A generic term for any consolidated or cemented deposit that is 50 percent or more volcanic ash.

Upland. An informal, general term for the higher ground of a region, in contrast with a low-lying adjacent area, such as a valley or plain, or for land at a higher elevation than the flood plain or low stream terrace; land above the footslope zone of the hillslope continuum.

Valley fill. The unconsolidated sediment deposited by any agent (water, wind, ice, or mass wasting) so as to fill or partly fill a valley.

Water bars. Smooth, shallow ditches or depressional areas that are excavated at an angle across a sloping road. They are used to reduce the downward velocity of water and divert it off and away from the road surface. Water bars can easily be driven over if constructed properly.

Water use. (1) In a restrictive sense, this term refers to the withdrawal of water for a specific purpose, such as public supply, domestic use, irrigation, cooling of thermoelectric power plants, and industrial processing. (2) More broadly, the term pertains to the interaction of humans with and their influence on the hydrologic cycle and includes such elements as water withdrawal, delivery, consumptive use, wastewater release, reclaimed wastewater, return flow, and in-stream use.

Water withdrawal. Removal of water from the ground or diversion of surface water for a specific use.

Appendices

Appendix I.—MLRAs, EPA Level III Ecoregions, and Forest Service Ecological Sections

Appendix I cross-references MLRAs with Environmental Protection Agency Level III Ecoregions and with United States Forest Service ecological units for the conterminous United States. The MLRAs are listed in numerical order, without regard to the LRRs in which they occur. The percentage column in the table indicates the extent to which the three resource units overlap. Minor overlaps (those making up less than 5 percent of the MLRA) are not included in the table.

MLRA		Forest Service Section		EPA Level III Ecoregion		% of MLRA
1	Northern Pacific Coast Range, Foothills, and Valleys	M242A	Oregon and Washington Coast Ranges	1	Coast Range	99
2	Willamette and Puget Sound Valleys	242A	Puget Trough	2	Puget Lowland	51
2	Willamette and Puget Sound Valleys	242B	Willamette Valley	3	Willamette Valley	45
3	Olympic and Cascade Mountains	M242B	Western Cascades	4	Cascades	64
3	Olympic and Cascade Mountains	M242D	Northern Cascades	77	North Cascades	33
4A	Sitka Spruce Belt	M242A	Oregon and Washington Coast Ranges	1	Coast Range	98
4B	Coastal Redwood Belt	263A	Northern California Coast	1	Coast Range	67
4B	Coastal Redwood Belt	261A	Central California Coast	1	Coast Range	13
4B	Coastal Redwood Belt	263A	Northern California Coast	78	Klamath Mountains	10
5	Siskiyou-Trinity Area	M261A	Klamath Mountains	78	Klamath Mountains	66
5	Siskiyou-Trinity Area	M261B	Northern California Coast Ranges	78	Klamath Mountains	16
5	Siskiyou-Trinity Area	M242B	Western Cascades	4	Cascades	8
6	Cascade Mountains, Eastern Slope	M242C	Eastern Cascades	9	Eastern Cascades Slopes and Foothills	74
6	Cascade Mountains, Eastern Slope	M242D	Northern Cascades	77	North Cascades	23
7	Columbia Basin	342I	Columbia Basin	10	Columbia Plateau	100
8	Columbia Plateau	342I	Columbia Basin	10	Columbia Plateau	96
9	Palouse and Nez Perce Prairies	331A	Palouse Prairie	10	Columbia Plateau	45
9	Palouse and Nez Perce Prairies	M332G	Blue Mountains	11	Blue Mountains	30
9	Palouse and Nez Perce Prairies	342I	Columbia Basin	10	Columbia Plateau	20
10	Central Rocky and Blue Mountain Foothills	342H	Blue Mountain Foothills	11	Blue Mountains	55
10	Central Rocky and Blue Mountain Foothills	342H	Blue Mountain Foothills	80	Northern Basin and Range	14
10	Central Rocky and Blue Mountain Foothills	342D	Snake River Basalts and Basins	12	Snake River Plain	12
11	Snake River Plains	342D	Snake River Basalts and Basins	12	Snake River Plain	89
12	Lost River Valleys and Mountains	332E	Beaverhead Mountains	17	Middle Rockies	80
12	Lost River Valleys and Mountains	M332F	Challis Volcanics	17	Middle Rockies	17
13	Eastern Idaho Plateaus	342D	Snake River Basalts and Basins	80	Northern Basin and Range	27
13	Eastern Idaho Plateaus	M331D	Overthrust Mountains	80	Northern Basin and Range	23
13	Eastern Idaho Plateaus	342J	Eastern Basin and Range	80	Northern Basin and Range	21
13	Eastern Idaho Plateaus	342D	Snake River Basalts and Basins	12	Snake River Plain	20
14	Central California Coastal Valleys	261A	Central California Coast	6	Southern and Central California Chaparral and Oak Woodlands	50
14	Central California Coastal Valleys	263A	Northern California Coast	6	Southern and Central California Chaparral and Oak Woodlands	24
14	Central California Coastal Valleys	M262A	Central California Coast Ranges	6	Southern and Central California Chaparral and Oak Woodlands	10
14	Central California Coastal Valleys	M261B	Northern California Coast Ranges	6	Southern and Central California Chaparral and Oak Woodlands	8
15	Central California Coast Range	M262A	Central California Coast Ranges	6	Southern and Central California Chaparral and Oak Woodlands	49
15	Central California Coast Range	261A	Central California Coast	6	Southern and Central California Chaparral and Oak Woodlands	15
15	Central California Coast Range	M261B	Northern California Coast Ranges	6	Southern and Central California Chaparral and Oak Woodlands	10
15	Central California Coast Range	M261C	Northern California Interior Coast Ranges	6	Southern and Central California Chaparral and Oak Woodlands	9
16	California Delta	262A	Great Valley	7	Central California Valley	85
16	California Delta	262A	Great Valley	6	Southern and Central California Chaparral and Oak Woodlands	8

MLRA		Forest Service Section		EPA Level III Ecoregion		% of MLRA
17	Sacramento and San Joaquin Valleys	262A	Great Valley	7	Central California Valley	87
17	Sacramento and San Joaquin Valleys	262A	Great Valley	6	Southern and Central California Chaparral and Oak Woodlands	6
17	Sacramento and San Joaquin Valleys	M261C	Northern California Interior Coast Ranges	6	Southern and Central California Chaparral and Oak Woodlands	6
18	Sierra Nevada Foothills	M261F	Sierra Nevada Foothills	6	Southern and Central California Chaparral and Oak Woodlands	72
18	Sierra Nevada Foothills	M261E	Sierra Nevada	8	Southern California Mountains	10
18	Sierra Nevada Foothills	262A	Great Valley	7	Central California Valley	6
19	Southern California Coastal Plain	261B	Southern California Coast	6	Southern and Central California Chaparral and Oak Woodlands	70
19	Southern California Coastal Plain	M262B	Southern California Mountain and Valley	6	Southern and Central California Chaparral and Oak Woodlands	26
20	Southern California Mountains	M262B	Southern California Mountain and Valley	8	Southern California Mountains	47
20	Southern California Mountains	M262B	Southern California Mountain and Valley	6	Southern and Central California Chaparral and Oak Woodlands	30
20	Southern California Mountains	261B	Southern California Coast	6	Southern and Central California Chaparral and Oak Woodlands	13
21	Klamath and Shasta Valleys and Basins	M261G	Modoc Plateau	9	Eastern Cascades Slopes and Foothills	70
21	Klamath and Shasta Valleys and Basins	M261D	Southern Cascades	9	Eastern Cascades Slopes and Foothills	13
21	Klamath and Shasta Valleys and Basins	M261G	Modoc Plateau	80	Northern Basin and Range	6
22A	Sierra Nevada Mountains	M261E	Sierra Nevada	5	Sierra Nevada	89
22B	Southern Cascade Mountains	M261D	Southern Cascades	5	Sierra Nevada	44
22B	Southern Cascade Mountains	M261D	Southern Cascades	9	Eastern Cascades Slopes and Foothills	35
22B	Southern Cascade Mountains	M261D	Southern Cascades	4	Cascades	9
23	Malheur High Plateau	342B	Northwestern Basin and Range	80	Northern Basin and Range	93
24	Humboldt Area	341E	Northern Mono	13	Central Basin and Range	67
24	Humboldt Area	M341D	West Great Basin and Mountains	13	Central Basin and Range	17
24	Humboldt Area	342B	Northwestern Basin and Range	80	Northern Basin and Range	10
24	Humboldt Area	341G	Northeastern Great Basin	13	Central Basin and Range	6
25	Owyhee High Plateau	342C	Owyhee Uplands	80	Northern Basin and Range	43
25	Owyhee High Plateau	341G	Northeastern Great Basin	80	Northern Basin and Range	13
25	Owyhee High Plateau	341G	Northeastern Great Basin	13	Central Basin and Range	13
25	Owyhee High Plateau	342J	Eastern Basin and Range	80	Northern Basin and Range	11
25	Owyhee High Plateau	M341A	East Great Basin and Mountains	13	Central Basin and Range	7
26	Carson Basin and Mountains	341D	Mono	13	Central Basin and Range	81
26	Carson Basin and Mountains	342B	Northwestern Basin and Range	13	Central Basin and Range	9
26	Carson Basin and Mountains	341E	Northern Mono	13	Central Basin and Range	8
27	Fallon-Lovelock Area	341E	Northern Mono	13	Central Basin and Range	74
27	Fallon-Lovelock Area	342B	Northwestern Basin and Range	13	Central Basin and Range	16
27	Fallon-Lovelock Area	M341D	West Great Basin and Mountains	13	Central Basin and Range	8
28A	Great Salt Lake Area	341A	Bonneville Basin	13	Central Basin and Range	73
28A	Great Salt Lake Area	M341A	East Great Basin and Mountains	13	Central Basin and Range	14
28A	Great Salt Lake Area	342J	Eastern Basin and Range	13	Central Basin and Range	5
28B	Central Nevada Basin and Range	M341A	East Great Basin and Mountains	13	Central Basin and Range	58
28B	Central Nevada Basin and Range	M341D	West Great Basin and Mountains	13	Central Basin and Range	27
28B	Central Nevada Basin and Range	341F	Southeastern Great Basin	13	Central Basin and Range	15

MLRA		Forest Service Section		EPA Level III Ecoregion		% of MLRA
29	Southern Nevada Basin and Range	341F	Southeastern Great Basin	13	Central Basin and Range	71
29	Southern Nevada Basin and Range	341F	Southeastern Great Basin	14	Mojave Basin and Range	10
29	Southern Nevada Basin and Range	341D	Mono	13	Central Basin and Range	6
30	Mojave Desert	322A	Mojave Desert	14	Mojave Basin and Range	92
31	Lower Colorado Desert	322C	Colorado Desert	81	Sonoran Basin and Range	39
31	Lower Colorado Desert	322B	Sonoran Desert	81	Sonoran Basin and Range	39
31	Lower Colorado Desert	322A	Mojave Desert	81	Sonoran Basin and Range	7
31	Lower Colorado Desert	M262B	Southern California Mountain and Valley	81	Sonoran Basin and Range	7
32	Northern Intermountain Desertic Basins	342A	Bighorn Basin	18	Wyoming Basin	69
32	Northern Intermountain Desertic Basins	342F	Central Basin and Hills	18	Wyoming Basin	29
34A	Cool Central Desertic Basins and Plateaus	342G	Green River Basin	18	Wyoming Basin	56
34A	Cool Central Desertic Basins and Plateaus	342F	Central Basin and Hills	18	Wyoming Basin	33
34B	Warm Central Desertic Basins and Plateaus	341B	Northern Canyonlands	20	Colorado Plateaus	44
34B	Warm Central Desertic Basins and Plateaus	341C	Uinta Basin	20	Colorado Plateaus	24
34B	Warm Central Desertic Basins and Plateaus	M341B	Tavaputs Plateau	20	Colorado Plateaus	20
34B	Warm Central Desertic Basins and Plateaus	M331H	North-Central Highlands and Rocky Mountains	20	Colorado Plateaus	5
35	Colorado Plateau	313B	Navaho Canyonlands	22	Arizona/New Mexico Plateau	19
35	Colorado Plateau	313A	Grand Canyon	22	Arizona/New Mexico Plateau	17
35	Colorado Plateau	313D	Painted Desert	22	Arizona/New Mexico Plateau	16
35	Colorado Plateau	313A	Grand Canyon	20	Colorado Plateaus	15
35	Colorado Plateau	341B	Northern Canyonlands	20	Colorado Plateaus	10
35	Colorado Plateau	313B	Navaho Canyonlands	23	Arizona/New Mexico Mountains	6
36	Southwestern Plateaus, Mesas, and Foothills	341B	Northern Canyonlands	20	Colorado Plateaus	23
36	Southwestern Plateaus, Mesas, and Foothills	313A	Grand Canyon	20	Colorado Plateaus	15
36	Southwestern Plateaus, Mesas, and Foothills	313B	Navaho Canyonlands	21	Southern Rockies	15
36	Southwestern Plateaus, Mesas, and Foothills	313B	Navaho Canyonlands	22	Arizona/New Mexico Plateau	13
36	Southwestern Plateaus, Mesas, and Foothills	M331G	South-Central Highlands	21	Southern Rockies	5
38	Mogollon Transition	313C	Tonto Transition	23	Arizona/New Mexico Mountains	44
38	Mogollon Transition	M313A	White Mountains-San Francisco Peaks-Mogollon Rim	23	Arizona/New Mexico Mountains	20
38	Mogollon Transition	313C	Tonto Transition	79	Madrean Archipelago	6
39	Arizona and New Mexico Mountains	M313A	White Mountains-San Francisco Peaks-Mogollon Rim	23	Arizona/New Mexico Mountains	80
39	Arizona and New Mexico Mountains	M313B	Sacramento-Monzano Mountains	23	Arizona/New Mexico Mountains	15
40	Sonoran Basin and Range	322B	Sonoran Desert	81	Sonoran Basin and Range	91
41	Southeastern Arizona Basin and Range	321A	Basin and Range	79	Madrean Archipelago	83
41	Southeastern Arizona Basin and Range	321A	Basin and Range	24	Chihuahuan Deserts	8
42	Southern Desertic Basins, Plains, and Mountains	321A	Basin and Range	24	Chihuahuan Deserts	77
42	Southern Desertic Basins, Plains, and Mountains	315A	Pecos Valley	24	Chihuahuan Deserts	6
43A	Northern Rocky Mountains	M333A	Okanogan Highland	15	Northern Rockies	30
43A	Northern Rocky Mountains	M333D	Bitterroot Mountains	15	Northern Rockies	29
43A	Northern Rocky Mountains	M333B	Flathead Valley	15	Northern Rockies	22
43A	Northern Rocky Mountains	M333C	Northern Rockies	41	Canadian Rockies	13

MLRA		Forest Service Section		EPA Level III Ecoregion		% of MLRA
43B	Central Rocky Mountains	M332A	Idaho Batholith	16	Idaho Batholith	20
43B	Central Rocky Mountains	M331A	Yellowstone Highlands	17	Middle Rockies	16
43B	Central Rocky Mountains	M331D	Overthrust Mountains	17	Middle Rockies	10
43B	Central Rocky Mountains	M332D	Belt Mountains	17	Middle Rockies	10
43B	Central Rocky Mountains	M332E	Beaverhead Mountains	17	Middle Rockies	8
43B	Central Rocky Mountains	M332B	Northern Rockies and Bitterroot Valley	17	Middle Rockies	6
43B	Central Rocky Mountains	M332F	Challis Volcanics	16	Idaho Batholith	5
43C	Blue and Seven Devils Mountains	M332G	Blue Mountains	11	Blue Mountains	91
44	Northern Rocky Mountain Valleys	M332E	Beaverhead Mountains	17	Middle Rockies	25
44	Northern Rocky Mountain Valleys	M333A	Okanogan Highland	15	Northern Rockies	19
44	Northern Rocky Mountain Valleys	M332D	Belt Mountains	17	Middle Rockies	16
44	Northern Rocky Mountain Valleys	M332B	Northern Rockies and Bitterroot Valley	17	Middle Rockies	14
44	Northern Rocky Mountain Valleys	M333B	Flathead Valley	15	Northern Rockies	11
44	Northern Rocky Mountain Valleys	M332D	Belt Mountains	43	Northwestern Great Plains	8
46	Northern Rocky Mountain Foothills	331D	Northwestern Glaciated Plains	42	Northwestern Glaciated Plains	35
46	Northern Rocky Mountain Foothills	331N	Belt Mountains	43	Northwestern Great Plains	20
46	Northern Rocky Mountain Foothills	331K	North Central Highlands	43	Northwestern Great Plains	14
46	Northern Rocky Mountain Foothills	M332D	Belt Mountains	43	Northwestern Great Plains	11
46	Northern Rocky Mountain Foothills	331K	North Central Highlands	42	Northwestern Glaciated Plains	6
47	Wasatch and Uinta Mountains	M341C	Utah High Plateau	19	Wasatch and Uinta Mountains	30
47	Wasatch and Uinta Mountains	M331D	Overthrust Mountains	19	Wasatch and Uinta Mountains	22
47	Wasatch and Uinta Mountains	M331E	Uinta Mountains	19	Wasatch and Uinta Mountains	13
47	Wasatch and Uinta Mountains	M331E	Uinta Mountains	20	Colorado Plateaus	8
47	Wasatch and Uinta Mountains	342E	Bear Lake	18	Wyoming Basin	5
48A	Southern Rocky Mountains	M331I	Northern Parks and Ranges	21	Southern Rockies	32
48A	Southern Rocky Mountains	M331G	South-Central Highlands	21	Southern Rockies	22
48A	Southern Rocky Mountains	M331H	North-Central Highlands and Rocky Mountains	21	Southern Rockies	16
48A	Southern Rocky Mountains	M331F	Southern Parks and Rocky Mountain Range	21	Southern Rockies	11
48A	Southern Rocky Mountains	M341B	Tavaputs Plateau	20	Colorado Plateaus	8
48B	Southern Rocky Mountain Parks	M331I	Northern Parks and Ranges	21	Southern Rockies	97
49	Southern Rocky Mountain Foothills	M331I	Northern Parks and Ranges	21	Southern Rockies	28
49	Southern Rocky Mountain Foothills	331I	Arkansas Tablelands	26	Southwestern Tablelands	27
49	Southern Rocky Mountain Foothills	M331F	Southern Parks and Rocky Mountain Range	21	Southern Rockies	25
49	Southern Rocky Mountain Foothills	331H	Central High Plains	25	High Plains	5
51	High Intermountain Valleys	331J	Northern Rio Grande Basin	22	Arizona/New Mexico Plateau	89
51	High Intermountain Valleys	331J	Northern Rio Grande Basin	21	Southern Rockies	8
52	Brown Glaciated Plain	331L	Glaciated Northern Grasslands	42	Northwestern Glaciated Plains	48
52	Brown Glaciated Plain	331D	Northwestern Glaciated Plains	42	Northwestern Glaciated Plains	46
53A	Northern Dark Brown Glaciated Plains	331E	Northeastern Glaciated Plains	42	Northwestern Glaciated Plains	78
53A	Northern Dark Brown Glaciated Plains	331L	Glaciated Northern Grasslands	42	Northwestern Glaciated Plains	10
53A	Northern Dark Brown Glaciated Plains	332A	Northeastern Glaciated Plains	46	Northern Glaciated Plains	9

MLRA		Forest Service Section		EPA Level III Ecoregion		% of MLRA
53B	Central Dark Brown Glaciated Plains	331E	Northeastern Glaciated Plains	42	Northwestern Glaciated Plains	87
53B	Central Dark Brown Glaciated Plains	332B	Western Glaciated Plains	46	Northern Glaciated Plains	6
53C	Southern Dark Brown Glaciated Plains	332B	Western Glaciated Plains	42	Northwestern Glaciated Plains	55
53C	Southern Dark Brown Glaciated Plains	332D	North-Central Great Plains	42	Northwestern Glaciated Plains	26
53C	Southern Dark Brown Glaciated Plains	331E	Northeastern Glaciated Plains	42	Northwestern Glaciated Plains	13
54	Rolling Soft Shale Plain	331M	Missouri Plateau	43	Northwestern Great Plains	86
54	Rolling Soft Shale Plain	331F	Western Great Plains	43	Northwestern Great Plains	11
55A	Northern Black Glaciated Plains	332A	Northeastern Glaciated Plains	46	Northern Glaciated Plains	99
55B	Central Black Glaciated Plains	332A	Northeastern Glaciated Plains	46	Northern Glaciated Plains	72
55B	Central Black Glaciated Plains	332B	Western Glaciated Plains	46	Northern Glaciated Plains	25
55C	Southern Black Glaciated Plains	332B	Western Glaciated Plains	46	Northern Glaciated Plains	48
55C	Southern Black Glaciated Plains	251B	North Central Glaciated Plains	46	Northern Glaciated Plains	26
55C	Southern Black Glaciated Plains	332D	North-Central Great Plains	42	Northwestern Glaciated Plains	25
56	Red River Valley of the North	251A	Red River Valley	48	Lake Agassiz Plain	71
56	Red River Valley of the North	222N	Lake Agassiz-Aspen Parklands	48	Lake Agassiz Plain	20
56	Red River Valley of the North	222N	Lake Agassiz-Aspen Parklands	49	Northern Minnesota Wetlands	5
57	Northern Minnesota Gray Drift	212N	Northern Minnesota Drift and Lake Plains	50	Northern Lakes and Forests	62
57	Northern Minnesota Gray Drift	222M	Minnesota and Northeast Iowa Morainal-Oak Savannah	51	North Central Hardwood Forests	20
57	Northern Minnesota Gray Drift	212N	Northern Minnesota Drift and Lake Plains	51	North Central Hardwood Forests	6
57	Northern Minnesota Gray Drift	212L	Northern Superior Uplands	50	Northern Lakes and Forests	5
58A	Northern Rolling High Plains, Northern Part	331K	North Central Highlands	43	Northwestern Great Plains	68
58A	Northern Rolling High Plains, Northern Part	331G	Powder River Basin	43	Northwestern Great Plains	11
58A	Northern Rolling High Plains, Northern Part	331M	Missouri Plateau	43	Northwestern Great Plains	9
58A	Northern Rolling High Plains, Northern Part	331N	Belt Mountains	43	Northwestern Great Plains	9
58B	Northern Rolling High Plains, Southern Part	331G	Powder River Basin	43	Northwestern Great Plains	89
58C	Northern Rolling High Plains, Northeastern Part	331M	Missouri Plateau	43	Northwestern Great Plains	100
58D	Northern Rolling High Plains, Eastern Part	331M	Missouri Plateau	43	Northwestern Great Plains	95
60A	Pierre Shale Plains	331F	Western Great Plains	43	Northwestern Great Plains	92
60B	Pierre Shale Plains, Northern Part	331K	North Central Highlands	43	Northwestern Great Plains	48
60B	Pierre Shale Plains, Northern Part	331M	Missouri Plateau	43	Northwestern Great Plains	35
60B	Pierre Shale Plains, Northern Part	331F	Western Great Plains	43	Northwestern Great Plains	16
61	Black Hills Foot Slopes	M334A	Black Hills	17	Middle Rockies	98
62	Black Hills	M334A	Black Hills	17	Middle Rockies	100
63A	Northern Rolling Pierre Shale Plains	331F	Western Great Plains	43	Northwestern Great Plains	98
63B	Southern Rolling Pierre Shale Plains	331F	Western Great Plains	43	Northwestern Great Plains	58
63B	Southern Rolling Pierre Shale Plains	332D	North-Central Great Plains	42	Northwestern Glaciated Plains	36

MLRA		Forest Service Section		EPA Level III Ecoregion		% of MLRA
64	Mixed Sandy and Silty Tableland and Badlands	331F	Western Great Plains	25	High Plains	54
64	Mixed Sandy and Silty Tableland and Badlands	331F	Western Great Plains	43	Northwestern Great Plains	38
65	Nebraska Sand Hills	332C	Nebraska Sand Hills	44	Nebraska Sand Hills	97
66	Dakota-Nebraska Eroded Tableland	331F	Western Great Plains	43	Northwestern Great Plains	38
66	Dakota-Nebraska Eroded Tableland	332D	North-Central Great Plains	42	Northwestern Glaciated Plains	30
66	Dakota-Nebraska Eroded Tableland	332D	North-Central Great Plains	43	Northwestern Great Plains	10
66	Dakota-Nebraska Eroded Tableland	332C	Nebraska Sand Hills	44	Nebraska Sand Hills	9
66	Dakota-Nebraska Eroded Tableland	332C	Nebraska Sand Hills	42	Northwestern Glaciated Plains	7
66	Dakota-Nebraska Eroded Tableland	332D	North-Central Great Plains	44	Nebraska Sand Hills	5
67A	Central High Plains, Northern Part	331F	Western Great Plains	25	High Plains	66
67A	Central High Plains, Northern Part	331H	Central High Plains	25	High Plains	23
67B	Central High Plains, Southern Part	331H	Central High Plains	25	High Plains	45
67B	Central High Plains, Southern Part	331C	Central High Tablelands	25	High Plains	21
67B	Central High Plains, Southern Part	331I	Arkansas Tablelands	26	Southwestern Tablelands	12
67B	Central High Plains, Southern Part	331B	Southern High Plains	25	High Plains	10
67B	Central High Plains, Southern Part	331I	Arkansas Tablelands	25	High Plains	7
69	Upper Arkansas Valley Rolling Plains	331I	Arkansas Tablelands	26	Southwestern Tablelands	97
70A	Canadian River Plains and Valleys	331B	Southern High Plains	26	Southwestern Tablelands	50
70A	Canadian River Plains and Valleys	315B	Texas High Plains	26	Southwestern Tablelands	15
70A	Canadian River Plains and Valleys	M313B	Sacramento-Monzano Mountains	22	Arizona/New Mexico Plateau	10
70A	Canadian River Plains and Valleys	M313B	Sacramento-Monzano Mountains	26	Southwestern Tablelands	9
70A	Canadian River Plains and Valleys	315B	Texas High Plains	25	High Plains	6
70B	Upper Pecos River Valley	315B	Texas High Plains	26	Southwestern Tablelands	38
70B	Upper Pecos River Valley	315A	Pecos Valley	26	Southwestern Tablelands	24
70B	Upper Pecos River Valley	315A	Pecos Valley	22	Arizona/New Mexico Plateau	12
70B	Upper Pecos River Valley	315A	Pecos Valley	24	Chihuahuan Deserts	10
70B	Upper Pecos River Valley	315B	Texas High Plains	25	High Plains	10
70C	Central New Mexico Highlands	315A	Pecos Valley	22	Arizona/New Mexico Plateau	42
70C	Central New Mexico Highlands	M313B	Sacramento-Monzano Mountains	22	Arizona/New Mexico Plateau	27
70C	Central New Mexico Highlands	M313B	Sacramento-Monzano Mountains	23	Arizona/New Mexico Mountains	18
70C	Central New Mexico Highlands	321A	Basin and Range	22	Arizona/New Mexico Plateau	5
70D	Southern Desert Foothills	315A	Pecos Valley	24	Chihuahuan Deserts	66
70D	Southern Desert Foothills	315A	Pecos Valley	23	Arizona/New Mexico Mountains	14
70D	Southern Desert Foothills	321A	Basin and Range	24	Chihuahuan Deserts	8
70D	Southern Desert Foothills	M313B	Sacramento-Monzano Mountains	23	Arizona/New Mexico Mountains	8
71	Central Nebraska Loess Hills	332C	Nebraska Sand Hills	27	Central Great Plains	93
72	Central High Tableland	331C	Central High Tablelands	25	High Plains	58
72	Central High Tableland	331H	Central High Plains	25	High Plains	14
72	Central High Tableland	331B	Southern High Plains	25	High Plains	13
72	Central High Tableland	331C	Central High Tablelands	27	Central Great Plains	10
73	Rolling Plains and Breaks	332E	South-Central Great Plains	27	Central Great Plains	83
73	Rolling Plains and Breaks	332C	Nebraska Sand Hills	27	Central Great Plains	7

MLRA		Forest Service Section		EPA Level III Ecoregion		% of MLRA
74	Central Kansas Sandstone Hills	332E	South-Central Great Plains	27	Central Great Plains	64
74	Central Kansas Sandstone Hills	251F	Flint Hills	27	Central Great Plains	19
74	Central Kansas Sandstone Hills	251F	Flint Hills	28	Flint Hills	17
75	Central Loess Plains	332E	South-Central Great Plains	27	Central Great Plains	68
75	Central Loess Plains	251H	Nebraska Rolling Hills	27	Central Great Plains	25
75	Central Loess Plains	332C	Nebraska Sand Hills	27	Central Great Plains	6
76	Bluestem Hills	251F	Flint Hills	28	Flint Hills	58
76	Bluestem Hills	255A	Cross Timbers and Prairie	28	Flint Hills	23
76	Bluestem Hills	251H	Nebraska Rolling Hills	28	Flint Hills	12
77A	Southern High Plains, Northern Part	331B	Southern High Plains	25	High Plains	88
77A	Southern High Plains, Northern Part	331B	Southern High Plains	26	Southwestern Tablelands	8
77B	Southern High Plains, Northwestern Part	331B	Southern High Plains	26	Southwestern Tablelands	40
77B	Southern High Plains, Northwestern Part	315B	Texas High Plains	25	High Plains	37
77B	Southern High Plains, Northwestern Part	331B	Southern High Plains	25	High Plains	15
77B	Southern High Plains, Northwestern Part	315B	Texas High Plains	26	Southwestern Tablelands	8
77C	Southern High Plains, Southern Part	315B	Texas High Plains	25	High Plains	95
77D	Southern High Plains, Southwestern Part	315B	Texas High Plains	25	High Plains	98
77E	Southern High Plains, Breaks	315F	Northern Texas High Plains	26	Southwestern Tablelands	76
77E	Southern High Plains, Breaks	315F	Northern Texas High Plains	25	High Plains	6
78A	Rolling Limestone Prairie	315C	Rolling Plains	27	Central Great Plains	90
78A	Rolling Limestone Prairie	315G	Eastern Rolling Plains	27	Central Great Plains	5
78B	Central Rolling Red Plains, Western Part	315C	Rolling Plains	26	Southwestern Tablelands	71
78B	Central Rolling Red Plains, Western Part	315C	Rolling Plains	27	Central Great Plains	14
78B	Central Rolling Red Plains, Western Part	315F	Northern Texas High Plains	26	Southwestern Tablelands	5
78C	Central Rolling Red Plains, Eastern Part	332F	South Central and Red Bed Plains	27	Central Great Plains	46
78C	Central Rolling Red Plains, Eastern Part	315C	Rolling Plains	27	Central Great Plains	26
78C	Central Rolling Red Plains, Eastern Part	332F	South Central and Red Bed Plains	26	Southwestern Tablelands	11
78C	Central Rolling Red Plains, Eastern Part	315F	Northern Texas High Plains	27	Central Great Plains	10
79	Great Bend Sand Plains	332E	South-Central Great Plains	27	Central Great Plains	62
79	Great Bend Sand Plains	332F	South Central and Red Bed Plains	27	Central Great Plains	35
80A	Central Rolling Red Prairies	255A	Cross Timbers and Prairie	27	Central Great Plains	55
80A	Central Rolling Red Prairies	332F	South Central and Red Bed Plains	27	Central Great Plains	28
80A	Central Rolling Red Prairies	255A	Cross Timbers and Prairie	29	Cross Timbers	6
80A	Central Rolling Red Prairies	315G	Eastern Rolling Plains	27	Central Great Plains	5
80B	Texas North-Central Prairies	315G	Eastern Rolling Plains	29	Cross Timbers	76
80B	Texas North-Central Prairies	315G	Eastern Rolling Plains	27	Central Great Plains	19
81A	Edwards Plateau, Western Part	321B	Stockton Plateau	24	Chihuahuan Deserts	32
81A	Edwards Plateau, Western Part	321B	Stockton Plateau	30	Edwards Plateau	25
81A	Edwards Plateau, Western Part	315C	Rolling Plains	30	Edwards Plateau	16
81A	Edwards Plateau, Western Part	321B	Stockton Plateau	25	High Plains	7

MLRA		Forest Service Section		EPA Level III Ecoregion		% of MLRA
81B	Edwards Plateau, Central Part	315D	Edwards Plateau	30	Edwards Plateau	90
81B	Edwards Plateau, Central Part	315C	Rolling Plains	30	Edwards Plateau	5
81C	Edwards Plateau, Eastern Part	315D	Edwards Plateau	30	Edwards Plateau	89
81C	Edwards Plateau, Eastern Part	315D	Edwards Plateau	29	Cross Timbers	6
81D	Southern Edwards Plateau	321B	Stockton Plateau	24	Chihuahuan Deserts	80
81D	Southern Edwards Plateau	321A	Basin and Range	24	Chihuahuan Deserts	19
82A	Texas Central Basin	315D	Edwards Plateau	30	Edwards Plateau	100
82B	Wichita Mountains	332F	South Central and Red Bed Plains	27	Central Great Plains	83
82B	Wichita Mountains	255A	Cross Timbers and Prairie	27	Central Great Plains	17
83A	Northern Rio Grande Plain	315E	Rio Grande Plain	31	Southern Texas Plains	54
83A	Northern Rio Grande Plain	315E	Rio Grande Plain	33	East Central Texas Plains	33
83B	Western Rio Grande Plain	315E	Rio Grande Plain	31	Southern Texas Plains	99
83C	Central Rio Grande Plain	315E	Rio Grande Plain	31	Southern Texas Plains	93
83C	Central Rio Grande Plain	315E	Rio Grande Plain	34	Western Gulf Coastal Plain	7
83D	Lower Rio Grande Plain	315E	Rio Grande Plain	34	Western Gulf Coastal Plain	70
83D	Lower Rio Grande Plain	315E	Rio Grande Plain	31	Southern Texas Plains	27
83E	Sandsheet Prairie	315E	Rio Grande Plain	34	Western Gulf Coastal Plain	89
83E	Sandsheet Prairie	255D	Central Gulf Prairie and Marshes	34	Western Gulf Coastal Plain	9
84A	North Cross Timbers	255A	Cross Timbers and Prairie	29	Cross Timbers	91
84B	West Cross Timbers	255E	Texas Cross Timbers and Prairie	29	Cross Timbers	69
84B	West Cross Timbers	255A	Cross Timbers and Prairie	29	Cross Timbers	22
84B	West Cross Timbers	315G	Eastern Rolling Plains	29	Cross Timbers	9
84C	East Cross Timbers	255E	Texas Cross Timbers and Prairie	29	Cross Timbers	87
85	Grand Prairie	255E	Texas Cross Timbers and Prairie	29	Cross Timbers	80
85	Grand Prairie	255A	Cross Timbers and Prairie	29	Cross Timbers	17
86A	Texas Blackland Prairie, Northern Part	255B	Blackland Prairie	32	Texas Blackland Prairies	75
86A	Texas Blackland Prairie, Northern Part	255C	Oak Woods and Prairie	33	East Central Texas Plains	11
86A	Texas Blackland Prairie, Northern Part	255C	Oak Woods and Prairie	32	Texas Blackland Prairies	8
86B	Texas Blackland Prairie, Southern Part	255C	Oak Woods and Prairie	32	Texas Blackland Prairies	73
86B	Texas Blackland Prairie, Southern Part	255C	Oak Woods and Prairie	33	East Central Texas Plains	24
87A	Texas Claypan Area, Southern Part	255C	Oak Woods and Prairie	33	East Central Texas Plains	86
87A	Texas Claypan Area, Southern Part	255C	Oak Woods and Prairie	32	Texas Blackland Prairies	7
87B	Texas Claypan Area, Northern Part	255C	Oak Woods and Prairie	33	East Central Texas Plains	41
87B	Texas Claypan Area, Northern Part	255B	Blackland Prairie	33	East Central Texas Plains	17
87B	Texas Claypan Area, Northern Part	231E	Mid Coastal Plains-Western	33	East Central Texas Plains	14
87B	Texas Claypan Area, Northern Part	231E	Mid Coastal Plains-Western	35	South Central Plains	10
87B	Texas Claypan Area, Northern Part	255A	Cross Timbers and Prairie	35	South Central Plains	6

MLRA		Forest Service Section		EPA Level III Ecoregion		% of MLRA
88	Northern Minnesota Glacial Lake Basins	212M	Northern Minnesota and Ontario	49	Northern Minnesota Wetlands	63
88	Northern Minnesota Glacial Lake Basins	212N	Northern Minnesota Drift and Lake Plains	50	Northern Lakes and Forests	29
89	Wisconsin Central Sands	222R	Wisconsin Central Sands	51	North Central Hardwood Forests	93
90A	Wisconsin and Minnesota Thin Loess and Till, Northern Part	212X	Northern Highlands	50	Northern Lakes and Forests	53
90A	Wisconsin and Minnesota Thin Loess and Till, Northern Part	212K	Western Superior Uplands	50	Northern Lakes and Forests	19
90A	Wisconsin and Minnesota Thin Loess and Till, Northern Part	212Q	North Central Wisconsin Uplands	51	North Central Hardwood Forests	6
90A	Wisconsin and Minnesota Thin Loess and Till, Northern Part	212T	Northern Green Bay Lobe	51	North Central Hardwood Forests	6
90A	Wisconsin and Minnesota Thin Loess and Till, Northern Part	212N	Northern Minnesota Drift and Lake Plains	50	Northern Lakes and Forests	6
90A	Wisconsin and Minnesota Thin Loess and Till, Northern Part	212K	Western Superior Uplands	51	North Central Hardwood Forests	5
90B	Wisconsin and Minnesota Thin Loess and Till, Southern Part	212Q	North Central Wisconsin Uplands	51	North Central Hardwood Forests	57
90B	Wisconsin and Minnesota Thin Loess and Till, Southern Part	212K	Western Superior Uplands	51	North Central Hardwood Forests	16
90B	Wisconsin and Minnesota Thin Loess and Till, Southern Part	222M	Minnesota and Northeast Iowa Morainal-Oak Savannah	51	North Central Hardwood Forests	13
90B	Wisconsin and Minnesota Thin Loess and Till, Southern Part	222M	Minnesota and Northeast Iowa Morainal-Oak Savannah	47	Western Corn Belt Plains	9
91A	Central Minnesota Sandy Outwash	222M	Minnesota and Northeast Iowa Morainal-Oak Savannah	51	North Central Hardwood Forests	48
91A	Central Minnesota Sandy Outwash	212N	Northern Minnesota Drift and Lake Plains	50	Northern Lakes and Forests	30
91A	Central Minnesota Sandy Outwash	251B	North Central Glaciated Plains	51	North Central Hardwood Forests	9
91A	Central Minnesota Sandy Outwash	212N	Northern Minnesota Drift and Lake Plains	51	North Central Hardwood Forests	6
91B	Wisconsin and Minnesota Sandy Outwash	212K	Western Superior Uplands	50	Northern Lakes and Forests	64
91B	Wisconsin and Minnesota Sandy Outwash	222M	Minnesota and Northeast Iowa Morainal-Oak Savannah	51	North Central Hardwood Forests	29
92	Superior Lake Plain	212Y	Southwest Lake Superior Clay Plain	50	Northern Lakes and Forests	70
92	Superior Lake Plain	212J	Southern Superior Uplands	50	Northern Lakes and Forests	20
92	Superior Lake Plain	212L	Northern Superior Uplands	50	Northern Lakes and Forests	7
93A	Superior Stony and Rocky Loamy Plains and Hills, Western Part	212L	Northern Superior Uplands	50	Northern Lakes and Forests	95
93B	Superior Stony and Rocky Loamy Plains and Hills, Eastern Part	212S	Northern Upper Peninsula	50	Northern Lakes and Forests	59
93B	Superior Stony and Rocky Loamy Plains and Hills, Eastern Part	212J	Southern Superior Uplands	50	Northern Lakes and Forests	37
94A	Northern Michigan and Wisconsin Sandy Drift	212H	Northern Lower Peninsula	50	Northern Lakes and Forests	87
94A	Northern Michigan and Wisconsin Sandy Drift	212H	Northern Lower Peninsula	56	Southern Michigan/Northern Indiana Drift Plains	9
94B	Michigan Eastern Upper Peninsula Sandy Drift	212R	Eastern Upper Peninsula	50	Northern Lakes and Forests	59
94B	Michigan Eastern Upper Peninsula Sandy Drift	212T	Northern Green Bay Lobe	50	Northern Lakes and Forests	37

MLRA		Forest Service Section		EPA Level III Ecoregion		% of MLRA
94C	Michigan Northern Lower Peninsula Sandy Drift	212H	Northern Lower Peninsula	50	Northern Lakes and Forests	99
94D	Northern Highland Sandy Drift	212X	Northern Highlands	50	Northern Lakes and Forests	98
95A	Northeastern Wisconsin Drift Plain	212Z	Green Bay-Manitowac Upland	53	Southeastern Wisconsin Till Plains	30
95A	Northeastern Wisconsin Drift Plain	212T	Northern Green Bay Lobe	51	North Central Hardwood Forests	26
95A	Northeastern Wisconsin Drift Plain	222K	Southwestern Great Lakes Morainal	53	Southeastern Wisconsin Till Plains	14
95A	Northeastern Wisconsin Drift Plain	212T	Northern Green Bay Lobe	50	Northern Lakes and Forests	14
95A	Northeastern Wisconsin Drift Plain	212Z	Green Bay-Manitowac Upland	51	North Central Hardwood Forests	12
95B	Southern Wisconsin and Northern Illinois Drift Plain	222K	Southwestern Great Lakes Morainal	53	Southeastern Wisconsin Till Plains	71
95B	Southern Wisconsin and Northern Illinois Drift Plain	222K	Southwestern Great Lakes Morainal	54	Central Corn Belt Plains	14
95B	Southern Wisconsin and Northern Illinois Drift Plain	222K	Southwestern Great Lakes Morainal	51	North Central Hardwood Forests	12
96	Western Michigan Fruit Belt	212H	Northern Lower Peninsula	51	North Central Hardwood Forests	55
96	Western Michigan Fruit Belt	212H	Northern Lower Peninsula	50	Northern Lakes and Forests	42
97	Southwestern Michigan Fruit and Truck Crop Belt	222J	South Central Great Lakes	56	Southern Michigan/Northern Indiana Drift Plains	80
97	Southwestern Michigan Fruit and Truck Crop Belt	222K	Southwestern Great Lakes Morainal	54	Central Corn Belt Plains	11
97	Southwestern Michigan Fruit and Truck Crop Belt	222J	South Central Great Lakes	54	Central Corn Belt Plains	8
98	Southern Michigan and Northern Indiana Drift Plain	222J	South Central Great Lakes	56	Southern Michigan/Northern Indiana Drift Plains	66
98	Southern Michigan and Northern Indiana Drift Plain	212H	Northern Lower Peninsula	56	Southern Michigan/Northern Indiana Drift Plains	18
98	Southern Michigan and Northern Indiana Drift Plain	251D	Central Till Plains and Grand Prairies	54	Central Corn Belt Plains	8
99	Erie-Huron Lake Plain	222U	Lake Whittlesey Glacrolacustrine Plain	57	Huron/Erie Lake Plains	69
99	Erie-Huron Lake Plain	222U	Lake Whittlesey Glacrolacustrine Plain	56	Southern Michigan/Northern Indiana Drift Plains	16
99	Erie-Huron Lake Plain	222J	South Central Great Lakes	56	Southern Michigan/Northern Indiana Drift Plains	6
101	Ontario-Erie Plain and Finger Lakes Region	222I	Erie and Ontario Lake Plain	83	Eastern Great Lakes and Hudson Lowlands	75
101	Ontario-Erie Plain and Finger Lakes Region	211J	Tug Hill Plateau-Mohawk Valley	83	Eastern Great Lakes and Hudson Lowlands	16
102A	Rolling Till Prairie	251B	North Central Glaciated Plains	46	Northern Glaciated Plains	72
102A	Rolling Till Prairie	222M	Minnesota and Northeast Iowa Morainal-Oak Savannah	51	North Central Hardwood Forests	8
102A	Rolling Till Prairie	251A	Red River Valley	51	North Central Hardwood Forests	6
102A	Rolling Till Prairie	251B	North Central Glaciated Plains	51	North Central Hardwood Forests	6
102B	Till Plains	251B	North Central Glaciated Plains	46	Northern Glaciated Plains	99
102C	Loess Uplands	251H	Nebraska Rolling Hills	47	Western Corn Belt Plains	49
102C	Loess Uplands	251B	North Central Glaciated Plains	47	Western Corn Belt Plains	17
102C	Loess Uplands	332C	Nebraska Sand Hills	47	Western Corn Belt Plains	11
102C	Loess Uplands	332C	Nebraska Sand Hills	27	Central Great Plains	11
103	Central Iowa and Minnesota Till Prairies	251B	North Central Glaciated Plains	47	Western Corn Belt Plains	78
103	Central Iowa and Minnesota Till Prairies	222M	Minnesota and Northeast Iowa Morainal-Oak Savannah	51	North Central Hardwood Forests	12
103	Central Iowa and Minnesota Till Prairies	222M	Minnesota and Northeast Iowa Morainal-Oak Savannah	47	Western Corn Belt Plains	5
104	Eastern Iowa and Minnesota Till Prairies	222M	Minnesota and Northeast Iowa Morainal-Oak Savannah	47	Western Corn Belt Plains	80
104	Eastern Iowa and Minnesota Till Prairies	251C	Central Dissected Till Plains	47	Western Corn Belt Plains	8
104	Eastern Iowa and Minnesota Till Prairies	222L	North Central U.S. Driftless and Escarpment	52	Driftless Area	8
105	Northern Mississippi Valley Loess Hills	222L	North Central U.S. Driftless and Escarpment	52	Driftless Area	86
105	Northern Mississippi Valley Loess Hills	222L	North Central U.S. Driftless and Escarpment	51	North Central Hardwood Forests	6

MLRA		Forest Service Section		EPA Level III Ecoregion		% of MLRA
106	Nebraska and Kansas Loess-Drift Hills	251H	Nebraska Rolling Hills	47	Western Corn Belt Plains	73
106	Nebraska and Kansas Loess-Drift Hills	251H	Nebraska Rolling Hills	40	Central Irregular Plains	13
106	Nebraska and Kansas Loess-Drift Hills	251H	Nebraska Rolling Hills	27	Central Great Plains	9
107A	Iowa and Minnesota Loess Hills	251B	North Central Glaciated Plains	47	Western Corn Belt Plains	99
107B	Iowa and Missouri Deep Loess Hills	251C	Central Dissected Till Plains	47	Western Corn Belt Plains	87
107B	Iowa and Missouri Deep Loess Hills	251H	Nebraska Rolling Hills	47	Western Corn Belt Plains	9
108A	Illinois and Iowa Deep Loess and Drift, Eastern Part	251D	Central Till Plains and Grand Prairies	54	Central Corn Belt Plains	93
108B	Illinois and Iowa Deep Loess and Drift, East-Central Part	251D	Central Till Plains and Grand Prairies	54	Central Corn Belt Plains	54
108B	Illinois and Iowa Deep Loess and Drift, East-Central Part	251C	Central Dissected Till Plains	54	Central Corn Belt Plains	30
108B	Illinois and Iowa Deep Loess and Drift, East-Central Part	222K	Southwestern Great Lakes Morainal	54	Central Corn Belt Plains	13
108C	Illinois and Iowa Deep Loess and Drift, West-Central Part	251C	Central Dissected Till Plains	47	Western Corn Belt Plains	95
108D	Illinois and Iowa Deep Loess and Drift, Western Part	251C	Central Dissected Till Plains	47	Western Corn Belt Plains	99
109	Iowa and Missouri Heavy Till Plain	251C	Central Dissected Till Plains	40	Central Irregular Plains	99
110	Northern Illinois and Indiana Heavy Till Plain	251D	Central Till Plains and Grand Prairies	54	Central Corn Belt Plains	61
110	Northern Illinois and Indiana Heavy Till Plain	222K	Southwestern Great Lakes Morainal	54	Central Corn Belt Plains	27
110	Northern Illinois and Indiana Heavy Till Plain	222K	Southwestern Great Lakes Morainal	53	Southeastern Wisconsin Till Plains	8
111A	Indiana and Ohio Till Plain, Central Part	222H	Central Till Plains-Beech-Maple	55	Eastern Corn Belt Plains	97
111B	Indiana and Ohio Till Plain, Northeastern Part	222H	Central Till Plains-Beech-Maple	55	Eastern Corn Belt Plains	60
111B	Indiana and Ohio Till Plain, Northeastern Part	222J	South Central Great Lakes	56	Southern Michigan/Northern Indiana Drift Plains	24
111B	Indiana and Ohio Till Plain, Northeastern Part	222J	South Central Great Lakes	55	Eastern Corn Belt Plains	12
111C	Indiana and Ohio Till Plain, Northwestern Part	222J	South Central Great Lakes	56	Southern Michigan/Northern Indiana Drift Plains	62
111C	Indiana and Ohio Till Plain, Northwestern Part	251D	Central Till Plains and Grand Prairies	54	Central Corn Belt Plains	25
111C	Indiana and Ohio Till Plain, Northwestern Part	251D	Central Till Plains and Grand Prairies	55	Eastern Corn Belt Plains	6
111D	Indiana and Ohio Till Plain, Western Part	222H	Central Till Plains-Beech-Maple	55	Eastern Corn Belt Plains	88
111D	Indiana and Ohio Till Plain, Western Part	251D	Central Till Plains and Grand Prairies	54	Central Corn Belt Plains	6
111E	Indiana and Ohio Till Plain, Eastern Part	222H	Central Till Plains-Beech-Maple	55	Eastern Corn Belt Plains	64
111E	Indiana and Ohio Till Plain, Eastern Part	221F	Western Glaciated Allegheny Plateau	61	Erie Drift Plain	34
112	Cherokee Prairies	251E	Osage Plains	40	Central Irregular Plains	70
112	Cherokee Prairies	255A	Cross Timbers and Prairie	40	Central Irregular Plains	17
113	Central Claypan Areas	223G	Central Till Plains-Oak Hickory	72	Interior River Valleys and Hills	68
113	Central Claypan Areas	251C	Central Dissected Till Plains	40	Central Irregular Plains	30
114A	Southern Illinois and Indiana Thin Loess and Till Plain, Eastern Part	222H	Central Till Plains-Beech-Maple	55	Eastern Corn Belt Plains	32
114A	Southern Illinois and Indiana Thin Loess and Till Plain, Eastern Part	223G	Central Till Plains-Oak Hickory	72	Interior River Valleys and Hills	29
114A	Southern Illinois and Indiana Thin Loess and Till Plain, Eastern Part	221F	Western Glaciated Allegheny Plateau	61	Erie Drift Plain	16
114A	Southern Illinois and Indiana Thin Loess and Till Plain, Eastern Part	223B	Interior Low Plateau-Transition Hills	71	Interior Plateau	8
114A	Southern Illinois and Indiana Thin Loess and Till Plain, Eastern Part	223D	Interior Low Plateau-Shawnee Hills	71	Interior Plateau	8

MLRA		Forest Service Section		EPA Level III Ecoregion		% of MLRA
114B	Southern Illinois and Indiana Thin Loess and Till Plain, Western Part	223G	Central Till Plains-Oak Hickory	72	Interior River Valleys and Hills	44
114B	Southern Illinois and Indiana Thin Loess and Till Plain, Western Part	223F	Interior Low Plateau-Bluegrass	55	Eastern Corn Belt Plains	36
114B	Southern Illinois and Indiana Thin Loess and Till Plain, Western Part	251C	Central Dissected Till Plains	54	Central Corn Belt Plains	7
115A	Central Mississippi Valley Wooded Slopes, Eastern Part	223G	Central Till Plains-Oak Hickory	72	Interior River Valleys and Hills	71
115A	Central Mississippi Valley Wooded Slopes, Eastern Part	223D	Interior Low Plateau-Shawnee Hills	72	Interior River Valleys and Hills	28
115B	Central Mississippi Valley Wooded Slopes, Western Part	223A	Ozark Highlands	72	Interior River Valleys and Hills	80
115B	Central Mississippi Valley Wooded Slopes, Western Part	223A	Ozark Highlands	39	Ozark Highlands	9
115C	Central Mississippi Valley Wooded Slopes, Northern Part	251C	Central Dissected Till Plains	72	Interior River Valleys and Hills	49
115C	Central Mississippi Valley Wooded Slopes, Northern Part	251C	Central Dissected Till Plains	54	Central Corn Belt Plains	31
115C	Central Mississippi Valley Wooded Slopes, Northern Part	251D	Central Till Plains and Grand Prairies	54	Central Corn Belt Plains	9
115C	Central Mississippi Valley Wooded Slopes, Northern Part	251C	Central Dissected Till Plains	40	Central Irregular Plains	7
116A	Ozark Highland	223A	Ozark Highlands	39	Ozark Highlands	98
116B	Springfield Plain	223A	Ozark Highlands	39	Ozark Highlands	100
116C	St. Francois Knobs and Basins	223A	Ozark Highlands	39	Ozark Highlands	100
117	Boston Mountains	M223A	Boston Mountains	38	Boston Mountains	78
117	Boston Mountains	M223A	Boston Mountains	37	Arkansas Valley	6
118A	Arkansas Valley and Ridges, Eastern Part	231G	Arkansas Valley	37	Arkansas Valley	85
118A	Arkansas Valley and Ridges, Eastern Part	M231A	Ouachita Mountains	37	Arkansas Valley	5
118B	Arkansas Valley and Ridges, Western Part	231G	Arkansas Valley	37	Arkansas Valley	56
118B	Arkansas Valley and Ridges, Western Part	255A	Cross Timbers and Prairie	29	Cross Timbers	17
118B	Arkansas Valley and Ridges, Western Part	255A	Cross Timbers and Prairie	37	Arkansas Valley	16
118B	Arkansas Valley and Ridges, Western Part	231G	Arkansas Valley	29	Cross Timbers	6
119	Ouachita Mountains	M231A	Ouachita Mountains	36	Ouachita Mountains	78
119	Ouachita Mountains	M231A	Ouachita Mountains	37	Arkansas Valley	10
119	Ouachita Mountains	231G	Arkansas Valley	37	Arkansas Valley	5
120A	Kentucky and Indiana Sandstone and Shale Hills and Valleys, Southern Part	223D	Interior Low Plateau-Shawnee Hills	72	Interior River Valleys and Hills	71
120A	Kentucky and Indiana Sandstone and Shale Hills and Valleys, Southern Part	223D	Interior Low Plateau-Shawnee Hills	71	Interior Plateau	25
120B	Kentucky and Indiana Sandstone and Shale Hills and Valleys, Northwestern Part	223D	Interior Low Plateau-Shawnee Hills	71	Interior Plateau	79
120B	Kentucky and Indiana Sandstone and Shale Hills and Valleys, Northwestern Part	223D	Interior Low Plateau-Shawnee Hills	72	Interior River Valleys and Hills	17
120C	Kentucky and Indiana Sandstone and Shale Hills and Valleys, Northeastern Part	223B	Interior Low Plateau-Transition Hills	71	Interior Plateau	95
121	Kentucky Bluegrass	223F	Interior Low Plateau-Bluegrass	71	Interior Plateau	88
121	Kentucky Bluegrass	222H	Central Till Plains-Beech-Maple	55	Eastern Corn Belt Plains	5

MLRA		Forest Service Section		EPA Level III Ecoregion		% of MLRA
122	Highland Rim and Pennyroyal	223E	Interior Low Plateau-Highland Rim	71	Interior Plateau	76
122	Highland Rim and Pennyroyal	223B	Interior Low Plateau-Transition Hills	71	Interior Plateau	17
123	Nashville Basin	223E	Interior Low Plateau-Highland Rim	71	Interior Plateau	100
124	Western Allegheny Plateau	221E	Southern Unglaciated Allegheny Plateau	70	Western Allegheny Plateau	84
124	Western Allegheny Plateau	221H	Northern Cumberland Plateau	70	Western Allegheny Plateau	12
125	Cumberland Plateau and Mountains	M221C	Northern Cumberland Mountains	69	Central Appalachians	42
125	Cumberland Plateau and Mountains	221H	Northern Cumberland Plateau	68	Southwestern Appalachians	26
125	Cumberland Plateau and Mountains	221H	Northern Cumberland Plateau	69	Central Appalachians	15
126	Central Allegheny Plateau	221E	Southern Unglaciated Allegheny Plateau	70	Western Allegheny Plateau	97
127	Eastern Allegheny Plateau and Mountains	M221B	Allegheny Mountains	69	Central Appalachians	37
127	Eastern Allegheny Plateau and Mountains	211G	Northern Unglaciated Allegheny Plateau	62	North Central Appalachians	27
127	Eastern Allegheny Plateau and Mountains	M221B	Allegheny Mountains	67	Ridge and Valley	8
127	Eastern Allegheny Plateau and Mountains	M221C	Northern Cumberland Mountains	69	Central Appalachians	8
127	Eastern Allegheny Plateau and Mountains	221E	Southern Unglaciated Allegheny Plateau	69	Central Appalachians	8
128	Southern Appalachian Ridges and Valleys	221J	Central Ridge and Valley	67	Ridge and Valley	30
128	Southern Appalachian Ridges and Valleys	231D	Southern Ridge and Valley	67	Ridge and Valley	30
128	Southern Appalachian Ridges and Valleys	M221A	Northern Ridge and Valley	67	Ridge and Valley	23
129	Sand Mountain	231C	Southern Cumberland Plateau	68	Southwestern Appalachians	85
129	Sand Mountain	231C	Southern Cumberland Plateau	71	Interior Plateau	5
129	Sand Mountain	231B	Coastal Plains-Middle	68	Southwestern Appalachians	5
130A	Northern Blue Ridge	M221D	Blue Ridge Mountains	66	Blue Ridge	91
130B	Southern Blue Ridge	M221D	Blue Ridge Mountains	66	Blue Ridge	88
130B	Southern Blue Ridge	231A	Southern Appalachian Piedmont	66	Blue Ridge	5
131A	Southern Mississippi River Alluvium	234D	White and Black River Alluvial Plains	73	Mississippi Alluvial Plain	62
131A	Southern Mississippi River Alluvium	234A	Southern Mississippi Alluvial Plain	73	Mississippi Alluvial Plain	18
131A	Southern Mississippi River Alluvium	234C	Atchafalaya and Red River Alluvial Plains	73	Mississippi Alluvial Plain	9
131A	Southern Mississippi River Alluvium	232E	Louisiana Coastal Prairie and Marshes	73	Mississippi Alluvial Plain	8
131B	Arkansas River Alluvium	234E	Arkansas Alluvial Plains	73	Mississippi Alluvial Plain	48
131B	Arkansas River Alluvium	234A	Southern Mississippi Alluvial Plain	73	Mississippi Alluvial Plain	45
131C	Red River Alluvium	231E	Mid Coastal Plains-Western	35	South Central Plains	38
131C	Red River Alluvium	234C	Atchafalaya and Red River Alluvial Plains	35	South Central Plains	25
131C	Red River Alluvium	232F	Coastal Plains and Flatwoods-Western Gulf	35	South Central Plains	24
131C	Red River Alluvium	234C	Atchafalaya and Red River Alluvial Plains	73	Mississippi Alluvial Plain	12
131D	Southern Mississippi River Terraces	234E	Arkansas Alluvial Plains	73	Mississippi Alluvial Plain	54
131D	Southern Mississippi River Terraces	234E	Arkansas Alluvial Plains	35	South Central Plains	24
131D	Southern Mississippi River Terraces	231E	Mid Coastal Plains-Western	35	South Central Plains	8
131D	Southern Mississippi River Terraces	234A	Southern Mississippi Alluvial Plain	35	South Central Plains	5
133A	Southern Coastal Plain	232B	Gulf Coastal Plains and Flatwoods	65	Southeastern Plains	38
133A	Southern Coastal Plain	232J	Southern Atlantic Coastal Plains and Flatwoods	65	Southeastern Plains	21
133A	Southern Coastal Plain	231B	Coastal Plains-Middle	65	Southeastern Plains	19
133A	Southern Coastal Plain	232H	Middle Atlantic Coastal Plains and Flatwoods	65	Southeastern Plains	10
133A	Southern Coastal Plain	231H	Coastal Plains-Loess	65	Southeastern Plains	6

MLRA		Forest Service Section		EPA Level III Ecoregion		% of MLRA
133B	Western Coastal Plain	231E	Mid Coastal Plains-Western	35	South Central Plains	62
133B	Western Coastal Plain	232F	Coastal Plains and Flatwoods-Western Gulf	35	South Central Plains	30
134	Southern Mississippi Valley Loess	231H	Coastal Plains-Loess	74	Mississippi Valley Loess Plains	62
134	Southern Mississippi Valley Loess	234D	White and Black River Alluvial Plains	73	Mississippi Alluvial Plain	7
134	Southern Mississippi Valley Loess	231H	Coastal Plains-Loess	65	Southeastern Plains	6
134	Southern Mississippi Valley Loess	234D	White and Black River Alluvial Plains	74	Mississippi Valley Loess Plains	5
135A	Alabama and Mississippi Blackland Prairie	231B	Coastal Plains-Middle	65	Southeastern Plains	89
135A	Alabama and Mississippi Blackland Prairie	231H	Coastal Plains-Loess	65	Southeastern Plains	7
135B	Cretaceous Western Coastal Plain	231E	Mid Coastal Plains-Western	35	South Central Plains	90
136	Southern Piedmont	231I	Central Appalachian Piedmont	45	Piedmont	49
136	Southern Piedmont	231A	Southern Appalachian Piedmont	45	Piedmont	46
137	Carolina and Georgia Sand Hills	232J	Southern Atlantic Coastal Plains and Flatwoods	65	Southeastern Plains	96
138	North-Central Florida Ridge	232K	Florida Coastal Plains Central Highlands	65	Southeastern Plains	53
138	North-Central Florida Ridge	232K	Florida Coastal Plains Central Highlands	75	Southern Coastal Plain	24
138	North-Central Florida Ridge	232J	Southern Atlantic Coastal Plains and Flatwoods	65	Southeastern Plains	11
139	Lake Erie Glaciated Plateau	221F	Western Glaciated Allegheny Plateau	61	Erie Drift Plain	85
139	Lake Erie Glaciated Plateau	222I	Erie and Ontario Lake Plain	83	Eastern Great Lakes and Hudson Lowlands	6
140	Glaciated Allegheny Plateau and Catskill Mountains	211F	Northern Glaciated Allegheny Plateau	60	Northern Appalachian Plateau and Uplands	48
140	Glaciated Allegheny Plateau and Catskill Mountains	211F	Northern Glaciated Allegheny Plateau	62	North Central Appalachians	14
140	Glaciated Allegheny Plateau and Catskill Mountains	211I	Catskill Mountains	58	Northeastern Highlands	13
140	Glaciated Allegheny Plateau and Catskill Mountains	222I	Erie and Ontario Lake Plain	83	Eastern Great Lakes and Hudson Lowlands	7
141	Tughill Plateau	211J	Tug Hill Plateau-Mohawk Valley	58	Northeastern Highlands	87
141	Tughill Plateau	211J	Tug Hill Plateau-Mohawk Valley	83	Eastern Great Lakes and Hudson Lowlands	7
142	St. Lawrence-Champlain Plain	211E	St. Lawrence and Champlain Valley	83	Eastern Great Lakes and Hudson Lowlands	70
142	St. Lawrence-Champlain Plain	M211D	Adirondack Highlands	58	Northeastern Highlands	13
142	St. Lawrence-Champlain Plain	211J	Tug Hill Plateau-Mohawk Valley	83	Eastern Great Lakes and Hudson Lowlands	6
143	Northeastern Mountains	M211A	White Mountains	58	Northeastern Highlands	41
143	Northeastern Mountains	M211D	Adirondack Highlands	58	Northeastern Highlands	23
143	Northeastern Mountains	211B	Maine-New Brunswick Foothills and Lowlands	82	Laurentian Plains and Hills	11
143	Northeastern Mountains	M211C	Green-Taconic-Berkshire Mountains	58	Northeastern Highlands	10
143	Northeastern Mountains	211A	Aroostook Hills and Lowlands	82	Laurentian Plains and Hills	7
144A	New England and Eastern New York Upland, Southern Part	221A	Lower New England	59	Northeastern Coastal Zone	54
144A	New England and Eastern New York Upland, Southern Part	221B	Hudson Valley	83	Eastern Great Lakes and Hudson Lowlands	15
144A	New England and Eastern New York Upland, Southern Part	221A	Lower New England	58	Northeastern Highlands	12
144B	New England and Eastern New York Upland, Northern Part	211D	Central Maine Coastal and Embayment	82	Laurentian Plains and Hills	28
144B	New England and Eastern New York Upland, Northern Part	M211B	New England Piedmont	58	Northeastern Highlands	26
144B	New England and Eastern New York Upland, Northern Part	221A	Lower New England	58	Northeastern Highlands	17
144B	New England and Eastern New York Upland, Northern Part	211C	Fundy Coastal and Interior	82	Laurentian Plains and Hills	7
144B	New England and Eastern New York Upland, Northern Part	M211A	White Mountains	58	Northeastern Highlands	6
145	Connecticut Valley	221A	Lower New England	59	Northeastern Coastal Zone	77
145	Connecticut Valley	M211B	New England Piedmont	58	Northeastern Highlands	20
146	Aroostook Area	211A	Aroostook Hills and Lowlands	82	Laurentian Plains and Hills	89
146	Aroostook Area	M211A	White Mountains	82	Laurentian Plains and Hills	8

MLRA		Forest Service Section		EPA Level III Ecoregion		% of MLRA
147	Northern Appalachian Ridges and Valleys	M221A	Northern Ridge and Valley	67	Ridge and Valley	91
147	Northern Appalachian Ridges and Valleys	M221B	Allegheny Mountains	67	Ridge and Valley	6
148	Northern Piedmont	221D	Northern Appalachian Piedmont	64	Northern Piedmont	89
149A	Northern Coastal Plain	232A	Northern Atlantic Coastal Plain	65	Southeastern Plains	40
149A	Northern Coastal Plain	232A	Northern Atlantic Coastal Plain	84	Atlantic Coastal Pine Barrens	33
149A	Northern Coastal Plain	232A	Northern Atlantic Coastal Plain	63	Middle Atlantic Coastal Plain	19
149B	Long Island-Cape Cod Coastal Lowland	221A	Lower New England	84	Atlantic Coastal Pine Barrens	96
150A	Gulf Coast Prairies	255D	Central Gulf Prairie and Marshes	34	Western Gulf Coastal Plain	68
150A	Gulf Coast Prairies	232E	Louisiana Coastal Prairie and Marshes	34	Western Gulf Coastal Plain	22
150B	Gulf Coast Saline Prairies	255D	Central Gulf Prairie and Marshes	34	Western Gulf Coastal Plain	65
150B	Gulf Coast Saline Prairies	Water	Water	0	NULL	17
150B	Gulf Coast Saline Prairies	232E	Louisiana Coastal Prairie and Marshes	34	Western Gulf Coastal Plain	11
150B	Gulf Coast Saline Prairies	315E	Rio Grande Plain	34	Western Gulf Coastal Plain	6
151	Gulf Coast Marsh	232E	Louisiana Coastal Prairie and Marshes	73	Mississippi Alluvial Plain	57
151	Gulf Coast Marsh	232E	Louisiana Coastal Prairie and Marshes	34	Western Gulf Coastal Plain	32
151	Gulf Coast Marsh	Water	Water	0	NULL	9
152A	Eastern Gulf Coast Flatwoods	232L	Gulf Coastal Lowlands	75	Southern Coastal Plain	76
152A	Eastern Gulf Coast Flatwoods	232D	Florida Coastal Lowlands-Gulf	75	Southern Coastal Plain	8
152A	Eastern Gulf Coast Flatwoods	232B	Gulf Coastal Plains and Flatwoods	75	Southern Coastal Plain	7
152B	Western Gulf Coast Flatwoods	232F	Coastal Plains and Flatwoods-Western Gulf	35	South Central Plains	88
152B	Western Gulf Coast Flatwoods	232E	Louisiana Coastal Prairie and Marshes	35	South Central Plains	7
153A	Atlantic Coast Flatwoods	232C	Atlantic Coastal Flatwoods	63	Middle Atlantic Coastal Plain	39
153A	Atlantic Coast Flatwoods	232C	Atlantic Coastal Flatwoods	75	Southern Coastal Plain	38
153A	Atlantic Coast Flatwoods	232I	Northern Atlantic Coastal Flatwoods	63	Middle Atlantic Coastal Plain	13
153A	Atlantic Coast Flatwoods	232H	Middle Atlantic Coastal Plains and Flatwoods	63	Middle Atlantic Coastal Plain	7
153B	Tidewater Area	232I	Northern Atlantic Coastal Flatwoods	63	Middle Atlantic Coastal Plain	52
153B	Tidewater Area	232C	Atlantic Coastal Flatwoods	75	Southern Coastal Plain	36
153B	Tidewater Area	232H	Middle Atlantic Coastal Plains and Flatwoods	63	Middle Atlantic Coastal Plain	8
153C	Mid-Atlantic Coastal Plain	232H	Middle Atlantic Coastal Plains and Flatwoods	63	Middle Atlantic Coastal Plain	91
153C	Mid-Atlantic Coastal Plain	232A	Northern Atlantic Coastal Plain	63	Middle Atlantic Coastal Plain	8
153D	Northern Tidewater Area	232H	Middle Atlantic Coastal Plains and Flatwoods	63	Middle Atlantic Coastal Plain	54
153D	Northern Tidewater Area	232A	Northern Atlantic Coastal Plain	84	Atlantic Coastal Pine Barrens	42
154	South-Central Florida Ridge	232K	Florida Coastal Plains Central Highlands	75	Southern Coastal Plain	70
154	South-Central Florida Ridge	232D	Florida Coastal Lowlands-Gulf	75	Southern Coastal Plain	23
154	South-Central Florida Ridge	232G	Florida Coastal Lowlands-Atlantic	75	Southern Coastal Plain	7
155	Southern Florida Flatwoods	232G	Florida Coastal Lowlands-Atlantic	75	Southern Coastal Plain	40
155	Southern Florida Flatwoods	232D	Florida Coastal Lowlands-Gulf	75	Southern Coastal Plain	39
155	Southern Florida Flatwoods	232K	Florida Coastal Plains Central Highlands	75	Southern Coastal Plain	8
155	Southern Florida Flatwoods	411A	Everglades	76	Southern Florida Coastal Plain	5
156A	Florida Everglades and Associated Areas	411A	Everglades	76	Southern Florida Coastal Plain	94
156B	Southern Florida Lowlands	232G	Florida Coastal Lowlands-Atlantic	75	Southern Coastal Plain	99

Appendix II.—Area of LRRs and MLRAs

Area and Proportionate Extent of the Land Resource Regions and Major Land Resource Areas

(MLRAs 33, 37, 45, 50, 59, 68, 100, and 132, described in earlier versions of Agriculture Handbook 296, are not listed separately because they have been incorporated into other MLRAs. There are currently no MLRAs 168-189, 198-219, or 247-269.)

Land resource region and major land resource area	Area		Extent in—	
			LRR	United States
	mi²	*km²*	*pct*	*pct*
A—Northwestern Forest, Forage, and Specialty Crop Region	90,165	233,635	---	2.51
1—Northern Pacific Coast Range, Foothills, and Valleys	10,295	26,675	11.4	0.29
2—Willamette and Puget Sound Valleys	12,210	31,640	13.5	0.34
3—Olympic and Cascade Mountains	24,375	63,170	27.0	0.68
4A—Sitka Spruce Belt	5,305	13,740	5.9	0.15
4B—Coastal Redwood Belt	4,670	12,095	5.2	0.13
5—Siskiyou-Trinity Area	20,150	52,215	22.3	0.56
6—Cascade Mountains, Eastern Slope	13,160	34,100	14.6	0.37
B—Northwestern Wheat and Range Region	81,255	210,555	---	2.26
7—Columbia Basin	6,610	17,130	8.1	0.18
8—Columbia Plateau	18,505	47,955	22.8	0.52
9—Palouse and Nez Perce Prairies	8,810	22,825	10.8	0.25
10—Central Rocky and Blue Mountain Foothills	17,515	45,385	21.6	0.49
11—Snake River Plains	16,475	42,685	20.3	0.46
12—Lost River Valleys and Mountains	6,070	15,735	7.5	0.17
13—Eastern Idaho Plateaus	7,270	18,840	8.9	0.20
C—California Subtropical Fruit, Truck, and Specialty Crop Region	62,350	161,570	---	1.74
14—Central California Coastal Valleys	3,170	8,215	5.1	0.09
15—Central California Coast Range	17,840	46,235	28.6	0.50
16—California Delta	805	2,080	1.3	0.02
17—Sacramento and San Joaquin Valleys	18,650	48,330	29.9	0.52
18—Sierra Nevada Foothills	8,160	21,145	13.1	0.23
19—Southern California Coastal Plain	4,120	10,675	6.6	0.11
20—Southern California Mountains	9,605	24,890	15.4	0.27
D—Western Range and Irrigated Region	549,725	1,424,480	---	15.30
21—Klamath and Shasta Valleys and Basins	11,495	29,790	2.1	0.32
22A—Sierra Nevada Mountains	18,810	48,745	3.4	0.52
22B—Southern Cascade Mountains	5,855	15,175	1.1	0.16
23—Malheur High Plateau	22,895	59,320	4.2	0.64
24—Humboldt Area	12,680	32,855	2.3	0.35
25—Owyhee High Plateau	28,930	74,960	5.3	0.81
26—Carson Basin and Mountains	6,520	16,890	1.2	0.18
27—Fallon-Lovelock Area	12,565	32,560	2.3	0.35
28A—Great Salt Lake Area	36,775	95,300	6.7	1.02
28B—Central Nevada Basin and Range	23,555	61,035	4.3	0.66
29—Southern Nevada Basin and Range	26,295	68,140	4.8	0.73
30—Mojave Desert	43,750	113,370	8.0	1.22

Area and Proportionate Extent of the Land Resource Regions and Major Land Resource Areas—Cont.

Land resource region and major land resource area	Area		Extent in—	
			LRR	United States
	mi²	*km²*	*pct*	*pct*
D—Western Range and Irrigated Region—Cont.				
31—Lower Colorado Desert	11,615	30,100	2.1	0.32
32—Northern Intermountain Desertic Basins	8,910	23,080	1.6	0.25
34A—Cool Central Desertic Basins and Plateaus	33,005	85,525	6.0	0.92
34B—Warm Central Desertic Basins and Plateaus	12,850	33,290	2.3	0.36
35—Colorado Plateau	71,735	185,885	13.0	2.00
36—Southwestern Plateaus, Mesas, and Foothills	23,885	61,895	4.3	0.66
38—Mogollon Transition	18,985	49,195	3.5	0.53
39—Arizona and New Mexico Mountains	15,150	39,255	2.8	0.42
40—Sonoran Basin and Range	31,765	82,310	5.8	0.88
41—Southeastern Arizona Basin and Range	15,730	40,765	2.9	0.44
42—Southern Desertic Basins, Plains, and Mountains	55,970	145,040	10.2	1.56
E—Rocky Mountain Range and Forest Region	236,510	612,875	---	6.58
43A—Northern Rocky Mountains	31,435	81,460	13.3	0.88
43B—Central Rocky Mountains	75,915	196,715	32.1	2.11
43C—Blue and Seven Devils Mountains	14,000	36,275	5.9	0.39
44—Northern Rocky Mountain Valleys	12,830	33,245	5.4	0.36
46—Northern Rocky Mountain Foothills	15,100	39,130	6.4	0.42
47—Wasatch and Uinta Mountains	23,825	61,740	10.1	0.66
48A—Southern Rocky Mountains	45,920	119,000	19.4	1.28
48B—Southern Rocky Mountain Parks	2,325	6,020	1.0	0.06
49—Southern Rocky Mountain Foothills	11,130	28,845	4.7	0.31
51—High Intermountain Valleys	4,030	10,445	1.7	0.11
F—Northern Great Plains Spring Wheat Region	142,225	368,535	---	3.96
52—Brown Glaciated Plain	23,040	59,700	16.2	0.64
53A—Northern Dark Brown Glaciated Plains	9,220	23,885	6.5	0.26
53B—Central Dark Brown Glaciated Plains	19,640	50,900	13.8	0.55
53C—Southern Dark Brown Glaciated Plains	3,990	10,340	2.8	0.11
54—Rolling Soft Shale Plain	29,280	75,870	20.6	0.82
55A—Northern Black Glaciated Plains	12,765	33,075	9.0	0.36
55B—Central Black Glaciated Plains	17,155	44,455	12.1	0.48
55C—Southern Black Glaciated Plains	10,835	28,075	7.6	0.30
56—Red River Valley of the North	16,300	42,235	11.5	0.45
G—Western Great Plains Range and Irrigated Region	213,945	554,395	---	5.96
58A—Northern Rolling High Plains, Northern Part	42,350	109,740	19.8	1.18
58B—Northern Rolling High Plains, Southern Part	19,265	49,915	9.0	0.54
58C—Northern Rolling High Plains, Northeastern Part	2,320	6,015	1.1	0.06
58D—Northern Rolling High Plains, Eastern Part	2,755	7,145	1.3	0.08
60A—Pierre Shale Plains	10,150	26,295	4.7	0.28
60B—Pierre Shale Plains, Northern Part	3,375	8,750	1.6	0.09
61—Black Hills Foot Slopes	1,865	4,840	0.9	0.05
62—Black Hills	3,040	7,875	1.4	0.08
63A—Northern Rolling Pierre Shale Plains	10,160	26,330	4.7	0.28
63B—Southern Rolling Pierre Shale Plains	4,460	11,565	2.1	0.12

Area and Proportionate Extent of the Land Resource Regions and Major Land Resource Areas—Cont.

Land resource region and major land resource area	Area		Extent in—	
			LRR	United States
	mi²	*km²*	*pct*	*pct*
G—Western Great Plains Range and Irrigated Region—Cont.				
64—Mixed Sandy and Silty Tableland and Badlands	11,895	30,825	5.6	0.33
65—Nebraska Sand Hills	20,545	53,235	9.6	0.57
66—Dakota-Nebraska Eroded Tableland	5,660	14,665	2.6	0.16
67A—Central High Plains, Northern Part	8,165	21,150	3.8	0.23
67B—Central High Plains, Southern Part	19,855	51,445	9.3	0.55
69—Upper Arkansas Valley Rolling Plains	11,920	30,885	5.6	0.33
70A—Canadian River Plains and Valleys	10,770	27,910	5.0	0.30
70B—Upper Pecos River Valley	9,900	25,660	4.6	0.28
70C—Central New Mexico Highlands	12,495	32,375	5.8	0.35
70D—Southern Desert Foothills	3,000	7,775	1.4	0.08
H—Central Great Plains Winter Wheat and Range Region	219,740	569,420	---	6.12
71—Central Nebraska Loess Hills	8,165	21,160	3.7	0.23
72—Central High Tableland	34,550	89,535	15.7	0.96
73—Rolling Plains and Breaks	21,485	55,670	9.8	0.60
74—Central Kansas Sandstone Hills	8,365	21,675	3.8	0.23
75—Central Loess Plains	8,055	20,870	3.7	0.22
76—Bluestem Hills	7,555	19,585	3.4	0.21
77A—Southern High Plains, Northern Part	10,005	25,930	4.6	0.28
77B—Southern High Plains, Northwestern Part	3,930	10,185	1.8	0.11
77C—Southern High Plains, Southern Part	20,955	54,300	9.5	0.58
77D—Southern High Plains, Southwestern Part	9,905	25,665	4.5	0.28
77E—Southern High Plains, Breaks	10,320	26,735	4.7	0.29
78A—Rolling Limestone Prairie	4,750	12,310	2.2	0.13
78B—Central Rolling Red Plains, Western Part	18,610	48,220	8.5	0.52
78C—Central Rolling Red Plains, Eastern Part	19,565	50,705	8.9	0.54
79—Great Bend Sand Plains	7,405	19,185	3.4	0.21
80A—Central Rolling Red Prairies	19,925	51,635	9.1	0.55
80B—Texas North-Central Prairies	6,195	16,055	2.8	0.17
I—Southwest Plateaus and Plains Range and Cotton Region	72,340	187,460	---	2.01
81A—Edwards Plateau, Western Part	16,550	42,885	22.9	0.46
81B—Edwards Plateau, Central Part	11,125	28,825	15.4	0.31
81C—Edwards Plateau, Eastern Part	8,060	20,890	11.1	0.22
81D—Southern Edwards Plateau	2,495	6,465	3.4	0.07
82A—Texas Central Basin	2,635	6,830	3.6	0.07
83A—Northern Rio Grande Plain	11,115	28,805	15.4	0.31
83B—Western Rio Grande Plain	9,285	24,060	12.8	0.26
83C—Central Rio Grande Plain	4,275	11,075	5.9	0.12
83D—Lower Rio Grande Plain	2,500	6,475	3.5	0.07
83E—Sandsheet Prairie	4,300	11,150	5.9	0.12
J—Southwestern Prairies Cotton and Forage Region	59,700	154,695	---	1.66
82B—Wichita Mountains	1,060	2,740	1.8	0.03
84A—North Cross Timbers	7,705	19,965	12.9	0.21
84B—West Cross Timbers	6,165	15,970	10.3	0.17

Area and Proportionate Extent of the Land Resource Regions and Major Land Resource Areas—Cont.

Land resource region and major land resource area	Area		Extent in— LRR	Extent in— United States
	mi²	*km²*	*pct*	*pct*
J—Southwestern Prairies Cotton and Forage Region—Cont.				
84C—East Cross Timbers	1,320	3,425	2.2	0.04
85—Grand Prairie	10,400	26,955	17.4	0.29
86A—Texas Blackland Prairie, Northern Part	15,110	39,150	25.3	0.42
86B—Texas Blackland Prairie, Southern Part	2,925	7,585	4.9	0.08
87A—Texas Claypan Area, Southern Part	10,535	27,295	17.6	0.29
87B—Texas Claypan Area, Northern Part	4,480	11,610	7.5	0.12
K—Northern Lake States Forest and Forage Region	118,775	307,795	---	3.31
57—Northern Minnesota Gray Drift	9,785	25,355	8.2	0.27
88—Northern Minnesota Glacial Lake Basins	11,695	30,300	9.8	0.33
89—Wisconsin Central Sands	3,420	8,860	2.9	0.10
90A—Wisconsin and Minnesota Thin Loess and Till, Northern Part	17,535	45,440	14.8	0.49
90B—Wisconsin and Minnesota Thin Loess and Till, Southern Part	8,935	23,155	7.5	0.25
91A—Central Minnesota Sandy Outwash	4,600	11,920	3.9	0.13
91B—Wisconsin and Minnesota Sandy Outwash	4,110	10,650	3.5	0.11
92—Superior Lake Plain	2,920	7,570	2.5	0.08
93A—Superior Stony and Rocky Loamy Plains and Hills, Western Part	8,570	22,205	7.2	0.24
93B—Superior Stony and Rocky Loamy Plains and Hills, Eastern Part	6,900	17,880	5.8	0.19
94A—Northern Michigan and Wisconsin Sandy Drift	9,020	23,380	7.6	0.25
94B—Michigan Eastern Upper Peninsula Sandy Drift	9,810	25,425	8.3	0.27
94C—Michigan Northern Lower Peninsula Sandy Drift	2,000	5,185	1.7	0.06
94D—Northern Highland Sandy Drift	2,100	5,445	1.8	0.06
95A—Northeastern Wisconsin Drift Plain	6,495	16,825	5.5	0.18
95B—Southern Wisconsin and Northern Illinois Drift Plain	10,880	28,200	9.2	0.30
L—Lake States Fruit, Truck Crop, and Dairy Region	45,715	118,460	---	1.27
96—Western Michigan Fruit Belt	2,790	7,230	6.1	0.08
97—Southwestern Michigan Fruit and Truck Crop Belt	3,085	7,995	6.7	0.09
98—Southern Michigan and Northern Indiana Drift Plain	18,930	49,050	41.4	0.53
99—Erie-Huron Lake Plain	10,950	28,370	24.0	0.30
101—Ontario-Erie Plain and Finger Lakes Region	9,960	25,815	21.8	0.28
M—Central Feed Grains and Livestock Region	282,450	731,905	---	7.86
102A—Rolling Till Prairie	16,545	42,870	5.9	0.46
102B—Till Plains	2,215	5,735	0.8	0.06
102C—Loess Uplands	11,445	29,655	4.1	0.32
103—Central Iowa and Minnesota Till Prairies	27,640	71,630	9.8	0.77
104—Eastern Iowa and Minnesota Till Prairies	9,660	25,040	3.4	0.27
105—Northern Mississippi Valley Loess Hills	17,950	46,515	6.4	0.50
106—Nebraska and Kansas Loess-Drift Hills	10,920	28,295	3.9	0.30
107A—Iowa and Minnesota Loess Hills	4,470	11,590	1.6	0.12
107B—Iowa and Missouri Deep Loess Hills	14,410	37,335	5.1	0.40
108A—Illinois and Iowa Deep Loess and Drift, Eastern Part	11,145	28,875	3.9	0.31
108B—Illinois and Iowa Deep Loess and Drift, East-Central Part	7,450	19,300	2.6	0.21

Area and Proportionate Extent of the Land Resource Regions and Major Land Resource Areas—Cont.

Land resource region and major land resource area	Area		Extent in—	
			LRR	United States
	mi²	*km²*	*pct*	*pct*
M—Central Feed Grains and Livestock Region—Cont.				
108C—Illinois and Iowa Deep Loess and Drift, West-Central Part	9,805	25,405	3.5	0.27
108D—Illinois and Iowa Deep Loess and Drift, Western Part	5,480	14,195	1.9	0.15
109—Iowa and Missouri Heavy Till Plain	15,895	41,185	5.6	0.44
110—Northern Illinois and Indiana Heavy Till Plain	7,535	19,525	2.7	0.21
111A—Indiana and Ohio Till Plain, Central Part	10,980	28,445	3.9	0.31
111B—Indiana and Ohio Till Plain, Northeastern Part	13,460	34,880	4.8	0.37
111C—Indiana and Ohio Till Plain, Northwestern Part	3,500	9,065	1.2	0.10
111D—Indiana and Ohio Till Plain, Western Part	5,355	13,880	1.9	0.15
111E—Indiana and Ohio Till Plain, Eastern Part	2,980	7,720	1.1	0.08
112—Cherokee Prairies	23,840	61,775	8.4	0.66
113—Central Claypan Areas	12,790	33,150	4.5	0.36
114A—Southern Illinois and Indiana Thin Loess and Till Plain, Eastern Part	4,550	11,795	1.6	0.13
114B—Southern Illinois and Indiana Thin Loess and Till Plain, Western Part	7,005	18,150	2.5	0.20
115A—Central Mississippi Valley Wooded Slopes, Eastern Part	3,690	9,565	1.3	0.10
115B—Central Mississippi Valley Wooded Slopes, Western Part	8,085	20,955	2.9	0.23
115C—Central Mississippi Valley Wooded Slopes, Northern Part	13,650	35,375	4.8	0.38
N—East and Central Farming and Forest Region	236,415	612,645	---	6.58
116A—Ozark Highland	32,845	85,110	13.9	0.91
116B—Springfield Plain	5,130	13,300	2.2	0.14
116C—St. Francois Knobs and Basins	1,600	4,150	0.7	0.04
117—Boston Mountains	6,850	17,755	2.9	0.19
118A—Arkansas Valley and Ridges, Eastern Part	6,755	17,510	2.9	0.19
118B—Arkansas Valley and Ridges, Western Part	3,070	7,960	1.3	0.09
119—Ouachita Mountains	11,885	30,800	5.0	0.33
120A—Kentucky and Indiana Sandstone and Shale Hills and Valleys, Southern Part	8,905	23,080	3.8	0.25
120B—Kentucky and Indiana Sandstone and Shale Hills and Valleys, Northwestern Part	3,040	7,875	1.3	0.08
120C—Kentucky and Indiana Sandstone and Shale Hills and Valleys, Northeastern Part	1,050	2,725	0.4	0.03
121—Kentucky Bluegrass	10,680	27,670	4.5	0.30
122—Highland Rim and Pennyroyal	21,530	55,790	9.1	0.60
123—Nashville Basin	5,625	14,580	2.4	0.16
124—Western Allegheny Plateau	12,880	33,375	5.4	0.36
125—Cumberland Plateau and Mountains	20,330	52,685	8.6	0.57
126—Central Allegheny Plateau	18,040	46,750	7.6	0.50
127—Eastern Allegheny Plateau and Mountains	19,440	50,370	8.2	0.54
128—Southern Appalachian Ridges and Valleys	21,095	54,660	8.9	0.59
129—Sand Mountain	8,030	20,805	3.4	0.22
130A—Northern Blue Ridge	1,555	4,030	0.7	0.04
130B—Southern Blue Ridge	16,080	41,665	6.8	0.45

Area and Proportionate Extent of the Land Resource Regions and Major Land Resource Areas—Cont.

Land resource region and major land resource area	Area		Extent in— LRR	Extent in— United States
	mi²	*km²*	*pct*	*pct*
O—Mississippi Delta Cotton and Feed Grains Region	38,865	100,710	---	1.08
131A—Southern Mississippi River Alluvium	29,555	76,585	76.0	0.82
131B—Arkansas River Alluvium	3,955	10,245	10.2	0.11
131C—Red River Alluvium	2,410	6,245	6.2	0.07
131D—Southern Mississippi River Terraces	2,945	7,635	7.6	0.08
P—South Atlantic and Gulf Slope Cash Crops, Forest, and Livestock Region	264,095	684,340	---	7.35
133A—Southern Coastal Plain	106,485	275,930	40.3	2.96
133B—Western Coastal Plain	45,450	117,770	17.2	1.27
134—Southern Mississippi Valley Loess	26,520	68,715	10.0	0.74
135A—Alabama and Mississippi Blackland Prairie	6,370	16,510	2.4	0.18
135B—Cretaceous Western Coastal Plain	3,970	10,290	1.5	0.11
136—Southern Piedmont	64,395	166,865	24.4	1.79
137—Carolina and Georgia Sand Hills	8,665	22,450	3.3	0.24
138—North-Central Florida Ridge	2,240	5,810	0.8	0.06
Q—Pacific Basin Region	999	2,585	---	---
190—Stratovolcanoes of the Mariana Islands	71	183	7.1	---
191—High Limestone Plateaus of the Mariana Islands	256	663	25.6	---
192—Volcanic Highlands of the Mariana Islands	78	202	7.8	---
193—Volcanic Islands of Western Micronesia	196	508	19.6	---
194—Low Limestone Islands of Western Micronesia	27	70	2.7	---
195—Volcanic Islands of Central and Eastern Micronesia	224	580	22.4	---
196—Coral Atolls of Micronesia	70	180	7.0	---
197—Volcanic Islands of American Samoa	77	199	7.7	---
R—Northeastern Forage and Forest Region	120,635	312,625	---	3.36
139—Lake Erie Glaciated Plateau	10,715	27,770	8.9	0.30
140—Glaciated Allegheny Plateau and Catskill Mountains	22,370	57,975	18.5	0.62
141—Tughill Plateau	1,175	3,045	1.0	0.03
142—St. Lawrence-Champlain Plain	7,040	18,240	5.8	0.20
143—Northeastern Mountains	36,840	95,465	30.5	1.03
144A—New England and Eastern New York Upland, Southern Part	18,590	48,180	15.4	0.52
144B—New England and Eastern New York Upland, Northern Part	20,500	53,125	17.0	0.57
145—Connecticut Valley	2,130	5,520	1.8	0.06
146—Aroostook Area	1,275	3,305	1.1	0.04
S—Northern Atlantic Slope Diversified Farming Region	40,865	105,905	---	1.14
147—Northern Appalachian Ridges and Valleys	20,750	53,775	50.8	0.58
148—Northern Piedmont	12,800	33,170	31.3	0.36
149A—Northern Coastal Plain	5,205	13,495	12.7	0.14
149B—Long Island-Cape Cod Coastal Lowland	2,110	5,465	5.2	0.06

Area and Proportionate Extent of the Land Resource Regions and Major Land Resource Areas—Cont.

Land resource region and major land resource area	Area		Extent in—	
			LRR	United States
	mi²	*km²*	*pct*	*pct*
T—Atlantic and Gulf Coast Lowland Forest and Crop Region	92,630	240,055	---	2.58
150A—Gulf Coast Prairies	16,365	42,410	17.7	0.46
150B—Gulf Coast Saline Prairies	3,420	8,865	3.7	0.10
151—Gulf Coast Marsh	8,495	22,015	9.2	0.24
152A—Eastern Gulf Coast Flatwoods	9,860	25,555	10.6	0.27
152B—Western Gulf Coast Flatwoods	5,880	15,240	6.3	0.16
153A—Atlantic Coast Flatwoods	28,720	74,420	31.0	0.80
153B—Tidewater Area	12,830	33,250	13.9	0.36
153C—Mid-Atlantic Coastal Plain	2,015	5,225	2.2	0.06
153D—Northern Tidewater Area	5,045	13,075	5.4	0.14
U—Florida Subtropical Fruit, Truck Crop, and Range Region	35,610	92,275	---	0.99
154—South-Central Florida Ridge	8,285	21,470	23.3	0.23
155—Southern Florida Flatwoods	18,575	48,135	52.2	0.52
156A—Florida Everglades and Associated Areas	6,915	17,920	19.4	0.19
156B—Southern Florida Lowlands	1,835	4,750	5.2	0.05
V—Hawaii Region	6,265	16,260	---	0.17
157—Arid and Semiarid Low Mountain Slopes	265	690	4.2	0.01
158—Semiarid and Subhumid Low Mountain Slopes	520	1,340	8.3	0.01
159A—Humid and Very Humid Volcanic Ash Soils on Low and Intermediate Rolling Mountain Slopes	535	1,390	8.5	0.01
159B—Subhumid and Humid Low and Intermediate Mountain Slopes	245	640	3.9	0.01
160—Subhumid and Humid Intermediate and High Mountain Slopes	500	1,290	8.0	0.01
161A—Lava Flows and Rock Outcrops	1,580	4,100	25.2	0.04
161B—Semiarid and Subhumid Organic Soils on Lava Flows	385	1,000	6.1	0.01
162—Humid and Very Humid Organic Soils on Lava Flows	550	1,430	8.8	0.02
163—Alluvial Fans and Coastal Plains	140	365	2.2	0.00
164—Humid and Very Humid Steep and Very Steep Mountain Slopes	760	1,970	12.1	0.02
165—Subhumid Intermediate Mountain Slopes	110	290	1.8	0.00
166—Very Stony Land and Rock Land	445	1,160	7.1	0.01
167—Humid Oxidic Soils on Low and Intermediate Rolling Mountain Slopes	230	595	3.7	0.01
W1—Southern Alaska	95,210	246,710	---	2.65
220—Alexander Archipelago-Gulf of Alaska Coast	27,435	71,085	28.8	0.76
221—Kodiak Archipelago	5,015	12,995	5.3	0.14
222—Southern Alaska Coastal Mountains	26,335	68,235	27.7	0.73
223—Cook Inlet Mountains	19,700	51,050	20.7	0.55
224—Cook Inlet Lowlands	10,635	27,565	11.2	0.30
225—Southern Alaska Peninsula Mountains	6,090	15,780	6.4	0.17
W2—Aleutian Alaska				
226—Aleutian Islands-Western Alaska Peninsula	10,670	27,645	100.0	0.30

Area and Proportionate Extent of the Land Resource Regions and Major Land Resource Areas—Cont.

Land resource region and major land resource area	Area		Extent in— LRR	Extent in— United States
	mi²	*km²*	*pct*	*pct*
X1—Interior Alaska	259,260	671,835	---	7.22
227—Copper River Basin	4,590	11,900	1.8	0.13
228—Interior Alaska Mountains	44,375	114,985	17.1	1.24
229—Interior Alaska Lowlands	36,320	94,120	14.0	1.01
230—Yukon-Kuskokwim Highlands	59,860	155,115	23.1	1.67
231—Interior Alaska Highlands	69,175	179,255	26.7	1.93
232—Yukon Flats Lowlands	12,785	33,130	4.9	0.36
233—Upper Kobuk and Koyukuk Hills and Valleys	12,910	33,455	5.0	0.36
234—Interior Brooks Range Mountains	19,245	49,875	7.4	0.54
X2—Western Alaska	91,300	236,585	---	2.54
235—Northern Alaska Peninsula Mountains	5,715	14,815	6.3	0.16
236—Bristol Bay-Northern Alaska Peninsula Lowlands	19,575	50,725	21.4	0.54
237—Ahklun Mountains	14,555	37,715	15.9	0.41
238—Yukon-Kuskokwim Coastal Plain	29,960	77,640	32.8	0.83
239—Northern Bering Sea Islands	3,575	9,260	3.9	0.10
240—Nulato Hills-Southern Seward Peninsula Highlands	17,920	46,430	19.6	0.50
Y—Northern Alaska	125,550	325,345	---	3.49
241—Seward Peninsula Highlands	13,455	34,870	10.7	0.37
242—Northern Seward Peninsula-Selawik Lowlands	8,165	21,155	6.5	0.23
243—Western Brooks Range Mountains, Foothills, and Valleys	23,070	59,780	18.4	0.64
244—Northern Brooks Range Mountains	15,695	40,675	12.5	0.44
245—Arctic Foothills	42,305	109,625	33.7	1.18
246—Arctic Coastal Plain	22,860	59,240	18.2	0.64
Z—Caribbean Region	3,595	9,310	---	---
270—Humid Mountains and Valleys	1,800	4,660	50.1	---
271—Semiarid Mountains and Valleys	525	1,365	14.6	---
272—Humid Coastal Plains	965	2,500	26.8	---
273—Semiarid Coastal Plains	305	785	8.5	---
United States Total	3,592,265	9,308,715	---	100.00

Appendix III.—Water Use

Comparison of Surface and Ground Water Use in the U.S. and the Caribbean in 1980, 1990, and 2000

		Fresh surface water use (millions of gallons per day)		Fresh ground water use (millions of gallons per day)	
State	Year	Total	Percent difference from 1990	Total	Percent difference from 1990
Alabama	2000	9,550	23	439	2
	1990	7,747		431	
	1980	10,641	37	347	-20
Alaska	2000	111	-63	50	-21
	1990	302		63	
	1980	224	-26	49	-23
Arizona	2000	3,304	-14	3,423	25
	1990	3,833		2,745	
	1980	7,953	107	4,222	54
Arkansas	2000	3,949	26	6,928	47
	1990	3,129		4,712	
	1980	15,688	401	4,012	-15
California	2000	23,213	13	15,204	4
	1990	20,563		14,577	
	1980	43,797	113	21,376	47
Colorado	2000	10,324	4	2,320	-16
	1990	9,913		2,774	
	1980	15,698	58	2,819	2
Connecticut	2000	564	-37	143	-14
	1990	901		166	
	1980	1,316	46	136	-18
Delaware	2000	466	-50	115	29
	1990	939		89	
	1980	139	-85	82	-9
District of Columbia	2000	10	-88	0	-100
	1990	80		1	
	1980	341	327	1	-20
Florida	2000	3,110	9	5,023	8
	1990	2,864		4,662	
	1980	7,389	158	3,799	-19
Georgia	2000	4,960	16	1,446	45
	1990	4,290		997	
	1980	6,698	56	1,171	17

Comparison of Surface and Ground Water Use in the U.S. and the Caribbean in 1980, 1990, and 2000—Cont.

		Fresh surface water use (millions of gallons per day)		Fresh ground water use (millions of gallons per day)	
State	Year	Total	Percent difference from 1990	Total	Percent difference from 1990
Hawaii	2000	208	-65	433	-26
	1990	601		588	
	1980	1,304	117	788	34
Idaho	2000	15,272	26	4,139	-45
	1990	12,162		7,594	
	1980	18,433	52	6,409	-16
Illinois	2000	12,973	-24	813	-19
	1990	17,115		1,002	
	1980	17,857	4	926	-8
Indiana	2000	9,464	8	656	6
	1990	8,800		622	
	1980	13,772	57	1,289	107
Iowa	2000	2,680	10	679	37
	1990	2,440		494	
	1980	4,301	76	758	54
Kansas	2000	2,822	64	3,790	-13
	1990	1,722		4,368	
	1980	6,564	281	5,619	29
Kentucky	2000	3,963	-3	190	-23
	1990	4,072		248	
	1980	4,875	20	248	0
Louisiana	2000	8,734	10	1,627	21
	1990	7,946		1,339	
	1980	12,282	55	1,762	32
Maine	2000	423	-5	81	-6
	1990	447		86	
	1980	840	88	81	-6
Maryland	2000	1,202	-2	225	-6
	1990	1,229		239	
	1980	1,130	-8	154	-36
Massachusetts	2000	782	-55	270	-20
	1990	1,735		338	
	1980	2,462	42	321	-5

Comparison of Surface and Ground Water Use in the U.S. and the Caribbean in 1980, 1990, and 2000—Cont.

State	Year	Fresh surface water use (millions of gallons per day) Total	Fresh surface water use Percent difference from 1990	Fresh ground water use (millions of gallons per day) Total	Fresh ground water use Percent difference from 1990
Michigan	2000	9,269	-15	734	4
	1990	10,918		703	
	1980	15,392	41	536	-24
Minnesota	2000	3,146	27	720	-10
	1990	2,475		798	
	1980	3,078	24	670	-16
Mississippi	2000	631	-3	2,181	-18
	1990	649		2,670	
	1980	2,868	342	1,504	-44
Missouri	2000	6,444	25	1,777	144
	1990	5,142		728	
	1980	6,817	33	479	-34
Montana	2000	8,103	-11	188	-8
	1990	9,093		205	
	1980	11,518	27	266	30
Nebraska	2000	4,386	6	7,858	62
	1990	4,149		4,850	
	1980	11,993	189	7,141	47
Nevada	2000	2,048	-10	758	-29
	1990	2,278		1,068	
	1980	3,587	57	709	-34
New Hampshire	2000	361	1	85	34
	1990	356		64	
	1980	385	8	65	3
New Jersey	2000	1,585	-4	584	3
	1990	1,653		566	
	1980	2,893	75	722	28
New Mexico	2000	1,710	-1	1,544	-12
	1990	1,721		1,761	
	1980	3,934	129	1,849	5
New York	2000	6,184	-36	893	7
	1990	9,641		838	
	1980	7,934	-18	788	-6

Comparison of Surface and Ground Water Use in the U.S. and the Caribbean in 1980, 1990, and 2000—Cont.

		Fresh surface water use (millions of gallons per day)		Fresh ground water use (millions of gallons per day)	
State	Year	Total	Percent difference from 1990	Total	Percent difference from 1990
North Carolina	2000	9,149	8	580	33
	1990	8,501		436	
	1980	8,079	-5	772	77
North Dakota	2000	1,017	-60	123	-26
	1990	2,539		167	
	1980	1,308	-48	118	-29
Ohio	2000	10,274	-5	878	-3
	1990	10,765		904	
	1980	13,534	26	977	8
Oklahoma	2000	989	30	771	17
	1990	761		661	
	1980	1,713	125	956	45
Oregon	2000	5,941	-22	993	28
	1990	7,664		777	
	1980	6,828	-11	1,133	46
Pennsylvania	2000	9,283	5	666	-35
	1990	8,809		1,023	
	1980	15,471	76	1,023	0
Rhode Island	2000	109	2	29	14
	1990	107		25	
	1980	175	63	38	50
South Carolina	2000	6,838	20	331	-7
	1990	5,719		355	
	1980	6,151	8	230	-35
South Dakota	2000	306	-10	222	-25
	1990	341		296	
	1980	697	104	329	11
Tennessee	2000	10,409	20	417	-17
	1990	8,685		504	
	1980	10,107	16	446	-11
Texas	2000	16,324	28	8,461	15
	1990	12,733		7,387	
	1980	14,320	12	8,038	9

Comparison of Surface and Ground Water Use in the U.S. and the Caribbean in 1980, 1990, and 2000—Cont.

State	Year	Fresh surface water use (millions of gallons per day) Total	Percent difference from 1990	Fresh ground water use (millions of gallons per day) Total	Percent difference from 1990
Utah	2000	3,739	8	1,021	6
	1990	3,474		963	
	1980	4,543	31	1,035	8
Vermont	2000	404	-32	43	-20
	1990	595		54	
	1980	344	-42	45	-16
Virginia	2000	4,888	14	313	-30
	1990	4,275		444	
	1980	5,576	30	392	-12
Washington	2000	3,799	-41	1,475	-1
	1990	6,457		1,487	
	1980	8,259	28	754	-49
West Virginia	2000	5,058	31	91	-88
	1990	3,868		728	
	1980	5,638	46	218	-70
Wisconsin	2000	6,785	16	813	20
	1990	5,827		680	
	1980	5,752	-1	613	-10
Wyoming	2000	4,404	-39	541	21
	1990	7,200		446	
	1980	5,397	-25	540	21
Puerto Rico	2000	483	15	137	-13
	1990	419		158	
	1980	819	95	319	102
U.S. Virgin Islands	2000	11	45	1	-91
	1990	7		11	
	1980	6	-15	4	-64
Totals	2000	262,163	1	83,226	4
	1990	259,654		79,888	
	1980	378,821	46	89,078	12

Appendix IV.—Soil Classification

In this appendix, the basic structure of the soil classification system used in the United States is described. This system has six categories (Soil Survey Staff, 1999). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. The categories are defined in the following paragraphs.

ORDER. Twelve soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Alfisol. The orders are described in the next part of this appendix.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udalfs (*Ud*, meaning humid, plus *alf*, from Alfisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; type of saturation; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Hapludalfs (*Hapl*, meaning minimal horizonation, plus *udalf*, the suborder of the Alfisols that has a udic soil moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic subgroup is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other taxonomic class. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Hapludalfs.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below tillage depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineralogy class, cation-exchange activity class, soil temperature regime, soil depth, and reaction class. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, active, mesic Typic Hapludalfs.

SERIES. The series consists of soils within a family that have horizons similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile.

Description of Soil Orders

Alfisols are in semiarid to moist areas. These soils result from weathering processes that leach clay minerals and other constituents out of the surface layer and into the subsoil, where they can hold and supply moisture and nutrients to plants. The soils formed primarily under forest or mixed vegetative cover and are productive for most crops.

Andisols form through weathering processes that generate minerals with little orderly crystalline structure. These minerals can result in an unusually high water- and nutrient-holding capacity. As a group, Andisols tend to be highly productive soils. They include weakly weathered soils with much volcanic glass as well as more strongly weathered soils. They are common in cool areas with moderate to high precipitation, especially those areas associated with volcanic materials.

Aridisols are soils that are too dry for the growth of mesophytic plants. The lack of moisture greatly restricts the intensity of weathering processes and limits most soil development processes to the upper part of the soils. Aridisols commonly accumulate gypsum, salt, calcium carbonate, and other minerals that are easily leached from soils in more humid environments.

Entisols are soils that show little or no evidence of pedogenic development. They occur in areas of recently deposited parent materials or in areas where erosion or deposition rates are faster than the rate of soil development, such as dunes, steep slopes, and flood plains. The soils occur in many environments.

Gelisols are soils that have permafrost near the soil surface and/or have evidence of cryoturbation (frost churning) and/or ice segregation. These soils are common in the higher latitudes or at high elevations.

Histosols have a high content of organic matter and no permafrost. Most are saturated throughout the year, but a few are freely drained. Histosols are commonly called bogs, moors, peats, or mucks. They form in decomposed plant remains that accumulate in water, forest litter, or moss faster than they decay. If these soils are drained and exposed to air, microbial decomposition is accelerated and the soils may subside dramatically.

Inceptisols are soils of semiarid to humid environments that generally exhibit only moderate degrees of soil weathering and development. These soils have a wide range in characteristics and occur in a wide variety of climates.

Mollisols are soils that have a dark colored surface horizon relatively high in content of organic matter. These soils are base rich throughout and therefore are quite fertile. They characteristically form under grass in climates that have a moderate to pronounced seasonal moisture deficit, such as the Great Plains and prairie regions.

Oxisols are highly weathered soils of tropical and subtropical regions. They are dominated by low-activity minerals, such as quartz, kaolinite, and iron oxides. They tend to have indistinct horizons. These soils characteristically occur on surfaces that have been stable for a long time. They have low natural fertility as well as a low capacity to retain additions of lime and fertilizer.

Spodosols formed through weathering processes that strip organic matter combined with aluminum (with or without iron) from the surface layer and deposit them in the subsoil. In undisturbed areas, a gray eluvial horizon that has the color of uncoated quartz overlies a reddish brown or black subsoil. These soils commonly occur in areas of coarse textured deposits under coniferous forests of humid regions. They tend to be acid and infertile.

Ultisols are soils in humid areas. They formed through fairly intense weathering and leaching processes that result in a clay-enriched subsoil dominated by minerals, such as quartz, kaolinite, and iron oxides. They are typically acid soils in which most nutrients are concentrated in the upper few inches. They have a moderately low capacity to retain additions of lime and fertilizer.

Vertisols have a high content of expanding clay minerals. They undergo pronounced changes in volume with changes in moisture content. They have cracks that open and close periodically and that show evidence of soil movement in the profile. Because they swell when wet, these soils transmit water very slowly and have undergone little leaching. They tend to be fairly high in natural fertility.

Additional Information

Additional information about soil taxonomy, including in-depth technical details about the classification system and descriptions of each of the soil series referred to in this publication, can be accessed online (http://soils.usda.gov/technical/classification/).

Definitions of many of the terms describing parent material and landforms are available in the National Soil Survey Handbook (http://soils.usda.gov/technical/handbook/contents/part629glossary1.html).

Detailed information about the soil surveys of specific areas can be obtained from the appropriate NRCS State Soil Scientist (http://soils.usda.gov/contact/state_offices/).

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