CHAPTER 3:
AFFECTED ENVIRONMENT

INTRODUCTION

This chapter describes the existing environment of Guadalupe Mountains National Park. The focus is on the park resources, visitor uses and experiences, socioeconomic environment, and park operations and facilities that could be affected by implementation of the alternatives. These topics were selected based on federal laws and regulations, executive orders, NPS expertise, and concerns expressed by other agencies or members of the public during scoping for this management plan. The conditions described in this chapter establish the baseline for the evaluation of environmental consequences that is provided in Chapter 4.

The Council on Environmental Quality (1978) guidelines for implementing the National Environmental Policy Act require that the description of the affected environment must focus on describing the resources that might be affected by implementation of the alternatives. To enhance reader understanding, the first section in this chapter gives a broad overview of the park and its regional context. The following sections provide more detailed descriptions of the existing conditions of the park resources that could be affected by implementing one or more of the alternatives that were described in Chapter 2.

Western escarpment

THE PARK AND ITS REGIONAL CONTEXT

Guadalupe Mountains National Park is in a remote, sparsely populated area of the southwestern United States. The park is in Culberson and Hudspeth Counties in west Texas, adjacent to the New Mexico state line.

The closest metropolitan areas are El Paso, Texas (population about 560,000), which is about 110 miles to the west, and Carlsbad, New Mexico (population about 25,000), which is about 55 miles northeast of the park. The nearest towns include the following:

- Queen, New Mexico, which is so small that it is not recognized by the U.S. Census Bureau, is 16 miles north of the park's Dog Canyon area.
- Dell City, Texas, is a small community of about 400 people serving an irrigated agricultural area about 20 miles west of the park boundary.
- Whites City, New Mexico, (population about 50) is 38 miles east of the park.
- Van Horn, Texas, the Culberson County seat with a population of about 2,000, primarily provides ranching and tourist services. It is approximately 60 miles south of the park

Administrative services are shared with Carlsbad Caverns National Park through an office in the city of Carlsbad, New Mexico.

Guadalupe Mountains National Park contains 86,416 acres. Most of the surrounding land is privately owned, although some land to the northwest, north, and northeast is owned by the U.S. government and managed by the U.S. Forest Service or Bureau of Land Management.

In the Dell City area, good underground aquifers allow farmers to irrigate several thousand acres and grow crops such as chilies and alfalfa. Elsewhere, the primary land use on private land outside the park is grazing. Because of the arid environment, extensive land areas are needed for grazing. As a result, ranches are large and ranch houses are widely spaced.

The Guadalupe Mountains are internationally significant because of their outstanding geologic, scientific, and scenic resources. Spectacular scenery is a major attraction for visitors. The Guadalupe escarpment rises steeply from the desert floor and is a major landmark along U.S. Highway 62/180. El Capitan, with its sheer, thousand-foot-high cliffs, is especially impressive. Guadalupe Peak, just north of El Capitan, is the highest point in Texas (8,749 feet). There are outstanding scenic vistas from Guadalupe Peak, Hunter Peak, and other locations in the remote high country.

The park contains important cultural resources, representing periods of human use by prehistoric peoples through the 19th century settlement and ranching operations. Several sites in the park are listed in or eligible for listing in the National Register of Historic Places.

Commercial airline services are available at El Paso and Carlsbad. Highway access to the park includes the following:

- Primary access is by U.S. Highway 62/180, which runs from El Paso to Carlsbad. This highway is a high-standard, two-lane road. About 4 miles of this highway are within the park boundary near Pine Springs.
- A paved road, New Mexico Highway 137, provides access to Dog Canyon from Queen, New Mexico to the north.

- The west side of the park can be accessed via Farm-to-Market Road 1576 from Dell City. A dirt road provides access to the Salt Basin Dunes area of the park.

Historically, a road crossed the southwest corner of the park from the William's Ranch to the old road to Dell City (the Gin Road). This 10-mile-long dirt road was only 8 to 10 feet wide and had an elevation gain of more than 1,370 feet. This road has not been used since the 1970s and is no longer passable by vehicles, with many deep arroyos cutting through the old roadbed. At one time, Hudspeth County constructed a bladed dirt road across private land from the west to connect to the western park boundary near this old road. It also has not been maintained and remains an old road scar on the landscape.

Power and telephone lines, high-pressure gas lines, and a transcontinental fiber-optic telephone cable generally parallel U.S. Highway 62/180 on the east and south sides of the park. To the west, power and telephone lines generally are outside the park, but traverse its southwest corner.

There is active oil and gas exploration on Bureau of Land Management and state of New Mexico lands northwest of the park, and on private lands in Texas to the south and southeast. Sulfur mining is occurring about 40 miles southeast of the park in Culberson County, Texas. Potash mines in the Carlsbad, New Mexico, area are still active, but production has declined in recent years. A small gypsum mine is less than 0.5 miles west of the park boundary near Dell City. A wind farm generates electricity in the Delaware Mountains several miles south of the park.

Outside the park, visitor facilities primarily are limited to rest stops with picnic tables at scenic locations. Except in Whites City, there is only one gasoline station between El Paso and Carlsbad. Whites City has a food store, fuel, restaurants, lodging, and camping. Non-local visitors to Guadalupe Mountains National Park who do not camp in the park obtain lodging at El Paso or Carlsbad, or, to a limited extent, Whites City, Van Horn, and Dell City.

Carlsbad Caverns National Park, a nationally known destination for travelers, is about 40 miles northeast of Guadalupe Mountains National Park. Other national park units in the region that are shown in the Guadalupe Mountains National Park Region map in the beginning of Chapter 1 include White Sands National Monument, Fort Davis National Historic Site, and Big Bend National Park.

CLIMATE

Although the park's Chihuahuan Desert location shapes the local climate, other influences are apparent:

- The northern portions of the park in Dog Canyon are cooler and moister, reflecting a climate more like the Great Basin.
- Eastern portions of the park have Great Plains connections.
- The higher elevations can be classified as an isolated extension of the Rocky Mountains.

Precipitation

Average annual precipitation is

- 17.72 inches in the high country, in the Bowl at 8,112 feet in elevation
- 17.40 inches on the east side of the park at Pine Springs at 5,440 feet in elevation
- 9.10 inches on the west side of the park at 3,867 feet in elevation

Winter fronts and summer convectional storms are primary sources of precipitation in the Guadalupe Mountains region. The higher elevations of the park tend to receive more winter precipitation, and the lower elevations receive more in the summer. Win-

ter fronts come from the west. Precipitation is generally gentle, widespread, and often of long duration. Winter storms usually begin around the end of October, and precipitation often falls as snow, with the relative amounts increasing both with elevation and latitude.

Summer storms, in late afternoon or evening rainfall, are fast moving, of short duration, and accompanied by high winds, thunder, and lightning. Rainfall from these cells is generally localized and heavy once the pattern sets up, with the initial development often bringing only dry lightning with virga (rainfall that evaporates before reaching the ground). Heavy downpours over sparsely vegetated desert uplands often cause flash flooding in downgradient canyons. These storms usually begin early in July, and the pattern persists until the end of September, when the interior of the southwest begins to cool down. The lightning associated with summer thunderstorms is the primary cause of natural fires that occur in the park.

Temperatures

The average daily maximum for the warmest month (June) in the Pine Springs area at the eastern base of the mountain (5,500 feet above mean sea level) is about 88 degrees Fahrenheit, and temperatures above 90 degrees Fahrenheit are common. The average monthly temperature at Pine Springs for the coldest month (January) is 42 degrees Fahrenheit, and lows in the 20s are common. On average, the high country at an elevation greater than 8,000 feet above mean sea level is about 10 degrees Fahrenheit cooler than the Pine Springs area, and the western side of the park, at an elevation of about 3,600 feet above mean sea level, is about 10 degrees warmer.

Winds

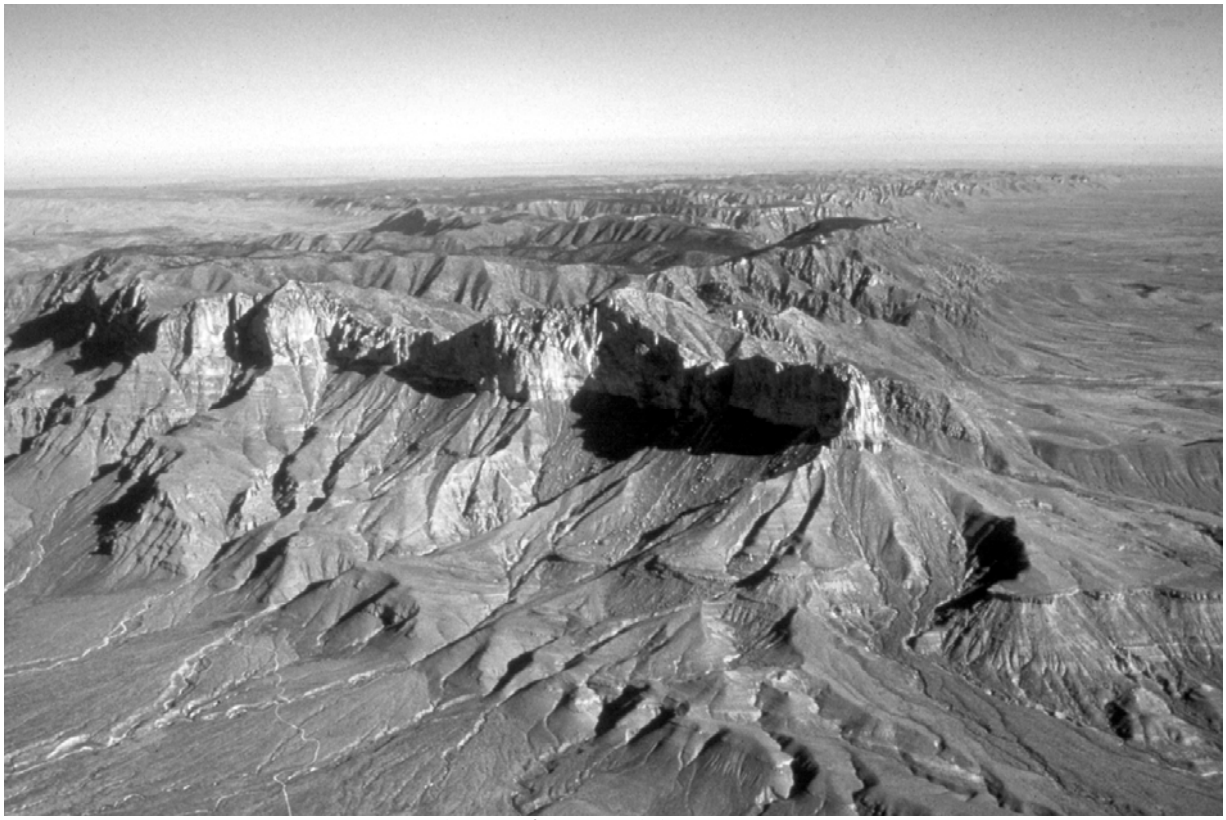
The Guadalupe Mountains, and especially Guadalupe Pass, are noted for high winds. The prevailing air movement is from the west and southwest. Local topography channels the wind into southwest-northeast directions, with southwest being the predominant direction. Strong winds often exceed 60 to 80 miles per hour, and can occur in excess of 100 miles per hour with the passage of cold fronts throughout the seasons from winter to early summer.

Topographic heating and cooling creates daytime upslope flow and nighttime downslope flow of air. By themselves, the thermal-related winds would not reach destructive velocities, but they may add 10 or 20 miles per hour to the velocity of wind from another source. This compounding effect makes the Guadalupes one of the windiest places in the nation.

PHYSIOGRAPHY

Physiographically, the Guadalupe Mountains are characterized as part of the Sacramento Section of the Basin and Range Province (Fenneman 1931).

The lower elevations of Guadalupe Mountains National Park consist of mostly sparsely vegetated Chihuahuan Desert and rolling foothills. Within this setting, the uplifted Permian reef forms a huge, V-shaped escarpment. The uplift creates a “sky island” in the midst of the desert, in which rests the Bowl, an area of relict forests that provide mostly mixed conifer habitat.



Aerial view of the Guadalupe Mountains

El Capitan, on the southern end of the escarpment, is a prominent park landmark that is visible for more than 90 miles. The impressive escarpment extends northwest from El Capitan and contains other distinctive peaks, including the 8,749-foot-high Guadalupe Peak, the highest point in Texas. The next three highest peaks in Texas, all of which exceed 8,000 feet above sea level, also are in the park. The base of the western escarpment is 3,650 feet in elevation, some 5,100 feet lower than Guadalupe Peak.

The uplift of the Guadalupe Mountains probably occurred in Miocene times, resulting in a fault-block mountain mass that tilts slightly to the northeast and has as its westerly margin the sheer fault-scarp. Principal drainage of the mountain mass has been to the east, and has created deeply incised canyons where relict biota survive. To the west, the sheer, slightly dissected fault scarp forms the eastern boundary of a bolson, or valley having no outlet. The internal runoff from this area collects in a great, shallow, evaporation basin known as the Salt Flats.

The high country's major scenic and scientific features are not visible from the desert floor. The high country's features include the following:

- A distinctive area of relict forest includes ponderosa pine, southwestern white pine, Douglas-fir, and a small grove of aspen.
- The Bowl, which is in the center of the 45,000-acre high country forest, provides mixed-conifer habitat.
- McKittrick Canyon extends out of the high country and through the eastern escarpment. Its south arm possesses special scenic appeal and scientific importance because of its unique geology and biotic communities.

HYDROLOGY

Most of the water sources of the Guadalupe Mountains originate in the upper mountainous regions and appear as springs and seeps at the base of the escarpment. Springs and tributaries between mountain peaks and ridges are few.

Cuts created through the rock layers by flowing water allow ground waters to drain into the canyons. Depending on rainfall, there can be numerous springs and seeps. However, most streams are intermittent because of the permeability of the strata. Only nine permanent springs have been identified within Guadalupe Mountains National Park.

The park includes two perennial streams: Choza and McKittrick. Choza is a spring-fed stream that runs along the surface for 1 to 1.5 miles. McKittrick Creek is a unique aquatic ecosystem. It is a small, discontinuous, spring-fed stream that runs for 7.7 miles in McKittrick Canyon. The principal direction of flow is easterly, cutting through the Permian limestone of the Guadalupe escarpment where the surface flow ends. Travertine deposits seal the bed and keep flow on the surface for much of the length of the canyon.

ZOOGEOGRAPHY

Biologically, the Guadalupe Mountains are an "island" in the Chihuahuan Desert. In a sense, the Guadalupe range is a connecting link between the Rocky Mountains, the Chihuahuan Desert of Mexico, the grasslands of the Great Plains, and the deciduous woodlands of the east. Dozens of plants and animals from all of these diverse habitats mingle here, many at the geographic limits of their range, isolated from other populations of their species by an expanse of desert.

The Guadalupe Mountains environment resulted from a gradual climatologic shift from a cool, moist climate during the late Pleistocene toward drier and warmer conditions. The highest portion of the Guadalupe Mountains range in the park provides a last refuge for many of the park's relict species of plants and animals.

The geologic events that resulted in the uplift of the ancient reef formation created a series of distinct climate zones and associated ecological communities that extend from the basin floor to the mountaintops. Climates at the lowest elevations are similar to those of northern Mexico, with cactuses and drought-resistant shrubs. At the highest elevations, the climate is similar to that in southern Canada, with areas that exhibit decidedly alpine characteristics. This wide range of environments has resulted in a wide diversity of plant and animal life.

In many Guadalupe Mountain communities, the plant overstory plays a critical role in shielding the surface microhabitats from the sun's heat and retaining soil moisture and humidity. In particular, important overstory layers are found in the bottoms of the deeply incised drainages in the eastern parts of the park, including McKittrick, Pine Springs, and Dog Canyons.

NATURAL RESOURCES

OVERVIEW

Natural resources of the park were identified in a geographical information system and were compiled to create the Natural Resource Distribution Analysis map. The park's soils, plant communities and vegetation, wildlife, geologic resources, and paleontological resources are likely to be influenced by actions by park managers and visitors. The current condition of each of these resources is described in this section.

SOILS

Soils differ considerably as a function of elevation and aspect in the Guadalupe Mountains. In general, soils are very thin to absent, calcareous, and of poor quality. The shallow soils tend to be held in place by rock cover, which also defends against erosion and keeps moisture from escaping. All soils in the park are highly susceptible to loss by wind and water erosion after they have been disturbed or exposed.

As elevation increases, more leaching of calcium carbonate is evident. Soils at higher elevations also become more clay based, exhibit evidence of clay translocation, contain more organic carbon, and become drier.

Flooding is regular in canyons, with deposition and cutting occurring as normal events. The many deep, dry arroyos reflect the significance of floods.

Thicker soils in the Salt Basin are highly alkaline (gypsiferous), and can support only a few, highly adapted plants. Cryptobiotic soils are common in the alkaline environment where gypsum sand dunes have become stabilized.

Cryptobiotic soils are living soil crusts that are dominated by cyanobacteria (formerly called blue-green algae), but that also include lichens, mosses, green algae, microfungi, and bacteria. These crusts play an important role in natural ecosystems. These bacteria also are important because of their ability to convert atmospheric nitrogen to a form that plants can use, and their capacity to intercept and store water. Both characteristics are especially important in desert ecosystems (like the Guadalupe region) where nitrogen levels are low and water is scarce.

Many human activities are incompatible with the presence and well-being of cryptobiotic soils. The "fibers" that give the crusts their strength are crushed by footprints or machinery. Vehicle or bicycle tracks are especially damaging, creating areas that are vulnerable to wind and water erosion, and rainfall carries away loose material, often creating channels along these tracks. Wind also blows pieces of the pulverized crust away, transporting the underlying loose soil, and often covering the nearby crusts. Burial can mean death because crustal organisms need light to photosynthesize. When crusts overlying large sandy areas are physically disturbed during dry periods, previously stable areas can become a series of shifting sand dunes in just a few years. Under ideal circumstances, a thin veneer of cryptobiotic soils may return in five to seven years, but in some disturbed areas, damage to the sheath material and the accompanying loss of soil nutrients result in a recovery period of 50 years or more.

PLANT COMMUNITIES AND VEGETATION

The park is in a vegetative transition zone where east meets west, and some plants found in the Rocky Mountains are at their

southernmost geographic limits. The mountains form a biological "island" that is surrounded by the northern Chihuahuan Desert and provides diverse plant communities. More than 1,000 species of plants have been recorded in the park, including 37 plant species of special concern. Of these, 16 are endemic to the Guadalupe Mountains.

Depending on the elevation and exposure, vegetation types in Guadalupe Mountains National Park include desertscrub, grasslands, chaparral, woodlands, and coniferous forest. Striking desert succulents, canyon fall color, and high-country conifers are all part of the park's appeal. The fall displays of western hophornbeam and bigtooth maple are particularly attractive. The only known Texas populations of this species of hophornbeam are common in park riparian woodland areas above 6,000 feet, with some also occurring at somewhat lower elevations in McKittrick Canyon.

Endemic plants are a special feature of Guadalupe Mountains National Park. Unique taxa occur in nooks on limestone cliffs and ledges, in high-elevation forested canyon bottoms, and along streams at lower elevation (Northington and Burgess 1979). The McKittrick pennyroyal, Guadalupe Mountain violet, McKittrick snowberry, and Guadalupe rabbitbrush, are examples of plants found nowhere else but the Guadalupes, as indicated by their names.

Within the park, seven vegetation types have been identified that correspond with the Brown-Lowe-Pase biomes as described for the biotic communities of the Southwest (Brown 1994). These include:

- Rocky Mountain (Petran) conifer forest
- Great Basin conifer woodland
- Madrean evergreen woodland
- interior chaparral
- [Chihuahuan] semidesert grassland
- Chihuahuan Desertscrub
- interior riparian / deciduous forest

In addition, a distinctive assemblage of plants has developed on and around the gypsum dunes.

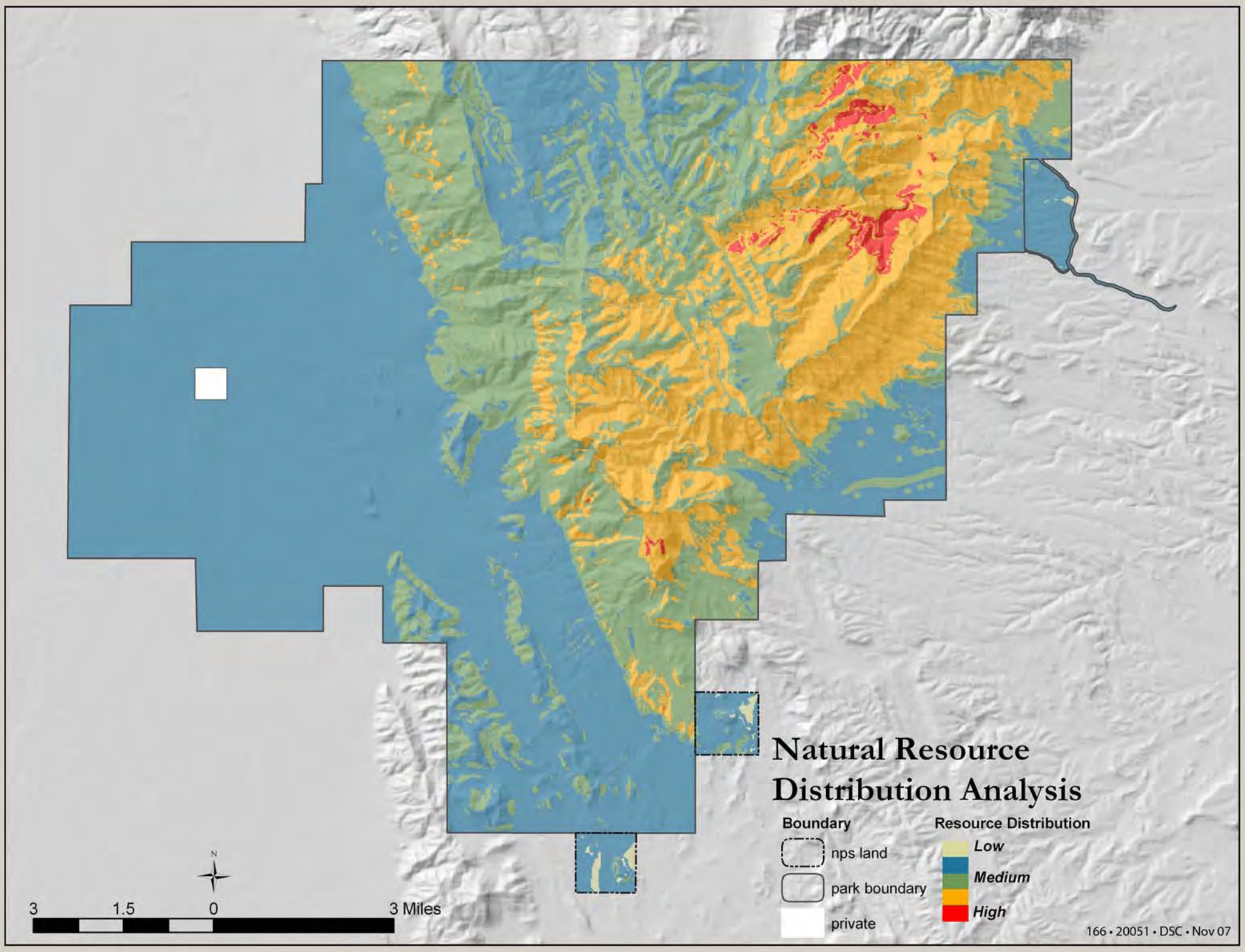
The characteristics of the major biotic communities in the park are summarized below. The Vegetation Types map illustrates the distribution of these plant communities within and outside the park boundaries.

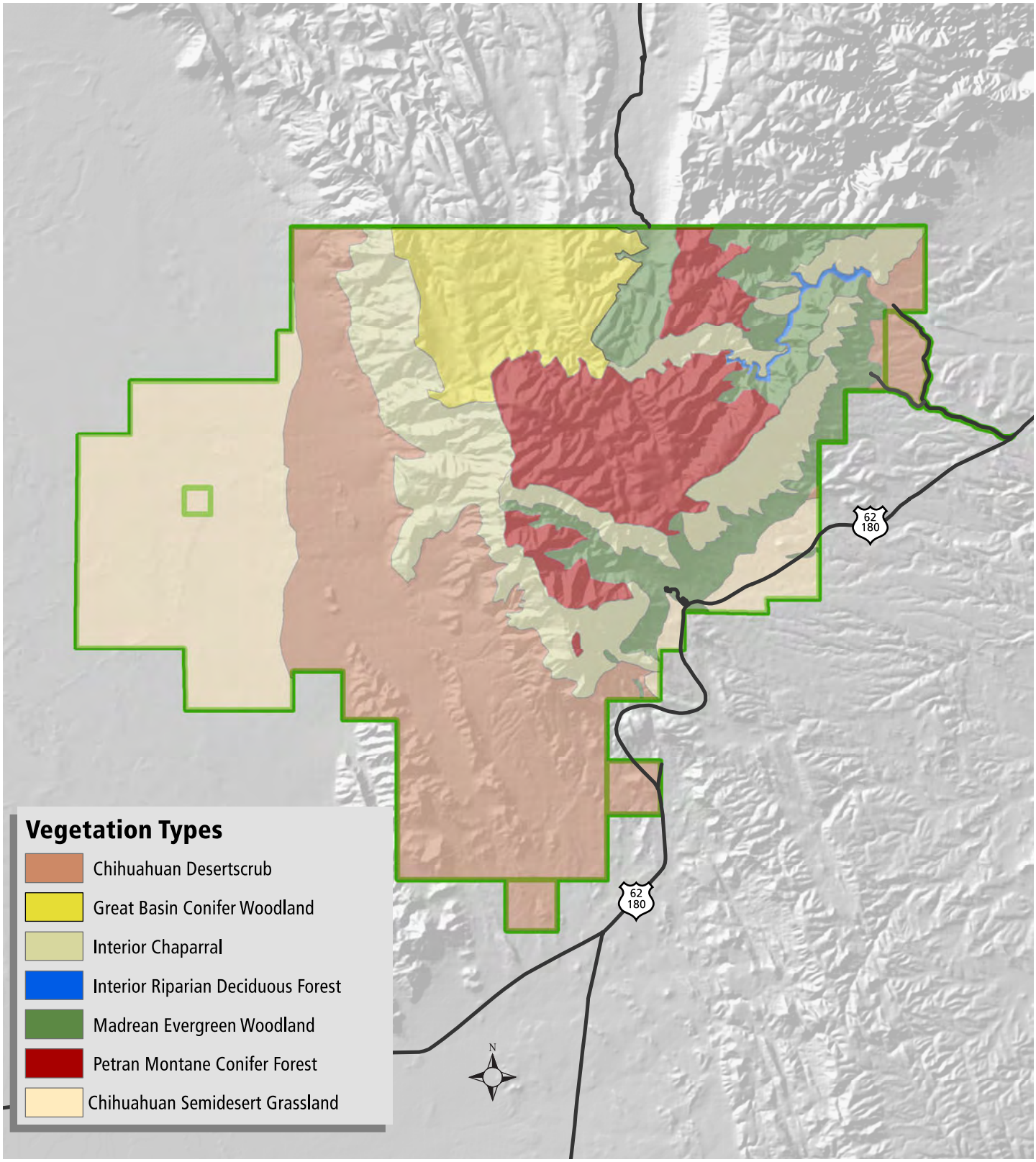
Rocky Mountain (Petran) Conifer Forest

The high country of the park, from 7,000 feet to 8,749 feet in elevation, contains a Rocky Mountain coniferous forest, which is some of the southernmost extent of this Rocky-Mountain-derived forest in the Chihuahuan Desert region in the United States. The closest occurrence of this vegetation type is about 70 miles to the northwest in the Sacramento Mountains. Douglas-fir, southwestern white pine, and ponderosa pine are dominant trees. The larger trees include firs with diameters of nearly 40 inches and ponderosa pines up to 32 inches in diameter. The only broadleaf deciduous trees of significance are Gambel oak (including one individual 32 inches in diameter, an unusually large size) and southwestern chokecherry (10 inches in diameter). A relict, isolated stand of quaking aspen persists in this zone.

Southwestern white pine and Douglas-fir dominate north-facing slopes with ponderosa pine and pinyon included in the mix. The drier, south-facing slopes support a ponderosa pine forest mixed with pinyon pines and alligator juniper.

Botanically, the inventory of trees, shrubs, flowering plants, and grasses is quite impressive and includes plants known nowhere outside the park. Many of the park endemics, such as the McKittrick pennyroyal, once listed as a threatened species, are found in limestone outcrops in the high country. The microflora and lower plants, such as ferns and mosses, have received little systematic study.


Natural Resource Distribution Analysis
Boundary
nps land
park boundary
private
Resource Distribution
Low
Medium
High
N
3
1.5
0
3 Miles
166 • 20051 • DSC • Nov 07



0 1 2 4 6 8 Miles

Vegetation Types

Guadalupe Mountains National Park

United States Department of the Interior / National Park Service

166 20 • 049 • IMRO GRP • November 2007

The high country gradually descends toward the northwest and includes the rugged topography of Lost Peak, Upper Dog and West Dog Canyons, and PX Flat. In these areas, the vegetation composition changes to a pinyon -juniper forest woodland.

The Bowl contains a relict pocket of true coniferous forest and is a popular hiking destination where visitors can experience this forested sky island in the Chihuahuan Desert. The topography of the area suggests the name, the Bowl, and provides outstanding habitat for species such as elk, mountain lion, black bear, wild turkey, and Montezuma quail. In the Bowl, desert plants such as agaves can be seen beside towering Douglas-fir and pines. In late summer, fields of nodding onion and other wildflowers such as Indian paintbrush and wallflowers bloom under the forest canopy.

Great Basin Conifer Woodland

Great Basin conifer woodlands, also known as pinyon-juniper woodlands, can be found in the northern canyons of the park and on dry or west-facing slopes, commonly between 5,000 feet and 7,000 feet elevation. Overstory constituents include pinyon pine, one-seed juniper, alligator juniper, Rocky Mountain juniper, and grey oak. Pinyon-juniper woodlands occupy areas characterized by intense sunlight, hot summers, relatively low precipitation, and high evapotranspiration. This woodland shifts between being woodier or grassier, depending on aspect, moisture conditions, grazing, fire frequency, and competition. Along their lower margins, pinyon-juniper woodlands mix with mountain grasslands and shrublands. At the upper limits, they can reach the forests of ponderosa pine.

Madrean Evergreen Woodland

Oaks dominate this woodland type that is found scattered throughout the park, mostly on shady canyon slopes. Beautiful Texas madrone trees are found in this vegetative type and add to the park's charm, along with New Mexico agave, alligator juniper, sumacs, and penstemons.

Interior Chaparral

The drier, south-facing slopes of the park's many deep canyons are covered with species such as mountain mahogany, ceanothus, sotols, sandpaper bush, and other shrubs that make up the interior chaparral community. This dense vegetation is important habitat for wildlife and for watershed protection.

Chihuahuan Semidesert Grassland

The Chihuahuan Desert once encompassed extensive grasslands, but only small remnants remain today. Stands of black grama, blue grama, muhlenbergias, and stipas (needlegrass) are still present in the park. With the cessation of livestock grazing, these grasslands are recovering and expanding. When moisture conditions are right, these grasslands can explode with color from the blooms of coneflowers, globe mallow, evening primroses, phlox, and other species.

Chihuahuan Desertscrub

Chihuahuan Desertscrub or shrub occupies the lowlands of the park. Stands of widely spaced, small-leaved shrubs are scattered across bajadas, flats, and dunes. Dominant shrubs such as catclaw acacia, allthorn, ratany, apache plume, and littleleaf sumac have tiny leaves to conserve water (microphyllous), grow slowly, and are widely spaced on flats and gravelly hills at the base of the south- and east-facing slopes and the west escarpment. Common succulent species that can withstand desert conditions include lechuguilla, New Mexico agave, torrey yucca, ocotillo, and several species of prickly pear, cholla, hedgehog, and pincushion cactus.

Areas of Chihuahuan Desertscrub may have been grassier before grazing. Today, many are dominated by creosote bush, which is the most characteristic plant of North America's hot deserts. It competes aggressively with other plants for water, and usually wins, accounting for its prevalence in many arid locations of the southwest.

Interior Riparian / Deciduous Forest

Deciduous trees grow primarily at springs and in streambeds at low elevations but become the dominant growth form on stream terraces and in the canyon heads above about 4,921 feet (1,500 m). Deciduous trees dominate north-facing slopes at this elevation and are joined by conifers on drier sites. Little walnut and velvet ash occur at the mouths of canyons, but as the stream elevation increases, western hophornbeam, bigtooth maple, and chinkapin oak come into the mix, especially on stream terraces, around springs, and in canyon heads.

McKittrick Canyon is the key representative of the hardwood / riparian forest and woodland in the park. The canyon is a popular attraction during autumn when the maples, oaks, and other deciduous trees bring vibrant colors to the canyon. Texas madrones are common in the canyon bottom. Penstemons, orchids, and columbines, along with ferns, sawgrass, and sedges, can be found in the canyon floor, as well as cacti, century plants, sotols, and towering yuccas. Species of interest include the possibly extirpated Guadalupe fescue and the Chapline's columbine.

Gypsum Dunes Flora

The gypsum dunes are found within the Chihuahuan semidesert grassland. The dunes' shifting sands and arid climate give rise to an ecologically unique area. Unusual botanical assemblages and hardy wildlife species endure the harsh conditions. These biological communities of the white sand dunes are an important and rare part of Texas' natural heritage.

Plants that survive on the dunes are adapted to strenuous conditions, such as high soil salinities, a mobile substrate, and large temperature fluctuations. Several unusual botanical species and communities are found on and around the dunes. About 40 plant species occur in association with the dune fields, and about 15 of these species are found in the heart of the dunes. Many of these plants are endemic. Among the most significant are the sand bluestem, broom pea, rosemary mint, soaptree yucca, and gyp grama. Rare species include Indian rice grass, gyp moonpod, shy mentzelia, and the pink plains penstemon. Botanical diversity increases where the dune fields meet the surrounding grasslands and the less-saline quartzose sand areas. Falsebuffalograss and sixweeks grama are among the roughly 30 species that occupy these transitional zones. Gypsum scalebroom is an endemic species of interest and concern.

WILDLIFE

From the Chihuahuan Desert to the conifer forest, the Guadalupe Mountains' diverse ecosystems are home to more than 60 species of mammals (Cornely 1991), 303 species of birds (including 94 breeding birds) (Newman 1997), and 55 species of reptiles and amphibians (Grace 1980 revised by Wauer 1991). The park represents a transition or overlap zone with species of birds, mammals, and reptiles present but separated from their normal range.

The park's springs and streams, including Upper Pine, Frijole, Smith, Manzanita, Choza, Guadalupe, and Bone Springs and McKittrick Creek, are important wildlife sustaining and viewing areas. In addition, the numerous intermittent springs and seeps in the park are essential for supporting wildlife.

Reliable water in these places and in McKittrick Canyon attracts mule deer, mountain lion, bobcat, ringtail, gray fox, and black bear.

Mammals

Some mammals, such as bobcat, mountain lion, coyote, and black bear, are reclusive, while mule deer are very common and obvious. Besides deer, people most often see cottontail, jackrabbit, and rock squirrel. Occasionally a gray fox or javelina (peccary) can be seen. The native Merriam's elk was extirpated around the turn of the 19th century. A herd of Rocky Mountain elk was reintroduced in the 1940s and 1950s and is currently estimated to include about 30 animals. Also present is the shy ringtail cat, a relative to the raccoon. At night, hognose skunks and bats can be seen.

Some mammals that once were present in the park are gone (extirpated). Most notably these include the pronghorn, black-tailed prairie dog, and bighorn sheep, all of which are found in suitable habitat southwest of the park. Exotics that are not native to the park, such as the aoudad, have been introduced and are present today.

At night, both large and small mammals venture onto the Salt Basin Dunes to search for food. The desert plants support a large population of kangaroo rats and pocket mice. Desert cottontails and black-tailed jackrabbits are common vertebrates. Foxes, coyotes, and snakes emerge from their dens to feed on these rodents. It is rare to see these animals, but the multitude of tracks traversing the dunes during the day reveal the struggle for survival that occurs at night.

Species of interest and special concern include the Guadalupe southern pocket gopher and Mogollon vole. Numerous bats, some rare, frequent the area, with some ranging from Carlsbad Caverns more than 30 miles away to feed in the park.

Birds

More than 300 species use the park, including 94 species that are known to breed in the park. The highest activity is early in the morning, just before sunrise. Good spots for bird watching are along the Devils Hall and Smith Springs Trails, at Frijole Ranch, and in Guadalupe and McKittrick Canyons.

- The most often observed birds of prey are hawks, but eagles, owls, and falcons can also be seen.
- The desert lowlands are home to the verdin, roadrunner, cactus wren, and several species of sparrows, to name a few.

American kestrel

- Bird species commonly seen at moderate elevations in the park include the canyon towhee, rufous-crowned sparrow, juniper titmouse, western scrub jay, and scaled quail. In summer, Scott's oriole, Say's phoebe, white-throated swift, and turkey vulture are common.
- The high country forests of Douglas-fir and southwestern white and ponderosa pine provide habitat for birds such as the mountain chickadee, Steller's jay, red-breasted nuthatch, pygmy nuthatch, red crossbill, and hairy woodpecker.

- Birdwatchers who come to the park hope to see rare magnificent and blue-throated hummingbirds and Montezuma quail.

The park is home to one threatened and endangered species, the Mexican spotted owl, and several species of concern, including the peregrine falcons, yellow-billed cuckoo, and burrowing owl. Guadalupe Mountains National Park has been identified as an Important Bird Area by Partners-In-Flight.

Reptiles and Amphibians

The park is home to nine species of amphibians and 45 species of reptiles. Several kinds of lizards are commonly seen along trails and on rocks, including collared lizards, Chihuahuan spotted whiptails, prairie lizards, skinks, and Texas horned lizards. Snakes are also common in the Guadalupes, including five species of rattlesnakes; the western diamondback and black-tailed rattlesnake are the most abundant. These snakes prey on small rodents and lizards and are important members of the natural community. Other reptiles in the park include mud and box turtles.

Several reptile species inhabit the Salt Basin Dunes area, including side-blotched lizards, long-nosed leopard lizards, western whiptail lizards, western diamondback rattlesnakes, and prairie rattlesnakes. The site's rarest animal resident is a white variety of the lesser earless lizard. This species is known to occur at only one other site in the world, the dunes of White Sands National Monument.

The Rio Grande leopard frog, western box turtle, Texas banded gecko, crevice spiny lizard, roundtail horned lizard, mountain shorthorned lizard, Trans-Pecos rat snake, gray-banded kingsnake, western hooknose snake, and rock rattlesnake are amphibians and reptiles of particular interest. Possible species of interest that are suspected to be present but have not been documented include the barking frog, smooth green snake, and desert massasauga (Grace 1980 revised by Wauer 1991).

Invertebrates

Many spiders are found in the park, including the large but harmless tarantula. Millipedes and centipedes are most commonly observed in the desert areas, together with several kinds of scorpions.

Grasshoppers are among the most conspicuous insects, and a dozen species may be found, including lubber grasshoppers. They often are fed on by the praying mantis. Ants, wasps, and bees are also part of the ecosystem.

In the higher elevations at certain times of the year, masses of ladybugs can be seen as they migrate. Beetles are abundant and often colorful. The Texas minute moss beetle and Guadalupe Mountains tiger beetle are species of special interest and concern.

Many butterflies fill the air in the canyons, often including yellow tiger swallowtails. A survey of butterflies and moths inventoried more than 1,250 species in the park, and at least 90 taxa of aquatic invertebrates have been found in McKittrick Canyon.

The wildlife of the Salt Basin Dunes is composed primarily of invertebrate species that are able to survive the desert conditions of the dune fields. Sand-treader camel crickets are common, along with various species of ants, flies, and beetles.

Light infestations of Douglas-fir beetle, budworm, and western pine beetle are present in the park, especially at higher elevations, where populations cyclically wax and wane.

GEOLOGIC RESOURCES

General

The Guadalupe Mountains are one of the finest examples of an ancient fossil reef on Earth. Geologists from around the world come to the park to study this extraordinary natural phenomenon.

Between 260 and 290 million years ago, during the Permian Period of geologic time, a large, tropical sea containing various life forms covered portions of Texas and New Mexico. Over millions of years, calcareous sponges, algae, and other lime-secreting organisms combined with vast quantities of lime precipitated directly from seawater to form the 400-mile long, horseshoe-shaped Capitan Reef. Eventually the sea evaporated, and a thick blanket of sediments and mineral salts filled the basin and buried the reef. The reef was entombed for hundreds of millions of years until about 20 to 30 million years ago, when uplift from major regional faulting exposed a part of the fossil reef and formed the Guadalupe Mountains.

Major outcrops of reef deposits occur in McKittrick Canyon and the classic geologic exposures along the western escarpment. The extensive exposures of the Permian reef are considered by geologists and paleontologists throughout the world as an outdoor laboratory of unique importance for investigating scientific principles; tracing the history of the earth; and understanding the origins of certain valuable mineral resources

Geologic Time

The geologic time scale is broken into several intervals, the name for each generally describing the types of fossils found in rocks deposited during that time interval. The longest time intervals are divided into eons.

The earliest or oldest eon on Earth is called the Hadean Eon, suggesting conditions during the fiery formation of the primordial Earth as being too hot for life to be possible.

The next oldest interval is the Archean Eon, meaning "beginning" which suggests that life first became possible during that time.

The next, younger division is known as the Proterozoic Eon. This name is a combination of two Greek words – protero, meaning "former" and zoe, meaning "life," referring to the simple and primitive condition of organisms that lived during that time.

The latest, or youngest eon in geologic time is the Phanerozoic Eon. Phanerozoic means "abundant life."

These long eons can be broken into smaller parts called eras. For instance, the Phanerozoic is divided into the Paleozoic Era (old life), Mesozoic Era (middle life), and Cenozoic Era (familiar life). These are based on the idea that the farther back in time one looks, the less familiar life forms will be. For instance, the Cenozoic is also called the "Age of Mammals," because there are abundant fossils of many different kinds of mammals in these rocks. The Mesozoic Era is the "Age of Dinosaurs." The fossils of the Paleozoic Era are mostly invertebrate animals with shells instead of backbones, although simple fish, early amphibians, and primitive reptiles are found.

Eras can be broken down into still smaller parts called periods. Periods are most often named for an area or region where those rocks were first studied. Examples are the Cambrian Period named for an area on the western Scottish Borderlands in northern England, or the Devonian Period named for Devonshire in southeastern England, or the Permian Period named for a region in Russia.

Periods are divided into smaller parts called series, which are also based on geographic areas. The latest division of the Paleozoic Era, the Permian Period, was only recently divided into three series. The oldest is the Cisuralian Series from the Ural Mountains in Russia. The youngest is the Lopingian Series from an area in China, but the one in between, the middle Permian, is the Guadalupian Series, named for the Guadalupe Mountains!

such as petroleum, potash, dolomite, and limestone. The reef rocks and adjacent permeable deposits form the main body of the Capitan Reef aquifer, which supplies water across a large area from Carlsbad, New Mexico to the Midland-Odessa area of Texas.

Geology of the Western Escarpment

The park's western escarpment has played an important role in revealing the story of the Permian Period in North America. These exposures are almost a mile thick and present one of the finest cross-sections of rocks in the world, showing complete lateral transitions from shallow-water marine deposits to deep-water marine deposits. Specifically, the abrupt changes in rock types reflect sediment deposition in shallowly submerged areas, on wave-built shoals, on the crest of the barrier reef, down the reef face, and in the cold, dark waters of the deep sea basin.

Geologists have intensively studied exposures on the lower section of the western escarpment, and numerous stratigraphic *type sections* are designated in this area. A *type section* serves as the defining unit to which all other rocks of similar age and composition can be compared. These exposures are carefully managed for preservation so that geologists can continue to study and learn about this ancient fossil reef and to provide continued enjoyment by the general public.

Stratotypes

Three localities in the park were recently designated as *global stratotype sections*. Global stratotype sections are *type sections* of international significance and are designated for having the world's best geological and paleontological record of any rock of its age.

The park's three global stratotype sections are formal international reference standards for the middle Permian Period of the geologic time scale. The middle Permian Period is now known worldwide as the Guadalupian Series and is named for the Guadalupe Mountains. This time interval is based on the presence of certain evolutionary transitions of fossil conodonts (microscopic teeth of an extinct marine vertebrate).

What Is a Reference Stratotype?

A stratotype is an especially fine outcrop (section) of rocks that represents a certain portion of geologic time. A global stratotype section is considered to be the world's best preserved and most complete rock outcrop representing its particular interval of geologic time. To be named a global stratotype section, an outcrop must have been studied extensively, must contain a wealth of fossils from a wide range of environments, and must not have been strongly deformed or heated by Earth processes. It must also be officially approved by a special committee of international geologists and be accessible to international researchers. Researchers maintain worldwide consistency in geologic time by comparing any fossils of a similar age back to those of the global stratotype section.

Gypsum Dunes

The white sands of the gypsum dunes rise up to 100 feet from the desert floor and provide a brilliant contrast to the dark, towering rock face of the Guadalupe Mountains. To the west are barren salt flats that are responsible for creating these beautiful dunes. As rainwater runs off the highly soluble limestone rocks that surround the area, salts are leached. When this runoff accumulates on the flats of the desert basin and evaporates, large grains of these salts are left behind. The wind carries the sand grains northeast toward the western escarpment of the Guadalupe Mountains. The air currents rising up over the mountains deposit the white sediments that form the gypsum dunes.

Salt Basin Dunes

Because of their isolated location and the harsh conditions of the surrounding environment, the gypsum dunes have remained largely undisturbed throughout the years. However, by the 1970s, damage by trespassers and off-road vehicles was threatening the integrity of this unique area. To ensure permanent protection, The Nature Conservancy purchased a portion of the site in 1980. The property has been managed as a nature preserve since that time.

Today, this small portion (226 acres) remains a private inholding in the park, but it is managed under a cooperative agreement between the Hudspeth Directive for Conservation, The Nature Conservancy, and the National Park Service as an integral part of the Salt Basin Dunes. The Nature Conservancy retains a conservation easement. The intent is to eventually transfer the 226-acre inholding to the National Park Service.

Geologic Resources on NPS-Owned Land outside the Park Boundary

The two sections of NPS-owned land that are outside the current boundary of the park have key geologic resources. The locations of these 1-mile-square sections, which are bounded by broken lines, can be seen on the Visual Resource Distribution Analysis map.

The section on the south boundary of the park has the largest, most contiguous, and best exposed outcrops of the Castile Formation and Reef Trail Member of the Bell Canyon Formation on NPS lands. The outcrops cover a time interval that correlates to the Upper Permian boundary in China, which is very important for global correlation of the

Guadalupian (Middle Permian) stratotype upper boundary. There also is one type lo cality for an invertebrate fossil in this section.

The section on the eastern boundary near the south end of the park contains numerous important geologic resources. These include

- the official type section of the Pipeline Shale Member of the Brushy Canyon Formation
- three type localities for several species of invertebrate fossils
- significant new localities for vertebrate (fish and shark) and plant remains
- four historically documented paleontological localities
- numerous newly documented paleontological localities
- the most significant fossil ammonoid locality on NPS lands

Caves

Caves in national park units are automatically considered to be significant for purposes of the Federal Cave Resources Protection Act of 1988. In addition, in accordance with Section 6.3.11.2 of *Management Policies 2006* (NPS 2006b), any cave whose entrance is in a designated wilderness area will be managed as wilderness. A cave management plan for the park was approved in 1991 when only 25 caves were known (NPS 1991). In the most recent count, 32 caves have been identified in Guadalupe Mountains National Park.

Caves in the Guadalupe Mountains are known worldwide for their large chambers and total volume; spectacular speleothem deposition of rare form, size, or beauty; joint controlled development; vertical drops of up to several hundred feet; and rare mineralogy that has resulted from upwelling of sulfur solutions, evaporation, and presence of magnesium in fore-reef and back-reef dolomites. Unfortunately, this is not true for the caves found in Guadalupe Mountains National Park. Because of the geological processes and uplifting that has occurred in the area, park caves are characterized by vertical shafts, poor chamber development, and fewer formations than are found throughout the rest of the Guadalupe Mountain range.

Recreational use of caves in the park is quite low, with very few access permit requests. This is probably because of the proximity of more well-known, more highly developed and decorated caves in Carlsbad Caverns National Park, within the Lincoln National Forest, and on Bureau of Land Management lands. In addition, most caves in the park are difficult to access, requiring a hike of up to several hours over rough terrain.

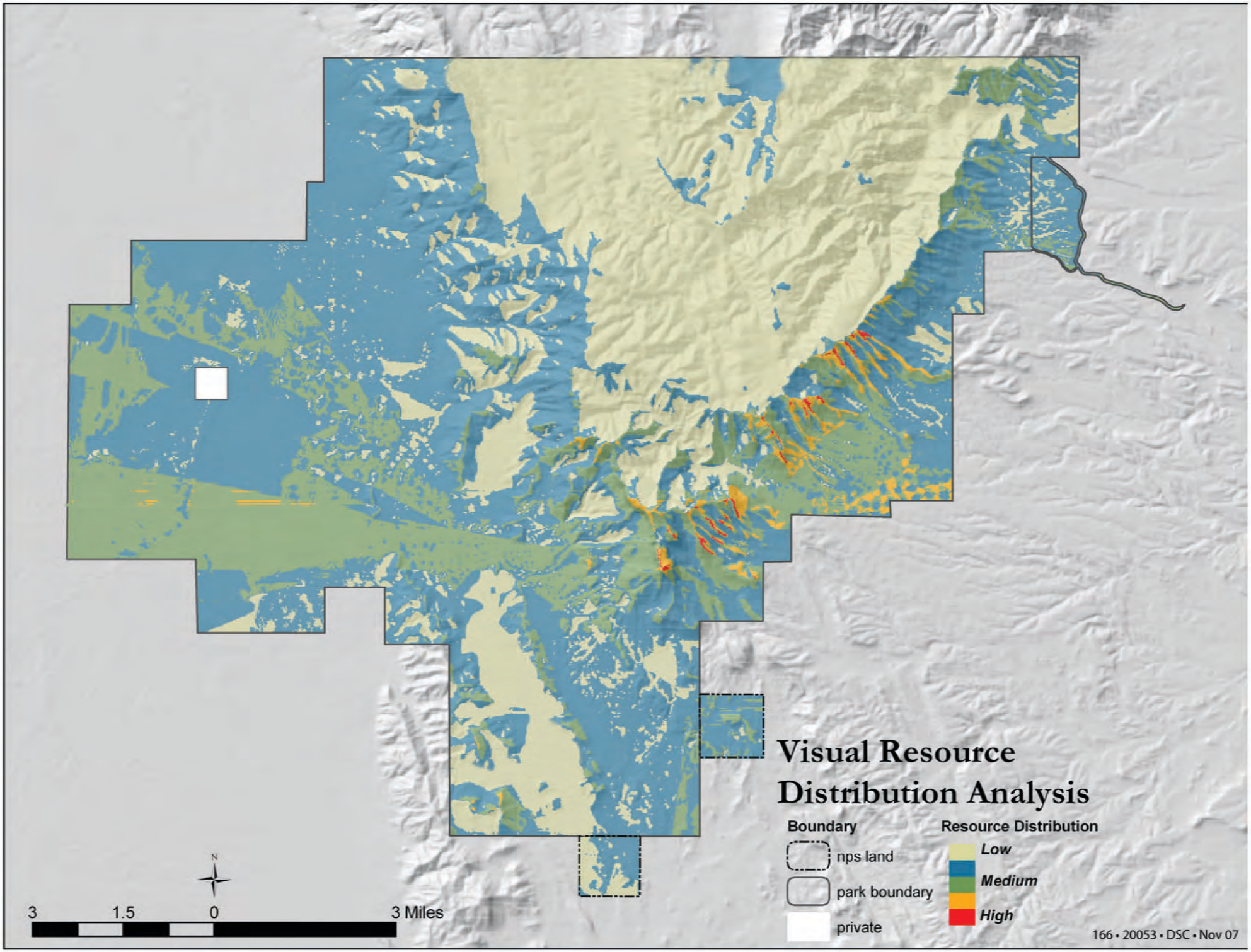
Caves in the park contain important habitat for populations of cave-dwelling or cave-using animals, including bats.

None of the known caves have any appreciable potential for public use in the anticipated interpretive activities for the park. Current cave policy for the area limits cave use to projects that have demonstrable value to the National Park Service in the management and knowledge of cave resources.

PALEONTOLOGICAL RESOURCES

Fossils

The Guadalupe Mountains of Texas and New Mexico contain the world's largest surface exposure of a Permian-aged reef. Permian fossils are most common in the reef and reef slope deposits of the Capitan Formation and in the eight limestone tongues found in the Cherry and Bell Canyon Formations. The greatest concentration of fossil diversity is in the Capitan Reef and reef slope deposits. Every geological formation in the park contains fossils, and fossils are visible on almost every mile of the park's 82 miles of hiking and nature trails.


Visual Resource
Distribution Analysis
Boundary
nps land
park boundary
private
Resource Distribution
Low
Medium
High
N
3
1.5
0
3 Miles
166 • 20053 • DSC • Nov 07

At least 22 type fossil localities occur in the park, with more to be added as a literature survey progresses. The total number of fossil species occurring in the park is estimated to be between 800 and 1,200, but a complete census is not available and that figure may be low. Fossils of the Permian Period include representatives of most invertebrate phyla as well as 20 to 40 species of fossil fish, including sharks.

Type Fossil Locality

This is a special designation given to the location where a type fossil of a formally named species was found. To name and describe a new species of living or extinct organism, one or a few specimens must be designated as the type or cotypes. These are the reference specimens to which all similar specimens are compared to determine if they belong to the same species. All named species of extinct and living organisms have at least one type specimen. If that specimen is lost or destroyed, new types could be collected from the type locality.

Using information from publications and geologic maps, it is estimated that 27,000 (31 percent) of the park's 86,416 acres have high potential to produce fossil materials.

Fossils in Caves

Caves in the park have provided 106 different species of Pleistocene animal and plant fossils. Four park caves contain the world's largest concentration of extinct fossil ground sloth dung deposits, which provide a rich sampling of the local flora occurring here at the end of the Ice Age. Ninety-four subfossil vertebrate taxa dated between 1,400 and 2,800 years before present were found in one cave. Fossil packrat middens were found in four caves, providing additional sampling of prehistoric Quaternary floras and faunas.

Several caves contain paleontological deposits or cultural sites. There are intact or partially intact vertically stratified paleontological deposits in at least five caves. Two containing human remains will soon be converted to Native American Graves Protection and Repatriation Act sites, according to consultations with affiliated tribes.