Ecoregions of New Mexico

Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources; they are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. By recognizing the spatial differences in the capacities and potentials of ecosystems, ecoregions stratify the environment by its propense response to disturbance (Bryce and others, 1999). These general purpose regions are critical for structuring and implementing ecosystem management strategies across federal agencies, state agencies, and nongovernment organizations that are responsible for different types of resources within the same geographical areas (Omernik and others, 2000).

The New Mexico ecoregion map was compiled at a scale of 1:250,000. It revises and subdivides an earlier national ecoregion map that was originally compiled at a smaller scale (USEPA, 2006; Omernik, 1987). The approach used to compile this map is based on the premise that ecological regions can be identified through the analysis of the spatial patterns and the composition of biotic and abiotic phenomena that affect or reflect differences in ecosystem quality and integrity (Wiken, 1986; Omernik, 1987, 1995). These phenomena include geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. The relative importance of each characteristic varies from one ecological region to another regardless of the hierarchical level.

A Roman numeral hierarchical scheme has been adopted for different levels of ecological regions. Level I is the coarsest level, dividing North America into 15 ecological regions. Level II divides the continent into 52 regions (Commission for Environmental Cooperation Working Group, 1997). At level III, the continental United States contains 104 ecoregions and the conterminous United States has 84 ecoregions (United States Environmental Protection Agency [USEPA], 2006). Level IV is a further subdivision of level III ecoregions. Explanations of the methods used to define the USEPA's ecoregions are given in Omernik (1995, 2004), Omernik and others (2000), and Gallant and others (1989).

New Mexico contains semiarid shrub- and grass-covered plains, forested mountains, glaciated peaks, woodland- and shrubland-covered plateaus, lava fields and volcanic plateaus, river floodplains, and arid deserts. Ecological diversity is enormous. There are 8 level III ecoregions and 55 level IV ecoregions in New Mexico and many continue into ecologically similar parts of adjacent states (Griffith and others, 2004; Woods and others, 2005; Chapman and others, 2006).

This poster is part of a collaborative project primarily between USEPA Region VI, USEPA National Health and Environmental Effects Research Laboratory (Corvallis, Oregon), New Mexico Environment Department (NMED), U.S. Department of Agriculture (USDA)–Natural Resources Conservation Service (NRCS), and U.S. Geological Survey (USGS)–National Center for Earth Resources Observation and Science (EROS). The project is associated with an interagency effort to develop a common framework of ecological regions (McMahon and others, 2001). Reaching that objective requires recognition of the differences in the conceptual approaches and mapping methodologies applied to develop the most common ecoregion-type frameworks, including those developed by the USDA–Forest Service (Bailey and others, 1994), the USEPA (Omernik, 1987, 1995), and the NRCS (U.S. Department of Agriculture–Soil Conservation Service, 1981). As each of these frameworks is further refined, their differences are becoming less discernible. Collaborative ecoregion projects, such as this one in New Mexico, are a step toward attaining consensus and consistency in ecoregion frameworks for the entire nation.

Literature Cited:

Bailey, R.G., Avers, P.E., King, T., and McNab, W.H., eds., 1994, Ecoregions and subregions of the United States (map) (supplementary table of map unit descriptions compiled and edited by McNab, W.H. and Bailey, R.G.): Washington, D.C., USDA–Forest Service, scale 1:7,500,000.

Bryce, S.A., Omernik, J.M., and Larsen, D.P., 1999, Ecoregions – a geographic framework to guide risk characterization and ecosystem management: Environmental Practice, v. 1, no. 3, p. 141-155.

Chapman, S.S., Griffith, G.E., Omernik, J.M., Price, A.B., Freeouf, J., and Schrupp, D.L., 2006, Ecoregions of Colorado: Reston, Virginia, U.S. Geological Survey, map scale 1:1,200,000.

Commission for Environmental Cooperation Working Group, 1997, Ecological regions of North America – toward a common perspective: Montreal, Commission for Environmental Cooperation, 71 p.

Gallant, A.L., Whittier, T.R., Larsen, D.P., Omernik, J.M., and Hughes, R.M., 1989, Regionalization as a tool for managing environmental resources: Corvallis, Oregon, U.S. Environmental Protection Agency, EPA/600/3-89/060, 152 p.

Griffith, G.E., Bryce, S.A., Omernik, J.M., Comstock, J.A., Rogers, A.C., Harrison, B., Greenwade, J., Glassy-Hornton, S., Moran, B.C., and Bezanson, D., 2004, Ecoregions of Texas: Reston, Virginia, U.S. Geological Survey, map scale 1:2,500,000.

McMahon, G., Gregonis, S.M., Waltman, S.W., Omernik, J.M., Thorson, T.D., Freeouf, J.A., Rorick, A.H., and Keys, J.E., 2001, Developing a spatial framework of common ecological regions for the conterminous United States: Environmental Management, v. 28, no. 3, p. 293-316.

Omernik, J.M., 1987, Ecoregions of the conterminous United States (map supplement): Annals of the Association of American Geographers, v. 77, no. 1, p. 118-125, scale 1:7,500,000.

Omernik, J.M., 1995, Ecoregions – a framework for environmental management, *in* Davis, W.S. and Simon, T.P., eds., Biological assessment and criteria-tools for water resource planning and decision making: Boca Raton, Florida, Lewis Publishers, p. 49-62.

Omernik, J.M., 2004, Perspectives on the nature and definition of ecological regions: Environmental Management, v. 34, Supplement 1, p. s27-s38.

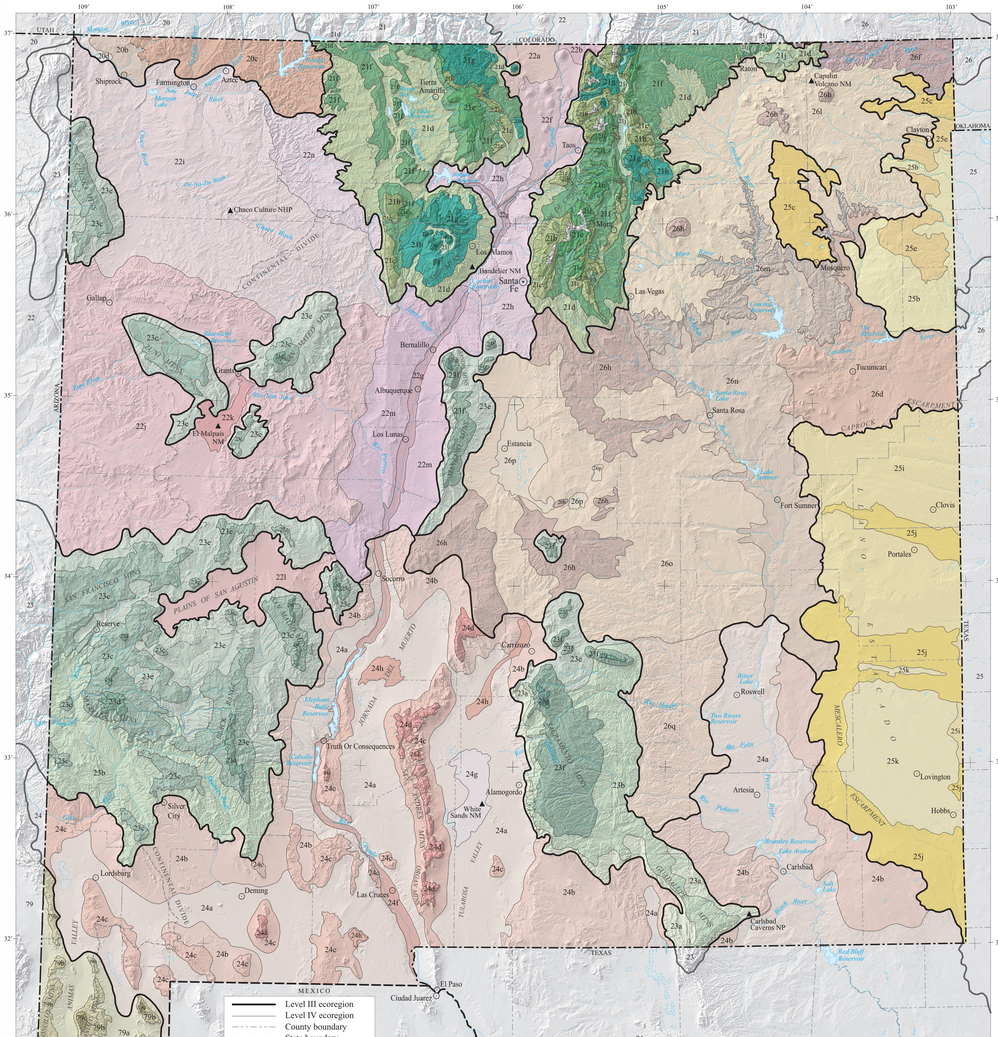
Omernik, J.M., Chapman, S.S., Lillie, R.A., and Dumke, R.T., 2000, Ecoregions of Wisconsin: Transactions of the Wisconsin Academy of Sciences, Arts, and Letters, v. 88, p. 77-103.

U.S. Department of Agriculture–Soil Conservation Service, 1981, Land resource regions and major land resource areas of the United States: Agriculture Handbook 296, 156 p.

U.S. Environmental Protection Agency, 2006, Level III ecoregions of the continental United States (revision of Omernik, 1987): Corvallis, Oregon, USEPA – National Health and Environmental Effects Research Laboratory, Map M-1, various scales.

Wiken, E., 1986, Terrestrial ecozones of Canada: Ottawa, Environment Canada, Ecological Land Classification Series no. 19, 26 p.

Woods, A.J., Omernik, J.M., Butler, D.R., Ford, J.G., Henley, J.E., Hoagland, B.W., Arndt, D.S., and Moran, B.C., 2005, Ecoregions of Oklahoma: Reston, Virginia, U.S. Geological Survey, map scale 1:1,250,000.



Horizontal sedimentary rocks carved into relief of broad mesas, valleys, and canyons typify Ecoregion 20. Most of the flow of the San Juan River originates in Colorado.

20. Colorado Plateaus

Rugged tabletland topography is typical of the Colorado Plateaus ecoregion. Canyons, mesas, plateaus, and mountains expose a long geologic history of rock formations. Precipitous side-walls mark abrupt changes in local relief, often of 1000 to 2000 feet or more. The region contains more pinyon-juniper and Gambel oak woodlands than the Wooded Plains ecoregion to the north. However, the region also has large low-lying areas containing saltbush-greasewood communities, and in Utah, blackbrush communities typical of hotter, drier areas. These communities are generally not found in the higher Arizona/New Mexico Plateau (22) to the south where grasslands were typically more common.

20b The arid **Shale Deserts and Sedimentary Basins** ecoregion consists of nearly level basins and valleys, benches, low rounded hills, and badlands. Rock outcrops occur; it is sparsely vegetated with mat saltbush, fourwing saltbush, greasewood, and shadscale. Native grasses included alkali sacaton, galleta grass, poverty threeawn, sand dropseed, and Indian ricegrass. It is lower in elevation with less pinyon-juniper woodland than the adjacent Semiarid Benchlands and Canyonlands (20c).

20c Broad, grass-, shrub-, and woodland-covered benches and mesas characterize the **Semiarid Benchlands and Canyonlands** ecoregion. Areas of high relief alternate with areas of low relief. Bedrock exposures are common along rims, escarpments, and on steep dip slopes. Pinyon and juniper are common on shallow soils and Gambel oak at higher elevations. On deeper soils, warm season grasses, sagebrush, fourwing saltbush, winterfat, and Mormon tea occur. The vegetation is not as sparse as in drier areas such as Ecoregions 20b and 20d.

20d Occurring primarily in Utah, the **Arid Canyonlands** ecoregion includes the inner gorge of the Colorado River and its major tributaries, such as the San Juan River. Much of the ecoregion is bounded by nearly vertical canyon walls that separate it from the adjacent, higher benchlands of Ecoregion 20c. Exposed bedrock is common. The New Mexico portion lacks the relief of most of the region in Utah. Soils are shallower with a drier moisture regime than those of Ecoregion 20c. Shadscale, saltbush, some sand sagebrush, and drought tolerant grasses including galleta grass and Indian ricegrass occur. This is the driest area of New Mexico, receiving less than 8 inches of annual rainfall.

21. Southern Rockies

The Southern Rockies are characterized by high elevation, steep, rugged mountains. Although coniferous forests cover much of the region, as in most of the mountainous regions in the western United States, vegetation, as well as soil and land use, follows a pattern of elevational banding. The lowest elevations are generally grass or shrub covered and heavily grazed. Low to middle elevations are also grazed and covered by a variety of vegetation types including juniper-oak woodlands, ponderosa pine, aspen, and Douglas-fir. Middle to high elevations are largely covered by coniferous forests and have little grazing activity. The highest elevations have alpine characteristics. Numerous perennial mountain streams with decidous riparian vegetation support coldwater fisheries and serve as wildlife corridors.

21a The **Alpine Zone** occurs on mountain tops above treeline, beginning at about 11,000 to 11,500 feet in New Mexico. It includes alpine meadows as well as snowfields, talus, and jagged peaks. Annual precipitation ranges from 25 to greater than 50 inches, falling mostly as snow. Vegetation includes low shrubs, cushion plants, and wildflowers and sedges in wet meadows. The forest-tundra interface is sparsely colonized by stunted, deformed Engelmann spruce, subalpine fir, and sometimes bristlecone pine and snow willow (krummholz vegetation). Ecoregion 21a is snow-free only 8 to 10 weeks annually. Snow cover is a major source of water for lower, more arid ecoregions.

21b The **Crystalline Subalpine Forests** ecoregion occupies a narrow elevational band on the steep, forested slopes of the mountains, becoming more extensive on the north slopes. The elevation range in New Mexico is generally 9000 to 11,500 feet, just below the Alpine Zone (21a). Dominant tree species are Engelmann spruce and subalpine fir. Douglas-fir dominates some aspen stands. Subalpine meadows also occur. Forest blowdown, insect outbreaks, fire, and avalanches affect the vegetation mosaic. Soils are weathered from a variety of crystalline and metamorphic materials, such as gneiss, schist, and granite, as well as some areas of igneous intrusive rocks. Recreation, logging, mining, and wildlife habitat are the major land uses.

21c The **Crystalline Mid-Elevation Forests** are found mostly in the 8000 to 10,000 feet elevation range on crystalline and metamorphic substrates. Natural vegetation includes ponderosa pine, aspen, Douglas-fir, and areas of limber pine. A diverse understory of shrubs, grasses, and wildflowers occurs. The variety of food sources supports a diversity of bird and mammal species. Forest stands have become denser in many areas due to decades of fire suppression. Land use includes wildlife habitat, livestock grazing, logging, mining, and recreation.

21d The **Foothill Woodlands and Shrublands** ecoregion is the low elevation portion of the Southern Rockies, and extends from southern Wyoming through Colorado and into New Mexico. In New Mexico, it is a transition area from the higher elevation forests to drier and lower plains (Ecoregion 26) and plateaus (Ecoregions 20, 22). Within the region, some flora and fauna species on the east side (Great Plains) may differ from those found to the west (Great Basin influence). This semiarid region has rolling to locally rugged terrain with irregular terrain of hills, ridges, and footslopes, with elevations mostly 6000 to 8500 feet, and a variety of rock and soil types. In New Mexico, pinyon-juniper and oak woodlands are dominant.

21e The **Sedimentary Subalpine Forests** ecoregion occupies much of the western half of the Southern Rockies in Colorado, areas of the Sangre de Cristo Range in Colorado and New Mexico, and the western part of the Tusas Mountains in New Mexico. The region occurs on sandstone, siltstone, shale, and limestone substrates. Stream water quality, water availability, and aquatic biota are affected in places by carbonate substrates that are soluble and nutrient rich. Some streams are endemic for cutthroat trout. Soils are generally finer-textured than those found on crystalline or metamorphic substrates of Ecoregion 21b. Subalpine forests dominated by Englemann spruce and subalpine fir are typical, often interspersed with aspen groves or mountain meadows. Some Douglas-fir forests are at lower elevations.

21f The **Sedimentary Mid-Elevation Forests** occupies canyons in the western and southern portions of the Southern Rockies in Colorado and in several areas of the Rockies in New Mexico at elevations generally below Ecoregion 21e. The elevation limits and vegetation of this region are similar to the crystalline (21c) and volcanic (21h) mid-elevation forests; however a larger area of Gambel oak woodlands and forest is found in this region. Carbonate substrates are dominant in some areas affect water quality, hydrology, and biota. Alternate substrates are less productive and support a less diverse and less productive forest. Soils are generally finer-textured than those found on crystalline and metamorphic substrates typical of Ecoregion 21c.

21g The steep, mountainous **Volcanic Subalpine Forests** ecoregion is composed of Tertiary or Quaternary volcanic rocks, primarily in the southern extension of the San Juan Mountains from Colorado and in parts of the Brazos, Jemez, and Taos mountains of New Mexico. Relatively young geologically, the high, rugged mountains still contain some large areas of intact habitat. Englemann spruce, subalpine fir, and aspen forests support a variety of wildlife.

21h The **Volcanic Mid-Elevation Forests** ecoregion occurs at elevations of about 7500 to 10,000 feet and is composed of igneous rocks of andesite and basalt. The majority of the region is found in the Jemez Mountains with smaller, scattered areas to the north and east. Forests of ponderosa pine, Douglas-fir, and aspen occur. Land use includes wildlife habitat, livestock grazing, logging, and recreation.

21j The **Grassland Parks** ecoregion, occurring primarily in Colorado, consists of high intermontane valleys with sufficient water availability to support grasslands and wet meadows. In New Mexico, the ecoregion is found in the Valle Grande/Valle San Antonio area in the Jemez Mountains, in the Moreno Valley and Costilla-Comanche-Valle Vidal areas in the Sangre de Cristo Mountains, and on top of Johnson Mesa near Raton. Grasslands with bunchgrasses are dominant, and include Parry's oatgrass, Arizona fescue, Idaho fescue, Thurber fescue, mountain muhly, bluebunch wheatgrass, needle-and-thread grass, Junegrass, and slender wheatgrass. There are only a few trees or shrubs, and if present, they are widely scattered and mature. Some springs and wetlands occur. Large elk herds are found in the valley parklands.

79. Madrean Archipelago

Also known as the Sky Islands in the United States, this is a region of basins and ranges with medium to high local relief, typically 3000 to 5000 feet. Native vegetation in the region is mostly grama-tobosa shrubsteppe in the basins and oak-juniper woodlands on the ranges, except at higher elevations where ponderosa pine is predominant. The region has ecological significance as both a barrier and bridge between two major cordilleras of North America: the Rocky Mountains and the Sierra Madre Occidental.

79a With valley plains, alluvial fans, and some low hills, the **Apachian Valleys and Low Hills** ecoregion is generally similar physiographically to the Chihuahuan Basins and Playas (24a). This region, however, has greater precipitation with more monsoonal influence, and has more grassland than Ecoregion 24a. The present vegetation is mostly sotol-yucca grassland, black grama, sane broodgrass, plains lovegrass, blue grama, hairy grama, sand dropseed, vine mesquite, curly mesquite, false mesquite, Mormon-tea, mimosa, yucca, ocotillo, cacti, and agave. Encroachment of honey mesquite has been significant in some areas.

79b The **Lower Madrean Woodlands** occur at intermediate elevations, generally above 5000 feet. It is a mild winter-wet summer woodland, shrubby in places. The Madrean encinal, or evergreen oak woodlands, have a mosaic of savannas, denser woodlands, and grassy openings. Emory, silverleaf, Toumey, and Arizona white oaks occur, along with scattered pinyon, juniper, mesquite, and chaparral species. Riparian areas of cottonwood, sycamore, and willow are valuable to neotropical birds and other wildlife of the area.

79c In contrast to the lower elevation woodlands of Ecoregion 79b, at elevations above about 7000 feet are the **Madrean Pine-Oak and Mixed Conifer Forests**. These include ponderosa pine-oak forests, ponderosa pine forests, montane fir forests, and mixed conifer forests. Some of the forests are open with a grassy understory. Ponderosa pine, southwestern white pine, Apache pine, and Chihuahuan pine are found here, along with some Douglas-fir. Gambel oak and alligator juniper are also components of these pine forests.

Complex dynamics among climate change, seasonal precipitation, fire, grazing, desert shrub expansion, and grasslands occurs in the Animas Valley of Ecoregion 79a. *Photo: Dan Imhoff*

The New Mexico state fish, the Rio Grande Cutthroat Trout is found in high mountain coldwater streams. Populations are being restored into historic headwater streams. *Photo: Mark Gruber, NMDGF*

Aquatic insects, such as this recently emerged stonefly (*Perlesmyia californica*) comprise the fish food base in high quality coldwater streams such as the upper Pecos River. *Photo: Steve Cary, NM State Parks*

North American elk, or wapiti, are found in many parts of Ecoregion 21. They move to lower elevations in winter for better forage. *Photo: Jeff Vanuga, NRCS*

Balancing demands for cattle, elk, fish, recreation, and stream water quality is a land management challenge in the Valles Caldera in Ecoregion 21j. *Photo: Measer Williams*

Ship Rock, a classic volcanic neck with radiating dikes, is in the western portion of Ecoregion 22j. Known as *Tse Bit' a'i*, or the Rock with Wings, it is a sacred site to the Navajo people. *Photo: L.J. Maker*

The Rio Grande Gorge cuts through the uninterrupted basalt lava flows of the Taos Plateau (22f). Canyon walls provide habitat for eagles, osprey, hawks, owls, and falcons. *Photo: Measer Williams*

Urban land cover sprawls across the Rio Grande in Albuquerque. *Photo: Robert Grammer*

Pikeminnows in the San Juan River are endangered. *Photo: USFWS*

Adobe structures of the Taos Pueblo were built between 1000 and 1450 A.D. *Photo: Mark Nohl*

Soil erosion and high sediment loads are typical in the Rio Puerco basin. *Photo: USGS*

The endangered Mexican gray wolf has been reintroduced in parts of the Gila National Forest. The often controversial recovery effort has been opposed by some livestock ranchers. *Photo: USFWS*

Precambrian granite is exposed on the west face of the Sandia Mountains near Albuquerque. Pennsylvanian limestones cap the 10,678-foot crest and the gentler eastern slope. *Photo: Ken Schefflr, NRCS*

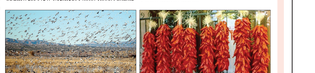
Pinyon pine, the state tree of New Mexico, is found mostly between 5000 and 8000 feet. Pine nuts have been a subsistence crop in the Southwest for more than 7000 years.

Once abundant, Gila trout are now listed as threatened. They are found in a few small headwater streams in Ecoregion 23, mostly in the Gila River basin. *Photo: USFWS*

Native populations of desert bighorn sheep have been drastically reduced from historical levels. Captive breeding and reintroduction programs for the subspecies have established some individuals in southwest New Mexico. *Photo: Robert Shantz*

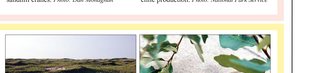
The state bird of New Mexico, roadrunners are well-adapted to desert environments. Their varied diet includes insects, spiders, lizards, snakes, fruits, and seeds. They often prefer to walk or run rather than fly. *Photo: Marcus Martin*

Bosque del Apache National Wildlife Refuge, south of Socorro, attracts one of the world's largest winter concentrations of sandhill cranes. *Photo: Dan Monaghan*



Chile pepper production occurs in several parts of the Chihuahuan Deserts ecoregion. New Mexico is the leading state in pungent chile production. *Photo: National Park Service*

Shin oaks in the Shinnery Sands ecoregion (25j) are seldom taller than two or three feet. They have a large underground stem and root system that helps stabilize the sandy soils.



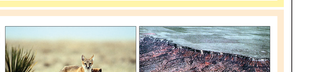
Sandslane lizards, a threatened species, are found in the Mescalero Sands of Ecoregion 25j. The decline of the lizard is a signal that the sand-shinnery oak ecosystem is being altered. *Photo: Don Sias*

Lesser prairie-chickens, a unique grouse of the High Plains, inhabit shinnery oak and sand sagebrush habitats. Their population has been greatly reduced due to rangeland alteration, drought, livestock grazing, and other land use practices. *Photo: Marcus Miller, NRCS*

Oil and gas production is common in the southern portion of Ecoregion 25 in New Mexico's Permian Basin. The state ranks 6th in in oil production and 2nd in gas production in the U.S. Increasing energy development can affect air, water, and habitat resources.

Swift foxes in New Mexico are found primarily in the shortgrass prairies of Ecoregions 25 and 26. They prefer areas of soil soils that support burrowing and foraging for large rodent populations. *Photo: NMDGF*

The flat terrain of the High Plains (25), upper right, contrasts with the Caprock Escarpment and more rugged topography of Ecoregion 26d south of the Canadian River. *Photo: R.D. Miller, USGS*



The classic cinder cone of Capulin Mountain, along with several other low volcanic peaks and lava flows, add to the geological and physical diversity of Ecoregion 26f. *Photo: R.D. Miller, USGS*

Once nearly extinct, pronghorn now occur in several parts of New Mexico. They are most abundant in the rolling, wide-open terrain of shortgrass or midgrass prairies, typical of many parts of Ecoregion 26. *Photo: Robert Shantz*

Snow cover can be deep in Ecoregions 21a and 21b near Wheeler Peak, the state's high point at 13,161 feet. The alpine and subalpine regions are important snow collection areas, providing water supplies to lower, more arid ecoregions. Average annual snowfall in the higher elevations is often over 100 inches and can exceed 300 inches in a few areas of New Mexico's Southern Rockies.

22. Arizona/New Mexico Plateau

The Arizona/New Mexico Plateau represents a large transitional region between the drier shrublands and wooded higher relief tablelands of the Colorado Plateaus (20) in the north, the lower, hotter, less vegetated Mojave Basin and Range (14) in the west, and the forested mountain ecoregions that border the region on the northeast (21) and south (23). Local relief in the region varies from a few feet on plains and mesa tops to well over 1000 feet along tableland side slopes. The Continental Divide splits the region, but is not a prominent topographic feature. The region extends across northern Arizona, northwestern New Mexico, and into Colorado in the San Luis Valley. Gunnison prairie dogs are a keystone species in many of the sagebrush ecosystems and their burrows provide habitat for other wildlife including burrowing owls, weasels, badgers, and a variety of snakes.

22a The **San Luis Shrublands and Hills** ecoregion, occurring mostly in Colorado, includes the higher relief foothill edges and low mountain areas within the San Luis Hills in Colorado, a series of low mountains, hills, and tilted mesas. It includes the San Luis Hills in Colorado, a series of low mountains, hills, and tilted mesas. The New Mexico portion includes the area northwest of the Taos Plateau Ecoregion (22f). Big sagebrush, rabbitbrush, and winterfat occur as well as grasslands of western wheatgrass, green needlegrass, blue grama, and needle-and-thread.

22b This region occurs primarily in Colorado, barely extending across the state line into New Mexico. Although precipitation in the **San Luis Alluvial Flats and Wetlands** ecoregion is low, water availability from mountain runoff, a high water table, and associated springs and wetlands have made cropland irrigation possible. The ecoregion was once dominated by shadscale, saltbush and greasewood, but most of the natural vegetation has been replaced by cropland. Cropland is common in the Colorado portion, with barley malt, potatoes, alfalfa, small grains, and hay, and smaller areas of vegetables such as spinach, head lettuce, and carrots. In the New Mexico portion, sagebrush is more common, with some irrigated areas for hay.

22f The **Taos Plateau** is a region of mostly Pliocene basaltic lavas with distinct cones of Pliocene composite volcanoes. This region has higher elevation volcanic cones than the San Luis Hills of 22a in Colorado; several cones are over 9000 feet and Ute Mountain is higher than 10,000 feet. The plateau surface has more sagebrush than Ecoregion 22a in Colorado. The plateau surface has only minor dissection, but the Rio Grande is confined to a deep canyon or gorge, 800 to 1000 feet deep in places. The ecoregion extends south to include the basalt-capped Black Mesa.

22g Once containing a perennially flowing, meandering, braided river, the **Rio Grande Floodplain** ecoregion has undergone many human alterations to its landscape and hydrology over the past 400 years. The once-shifting Rio Grande had mosaics of riparian woodlands and shrublands along with a variety of wetland meadows, ponds, and marshes. The gallery forest, or bosque, of cottonwood and willow with understories of coyote willow, New Mexico olive, false indigo, and seepwillow depended on this dynamic system. A long history of irrigation and drainage canals, levees and jetty jacks, and upstream dams have altered river flows and narrowed and straightened the stream channel. Conversion to cropland, and rural farm and ranch houses, and urban and suburban uses have also altered the region. Cottonwood and willow, dependent on spring flooding, have been widely replaced by invasive saltcedar and Russian olive.

22h The **North Central New Mexico Valleys and Mesas** is an area of mostly pinyon pine and juniper savanna, and mesa and valley topography similar to some parts of Ecoregion 22. Situated between portions of the Southern Rockies (21) to the east and west, and dominated by young geologic features of the Espanola rift basin and ancestral Rio Grande floodplain, ecological differences are apparent. It has a cooler climate with slightly greater precipitation, streams tend to have more water flow, and there is a different species mix of flora and fauna compared to 22b, 22g, or 22m. It differs from 22f in geology, topography, and vegetation; from 22i and 22m in elevation, climate, and vegetation. It has a mix of geology, mostly Tertiary sedimentary or Tertiary and Quaternary volcanic rocks.

22i The **San Juan/Chaco Tablelands and Mesas** ecoregion of plateaus, valleys, and canyons contains a mix of desert scrub, semi-desert shrub-steppe, and semi-desert grasslands. Shadscale, fourwing saltbush, mormon tea, Indian ricegrass, galleta, and blue and black gramas are typical. It is more arid, has generally lower elevations, and less pinyon-juniper than the Semiarid Tablelands (22j) to the south or Ecoregion 22n to the east. It is mostly composed of gently dipping Tertiary and Cretaceous sedimentary rocks. Oil and gas production occurs mostly in the northern part of the region. It contains the upper reaches of the Rio Puerco, an area of severe erosion due to geology, topography, and human influences.

Ruins of Puebloan dwellings along Chaco Wash constructed in 1100-1130 A.D. *Photo: USGS*
Below: Cretaceous shale in the De-Na-Zin Wash area of Ecoregion 22i. *Photo: Jim Ott*

Ship Rock, a classic volcanic neck with radiating dikes, is in the western portion of Ecoregion 22j. Known as *Tse Bit' a'i*, or the Rock with Wings, it is a sacred site to the Navajo people. *Photo: L.J. Maker*

The Rio Grande Gorge cuts through the uninterrupted basalt lava flows of the Taos Plateau (22f). Canyon walls provide habitat for eagles, osprey, hawks, owls, and falcons. *Photo: Measer Williams*

Urban land cover sprawls across the Rio Grande in Albuquerque. *Photo: Robert Grammer*

Pikeminnows in the San Juan River are endangered. *Photo: USFWS*

Adobe structures of the Taos Pueblo were built between 1000 and 1450 A.D. *Photo: Mark Nohl*

Soil erosion and high sediment loads are typical in the Rio Puerco basin. *Photo: USGS*

23. Arizona/New Mexico Mountains

The Arizona/New Mexico Mountains are distinguished from neighboring mountainous ecoregions by their lower elevations and associated vegetation indicative of drier, warmer environments, due in part to the region's more southerly location. Forests of spruce, fir, and Douglas-fir, common in the Southern Rockies (21) and the Wasatch and Uinta Mountains (19), are only found in limited areas at the highest elevations in this region. Chaparral is common at lower elevations in some areas, pinyon-juniper and oak woodlands are found at lower and middle elevations, and the higher elevations are generally covered by forests or grasslands, these mountains are the northern extent of some Mexican plant and animal species. Surrounded by deserts or grasslands, these mountains in New Mexico can be considered biogeographical islands.

23a The **Chihuahuan Desert Slopes** are found on the Guadalupe and Sacramento mountains. The lower slopes of these mountains represent a continuation of the Chihuahuan Desert ecosystem; soils and vegetation in much of Ecoregion 23a are similar to those in the Low Mountains and Bajadas (24c) of the Chihuahuan Deserts (24). The lower slopes were once mostly grasslands overgrazed in the late 19th century and subsequently invaded by desert shrubs. Yucca, sotol, lechuguilla, ocotillo, and cacti now dominate the rocky slopes below 5500 feet. Grasslands persist near alluvial fans and on gentle slopes with deeper, sandstone-derived soils. Water is scarce; the few streams that originate from springs at higher elevations do not persist beyond the mouths of major canyons.

23b The **Madrean Lower Montane Woodlands** ecoregion covers the slopes of the Guadalupe, Sacramento, Mimbres, Big Burro, and Mogollon mountains, generally between 5500 to 7200 feet, with densities of juniper, pinyon pine, and oak varying according to aspect. There are some similarities to Ecoregion 23c; however, Ecoregion 23b has milder winters, wetter summers, and inclusions of alligator juniper and Madrean evergreen oak species. At middle elevations, dense thickets of shrubs such as desert ceanothus, alderleaf mountain mahogany, and catclaw mimosa form chaparral communities. Other areas are grassy and park-like with scattered trees. A few small areas of ponderosa pine, Douglas-fir, or southwestern white pine occur at the highest elevations, outliers of Ecoregions 23c or 23f. In the west, the Gila River and tributaries have many endemic aquatic organisms including fish, amphibians, and insects.

23c The **Montane Conifer Forests** are found west of the Rio Grande at elevations from about 7000 to 9500 feet. Ponderosa pine and Gambel oak are common, along with mountain mahogany and serviceberry. Some Douglas-fir, southwestern white pine, and white fir occur in a few areas. Blue spruce may occasionally be found in cool, moist canyons. The influence of the Sierra Madre flora is seen mostly in the southern mountains and diminishes to the north. In the far south, other oaks appear, such as silverleaf oak, netleaf oak, Arizona white oak, and Emory oak. The summer rains are especially important for herbaceous plants. The region is geologically diverse with volcanic, sedimentary, and some intrusive and crystalline rocks. Endemic Gila trout occur in some of the region's streams. Livestock grazing, logging, and recreation are the primary land uses. Wildfire is an important feature influencing the forested ecosystems in this region.

23d The **Arizona/New Mexico Subalpine Forests** occur west of the Rio Grande at the higher elevations, generally above 9500 feet. The region includes parts of the Mogollon Mountains, Black Range, San Mateo Mountains, Magdalena Mountains, and Mount Taylor. The Madrean Lower Montane Woodlands (23b), foreground, contrast with the more rugged Mogollon Mountains of Ecoregions 23c and 23d. The Mogollon Mountains include peaks over 10,000 feet in elevation and form the core of the Gila Wilderness. Created in 1924 at the urging of conservationist Aldo Leopold, the Gila Wilderness was the world's first designated wilderness area. *Photo: April Sterling*

Chihuahuan Desert vegetation can range from areas of very sparse scrub and shrublands, to dense shrublands, desert grasslands, and at higher elevations, some woodland. These are dynamic systems, influenced by precipitation, soil erosion, fire frequency, and human land use. *Photo: Nathan Newcomer*

Playa lakes occur in many of the agricultural landscapes of the Llano Estacado (25i). Many playas have been affected by plowing, sedimentation, or use for irrigation. Protection of these shallow, seasonal wetlands is important for waterfowl habitat, recharge of the Ogallala Aquifer and, ultimately, the health of the High Plains economy. In some areas, about 85-90% of the aquifer's recharge is focused through the playa lakes. *Photo: NRCS*

24. Chihuahuan Deserts

This desert ecoregion extends from the Madrean Archipelago (79) in southeast Arizona to the Edwards Plateau (30) in south-central Texas. It is the northern portion of the southermost desert in North America that extends more than 500 miles south into Mexico. The physiography is generally a continuation of basin and range terrain that is typical of the Mojave Basin and Range (14) and the Central Basin and Range (13) ecoregions to the west and north, although the pattern of alternating mountains and valleys is not as pronounced as it is in Ecoregions 13 and 14. The mountain ranges (sky islands) are a geologic mix of Tertiary volcanic and intrusive granitic rocks, Paleozoic sedimentary layers, and some Precambrian granitic plutonic rocks. Outside the major river drainages, such as the Rio Grande and Pecos River, the landscape is largely internally drained. Vegetative cover is predominantly desert grassland and arid shrubland, except for high elevation islands of oak, juniper, and pinyon pine woodland. The extent of desert shrubland is increasing across lowlands and mountain foothills due to gradual desertification caused in part by historical grazing pressure.

24a The **Chihuahuan Basins and Playas** include alluvial fans, internally drained basins, and river valleys mostly below 4500 feet. The major Chihuahuan basins formed during Tertiary Basin and Range tectonism when the Earth's crust stretched and fault collapse resulted in sediment-filled basins. These low elevation areas are some of the hottest and most arid habitats in the state. The playas and basin floors have saline or alkaline soils and areas of salt flats, dunes, and windblown sand. The typical desert shrubs and grasses, the dominant creosotebush, along with tarbush, fourwing saltbush, acacias, gyp gr