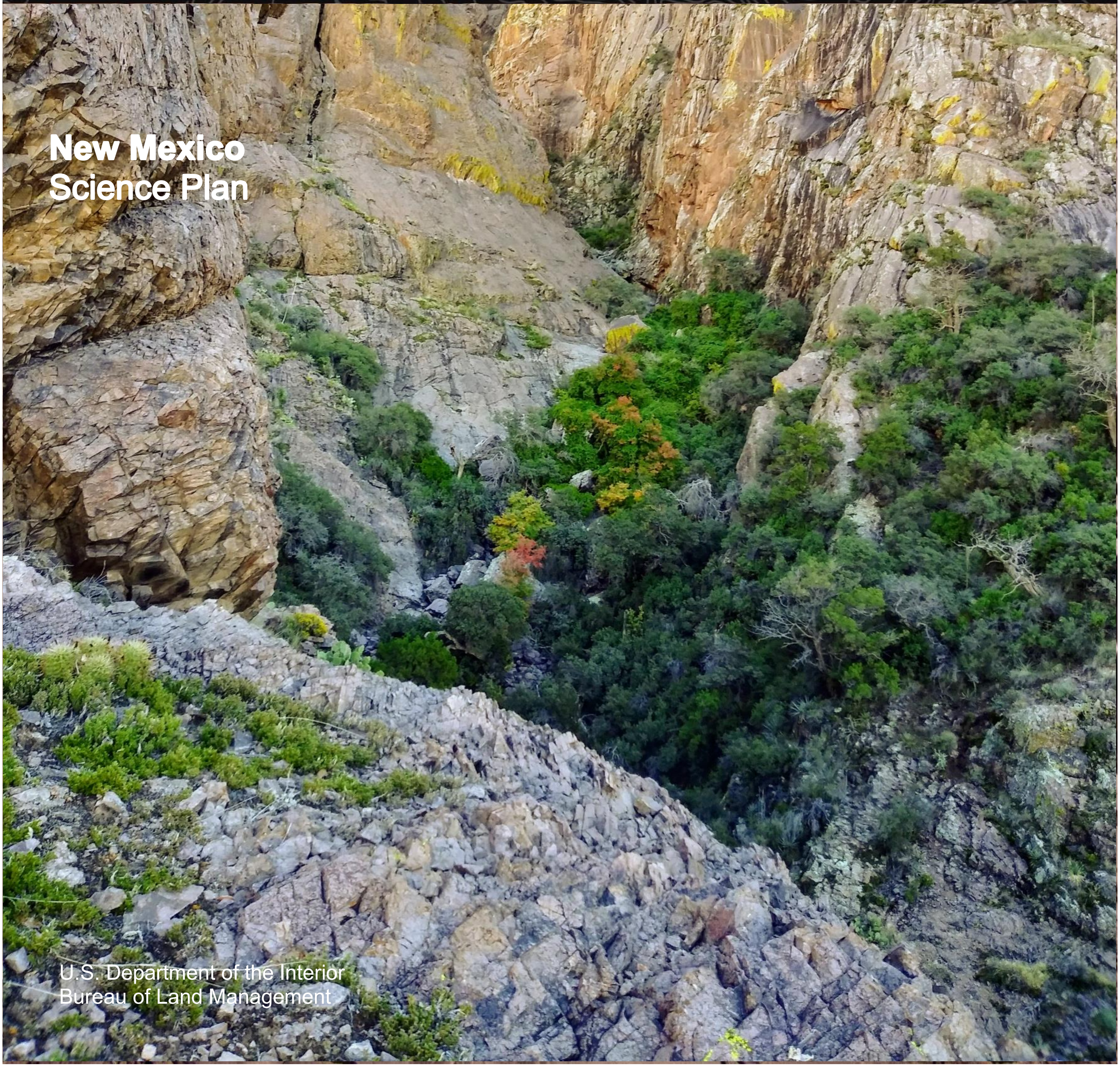
NATIONAL CONSERVATION LANDS

Organ Mountains-Desert Peaks

National Monument



New Mexico

Science Plan

U.S. Department of the Interior
Bureau of Land Management

Organ Mountains-Desert Peaks National Monument Science Plan

1: INTRODUCTION AND SCIENTIFIC MISSION

1.1: Purpose of NLCS Science Plans

The National Landscape Conservation System (NLCS) was administratively established in 2000 and legislatively codified in the Omnibus Public Land Management Act of 2009 (PL 111-011 2009). It was subsequently renamed National Conservation Lands, but still uses the NLCS acronym. The system encompasses nearly 900 units spread across approximately 27 million acres of public lands managed by the U.S. Department of the Interior (USDI), Bureau of Land Management (BLM). The BLM is mandated to conserve, protect, and restore the outstanding cultural, ecological, and scientific values of NLCS units. Scientific investigation can aid in the conservation, protection, and restoration of these lands; and therefore, science is strategically planned and organized within NLCS units.

The objectives of NLCS units' science plans are to:

- Identify the scientific mission of the unit;
- Summarize past scientific efforts in the unit, i.e. the scientific background of the unit;
- Identify the priority needs and management issues within the unit that can be addressed by scientific inquiry;
- Define a strategy for accomplishing the scientific goals of the unit;
- Develop science protocols to, for example, ensure that scientific inquiry does not negatively impact the long-term sustainability of the unit and its resources;
- Create a system to organize scientific reports; and,
- Help and promote the integration of science into management.

The science plans of NLCS units are considered "living" documents and should be revised and updated frequently. Scientific needs that emerge during the course of implementing a science plan may be added to the plan on an as-needed basis to meet the unit's scientific mission. This science plan will be used as the basis for conducting science in Organ Mountain-Desert Peaks National Monument (OMDPNM or Monument).

Science has been defined within the BLM several times (USDI, BLM 2007, 2008). For this plan, science is defined as the study of natural and social phenomena using repeatable observations or experiments. In the context of land management, scientific data are collected, analyzed, or synthesized to increase knowledge and support decision-making. Within NLCS units there is an expectation for “identifying science needed to address management issues, communicating those needs to science providers, and incorporating the results into the decision-making process.” (USDI, BLM 2007)

1.2: Unit and geographic area description

On May 21, 2014 President Barack Obama signed Proclamation 9131 declaring the Organ Mountains-Desert Peaks National Monument (Section 11 – Unit’s Legislation). The President established the OMDPNM to “preserve its cultural, prehistoric, and historic legacy and maintain its diverse array of natural and scientific resources, ensuring that the prehistoric, historic, and scientific values of this area remain for the benefit of all Americans.” The Proclamation is clear about the purpose for preservation, the values of the landscape, and in describing the breadth of scope for management response. Six primary resources, objects, and values were identified in the Proclamation: visual resources, cultural resources, geological resources, paleontological resources, educational values, and scientific values. The proclamation also establishes that the Secretary of the Interior will manage the Monument through the BLM as a NLCS unit consistent with the Federal Land Policy and Management Act (FLPMA) of 1976. This expansive mosaic of semi-desert area is cut by a precious few ribbons of riparian habitat that offer food, water, and cover for a variety of resident and migratory species, a dormant volcano, high desert peaks, and offers one of the most significant systems of prehistoric sites in the American Southwest.

The OMDPNM encompasses 496,529 acres of BLM administered land in southern New Mexico within Doña Ana and Luna Counties and consists of five mountain ranges: Organ, Doña Ana, Sierra de las Uvas, Robledo, and the Potrillo Mountains (Figure 1). These mountain ranges make up four OMDPNM units, which are administered as part of the BLM’s NLCS. Currently, 67,083 acres within the OMDPNM boundary are administered by the New Mexico State Land Office.

The Organ Mountains Unit is located about 10 miles east of the city of Las Cruces, in Doña Ana County, and borders the west side of the White Sands Missile Range. The geologic features of the range, including the spires, crevices, and canyons, are visually stunning and can be visible more than 100 miles away. The highest point is Organ Needle at 8,990 feet.

Northwest of the Organ Mountains and about 5 miles north of Las Cruces is the Doña Ana Mountains Unit, which shares the southern border of the Jornada Experimental Range. The

Doña Ana Mountains reach an elevation of 5,800 feet and were designated as an Area of Critical Environmental Concern (ACEC) to protect scenic, botanical, and wildlife values.

Northwest of Las Cruces lies the Robledo and Sierra de las Uvas Mountains Unit, which is made up of the Sierra de las Uvas Mountains on the northwestern end and the Robledo Mountains on the southeastern end. The unit is delineated by Highway 26 on the north and west side, I-10 on the south, and the Rio Grande on the east. Cultural and historic artifacts include evidence of World War II bombing targets, petroglyphs, and pit houses. This range is also home to the BLM-managed Prehistoric Trackways National Monument.

The Potrillo Mountains Unit is located approximately 30 miles southwest of Las Cruces. The mountains exhibit prime examples of Chihuahuan Desert vegetation as well as a remarkable volcanic field made up of cinder cones, maar craters, lava flows, and the inactive shield volcano of Aden Crater. Its oldest maar crater is thought to be the mile-wide Kilbourne Hole, at more than 80,000 years old.

The OMDPNM includes three ACECs, 10 Wilderness Areas (WAs), one Research Natural Area, one National Natural Landmark, and three National Recreation Trails. The three ACECs are the Doña Ana Mountains ACEC, Organ/Franklin Mountains ACEC, and the Robledo Mountains ACEC. For more information on Wilderness see Sections 1.3 and 2.1.15 in this document.

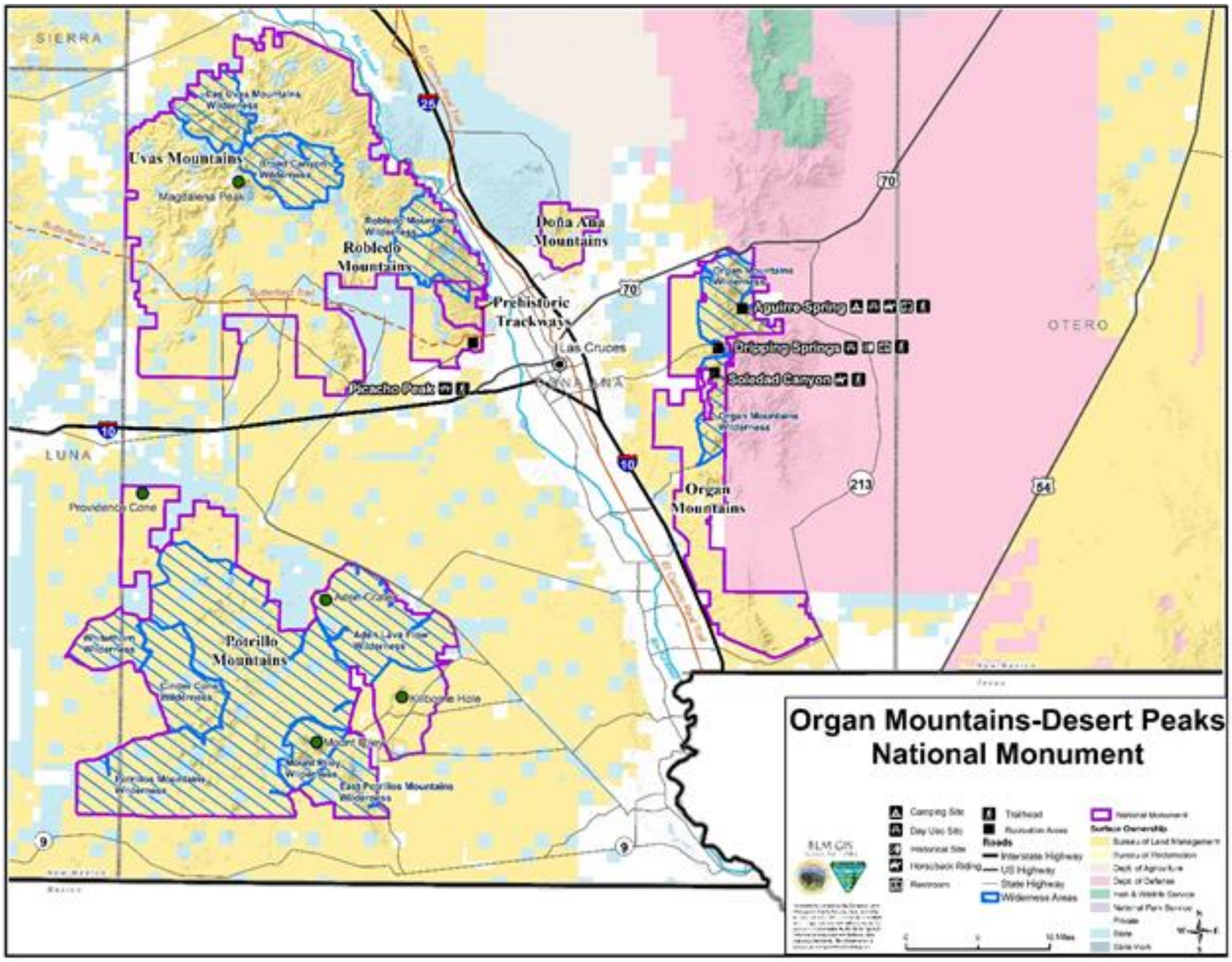


Figure 1: Map of the Organ Mountains-Desert Peaks National Monument and surrounding lands.

1.3: John D. Dingell, Jr. Conservation, Management, and Recreation Act of 2019

On March 12, 2019, the President enacted into law the S.47 Bill, John D. Dingell, Jr. Conservation, Management and Recreation Act (Dingell Act). Ten new WAs were designated within OMDPNM and Prehistoric Trackways National Monument (PTNM) encompassing approximately 241,554 acres of wilderness (Figure 1). The 10 WAs include the Aden Lava Flow WA, Broad Canyon WA, Cinder Cone WA, East Potrillo Mountains WA, Organ Mountains WA, Robledo Mountains WA, Sierra del las Uvas WA, Potrillo Mountains WA, Whitethorn WA, and the Mount Riley WA.

1.4: Scientific Mission of the Unit

Per the 2014 proclamation, OMDPNM was designated to "preserve its cultural, prehistoric, and historic legacy and maintain its diverse array of natural and scientific resources, ensuring that the prehistoric, historic, and **scientific** values of this area remain for the benefit of all Americans". The resources of scientific interest at OMDPNM include the formation of desert soils and sedimentary rock, including geological studies of sedimentation and stratigraphy, as well as other wide-ranging topics on desert soil formation and volcanology. The Robledo Mountains are also an important site for paleontological research, where fossilized tracks and other prehistoric remains date to the Permian period. There is a rich diversity of animal and plant communities, including several vegetation zones in the Sierra de las Uvas and Potrillo Mountains. The Doña Ana Mountains have been an important feature of many studies in wildlife biology, botany, and ecology.

2: SCIENTIFIC BACKGROUND OF THE NLCS UNIT

2.1: Completed research and science available on OMDPNM

Research is considered for the following Science Areas, slightly modified from management categories outlined in the Analysis of the Management Plan (USDI, BLM 2018):

2.1.1: Fish, Wildlife, and Habitat

BLM Points of Contact (POC): Timothy Frey, Jesarey Barela, Mara Weisenberger

Topic: **New Mexico State University Species Data Mining**

See 2.1.2: Special Status Species below

Topic: **Preferred Habitat of Desert Bighorn Sheep in the San Andres Mountains, New Mexico**

Principal Investigator: Andrew Sandoval, New Mexico State University

The preferred habitat for desert bighorn sheep (*Ovis canadensis mexicana*) consisted of a series of broken cliffs, ledges, deep canyons, and rock outcrops. These areas were designated as the cliff habitat type and accounted for 70 percent of the sheep observations. Slope gradients between 20 and 60 percent received 65 percent of the utilization. Preferred habitats had a 41 percent ground cover. Shrubs made up 24 percent, grasses comprised 14 percent, and forbs accounted for 3 percent of the ground cover. A close relationship was apparent between sheep distribution and the availability of water and escape terrain. Eighty-eight percent of the sheep sighted were within 1,500 m (1,640 yd) of water, and 76 percent of the sheep sighted were within 100 m (109 yd) of cliffs or rock outcrops. Direct interspecific competition with mule deer (*Odocoileus hemionus*) was evident. Seventy-four percent of the bighorn diet and 76 percent of the deer diet were composed of mountain mahogany (Cercocarpus spp.), globemallow (*Sphaeralcea* spp.), and bladder pod (*Physaria purpurea*). Spatial competition was alleviated somewhat by the topography of their preferred habitat, with bighorn occupying rougher terrain. (Sandoval 1979).

Topic: **Evaluating Bighorn Habitat: A Landscape Approach**

Principal Investigator: William Dunn, Ph.D., University of New Mexico

Used Geographic Information Systems (GIS) to measure habitat and impacts for Rocky Mountain (*O. canadensis canadensis*) and Desert Bighorn sheep (*O. canadensis mexicana*) on landscape scale in New Mexico. Potential suitability and current suitability were determined for each study area. Habitat components measured for desert bighorn sheep in southern New Mexico included total habitat, escape terrain escape terrain contiguity, and water availability. (Dunn, 1996).

Topic: **Precipitation, Density, and Population Dynamics of Desert Bighorn Sheep on San Andres National Wildlife Refuge, New Mexico**

Principal Investigator: Louis Bender, Ph.D., New Mexico State University

In arid environments, plant communities and consequently herbivore populations are strongly dependent upon precipitation, which is highly variable seasonally and annually. A retrospective exploratory analysis of desert bighorn sheep (*O. canadensis mexicana*) population dynamics on San Andres National Wildlife Refuge (SANWR), New Mexico, 1941-1976, was conducted by modeling sheep population size as a function of previous population sizes and precipitation. Precipitation limited populations of desert bighorn sheep on SANWR primarily in a density-independent manner by affecting production or survival of lambs, likely through influences on forage quantity and quality. Habitat evaluations and recovery plans for desert bighorn sheep need to consider fundamental influences on populations such as precipitation and food, rather than focus solely on proximate issues such as security cover, predation, and disease. (Bender & Weisenberger. 2005).

Topic: **The restoration of desert bighorn sheep in the Southwest, 1951–2007: factors influencing success**

Principal Investigator: Brian Wakeling, Arizona Game and Fish Department

The restoration of desert bighorn sheep (*O. canadensis mexicana*) to abundant populations at the end of the twentieth century following historic low numbers during the first half of the same century is a testament to the North American Model of Wildlife Conservation. The relative influence of management activities on several populations were evaluated and insights into the efficacy and limitations of restoration and management activities were explored. (Wakeling et al. 2009).

Topic: **Occupancy and habitat correlates of javelinas in the southern San Andres Mountains, New Mexico**

Principal Investigator: Louis Bender, Ph.D., New Mexico State University

Javelinas (*Pecari tajacu*) are expanding their range northward in the southwestern United States, but little is known of habitat relationships in northern populations. Researchers used occupancy modeling and maximum entropy modeling of data collected from a camera-trapping grid to investigate javelina occupancy and identify habitat correlates associated with presence in the southern San Andres Mountains of south-central New Mexico. Presence of javelinas was most strongly associated with areas in close proximity to permanent water sources; with overstory or high shrub canopies of riparian, oak–mountain mahogany, or pinyon–juniper; and with low (<6%) slopes. Circadian patterns of behavior indicated that javelinas were primarily diurnal during colder months and nocturnal during warmer months. Expansion of javelina occupancy may be related to a slight trend in increasing minimum winter temperatures, because severe winters were hypothesized to limit the northern distribution of javelinas. Additionally, javelinas appear dependent upon a tree or shrub overstory, ideally associated with riparian corridors, to mitigate heat stress associated with occupancy of Chihuahuan Desert habitats. (Bender et al. 2014).

Topic: **Wintering Bird Density and Habitat Use in Chihuahuan Desert Grasslands**
Principal Investigator: Arvind Panjabi, Bird Conservancy of the Rockies
In January 2007, Rocky Mountain Bird Observatory (RMBO), together with Universidad Autónoma de Nuevo Leon, initiated a first-ever, region-wide pilot survey to inventory, research and monitor wintering birds in Chihuahuan Desert Grassland Priority Conservation Areas (GPCAs) in Mexico. This effort was refined and expanded in January and February of 2008 and 2009. An immediate and broad array of conservation solutions are needed to slow and reverse current trends in Chihuahuan Desert grassland loss. Continued avian inventories and monitoring will allow the BLM to identify spatiotemporal patterns of abundance, species habitat requirements, important wintering areas and land use changes, while continuing to provide an avenue for outreach and education. (Panjabi et al. 2010).

Topic: **Breeding Bird Communities and Nest Plant Selection in Chihuahuan Desert Habitats in South-Central New Mexico.**
Principal Investigator: Jeffrey Kozma, U.S. National Biological Service, Texas Cooperative Fish and Wildlife Research Unit, Texas Tech Univ., Lubbock, Texas
Study authors (Kozma & Matthews 1997) examined the significance of arroyo-riparian habitat to birds in the Chihuahuan Desert of south-central New Mexico. Nest density in arroyos was more than twice that of uplands (0.64 nests/ha versus 0.27 nests/ha). Torrey yucca (*Yucca torreyi*),

javelina bush (*Condalia warnockii*), and little-leaf sumac (*Rhus microphylla*) were the most frequently used nest substrates, even though these shrubs were among the lowest in density. Maintaining this habitat and protecting sparse shrub species used as nest substrates may have long term importance in managing Chihuahuan Desert bird communities. (Kozma & Mathews 1997).

Topic: **Effects of including non-breeding bird species on predicted bird distribution for conservation planning in New Mexico**

Principal Investigator: Bruce Thompson, Ph.D., New Mexico State University

Study authors (Thompson et al. 2001) compared biodiversity estimates including non-breeding birds to estimates including only breeding birds in terms of estimated patterns of species richness. Inclusive and breeding bird richness estimates agreed about general location of some species-rich areas and the most species-poor areas in the state but were less comparable for intermediate areas of bird occurrence. Their analyses indicated that only assessing breeding distribution does not reliably predict relative importance of areas used by birds throughout New Mexico and should not be used exclusively to identify potential gaps in conservation for land use evaluation and planning. (Thompson et al. 2001).

Topic: **Satellite Image Texture and a Vegetation Index Predict Avian Biodiversity in the Chihuahuan Desert of New Mexico**

Principal Investigator: Véronique St. Louis, Dept of Forest and Wildlife Ecology, Univ. of Wisconsin, Madison

Predicting broad-scale patterns of biodiversity is challenging, particularly in ecosystems where traditional methods of quantifying habitat structure fail to capture subtle but potentially important variation within habitat types. Here, study authors (St. Louis et al. 2009) tested the importance of habitat structure (i.e. fine-scale spatial variability in plant growth forms) and plant productivity (i.e. amount of green biomass) for predicting avian biodiversity. Study authors used image texture (i.e. a surrogate for habitat structure) and vegetation indices (i.e. surrogates for plant productivity) derived from Landsat Thematic Mapper (TM) data for predicting bird species richness patterns in the northern Chihuahuan Desert of New Mexico. Results highlight that texture measures from Landsat imagery were useful for predicting patterns of bird species richness in semi-arid ecosystems and that image texture is a promising tool when assessing broad-scale patterns of biodiversity using remotely sensed data. (St. Louis et al. 2009).

Topic: **Restoration Practices Have Positive Effects on Breeding Bird Species of Concern in the Chihuahuan Desert**

Principal Investigator: John Coffman, New Mexico State University

Woody plant encroachment into grasslands is a global concern. Efforts to restore grasslands often assume that removal of woody plants benefits biodiversity but assumptions are rarely tested. In the Chihuahuan Desert of the Southwestern United States, study authors (Coffman et al. 2014) tested whether abundances of grassland specialist bird species would be greater in plant communities resulting from treatment with herbicides to remove encroaching shrubs compared with untreated shrub-dominated areas that represented pretreatment conditions. Vegetation in treatment areas had higher perennial grass foliar and basal cover and lower shrub foliar cover compared with untreated areas. Several regionally declining grassland specialists exhibited higher occurrence and relative abundance in treated areas. Results indicate that shrub removal can have positive effects on grassland specialist bird species, but that a mosaic of treated and untreated areas might be most beneficial for regional biodiversity. (Coffman et al. 2014).

Topic: **Breeding Bird Distribution in Chihuahuan Desert Habitats**

Principal Investigator: Luis Naranjo, New Mexico State University

The study was conducted on the Long Term Ecological Research (LTER) exclosure located at the southern end of the Jornada del Muerto Plain in Doña Ana Co., New Mexico. Twenty-eight species were found, of which the 13 more common were examined in detail. Study authors (Naranjo and Raitt 1993) compared mean densities of all species among four transects and among three physiognomically distinct habitats (Naranjo and Raitt 1993).

Topic: **Characterization of Vegetation and Small Mammal Communities in Chihuahuan Desert Grasslands, Master's Thesis.**

Principal Investigator: Randy Seeley, New Mexico State University

This study evaluated relationships between desert grassland vegetative and environmental characteristics at 17 study sites on the San Andres National Wildlife Refuge and the Chihuahuan Desert Rangeland Research Center. Perennial grass cover, rock cover, canopy gap, bare ground and total dead vegetation were the most important discriminating variables that explained site clusters. Results revealed that vegetation differences were not clearly explained by differences in environmental variables, and convergence of vegetation types was observed on sites with differing environmental characteristics (Seeley 2014).

Topic: **Winter Activity of Bats over Water and along Flyways in New Mexico**

Principal Investigator: Keith Geluso, Ph.D., University of Nebraska Kearney

During colder months in temperate regions, non-migratory bats are suspected to remain relatively inactive during hibernation. Geluso (2007) examined activity of bats November-March in a region of North America with moderate winter temperatures. Bats were captured in nets over water and along flyways in southern and central New Mexico. Body masses of most species were lowest in March. During the study, activity of bats was positively, but not significantly, correlated with ambient air temperature at dusk. In this region of North America, many individuals of several species do not hibernate for the entire winter nor do they migrate from the region (Geluso 2007).

Topic: **Habitat Use, Predation, and Abundance in Parthenogenetic and Gonochoristic Whiptail Lizards in the northern Chihuahuan Desert**

Principal Investigators: Carl S. Lieb, PhD – University of Texas at El Paso

Julia Sandoval Alva – Doctoral Student, University of Texas at El Paso

(Study is ongoing and not published as of July 2020)

The goal of this study is to determine predator attack rates of closely related parthenogenetic and gonochoristic whiptail lizards in different habitats in northern Chihuahuan Desert habitats of the El Paso TX/Las Cruces NM borderland region. Authors will determine if the lizard's habitat preferences are correlated with the predation pressure and/or the abundance of each species. Parthenogenetic whiptail lizards will be compared to the gonochoristic whiptail lizards, and the parthenogenetic diploid, and parthenogenetic triploids will be compared to each other.

Topic: **Patterns of Daily and Seasonal Activity of Whiptail Lizards in The Desert Southwest**

Principal Investigators:

Jerry Johnson, PhD (Dissertation Advisor) – University of Texas at El Paso

Guillermo Alvarez – Doctoral Student, University of Texas at El Paso

(Study is ongoing and not published as of July 2020)

The main goal of this study is to continuously monitor several species of diurnal whiptail lizards across multiple sites using pitfall traps implemented with motion-activated cameras. An objective of the research is to study sites across the Chihuahuan Desert where several species of whiptail lizards co-occur, specifically members of the *Aspidoscelis tesselata* species complex across southeastern Colorado, New Mexico, and Texas. Documenting the exact date and time each animal is captured will allow the researchers to estimate the activity patterns of whiptail lizards, other terrestrial lizards, snakes, and invertebrates identified in the camera footage.

Topic: **Collect water samples at Dripping Springs New Mexico to study the microbial diversity and seasonal variations of the spring water**.

Principal Investigators:

John Kyndt, PhD – Bellevue University

Isabella Shoffstall – Undergraduate Student, New Mexico State University

(Study is ongoing and not published as of July 2020)

Microbial species variation is being studied by obtaining samples from both the small reservoir and the runoff stream in winter and spring of 2020. Small samples (15 ml in triplicates from the two locations) are being collected in a sterile manner, stored on ice packs and shipped to the labs at Bellevue University for metagenomic sequencing. The data will be compared to the summer samples collected in 2019 and analyzed for seasonal variations of microbial composition. The data will be made publicly available by depositing it into Genbank, and a follow-up publication describing more details about the diversity and seasonal variation of the microbial life in the springs will be generated.

2.1.2: Special Status Species

BLM Points of Contact (POC): Patrick Alexander, Jesarey Barela, Mara Weisenberger

Topic: **Northern Aplomado Falcon Survey Work**

Principal Investigator: Ray Meyer, La Tierra Environmental Consulting

This project involves protocol surveys and nest monitoring on public land throughout the Chihuahuan Desert in the Las Cruces District. The project involves surveying and monitoring breeding success of the Northern Aplomado Falcon (*Falco femoralis*) population, a species listed as endangered under the ESA. The project includes an assessment of habitat and monitoring nesting/fledgling success. (La Tierra Environmental Consulting, Ray Meyer).

Topic**: Occurrence and Habitat use by *Leptonycteris* bats in the Southwest**

Principal Investigator: Kathryn E. Stoner, Ph.D., Colorado State University

(Study is ongoing and not published as of July 2020)

This is a funded BPSS project proposal by Marikay Ramsey, originally in conjunction with New Mexico State University. The study is now through Colorado State University. The current Assistance Agreement for the work extends through 2022. The study consists of long-term monitoring of populations of *Leptonycteris* spp. In New Mexico, as well as their roost sites, and their main plant resources (agave) in this region, in order to determine the effects of climate change on this endangered species. This project is in the Bootheel. This work was outside of OMDPNM boundaries. Specific goals include:

1. Document arrival and departure times, relative abundance, and population structure of *Leptonycteris nivalis* and *Leptonycteris yerbabuenae* in southwestern New Mexico.
2. Document ambient temperature, humidity and precipitation (outside only) outside and inside of identified *Leptonycteris* roosts.
3. Document food plant resources of *Leptonycteris* spp. in New Mexico.
4. Document flowering phenology of main *Leptonycteris* food resources (*Agave spp*.).

Topic: **Habitat Selection by the Organ Mountains Colorado Chipmunk**
Principal Investigators: Brittany R. Schweiger and Jennifer K. Frey, NMSU
(Study is ongoing and not published as of July 2020)
There is a need to better understand this endangered and iconic chipmunk's ecology and habitat selection in order to evaluate threats and make informed management decisions. The main goal of this study is to use radio-telemetry to evaluate habitat selection by the Organ Mountains chipmunk at multiple spatial scales including landscape, macro-, and micro-habitat (Johnson 1980). Other methods to evaluate habitat, such as GIS species distribution models, are not ideally suited to model habitat selection of the Organ Mountains chipmunk due to the small size of the mountain range, poor quality occurrence data, low resolution of models, and complex topography that results in admixture of vegetation zones (Frey and Kopp 2013). Data on habitat selection will allow us to more accurately model the distribution of the chipmunk and determine habitat features crucial for its persistence. Further, use of radiotelemetry will also allow us to address other critical information gaps about the ecology of this species. Therefore, other objectives include evaluating home range, space use, dispersal movements, activity pattern, and other elements of the chipmunk's natural history. Results of this study will provide scientifically defensible information that can serve as a basis for managing this unique chipmunk.

Topic**: New Mexico Rare Plants**

Principal Investigator: New Mexico Rare Plant Conservation Partnership (New Mexico Energy, Minerals, and Natural Resources Department, Natural Heritage New Mexico, Bureau of Land Management, U.S. Forest Service, and other partners)

The New Mexico Rare Plant Technical Council includes members from New Mexico Energy, Minerals, and Natural Resources Department, Institute for Applied Ecology, University of New Mexico, New Mexico State University, San Juan College, Navajo Nation, U.S. Forest Service, U.S. Fish and Wildlife Service, BLM, and others. The council maintains a website that summarizes current knowledge on the distribution, identification, habitat, and conservation of rare plants in New Mexico, including federal special status species.

Topic**: Taxonomy of the Sneed's pincushion cactus species complex**

Principal Investigators: Allan D. Zimmerman, Root Gorelick (Carleton University), Marc Baker (Arizona State University), Edward Castetter (University of New Mexico), and others

Many taxonomists have worked on the Sneed's pincushion species complex, recognizing between one and eleven different taxa. There has been little agreement between taxonomists. The most complete work on the species complex was conducted by Zimmerman (1985), who also co-authored the treatment in the Flora of North America (Zimmerman and Parfitt, 2003). Baker and Johnson (2000), Castetter et al. (1975) have also published important work on the species complex. Several of the taxa in the more "split" taxonomy are rare and receive legal protection. Two of these, Sneed's pincushion (*Coryphantha sneedii* var. *sneedii*, federally Endangered) and Organ Mountains pincushion (*Coryphantha organensis*, BLM Sensitive) occur in OMDPNM. The taxonomy of this species complex remains uncertain and has implications for the conservation of these plants.

Topic**: Organ Mountains scaleseed**

Principal Investigator: Guy Nesom, Drexel University and Botanical Research Institute of Texas

Nesom (2012) revised the genera *Apiastrum, Ammoselinum*, and *Spermolepis*, and in the process described Organ Mountains scaleseeed (*Spermolepis organensis,* BLM Sensitive) as a new species. At the time it was named, only a single specimen was known, on the east side of the Organ Mountains. Surveys by the BLM, White Sands Missile Range, and San Juan College from 2013 to 2016 found new populations on the northeastern bajada of the Organ Mountains.

All of Organ Mountains scaleseed's known occupied habitat is within OMDPNM, although potential habitat extends onto adjacent private and missile range lands.

Topic: **Sand prickly-pear**

Principal Investigator: Bureau of Land Management

Sand prickly-pear (*Opuntia arenaria*, BLM Sensitive) is narrowly distributed, occurring only in Doña Ana and Luna counties in New Mexico, and southward for ca. 40 miles into Texas and the Mexican state of Chihuahua. The largest known populations are in the breaks along the Rio Grande Valley, between Las Cruces and El Paso, Texas, including within OMDPNM. BLM staff, Chicago Botanic Garden interns, employees of the Institute for Applied Ecology, and students at New Mexico State University have conducted monitoring of natural and transplanted populations, and surveys of potential habitat, from 2006 to present. Howard (2006, 2007) and Ward and Wilkins (2013) summarized early monitoring results. Transplantation has had limited success as a mitigation effort. Disease and herbivory by small mammals have been identified as likely factors in low transplantation success and may cause declines in natural populations. Data was most recently collected in the fall of 2019, but results have not yet been finalized.

Topic: **Organ Mountains evening primrose**

Principal Investigator: Bureau of Land Management

Organ Mountains evening primrose (*Oenothera organensis*, BLM Sensitive) occurs only in the Organ Mountains, in pockets of moist soil in canyon bottoms. This species occurs in very small, isolated populations, but is self-incompatible and relies on hawkmoths in the genus *Manduca* for pollination. As a result, it has been the subject of studies related to pollination and self-incompatibility, including genetics (Emerson, 1938; Brown and Crouch, 1990; Levin et al., 1979; Mäkinen and Lewis, 1962), pollen tube growth (Dickinson and Lawson, 1975; Emerson, 1940; Havens, 1994), and seed maturation (Havens and Delph, 1996).

2.1.3: Vegetative Communities

BLM POC: Patrick Alexander

Topic: **Flora of New Mexico**

Principal Investigator: Kelly W. Allred

Flora Neomexicana III (Allred and Ivey, 2012) is currently the authoritative work on the vascular flora of New Mexico, including the plants of OMDPNM, and is used as the primary source for plant taxonomy in the AIM program in New Mexico. Kelly Allred is nearing completion of an updated edition, which will include non-vascular plants.

Topic: **New Mexico Vegetation**

Principal Investigator: William Dick-Peddie

The primary published work on the vegetation of New Mexico generally was written by Dick-Peddie (1993) and includes generalized descriptions of the past and current vegetation in the monument area, as well as coarse vegetation mapping.

Topic: **Plant Ecology of the Jornada Experimental Range**

Principal Investigators: Many researchers at Jornada Experimental Range (United States Department of Agriculture, Agricultural Research Service) and New Mexico State University.

Research on diverse topics related to plant ecology and management has been ongoing at the Jornada Experimental Range, adjacent to the Doña Ana Mountains. Research at the Jornada Experimental Range focuses primarily on the ecology of bajada, alluvial fan collar, alluvial plain, and playa landforms, and is less informative about the ecology of the various mountain ranges in OMDPNM. Summaries of plant ecology research at the Jornada are available in Havstad et al. (2006) and Gibbens et al. (2005).

Topic: **Vegetation of White Sands Missile Range**

Principal Investigators: Esteban Muldavin, Ph.D., Yvonne Chauvin, and Glenn Harper, Natural History New Mexico, University of New Mexico.

White Sands Missile Range, ca. 20 miles east-northeast from the monument, includes sedimentary mountains similar to those of the monument. Muldavin et al. (2000) classified and mapped the vegetation throughout the missile range.

Topic: **Prehistoric Vegetation of Bishops Cap Hills**

Principal Investigators: Tom Van Devender and Benjamin Everitt

Van Devender and Everitt (1977) report vegetation of the Bishops Cap Hills, in OMDPNM southwest of the Organ Mountains, from ca. 10,500 years ago based on data from packrat middens. The site was a xeric woodland dominated by juniper at that time, while it is Chihuahuan Desert shrubland now, but most of the species found in the packrat middens are still present in the Bishops Cap Hills.

Topic: **Assessment, Inventory, and Monitoring (AIM) Data**

Principal Investigator: Bureau of Land Management, Las Cruces District Office

AIM is a BLM-wide ecological monitoring program, based on five principles: standardized methods; statistically valid sample design; electronic data capture and management; structured implementation; and integration with remote sensing. There are separate terrestrial and aquatic AIM programs, using different methods. No aquatic AIM plots are located within OMDPNM. A terrestrial AIM project covering all BLM land within grazing allotments that intersect OMDPNM was initiated in 2016, and 309 plots have been read so far. In 2021, re-reads of existing plots will begin, and some new plots will be added. Terrestrial AIM data includes measurement of foliar and basal cover by species, cover of the soil surface by plants, litter, or rocks, canopy gap, soil stability, a plot-level species inventory, plot photographs, and characterization of a soil pit the first time a plot is read. Plant production is included as a supplemental method on approximately half of the plots.

Websites:

https://landscape.blm.gov/geoportal/catalog/AIM/AIM.page

https://aim.landscapetoolbox.org/

Topic: **Effects of herbicide treatments targeting shrubs**

Principal Investigators: Brandon Bestelmeyer and Laura Burkett, USDA-ARS Jornada Experimental Range

Herbicide treatments intended to restore grasslands by removing shrubs (especially creosote bush, *Larrea tridentata*) have been undertaken in Las Cruces District Office since the 1980s, with the number of acres treated increasing in 2007 with the initiation of the Restore New Mexico partnership. Monitoring of the effects of these herbicide treatments was initiated in 2007 and is ongoing. Results have been variable. Increases in the perennial grass species that characterize intact grassland have been rare, while increases in short-lived, disturbance-adapted grasses like fluffgrass (*Dasyochloa pulchella*), annual grasses, and annual forbs have been common. Bush muhly (*Muhlenbergia porteri*) often increases in size, but with little establishment of new individuals. Shrubs sometimes recolonize sites after two or three decades. The plant communities created by herbicide treatments have been characterized as “novel ecosystems” (Miller and Bestelmeyer, 2016).

2.1.4: Livestock Grazing

BLM POC: Jesarey Barela

Topic: **Chihuahuan Desert Rangeland, Livestock Grazing, and Sustainability**

Proper management of livestock grazing is sustainable and, in many cases, improves resources. Poorly controlled livestock grazing when unmanaged, leads to resource destruction. This applies to mining, logging, farming, wildlife grazing, and recreation as well as livestock grazing. (Holechek 1991).

Topic: **Moderate and light cattle grazing effects on Chihuahuan Desert rangelands**

Range condition, vegetation production, composition, and cover were compared between lightly and moderately grazed rangelands in the Chihuahuan Desert in southwestern New Mexico to determine if these levels of utilization were sustainable in this area. Compared to light use, moderate use increased shrub cover and reduced total standing crop and cover of grasses, forbs, and black grama (*Bouteloua eriopoda*), an important grass species in this area. Over the 13-year study, the lightly grazed pasture increased in range condition, whereas range condition on the moderately used pasture declined, probably due to the lower stubble heights remaining after moderate utilization which decreased survival of perennial grasses. These results suggest that light use (25-35% use of key forage species) on arid grasslands is sustainable while moderate use will cause range degradation, however, the authors caution that even light use in drought years will cause range degradation and grazing management in these areas should be adapted to forage and weather conditions (Holechek et al. 2003).

Topic: **Range Management: Principles and Practices (Holechek et al. 2011)**

This book is to introduce students to the science of range management, coupling the latest concepts and technology with proven traditional approaches. It captures the fundamentals and perspectives of the key subjects in the field of range management.

2.1.5: Wildland Fire Ecology and Management

BLM POCs: Mara Weisenberger and Patrick Alexander

Topic: **Reconstruction and interpretation of historical patterns of fire occurrence in the Organ Mountains, New Mexico.**

Principal investigator: Kiyomi Morino, Laboratory of Tree Ring Research, University of Arizona

The purpose of this research was to reconstruct and interpret the history of fire in the Organ Mountains, New Mexico. Dendrochronological techniques were used to date fire scars on 90 trees comprising ten sites within the Fillmore Canyon watershed. Two fire regimes were identified during the pre-settlement period. Fire Regime I, 1650-1805, was characterized by a high fire frequency (ca. once every two years) and a predominance of patchy fires. Fire Regime II, 1805-1874, was characterized by a lower fire frequency (ca. once every 3.5 years) and a predominance of widespread fires. During the post-settlement period fire was virtually non-existent. Fire-precipitation associations suggest that low fuel moisture levels were a pre-condition for widespread fires. (Morino, K. 1996)

Topic: **Effects of Fire on Wildlife in Southwestern Lowland Habitats**

Principal Investigators: Carl E. Bock and Jane H. Bock, Department of Environmental, Population, and Organismic Biology, University of Colorado, Boulder, CO

This paper reviewed and synthesized information about the responses of wildlife to fire in the grasslands and shrublands of Arizona and New Mexico between 1974 and 1988. Habitat types included Great Basin Shrubsteppe, Interior Chaparral, Madrean Everreen Woodland, Sonoran Desertscrub, and Chihuahuan Shrubsteppe. The authors concluded that as with Great Basin Shrubsteppe and interior chaparral, prescribed fire will benefit wildlife in Chihuahuan Shrubsteppe if it is used to create mosaics. Fire can stimulate herb, seed, and perhaps grass production. Scattered shrubs and mesquite are likely to enhance the wildlife value of most areas, compared either to dense stands of woody vegetation or to pure grasslands. Ground cover should return to pre-bum conditions in about three growing seasons. (Bock and Bock, 1990).

Topic: **Burning for Big Game**

Principal Investigator: Louis C. Bender, Ph.D., New Mexico State University

Prescribed burning is a management tool that is increasingly used to alter the composition and structure of vegetation on public and private lands in New Mexico. Burning is frequently prescribed to increase habitat quality for big game species, such as mule deer (*Odocoileus hemionus*), elk (*Cervus elaphus*), and pronghorn (*Antilocapra americana*), and can be an economically viable alternative to more costly management practices, of wildlife habitat and economics of wildlife enterprises. However, there are significant differences between burning to benefit big game and their habitat and burning for other ecological factors, such as brush control, mimicking “natural” fire regimes, or urban interface clearing. Optimal burning prescriptions for big game habitat differ from other burning prescriptions in terms of season of burn, intensity of burn, and other factors. Prescribed burns for big game are most common in conifer forests and woodlands but are also valuable in grasslands and shrublands. Most forage benefits for big game in piñon-juniper come from increasing forage biomass by opening the piñon-juniper overstory (Van Hooser et al., 1993), but changes in big game use following mechanical manipulation only (thinning, cabling, chaining, etc.) have been mixed (Howard et al., 1987). In contrast, big game consistently shows positive responses to burning piñon-juniper (Greenwood et al., 1999; Erskine and Goodrich, 1999). In areas of New Mexico where cheatgrass (*Bromus tectorum*) is present, additional actions, such as seeding with desirable grasses and forbs, may be necessary to prevent the burned areas from becoming dominated by this noxious invasive exotic grass (Bender 2011).

Topic: **Burning season effect on four southern Chihuahuan desert plants**

Principal investigator: Miguel Luna-Luna, Texas Tech University

Use of prescribed fire to manage undesirable vegetation in the Chihuahuan Desert of Mexico, promises acceptable results, but information on plants’ responses to different weather conditions and fuel load availabilities is lacking in Mexico. This study investigated the effect of three burning seasons with two fuel load simulations and two plant’s size on plant mortality and changes in basal area of four native species of southern Chihuahuan Desert. The study was conducted in the Mexican High Plateau in Jalisco, Mexico during two consecutive years, 2005 and 2006, in a shortgrass prairie of blue grama (*Bouteloua gracilis*) with problematical populations of broomweed (*Isocoma venetus*), brickellbush (*Brickellia spinulosa*) and broomgrass (*Muhlembergia rigida*). Based in our results and considering the weather conditions of the Chihuahuan Desert in this region of Mexico, winter season was judged best for prescribed burning, because it was more detrimental for basal area changes on broomgrass muhly, but did not have negative effects on blue grama basal area changes. (Luna-Luna 2009)

Topic: **Effects of fire, grazing, and the presence of shrubs on Chihuahuan desert grasslands**

Principal investigators: Paul B. Drewa and Kris M. Havstad, USDA ARS, Jornada Experimental Range

Responses of herbaceous and suffrutescent species to fire, grazing, and presence of *Prosopis glandulosa* were examined in a Chihuahuan desert grassland in south0central New Mexico. Following fires in June 1995, unfenced plots were exposed to livestock grazing over 4 years. Perennial grass cover, primarily *Bouteloua eriopoda*, decreased by 13% in burned plots but increased 5% in unburned areas. Conversely, perennial forb cover was 4% greater after fire. Perennial grass frequency decreased 30% more and perennial forb frequency increased 10% more following burning. Further, increases in evenness after fire resulted in a 225% increase in species diversity. Grazing also resulted in a decrease in perennial grass cover while frequency decreased 22% more in grazed than ungrazed plots. Only frequency and not cover of perennial forbs and annual grasses increased more following grazing. Presence of *P. glandulosa* had no differential effect on responses of non-shrub species. Fires were conducted during near drought conditions while grazing occurred during years of precipitation equivalent to the long-term average. Precipitation immediately following fire may be critical for recovery of *B. eriopoda*-dominated desert grasslands; relationships between fire and postfire precipitation patterns require future investigation (Drewa and Havstad 2001).

Topic: **Fire, grazing, and honey mesquite invasion in black grama-dominated grasslands of the Chihuahuan Desert: a synthesis.**

Principal Investigators: Paula Drewa, Debra Peters, and Kris Havstad, Ph.D., Jornada Experimental Range.

Prior to European settlement, the Chihuahuan Desert was partly comprised of grasslands dominated by the perennial grass, black grama (*Bouteloua eriopoda*), as well as by other species of herbaceous vegetation. Honey mesquite (*Prosopis glandulosa*) was mostly abundant in adjacent lower lying areas of water runoff and intermittent streambeds. Since the late 19th century, however, cattle have been directly responsible for increased abundances and expanded distributions of honey mesquite through consumption and dissemination of seed. Additionally, a period of overgrazing and interactive effects with other factors, such as drought and small mammal herbivory, resulted in reduced abundances of black grama. As a result of decreased fuel abundance, lightning-initiated fires that likely occurred just prior and throughout the growing season have decreased in size, intensity, and frequency. However, fire is effective in top-killing, returning shrubs to an immature life history stage, and remains an effective deterrent in slowing honey mesquite invasion. The recurrence of fire is highly contingent on the degree and rate of black grama recovery that may be determined by the timing and amount of precipitation immediately following fires, as well as the degree of livestock grazing. (Drewa et al. 2001)

Topic: **Ecophysiological responses of Chihuahuan desert grasses to fire**
Principal Investigators: B. W. Allred and K.A. Snyder, USDA-ARS Jornada Experimental Range
To better understand the effects of fire in the Chihuahuan desert, gas exchange characteristics of two dominant grass species, *Bouteloua eriopoda* and *Aristida purpurea*, and soil nitrogen availability were studied in response to prescribed fire at the Jornada Experimental Range in southern New Mexico. Burned and unburned plant individuals were measured before and after fire. Rates of net photosynthesis and stomatal conductance were highest in burned individuals, with those of *A. purpurea* exceeding *B. eriopoda*. Soil nitrogen supply rates increased compared to unburned controls. Similar to other grasslands where fire is common, physiological characteristics of vegetation responded positively. These adaptations indicate that fire may be beneficial in the preservation and restoration of native grasses. It is known that the use of prescribed fire as a restoration tool may be useful in reducing shrub volume, but does not often result in shrub mortality (Allred and Snyder 2008; Drewa and Allred, 2003).

Topic: **Effects of Fire Season and Intensity on *Prosopis glandulosa Torr. Var. Glandulosa***
Principal Investigator: Paul Drewa, USDA-ARS, Jornada Experimental Range
In pyrogenic ecosystems, responses of resprouting woody vegetation may depend more on fire season than on intensity. Clipping as well as low and high intensity fires (natural and added fuels, respectively) were applied during the 1999 growing season and the 2000 dormant season. Both fire season and intensity affected shrub responses. Fire season and intensity influence shrub responses in different ways via different mechanisms. *Prosopis glandulosa* has the potential to respond more after dormant season than growing season fires, perhaps as determined by carbohydrate availability in underground organs at the time of fire. However, realization of this potential is contingent on fire intensity as influenced primarily by fuel amount. In turn, fire intensity will determine the amount and duration of heat penetration into soils and thus the amount of damage to growing points of under-ground organs. (Drewa 2003)

Topic: **Population and clonal level response of a perennial grass following fire in the northern Chihuahuan Desert**

Principal Investigators: Paul Drewa, Debra Peters, and Kris Havstad, USDA ARS, Jornada Experimental Range

Research suggests that fire delays the resprouting of perennial grasses well after two growing seasons. However, such results are confounded by livestock grazing, soil erosion, and drought. Additionally, post-fire grass responses may depend on initial clone size. We evaluated the effects of fire, grazing, and clone size on *Bouteloua eriopoda* (black grama) in southern New Mexico grasslands. At a population level, canopy and litter cover were each approximately 50% less in burned than unburned areas. However, compared to initial levels, canopy height had increased by 10% at the end of the study, regardless of fire. At a clonal level, basal cover reductions were attributed mostly to large clones that survived fire. Smaller clone densities had decreased by as much as 19% in burned compared to unburned areas, and fire reduced the basal cover of medium clones. Basal and canopy cover, recruitment, and clone basal area decreased with increased fire temperatures. Almost all responses were independent of grazing, and interactive effects of grazing and fire were not detected. Fire did not kill all perennial grass clones, regardless of size. However, rapid responses were likely influenced by above-average precipitation after fire. Future studies in desert grasslands should examine how perennial grass dynamics are affected by fire, precipitation patterns, and interactions with grazing. (Drewa et al. 2006)

Topic: **Fire Effects on Vegetation of a Northern Chihuahuan Desert Grassland.**

Principal Investigator: J. Malcolm Cornelius, New Mexico State University

It has been hypothesized that fire was important in maintenance of southwestern US desert grasslands, and that decreased fire frequency and intensity caused by lowered fuel levels from livestock grazing may be one cause of desertification of these desert grasslands. This research examines fire effects in a black grama (*Bouteloua eriopoda*) grassland, and assesses the potential historical role that fire may have had in these grasslands. Permanent plots were located on a northern Chihuahuan Desert grassland study site (south-central New Mexico). Selected plots were burned in May 1984 and May 1985. Plant canopy cover was estimated within plots in spring 1984 (preburn) and fall 1984 through 1986. Following burning, cover increase of perennial grass (primarily *B. eriopoda*) was slow (6-8 years estimated to return to preburn cover), and variation between years was high. (Conelius 1988)

Topic: **Wildland Fire in Ecosystems**

Principal Investigators: K. Zouhar, Jane Kapler Smith, Steve Sutherland, Matthew Brooks, USDA Forest Service, Rocky Mountain Research Station

This state-of-knowledge review of information on relationships between wildland fire and nonnative invasive plants can assist fire managers and other land managers concerned with prevention, detection, and eradication or control of nonnative invasive plants. The 16 chapters in this volume synthesize ecological and botanical principles regarding relationships between wildland fire and nonnative invasive plants, identify the nonnative invasive species currently of greatest concern in major bioregions of the United States, and describe emerging fire-invasive issues in each bioregion and throughout the nation. This volume can help increase understanding of plant invasions and fire and can be used in fire management and ecosystem-based management planning. The volume's first part summarizes fundamental concepts regarding fire effects on invasions by nonnative plants, effects of plant invasions on fuels and fire regimes, and use of fire to control plant invasions. The second part identifies the nonnative invasive species of greatest concern and synthesizes information on the three topics covered in part one for nonnative plants in seven major bioregions of the United States: Northeast, Southeast, Central, Interior West, Southwest Coastal, Northwest Coastal (including Alaska), and Hawaiian Islands. The third part analyzes knowledge gaps regarding fire and nonnative invasive plants, synthesizes information on management questions (nonfire fuel treatments, postfire rehabilitation, and postfire monitoring), summarizes key concepts described throughout the volume, and discusses urgent management issues and research questions (Zouhar et al. 2008).

Topic: **Prescribed burning to affect a state transition in a shrub-encroached desert grassland**

Principal Investigators: K.M. Havstad and D. James, USDA-ARS Jornada Experimental Range

Prescribed burning is a commonly advocated and historical practice for control of woody species encroachment into grasslands on all continents. However, desert grasslands of the southwestern United States often lack needed herbaceous fuel loads for effective prescriptions, dominant perennial graminoids may have poor fire tolerance, and some systems contain fire-tolerant invasive species. We examined long-term vegetation responses of a black grama (*Bouteloua eriopoda* Torr.) grassland that had been invaded by honey mesquite (*Prosopis glandulosa*) following a single prescribed burn. Vegetation responses to a 1995 prescribed burn were evaluated in a replicated randomized complete block design with a 2x2 factorial treatment structure. Treatments were prescribed burning and livestock exclusion for both a grassland-dominated and a shrub-encroached grassland state within a complex of sandy and shallow sandy ecological sites. Vegetation responses were measured in 2008, 13 years after the burn treatment application. Neither black grama basal cover nor honey mesquite canopy cover were responsive ($p < 0.05$) to any treatment. A single prescribed burn would be ineffective as a shrub control practice in this environment. Repeated but infrequent prescribed burning within shrub-encroached vegetative states, when used in combination with managed grazing, may be the management required for a transition to desert grassland states within these ecological sites (Havstad and James 2010).

2.1.6: Geological Resources (including minerals and Cave/Karst)

BLM POC: Colin Dunn, Paleontologist

Note: References for this section (and section 2.1.7) provided in separate bibliography.

Topic: **Geologic Maps**

Principal Investigators: USGS, New Mexico Bureau of Geology and Mineral Resources

South-central New Mexico has been mapped geologically many times at different scales over the last 70 years or more. Some of the first published maps were part of the New Mexico Geological Society's 4th Fall Field Conference in 1953 (Flower, 1953a, 1953b; Kottlowski, 1953a; Kottlowski, et al., 1953). Preliminary regional scale mapping followed in the 1960s (Dane and Bachman, 1961; Foster and Stipp, 1961; Hawley and Kottlowski, 1965; Kottlowski, 1960a; Morrison, 1969). Beginning in the 1970s, the New Mexico Bureau of Geology and Mineral Resources began to publish geologic maps, bulletins, circulars, and open-file reports for 7.5' quadrangles (or at least at 1:24,000) for areas that are today in the monument (Clemons, 1976, 1977, 1979; Clemons and Seager, 1973; Hoffer, 1976; Kelley and Matheny, 1983; Seager, 1973, 1975a; Seager and Clemons, 1974, 1975; Seager and Hawley, 1973; Seager and Mack, 1994; Seager, et al., 1975, 1976, 2008). The USGS also published maps during this time (Harbour, 1972; Hayes and Cone, 1975). Two 7.5' quadrangles have been mapped as part of the USGS and NMBGMR STATEMAP program (Seager, 2010, 2018). However, geologic mapping is currently happening in quads in the Las Cruces area that also cover parts of OMDPNM. The NMBGMR Memoir 36 (scale 1:31,250) is the best geologic map we have of the Organ Mountains and Bishop Cap (Seager, 1981). Besides the New Mexico state geologic map at 1:500,000 (NMBGMR, 2003), the best coverage of the monument is from three maps of the Las Cruces and northeast El Paso 1° x 2° sheet at 1:125,000 (Seager, 1995; Seager, et al., 1982, 1987).

Topic: **Igneous Petrology and Stratigraphy**

Igneous history of OMDPNM and the surrounding area is varied and expansive (Amato, et al., 2017 ; Darton, 1928; Denison and Hetherington, 1969; Hawley, 1975; Hawley and Kottlowski, 1969; Jahns, et al., 1955; Jenness, et al., 1984; Kues, 2008; Clemons, 1975a; Elston, et al., 1975; Giles, 1965; Hoffman and Michelfelder, 2018; McMillan, et al., 2011).

Subtopic: **Palm Park Formation**

The ~48Ma mostly pyroclastic deposits of the Palm Park Formation is exposed throughout the Mesilla Basin, both in and out of the Monument, and represents the only evidence of the stratovolcanoes that produced it. (Creitz, et al., 2017, 2018; Hoffman and Michelfelder, 2018; Hunt and Lucas, 1998d; Jacobs, et al., 2018; Krainer and Lucas, 2012c; McMillan, 2004; Ramos, et al, 2018c; Ramos, et al, 2018d).

Subtopic: **Eocene Calderas and the Rio Grande Rift**

New Mexico is bisected by the Rio Grande Rift, a part of the Basin and Range Physiographic Provence and a major tectonic influence on south-central New Mexico for the last 36 million years (Abera, et al., 2015; Amato, et al., 2012, 2018; Anthony, et al., 2002; Aranda-Gomez, et al., 2007; Baldridge, 2006; Biddle, et al., 2018; Brown, 2006, 2009; Brown and Johnson, 2019; Callaghan, 1953, Chapin and Seager, 1975b; Decker and Smithson, 1975; DeAngelo and Keller, 1988; Hamblock, et al., 2007; Hawley, 1978; Hoffer, et al., 1998; Keller and Cather, 1994; Keller, et al., 1998; Fitzpatrick, 1989; Jiminez and Keller, 2000; Keller and Baldridge, 1999; Kelley, 1955; Mack, 2014; Mack, et al., 2018; McMillan, 1998; McMillan, et al., 2010; Ramberg, et al., 1978; Paliewicz, 2015; Ramos, et al., 2003; Repasch, et al., 2017; Salyards, 1991; Satsukawa, et al., 2011; Seager, 1975b; Woodward, et al., 1975). The igneous rocks of the modern Dona Ana Mountains (Askin, et al., 2017; Ramos, et al, 2018b; Ramos and Heizler, 2018; Seager, 2018; Seager, et al., 1976; Seager and Mack, 2018) and Organ Mountains (Glover, 1975; Lente and Johnson, 2019; Ramos, et al, 2018a; Rioux, et al, 2016; Seager and McCurry, 1998; Yanicak, 1992) are what remains from two expansive volcanic calderas that were active as the Rio Grande Rift began 36 Ma, and are part of the spatially expansive Moggollon-Datil Ignimbrite Field to the northeast of OMDPNM (Datl] McIntosh, et al., 1991, 1992; Elston, 1976, 2001, 2008; McIntosh, et al, 1986; Osburn and Chapin, 1983).

Subtopic: **Cinder Cones and Lava Flows**

The cinder cones of the West Potrillos, along with Aden Crater and the Aden and Afton Lava Flows have been studied in depth for many years (Anthony and Poths, 1992; Clemons, 1975b; De Hon and Earl, 2015, 2018a, 2018b, 2019; Hoffer, 1969a, 1969b, 1975a, 1975b, 1988; Hoffer, et al., 1998; Johnson, 1984; Jones, et al., 1987; Merifield, 1972; Seager, 1989; Seager and Mack, 1994; Thompson, et al., 2005; Williams, 1999).

Subtopic: **Kilbourne Hole and other Maars, and related Mantle and Mineral Studies**

Kilbourne Hole is the largest of a handful of maar located in and around the Potrillo Unit of OMDPNM. Researchers have used Kilbourne Hole to study the crystal structure of olivine and peridot, the structure and composition of the Earth's Mantle, and how volcanic maar in general are formed (Anthony, et al., 2002; Arnason and Bird, 2000; Beard, et al., 1993; Begaudeau, et al., 2012; Blanchard, et al., 2017; Bonadiman, et al., 2009; Breitenfeld, et al., 2018; Bussod, 1981, 1983; Bussod and Irving, 1981; Bussod and Williams 1991; Carter, 1970; Cordell, 1975; Dasgupta and Gupta, 2012; Davis, et al., 2009; De Hon, 1965; Dromgoole and Pasteris, 1987; Feigenson, 1986; French IV and McMillan, 1996; Grew, 1979; Harvey, et al., 2016; Harvey, et al., 2012; Hattori, et al., 2002; Hofmeister, 2012; Hoover and Tippens, 1975; Hunt and Lamb, 2019; Irving, 1979; Jackson and Bisdorf, 1975; James and Padovani, 1980; Kumamoto, et al., 2017; Lesher, 2003; Liati and Gebauer, 2009; Lock, et al., 2007; Lorand and Luguet, 2016; Love, et al., 2018; Luguet and Reisberg, 2016; Mosenfelder, et al., 2006; Mosenfelder and Rossman, 2013a, 2013b; O'Donnell, et al., 1975; O'Driscoll and Gonzalez-Jimene, 2016; Padovani and Reid, 1989; Page, 1975; Palke, et al., 2012; Park, et al., 2017; Pearce and Reagan, 2019; Perkins and Anthony, 2011; Perrillat, et al., 2007; Putirka, et al., 2018; Roden, et al., 1988; Sattari, et al., 2002; Scherer, et al., 1977; Seager, 1987, Stalder, 2004; Stalder, et al., 2009; Stalder, et al., 2008; Tabor, et al., 2010; Tian, et al., 2017; Towle, 1975; Upton, et al., 2003; Walker, 2016; Weis, et al., 2016; White, 2015; Yang, et al., 2016; Zhang, et al., 2013).

Topic: **Sedimentary Petrology and Stratigraphy**

Sedimentary rocks of a variety of ages are found throughout the monument and region. Paleozoic marine limestones and shales make up the North Franklins, Bishop Cap, the East Potrillos, and Robledo Mountains. The Robledo Mountains also contain terrestrial sediments from the Paleozoic. The East Potrillo Mountains contain the only Cretaceous-age rocks in the monument, which are limestones and shales. Cenozoic sedimentary geologic sediments originate primarily from the Ancestral Rio Grande or from erosion of the mountains, but some older volcaniclastic units are found in the Sierra de las Uvas.

Subtopic: **Paleozoic Sedimentary Geology**

A suite of Paleozoic marine sediments from Cambrian through the early Permian have been studied since the 1920s and continues to this day. This includes many measured stratigraphic sections and extrapolation of the paleoenvironments, which has allowed us to understand the progression of the environments in this area over ~250 million years (Angeo, et al., 1991; Armstrong, 1962a, 1962b; Balk, 1965; Bachman, 1975; Bachman and Myers, 1969; Braddy, 1995; Bruno, 1988; Cather, 2002; Clemons, 1991; Cook, et al., 1998; Copine, 1992; Darton, 1928; DiMichele, et al., 2007, 2015a, 2015b; Durr, 2010; Flower, 1953a, 1953b, 1953c, 1955, 1961, 1965, 1969; Foster and Meyer, 1972; Hannibal, et al., 2005; Harbour, 1972; Harder, et al., 2015; Harris, et al., 1992; Haubold et al., 1995; Hayes and Cone, 1975; Hill, 1959; Hook and Flower, 1977; Hunt and Lucas, 1998c, 1998d, 1998d; Hunt, 1983; Hunt, et al., 1993; Hunt, et al., 1994a; Jichara, 1956; Julian and Zidek, 1991; Jordan, 1971, 1975; Kietzke and Lucas, 1995; Klein, et al,. 1995; Kotlowski, et al., 1973; Kottlowski and Hawley, 1975; Kottlowski and Seager, 1998; Kottlowski, 1953a; 1957, 1960a, 1960b, 1960c, 1963, 1965, 1969; Kottlowski, et al., 1956; Kozur and Lemone, 1995a; 1995b; Krainer and Lucas, 1995; 2012b; Krainer, et al., 2012, 2015, 2019; Kues, 1986, 1995, 2001, 2002a, 2002b; LaMone, et al., 1975; Lawton, et al., 2002; LeMone, 1969a, 1969b; LeMone, et al., 1967, 1971; Leopoldt and Kortemeier, 1984; Lerner and Lucas, 2015; Love and Seager, 1996; Love, et al., 2018; Lovejoy, 1975; Lovejoy, 1976; Lucas and DiMichele, 2015; Lucas and Estep, 2000; Lucas and Kariner, 2018; Lucas and Krainer, 2011; Lucas, 1993; Lucas, 2012; Lucas, et al., 1994; Lucas, et al., 1995; Lucas, et al., 1998a; Lucas, et al., 1998b; Lucas, et al., 1998c; Lucas, et al., 1998d; Lucas, et al., 2000; Lucas, et al., 2002a; Lucas, et al., 2002b; Lucas, et al., 2005; Lucas, et al., 2015a; Lucas, et al., 2016; MacDonald, 1990, 1994, 1995; Mack and James, 1986; Mack, 2002; Mack, 2007; Mack, et al., 1988; Mack, et al., 1991; Mack, et al., 1998a; Mack, et al., 2003; Mack, et al., 2013; McGlasson, 1969; McMillan, et al., 2000; Metcalf, 1969; Meyer, 1966; Meyer, 2012; Minter and Braddy, 2009; Minter, 2005; Pope, 2002; Pope, 2002; Repetski, 1988; Riley, 1984; Ruhe, 1967; Satsukawa, et al., 2011; Schult, 1995a; Schult, 1995b; Seager and Hawley, 1973; Seager and Mack, 1990; Seager and Mack, 1994; Seager, 1973; Seager, 1975a, 1975b; Seager, 1981; Seager, 2010; Seager, 2018; Seager, et al., 1975; Seager, et al., 1976; Seals, et al., 2002; Soreghan, 1994; Stageman, 1987; Stageman, 1988; Strain, 1969; Thompson and Kottlowksi, 1955; Tidwell and Munzing, 1995; Vanderhill, 1986; Voigt, et al., 2013a; Voigt, et al., 2013b; Wahlman and King, 2002; Wilson and Jordan, 1988; Wilson, 1989; Wilson, et al., 1969).

Subtopic: **Cretaceous Geology**

The only exposed Mesozoic sediments are of Lower Cretaceous-age of marine origin in the East Potrillo Mountains. The area has been mapped geologically at 1:24,000 and the sediments correlated to other Cretaceous outcrops in the Bootheel of New Mexico (Bushnell, 1955; Cather, 2012; Lawton, 2000; Lucas, 2000; Mack, 1987; Mack, et al, 1988; Mack, et al., 1998a; Seager and Mack, 1994)

Subtopic: **Cenozoic Sedimentary Geology**

The oldest Cenozoic Sedimentary rocks in the monument are the Love Ranch, Rubio Peak, Palm Park, the Bell Top (in part), and the Rincon Valley Formations. These units chart the geologic history of the monument from the Laramide Orogeny (which created most of the Rocky Mountains), into the initiation of the Rio Grande Rift and the Organ and Doña Ana Calderas, through the time of local sedimentation strongly influenced by volcanic eruptions to the northwest, the initiation of local mountain uplifts and subsequent erosion, and into the beginnings of the Ancestral Rio Grande into the region (Clemons and Seager, 1973; Clemons, 1975a, 1976, 1977, 1979; Krainer and Lucas, 2012a; Lucas and Williamson, 1993; Mack and McMillan, 1998; Mack, et al., 1998a; Meyer, 2012; Ramos, et al, 2018c; 2018d; Seager and Mack, 1994, Seager, 1973; 1975b, 1981, 2010, 2018; Seager, et al., 1975).

Subtopic: **Camp Rice Formation and other Basin Fill Deposits**

For the last 5Ma, the Ancestral Rio Grande has been depositing muds, silts, sands, and gravels into the Rio Grande Valley. However, the river's course fluctuated wildly around the OMDPNM area, ranging from the western side of the Robledo Mountains to the eastern side of the Franklin Mountains, and everywhere in between. Concurrently, the erosion of the mountains built large alluvial fans and piedmont-slope deposits. In the upper Pleistocene and into the Quaternary, multiple generations of river backfilling and downcutting created stepped terraces. The Camp

Rice Formation is the only geologic formation found in all units of the Monument, and it's study continues to this day (Deutz, et al., 2002; Dhillon, 2011; Fitzsimmons, 1955; Gile, 1987; Gile, 1994, 2002, Gile, et al., 1981, 2007; Giles, 1986; Gill, et al., 2018; Gustavson, 1991; Hall, 2010; Hawley and Clemons, 1975; Hawley and Kottlowski, 1969; Hawley and Lozinsky, 1993; Hawley, 1965, 1975a, 1975b, 1984; Hawley, et al., 1969; Heckman and Mueller, 1993; Henderson, 1997; Hunt, 1978; James, et al., 1991; Jochems and Morgan, 2018; Jones and Mack, 2009; Jones, 2010; Keller, et al., 1986; Koning, et al., 2018; Kottlowski, 1953b; Kottlowski, 1955; Kottlowski, et al., 1953; Leeder, et al., 1996; Leopoldt and Kortemeier, 1984; Lerner and Lucas, 2015; Love and Seager, 1996; Love, et al., 2018; Lovejoy, 1975; Lovejoy, 1976; Lucas and Morgan, 2005; Lucas, et al., 1994; Lucas, et al., 1998d; Lucas, et al., 2000; Lucas, et al., 2002a; Lucas, et al., 2002b; Lucas, et al., 2005; Lucas, et al., 2015a; Lucas, et al., 2016; MacDonald, 1995; Mack and James, 1986; Mack and James, 1992; Mack and James, 1993; Mack and Madoff, 2005; Mack and McMillan, 1998; Mack and Seager, 1990; Mack, 2018; Mack, et al., 1993; Mack, et al., 1994a; Mack, et al., 1994b; Mack, et al., 1996; Mack, et al., 1998a; Mack, et al., 1998b; Mack, et al., 1998c; Mack, et al., 1998d; Mack, et al., 2006; Mack, et al., 2009; Madoff, 2002; McDonald and Morgan, 2011; Metcalf, 1969; Morgan and Lucas, 2003; Morgan and Lucas, 2011; Morgan, et al., 1998; Morgan, et al., 2004; Morgan, et al., 2017; Morgan, et al., 2018; Naus, 2002; Nickerson and Myers, 1993; Polyak and Asmerom, 2001; Polyak, et al., 2001; Reeves Jr., 1965; Repasch, et al., 2017; Riley, 1984; Ruhe, 1967; Satsukawa, et al., 2011; Schult, 1995a; Schult, 1995b; Seager and Hawley, 1973; Seager and Mack, 1990; Seager and Mack, 1994; Seager, 1973; Seager, 1975a, 1795b; Seager, 1981; Seager, 2010; Seager, 2018; Seager, et al., 1975; Seager, et al., 1976; Sellepack, 2003; Strain, 1969; Thompson and Kottlowksi, 1955; Tidwell and Munzing, 1995; Vanderhill, 1986).

Topic: **Minerals**

The Organ Mountains had a long history of mining for barite, flourite, and uranium. Geothermal energy and exploration has occurred near the monument in the Rio Grande Valley near Radium Springs and Tortugas, as well as in the Potrillo Mountains. Limited oil and gas exploration did occur but potential is negligible (Aranda-Gomez, et al., 2007; Austin, et al., 1998; Burnham, 1959; Butler, 1996; Crowley, 1978; Decker, et al., 1975; Duncan and Mancini, 1991; Dunham, 1935; Harbour, 1972; Hatton, 1981; Hayes and Cone, 1975; Hutchins, 1983; Jones, et al., 1987; Kilburn, et al., 1988; Kottlowski, 1957; Kottlowski, 1962; Lmarre, 1975; Lueth and McLemore, 1998; McAnulty, 1975; McAnulty, 1978; McLemore, 1988; McLemore, 1998; McLemore, 2005; McLemore, 2018; MCLemore, et al., 1998; Newcomer Jr. and Giordano, 1986; O'Driscoll and Gonzalez-Jimene, 2016; Page, 1975; Rice, et al., 2002; Rzonca, et al., 2002; Sandeen, 1953; Seager, 1981; Swanberg, 1975; Thompson III and Bieberman, 1975; Wengerd, 1969; Williams, et al., 1979; Witcher, 1988)

Topic: **Caves and Karst**

Most cave and Karst investigations have largely focused on resources besides the caves themselves, especially Paleontology, although some of these do diagram the caves (Brattstrom, 1964; Fosberg, 1936; Simons and Alexander, 1964; Thompson, 1980).

2.1.7: Paleontological Resources

BLM POC: Colin Dunn

Note: References for this section (and section 2.1.6) provided in separate bibliography.

Topic: **Vertebrate Ichnofossils**

Permian age vertebrate ichnofossils have been known to occur in the Robledo Mountains since the 1930s (Vaughn, 1969), but it was Jerry MacDonald, in 1987, that brought them into the national and international consciences (MacDonald, 1990, 1994, 1995). These ichnofossils have been studied (or mentioned) at length in the intervening decades (Berman, 1993; Braddy, et al., 2003; Haubold et al., 1995; Hunt and Lucas, 1998a, 1998b, 1998c, 1998d, 2015; Hunt, et al., 1993; Hunt, et al., 1994a, 1994b; 1995a, 1995b, 1995c; Lerner and Lucas, 2015; Lucas and DiMichele, 2015; Lucas and Hunt, 1998; Lucas, 1998; Lucas, et al., 1995, 1998a, 1998b, 2005, 2015a, 2015b; MacDonald, 1995; Minter and Braddy, 2009; Minter, 2005; Schult, 1995a, 1995b; Voigt and Lucas, 2015; Voigt, et al., 2013a, 2013b). Most recently, Lucas et al. (2015a) performed a conservative reanalysis on the NMMNHS collections and concluded that eight tetrapod ichnogenera have been described in the Robledo Mountains Formation. NMMNHS holds 775 tetrapod footprint specimens collected over 48 localities within PTNM. Of those, only ~40% can be identified with certainty. Of that 40%, 90% belong to three ichnotaxa: *Batrachichnus salamandroides* (temnospondyl amphibians), *Dromopus lacertoides* (araeoscelids), and *Dimetropus leisnerianus* (pelycosaurian-grade synapsids). The remaining have been identified as *Matthewichnus caudifer* (microsaur lepospondyls), *Hyloidichnus bifurcatus* (captorhinomorphs), rare *Amphisauropus kablikae* (seymouriamorphs) and *Notalacerta missouriensis* and *Robledopus macdonaldi* (basal non-diapsid eureptilian tracks) (Voigt and Lucas, 2015). Other vertebrate inchnotaxa include *Undichna* (fish swimming trace), and *Lunichnium rotterodium* and *Characichnos* (tetrapod swim traces) (Minter and Braddy, 2009; Voigt and Lucas, 2015)

Topic: **Invertebrate Ichnofossils (Permian)**

Permian age invertebrate ichnofossils in the Robledo Mountains have been described and studied since the early 1990s (Braddy and Briggs, 2002; Braddy, 1995, 1998; Hannibal, et al., 2005; Hunt, et al., 1993, 1994a, 1995c; Kozur and LeMone, 1995b, Lucas, et al., 1995, 1998a, 1998b, 2005; Mack, et al., 2003; Minter, 2005). This culminated in a comprehensive report on the ichnology of the Robledo Mountains Formation by Minter and Braddy (2009). Since then, Lucas et al. (2013) described a scorpionid resting trace, the first of its kind from the Permian, and Lerner and Lucas (2015) described a new ichnoassociation (*Selenichnites*). The Robledo Mountains Formation is host to numerous invertebrate trackways, dominated by arthropods. Ichnotaxa include: *Dendroidichnites*, *Diplichnites* and *Diplopodichnus* (myriapods), *Kouphichnium* (xiphosurids), *Lithographus* (pterygote insects), *Octopodichnus* (arachnids), *Palmichnium* (eurypterids), and *Tonganoxichnus* and *Stiaria* (apterygote insects) (Minter and Braddy, 2009). Ichnotaxa associated to invertebrate resting traces include: *Lockeia*, *Rotterodichnium*, *Selenichnites*, and *Alacranichnus* (Minter and Braddy, 2009; Lucas et al., 2013). Ichnotaxa associated with arthropod grazing include: *Striatichnium* and *Stiallia*. Other invertebrate grazing trails include *Cochlichnus* and *Treptichnus* (Minter and Braddy, 2009). Other invertebrate ichnotaxa include *Augerinoichnus* (horizontal and coiling burrow) and the typically deep marine *Spirorhaphe azteca* (Minter and Braddy, 2009).

Topic: **Invertebrate Body Fossils**

Marine invertebrate fossils are found throughout the Paleozoic limestones in OMDPNM, although for the most part little systematic study and inventory has occurred. A notable exception is Kues (1995) who provided a systematic description of some of the marine taxa encountered in the Robledo Mountains Formation. Otherwise, most other detailed studies focus on invertebrate microfossils for their use in biostratigraphy (Copine, 1992; Flower, 1954, Flower, 1961; Flower, 1969; Harbour, 1972; Harder, et al., 2015; Hayes and Cone, 1975; Heckert, et al., 2004; Hill, 1959; Hook and Flower, 1977; Gordon, 1986; Kelley and Matheny, 1983; Kues, 1986; Kues, 2002a; Kues, 2002b; LeMone, et al., 1967; Mack, 2002; Repetski, 1982; Repetski, 1988; Wahlman and King, 2002). The Mesozoic is only represented by two geologic formations in OMDPNM: The Hell-To-Finish and the U-Bar. Both are marine limestones and shales, and contain abundant gastropods, bivalves, and foraminifera (Bowers, 1960; Powell, 1983; Seager and Mack, 1994).

Topic: **Vertebrate Body Fossils**

Subtopic: **Fish assemblage from the Late Pennsylvanian of the Robledo Mountains**

Principal Investigators: Alexander O. Ivanov (Department of Sedimentary Geology, Institute of Earth Sciences, St. Petersburg State University, Russia) and Spencer G. Lucas (New Mexico Museum of Natural History and Science, Albuquerque, NM)

The Authors describe a very diverse and rich assemblage of fossil fishes from the Upper Pennsylvanian (Missourian) interval of the Horquilla Formation in the Robledo Mountains of southern New Mexico, USA. The assemblage includes bransonelliforms, symmoriiforms, a ctenacanthiform, a jalodontid, euselachians, neoselachians, an orodontiform, a helodontiform, an eugeneodontiform, a petalodontiform, a psephodontid, an acanthodian and actinopterygians. The occurrences of protacrodontids and orodontids in the Missourian are their youngest records, and *Bransonella*, *Adamantina*, and *Cooleyella*, are the first time reported from New Mexico. For the first time, the vascularization system of the teeth of *Adamantina*, *Bransonella*, *Helodus* and *Agassizodus* has been studied using a micro-CT. The fish assemblage from the Horquilla Formation of the Robledo Mountains is one of the most taxonomically diverse assemblages of Paleozoic fish in New Mexico.

Subtopic: **Aden Fumarole, Shelter Cave, and other Cave Deposits**

Beginning in the 1920s, paleontological resources were discovered in several caves in south central New Mexico. Within the Aden Crater Fumarole was found a partially mummified adolescent Shasta Ground Sloth (*Nothrotheriops shastensis*) that was collected by the Yale Peabody Museum, where it now resides (other material collected reside in the collections of the University of Texas El Paso) (Eames, 1930; Lull, 1929, 1930; McDonald and Jefferson, 2008, McDonald and Morgan, 2011; Simons and Alexander, 1964).

Shelter Cave sits on the western side of Bishop Cap and within it was found numerus fossils of birds, reptiles, and mammals, which now reside in the collections of the Las Angeles County Museum. These collections, and others from this region, shed light on the composition of the paleofauna at the end of the Wisconsin Glaciation (Brattstrom, 1961, 1964; Carraway, 2010; Fosberg, 1936; Hall, 1936; Harris and Crews, 1983; Harris, 1977, 1985a, 1993c; Hausman, 1929, 1936; Howard and Miller, 1933; Howard, 1971; Long and Martin, 1974; McDonald and Jefferson, 2008; McDonald and Morgan, 2011; Rea, 1980; Simons and Alexander, 1964; Smartt, 1977; Stock, 1930, 1932, 1936; Strain, 1966; Tedford, 1981; Thompson, 1980; Van Devender and Spaulding, 1979; Van Devender et al., 1976).

Subtopic: **Camp Rice Paleofauna**

The Plio-Pleistocene Camp Rice Formation has a high potential to produce scientifically important paleontological resources. Hundreds of localities are documented from the New Mexico-Mexico-Texas Border up the Rio Grande Valley through Hatch, NM. While most of these localities are out of OMDPNM, several are very near the boundary, and the monument does contain large swaths of the Formation that have had little to no inventory. Every locality provides information on the larger geologic Formation, and therefore OMDPNM (Houde and Peltier, 2018a, 2018b; Lucas, 2015; Lucas, et al., 1998d, 1999, 2000; Morgan and Harris, 2015; Morgan and Lucas, 2003, 2011; Morgan, 2008, 2015; Morgan, et al., 1998, 2004, 2017, 2018; Tedford, 1981; Vanderhill, 1986).

Topic: **Paleobotany**

Initial studies of paleobotany focused on the occurrence of algae (LeMone, et al., 1967) in early Permian marine sediments, or early conifer ichnofossils that accompany the vertebrate and invertebrate ichnofossils in the terrestrial sediments (Kozur and LeMone, 1995a; Lucas, et al., 1995, 1998b, 2005; MacDonald, 1995). Tidwell and Muzing (1995) did the first research of the Permian petrified wood, however the bulk of the research was conducted more recently (DiMichele, et al., 2007, 2015a, 2015b; Kurzawe and Falcon-Lang, 2013; Falcon-Lang, et al., 2014, 2015; Krainer, et al., 2015; Lucas and DiMichele, 2015; Lucas, et al., 2015a, 2015b; Voigt, et al., 2013b). Some instances of older plant material (*Lepidodendron*) is reported from the Helms Formation in the North Franklin Mountain (Harbour, 1972; Kelley and Matheny, 1983). Thus far the only reported Cenozoic fossil plants from within the monument come from Shelter Cave (Fosberg, 1936), but the Camp Rice Formation is known to produce petrified wood and other plant material (Axelrod, 1975; Dhillon, 2011; LeMone and Johnson, 1969; Meyer, 2012).

2.1.8: Soil Resources

BLM POC: Gordon Michaud

Topic: **Soil Web Apps**

Principal Investigator: University of California (UC) Davis California Soil Resource Lab

The website for this project (https://casoilresource.lawr.ucdavis.edu/soilweb-apps) contains four Soil Apps. **SoilWeb** allows user to explore soil survey areas using an interactive Google map. View detailed information about map units and their components. This app runs in your web browser and is compatible with desktop computers, tablets, and smartphones; **SoilWeb Earth** Soil survey data are delivered dynamically in a KML file, allowing you to view mapped areas in a 3-D display. You must have Google Earth or some other means of viewing KML files installed on your desktop computer, tablet, or smartphone; **SEE** is soil series extent explorer allowing the user to explore the spatial extent of soil types nationwide. **Soil Properties** allows the user to view regional trends for a variety of soil properties.

Topic: **National Cooperative Soil Survey Soil Characterization Data**

Principal Investigator: United State Department of Agriculture

The website for this project (https://ncsslabdatamart.sc.egov.usda.gov/) is the National Cooperative Soil Survey (NCSS) Soil Characterization Database. This application allows one to generate, print, and download reports containing soil characterization data from the National Soil Survey Center (NSSC) Kellogg Soil Survey Laboratory (KSSL) and cooperating laboratories. The data are stored and maintained by the NSSC–KSSL. Data can be viewed onscreen or downloaded in comma-delimited text files for use in other applications. Website also includes a Microsoft Access database that contains the most commonly requested data from the National Cooperative Soil Survey Laboratories. The database includes data from the Kellogg Soil Survey Laboratory and cooperating universities. In addition to commonly requested data, the Access database includes metadata tables that describe the column headings of the laboratory data tables. In the Access database, the results of similar analyses have been combined and are presented in common columns. Users that wish to obtain the original data, which is separated by method codes, can download the data from the Basic or Advanced query pages. Finally website has Interactive Locator Maps, allowing userto locate pedons spatially.

Topic: **Ecological Site Descriptions – Ecosystem Dynamics Interpretive Tool (EDIT)**

Principal Investigators: U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), the U.S. Department of Agriculture Agricultural Research Service (ARS) Jornada Experimental Range and New Mexico State University.

The website for the Ecosystem Dynamics Interpretive Tool (EDIT) (edit.jornada.nmsu.edu/) is an online information system for the development and sharing of ecological site descriptions, ecosystem state and transition models, and land management knowledge. Ecological sites are the basic component of a land-type classification system that describes ecological potential and ecosystem dynamics of land areas. All land/land use types are identified within the ecological site system, including rangeland, pasture, and forest land.

Topic: **Web Soil Survey Soil Survey Geographic Database (SSURGO)**

Principal Investigators: United States Department of Agriculture NRCS

The Web Soil Survey (WSS) (https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm) provides soil data and information produced by the National Cooperative Soil Survey (USDA, NRCS 2017). It is operated by the USDA Natural Resources Conservation Service (NRCS) and provides access to the largest natural resource information system in the world. NRCS has soil maps and data available online for more than 95 percent of the nation's counties and anticipates having 100 percent in the near future. The site is updated and maintained online as the single authoritative source of soil survey information. Web Soil Survey is in Soil Survey Geographic Database (SSURGO) format, with the soil survey information displayed in tables or as maps and is available for most areas collected at a scale of ranging from 1:12,000 to 1:63,360. More details were gathered at a scale of 1:12,000 than at a scale of 1:63,360.

Topic: **State Soil Geographic Survey (STATSGO)**

Principal Investigators: United States Department of Agriculture NRCS

The website for the State Soil Geographic Soil Survey (https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053629) is a Digital General Soil Map of the United States (STATSGO2) is a broad-based inventory of soils and non-soil areas that occur in a repeatable pattern on the landscape and that can be cartographically shown at the scale mapped of 1:250,000 in the continental United States. The level of mapping is designed for broad planning and management uses covering state, regional, and multi-state areas. The U.S. General Soil Map is comprised of general soil association units and is maintained and distributed as a spatial and tabular dataset

Topic **Gridded Soil Survey Geographic Database (gSSURGO)**

Principal Investigators: United States Department of Agriculture Natural Resources Conservation Service

The website for the Gridded SSURGO (gSSURGO; https://data.nal.usda.gov/dataset/gridded-soil-survey-geographic-database-gssurgo) is derived from the Soil Survey Geographic (SSURGO) Database. SSURGO is generally the most detailed level of soil geographic data developed by the National Cooperative Soil Survey (NCSS) in accordance with NCSS mapping standards. The tabular data represent the soil attributes, and are derived from properties and characteristics stored in the National Soil Information System (NASIS). The gSSURGO data were prepared by merging traditional SSURGO digital vector map and tabular data into State-wide extents, and adding a State-wide gridded map layer derived from the vector, plus a new value added look up (valu) table containing "ready to map" attributes. The gridded map layer is offered in an ArcGIS file geodatabase raster format.

The raster and vector map data have a State-wide extent. The raster map data have a 10 meter cell size that approximates the vector polygons in an Albers Equal Area projection. Each cell (and polygon) is linked to a map unit identifier called the map unit key. A unique map unit key is used to link to raster cells and polygons to attribute tables, including the new value added look up (valu) table that contains additional derived data.

Topic **Gridded National Soil Survey Geographic Database (gNATSGO)**

Principal Investigators: United States Department of Agriculture Natural Resources Conservation Service

The website for he newest gridded National Soil Survey Geographic Database (gNATSGO; https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcseprd1464625) is a USDA-NRCS Soil & Plant Science Division (SPSD) composite database that provides complete coverage of the best available soils information for all areas of the United States and Island Territories. It was created by combining data from the Soil Survey Geographic Database (SSURGO), State Soil Geographic Database (STATSGO2), and Raster Soil Survey Databases (RSS) into a single seamless ESRI file geodatabase. The gNATSGO database contains a 10-meter raster of the soil map units and 70 related tables of soil properties and interpretations. It is designed to work with the SPSD gSSURGO ArcTools. Users can create full coverage thematic maps and grids of soil properties and interpretations for large geographic areas, such as the extent of a State or the conterminous United States.

Topic: **Dust Mitigation Handbook**

Principal Investigator: U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) and the USDA Southern Plains and Southwest Climate Hubs

The USDA Natural Resources Conservation Service (NRCS) and the USDA Southern Plains and Southwest Climate Hubs developed of a new resource – the Dust Mitigation Handbook (https://www.climatehubs.usda.gov/hubs/southwest/topic/dust-mitigation-handbook). The Handbook was authored by a team of NRCS and Agricultural Research Service (ARS) scientists, including Steve Smarik, NRCS State Resource Conservationist for Arizona and Liaison to the USDA Southern Plains and Southwest Climate Hubs in 2018-2019. The Handbook represents a "OneUSDA" vision for conservation management under varying and changing environmental conditions, and is intended for resource managers in USDA and other land management agencies who are struggling with dust challenges and working with producers to craft solutions.

Dust emission from cropland and rangeland is problematic in many areas, particularly where dry conditions and high wind velocities exist. Producers and specialists need a resource with in-depth solutions to specific dust and wind erosion problems. For a changing future, where uncertain climate and water supply conditions may prompt farmers to fallow increasing acreage of once-actively planted cropland, this handbook is a timely resource.
To view or download the manual go to: https://dust.swclimatehub.info/

Topic: **DRAFT Soil Resource Management Program Handbook**

Principal Investigator: Bureau of Land Management

This handbook outlines soil resource management program responsibilities for the system of public lands administered by the Bureau of Land Management under the Federal Land Policy Management Act and BLM Manual 7100 (Soil Resource Management, revised 15 September 2008). The handbook is in review as of 2020 (BLM Handbook-H-XXX; in review)

Topic: **Assessment of Soil and Water Resources in the Organ Mountains-Desert Peaks National Monument, New Mexic**o

Principal Investigator: U.S. Geological Survey

The U.S. Geological Survey conducted a study to assess the soil and water resources within the Monument to provide an inventory and compilation of natural-resource information needed by resource managers for the BLM's land-use planning process for this new national monument (Blake et al. 2020). The overall objectives of this study were to (1) compile and interpret existing soil- and water-resource data for the Monument and (2) provide a basic assessment of the surface hydrological effects of selected alternatives to current land use and infrastructure.

Topic: **Assessment of Water Resources and the Potential Effects from Oil and Gas Development in the Bureau of Land Management Tri-County Planning Area**, **Sierra, Doña Ana, and Otero Counties, New Mexico U.S. Geological Survey Scientific Investigations Report 2017–5151, 87**

Principal Investigator: U.S. Geological Survey

The U.S. Geological Survey conducted a study to assess the water resources and potential effects on the water resources from oil and gas development in the Tri-County planning area. The Tri-County planning includes approximately 9.3 million acres encompassing Sierra, Doña Ana, and Otero Counties, New Mexico. The study focused on a better understanding of the water uses across the Tri-County Area and the potential effects of oil and gas development on the Jornada del Muerto, Tularosa Basin, and Otero Mesa, which are three areas within the Tri-County Planning area. The overall objectives of this study were to improve the existing characterization of surface-water and groundwater resources

Topic: **Cryptogam Study**

Principal Investigator: Nicole Pietrasiak, Ph.D., New Mexico State University

During Fiscal Years 2018 and 2019 a cryptogam inventory was initiated at 26 locations within the Organ Mountains-Desert Peaks National Monument, collecting 120 samples and identifying 76 morpho species of cyanobacteria representing 47 genera. In addition to the cyanobacteria collection, a lichen survey was conducted at the same locations and yielded an estimated 100 species to date. A budget proposal has been written for Fiscal Years 2020 and 2021 to continue the study.

Topic: **Soil Survey of Doña Ana County Area New Mexico**

Principal Investigators: U.S. Department of Agriculture Soil Conversation Service (Currently Natural Resources Conservation Service); New Mexico Agricultural Experiment Station; BLM. This is the 1977 Soil Survey Manual for Doña Ana County Area New Mexico, with major fieldwork done during the period between 1961-1975. It references soil conditions in 1975 and all soil names descriptions were approved in 1975. This document was part of the technical assistance to the La Union and Caballo Natural Resource Conservation Districts. This document is used only for historical reference, with Web Soil Survey having the most current soil survey information.

Topic: **Soil Survey of Luna County Area New Mexico**

Principal Investigators: USDA Soil Conversation Service (Currently Natural Resources Conservation Service); New Mexico Agricultural Experiment Station

This is the 1967 Soil Survey Manual for Luna County with major fieldwork done during the period between 1965-1966. It references soil conditions in 1967 and all soil names and descriptions were approved in 1967. This document was part of the technical assistance furnished chiefly by the Deming Natural Resource Conservation District and to the Grant and Caballo Natural Resource Conservation Districts. This document is used only for historical reference, with Web Soil Survey having the most current soil survey information.

Topic: **Assessment Inventory and Monitoring (AIM) Data**

See 2.1.3: Vegetative Communities, above.

2.1.9: Water Resources

BLM POCs: Timothy Frey, Corey Durr

Topic: **Assessment of Soil and Water Resources in the Organ Mountains-Desert Peaks National Monument, New Mexic**o

Principal Investigator: U.S. Geological Survey (USGS)

This study presents the data used to assess the hydrologic and soil resources of the Organ Mountains-Desert Peaks National Monument (Blake et al. 2020; Mitchell et al. 2019). The overall objectives of this study are to improve the existing characterization of surface-water, groundwater, soil, and land form resources across the Monument and provide hydrologic information related to potential future infrastructure development such as trails, roads, and campgrounds. Specific objectives of this project are to compile and document published literature and existing data related to hydrologic and soil resources, identify potential weathering and erosion sites through geologic maps and modeled methods, create a land form map in order to better identify soils in the monument, and use watershed models to determine the effects of different scenarios on the environment of the monument such as grazing, lack of vegetation, and other factors.

Topic: **Rangeland Hydrology Erosion Model (RHEM) Input and Output Files**
Principal Investigators: Johanna Blake, New Mexico Water Science Center
The Rangeland Hydrologic Erosion Model (RHEM) is an online model developed by the United States Department of Agriculture that is used to predict erosion and runoff in rangelands (Mitchell et al. 2019). The model was used to determine runoff and erosion predictions for five different scenarios in the Organ Mountains-Desert Peaks National Monument. The five scenarios that RHEM used to look at in the monument include current conditions as of 2016; climate variability; scrub encroachment; drought, heavy grazing or land-use pressure; and vegetation removal.

The outputs of each scenario are represented as one shapefile which can have attributes selected to display each appropriate scenario. The model input and output files are available at: https://www.sciencebase.gov/catalog/item/5bb67df4e4b0fc368e894698

Topic: **Assessment of Water Resources and the Potential Effects from Oil and Gas Development in the Bureau of Land Management Tri-County Planning Area**, **Sierra, Doña Ana, and Otero Counties, New Mexico U.S. Geological Survey Scientific Investigations Report 2017–5151, 87**
Principal Investigator: Johanna Blake, U.S. Geological Survey
The U.S. Geological Survey (USGS) conducted a study to assess the water resources and potential effects on the water resources from oil and gas development in the Tri-County planning area, Sierra, Doña Ana and Otero Counties. Three specific areas, Jornada, Tularosa Basin and Otero Mesa, were considered (Blake et al. 2018).

Topic: **Bacterial Diversity of Water and Soil Samples from Dripping Springs in the Organ Mountains (New Mexico), Determined by Using 16S rRNA Gene Amplicon Sequencing**
Principal Investigator: John A. Kyndt, Bellevue University, Nebraska.
This is an initial microbial analysis of the spring water and surrounding microbial mat at Dripping Springs. Both soil-water and water samples showed a high level of microbial biodiversity consistent with the secluded and pristine nature of the area (Kyndt 2019).

Topic: **Geospatial scaling of runoff and erosion modeling in the Chihuahuan Desert**
Principal Investigators: Grady Ball and Kyle Douglas-Mankin, U.S. Geological Survey
Rangeland Hydrology and Erosion Model (RHEM) parameters were developed from plot-scale foliar and ground-cover transect data for an arid, grass-shrub rangeland in southern New Mexico, and a method was assessed to upscale transect-plot parameters to a large landscape. These results demonstrate that Ke parameters developed using geospatial data calibrated to plot data can be extrapolated to large spatial areas and provide reasonable simulation of runoff using RHEM. However, these same geospatial methods do not provide reasonable estimation of Kss or simulation of soil loss. Representation of litter and rock cover variables, which are highly spatially heterogeneous at the plot scale, was inadequate to accurately represent Kss or soil loss using RHEM (Ball and Douglas-Mankin 2019).

2.1.10: Air Quality
BLM POC: Gordon Michaud

Topic: **Fugitive Dust Control**
Principal Investigators: New Mexico Environment Department (NMED) Air Quality Board
NMED developed a fugitive dust rule in conjunction with the mitigation plan to detail mandatory measures to abate certain controllable sources in Doña Ana and Luna Counties. NMED Air Quality Board adopted the rule on October 26, 2018. New Mexico Administrative Code (NMAC) regulation 20.2.23 NMAC, Fugitive Dust Control (Applicable in Doña Ana and Luna Counties only).

Topic: **Air Resources Technical Report (ARTR) for Oil and Gas Development**

Principal Investigators: Bureau of Land Management

The purpose of this document is to collect, present, discuss and summarize technical information on air quality, air quality related values, greenhouse gas emissions and climate change relative to air resources with the BLM New State Office Planning areas (New Mexico, Oklahoma, Texas and Kansas). Much of the information contained in this document is directly related to air quality in the context of oil and gas development; other information is generalized air quality that can be applied to other development scenarios and assessments. This information can then be incorporated by reference into the site-specific National Environmental Policy Act (NEPA) documents (Environmental Assessment (EA), Application for Permit to Drill (APD), etc) as necessary. In addition, data is included in the appendices which can be incorporated into the site-specific analysis included in the APD EAs

Topic: **U.S EPA Air Quality Design Values**

Principal Investigators: U.S. Environmental Protection Agency (EPA)

Website: https://www.epa.gov/air-trends/air-quality-design-values. A design value is a statistic that describes the air quality status of a given location relative to the level of the National Ambient Air Quality Standards (NAAQS). Design values are typically used to designate and classify nonattainment areas, as well as to assess progress towards meeting the NAAQS. To view a list of areas designated nonattainment, see EPA's Green Book site. Design values are computed and published annually by EPA's Office of Air Quality Planning and Standards and reviewed in conjunction with the EPA Regional Offices. Some of these design values can change after the date of publication for a variety of reasons. The information listed in these reports and in these tables is intended for informational use only and does not constitute a regulatory determination by EPA as whether an area has attained a NAAQS. The Design Values are incorporated into the BLM’s Air Resources Technical Report for Oil and Gas Development

Topic **Air Now**

Principal Investigator: U.S. Environmental Protection Agency

Website: https://www.airnow.gov/. The Air Quality Index (AQI) provides information regarding how clean or polluted the outdoor air is, along with associated health effects that may be of concern. The AQI translates air quality data into numbers and colors that help people understand when to take action to protect their health.

Topic: **EPA's Regional Haze program**

Principal Investigator: U.S. Environmental Protection Agency; NMED

Website https://www.epa.gov/visibility/list-areas-protected-regional-haze-program. Regional Haze Program addresses reduced visibility in national parks and Wilderness areas. EPA refers to these areas as "Class I Areas and in New Mexico there are 9 mandatory federal Class I Areas (CIAs). For a current map and table listing New Mexico's Class I areas visit New Mexico Environment Department Air Quality Bureau regional haze website at https://www.env.nm.gov/air-quality/reg-haze/. The map and table show the areas that are protected in NM and some in neighboring states near NM's border.

On December 14, 2016, the U.S. Environmental Protection Agency (EPA) finalized revisions to the Regional Haze Rule, which describes actions that states must take when submitting regional haze state implementation plans (SIPs) and progress reports. The New Mexico Environment Department (NMED) Air Quality Bureau is the principle investigator and is the agency responsible for submitting SIPs.

Topic **Western Regional Air Partnership**

Principal Investigator: Western States

Website: http://www.wrapair2.org/emissions.aspx. The Western Regional Air Partnership (WRAP) will provide emissions data tracking and related technical analyses to assist states, tribes, federal land managers, local air agencies and the US EPA with understanding current and evolving regional air quality issues in the West. The regional effort on emissions includes work to fully characterize sources important in the West, as well as those sources contributing to Western air quality issues from outside the WRAP region.

Topic: **New Mexico Environment Department Air Monitoring Sites**

Principal Investigator: New Mexico Environment Department Air Quality Bureau

Website: http://nmaqinow.net/. Provides photos of the sites, information about what pollutants are monitored and their potential health effects, site data, customizable reports, and maps and links to other sources of air monitoring data and information. Monitoring stations focus on carbon monoxide, nitrogen oxide, particulate matter, ozone and sulfur dioxide.

Topic: **EPA Greenbook (Nonattainment Areas for Criteria Pollutants)**

Principal Investigator: U.S. Environmental Protection Agency

Website: https://www.epa.gov/green-book. The EPA Green Book provides detailed information about area National Ambient Air Quality Standards (NAAQS) designations, classifications and nonattainment status. Information is current as of the Green Book posted date and is available in reports, maps and data downloads

Topic: **AP 42: Compilation of Air Emissions Factors**

Principal Investigator: U.S. Environmental Protection Agency

Website: https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors AP-42, Compilation of Air Pollutant Emissions Factors, has been published since 1972 as the primary compilation of EPA's emissions factor information. It contains emissions factors and process information for more than 200 air pollution source categories. A source category is a specific industry sector or group of similar emitting sources. The emissions factors have been developed and compiled from source test data, material balance studies, and engineering estimates. The Fifth Edition of AP-42 was published in January 1995. Since then EPA has published supplements and updates to the fifteen chapters available in Volume I, Stationary Point and Area Sources.

Topic **Permitting Section**

Principal Investigator: New Mexico Environment Department Air Quality Bureau

This website has an electronic GIS mapping tool of permitted sources in New Mexico. APMAP provides a link (https://www.env.nm.gov/air-quality/permitting-section-home-page/) to access the tool and explore mapped permitted facilities along with their permit documents. The AQB Permitting Section processes permit applications for industries that emit certain levels of pollutants to ambient air. The Permitting Section consists of three units: The Minor Source Unit, The Major Source Unit, and The Technical Services Unit. Industries that wish to build or modify facilities that emit certain levels of air pollutants (emissions) into the air must obtain an air quality permit prior to construction. These facilities are subject to and the associated construction permits are issued pursuant to the New Mexico Administrative Code (NMAC) regulation 20.2.72 NMAC and 20.2.74 NMAC.

Topic: **Greenhouse Gases**

Principal Investigator: U.S. Environmental Protection Agency

Website https://www.epa.gov/ghgreporting. The Green House Gas Reporting Program (GHGRP) requires reporting of greenhouse gas (GHG) data and other relevant information from large GHG emission sources, fuel and industrial gas suppliers, and CO2 injection sites in the United States. Approximately 8,000 facilities are required to report their emissions annually, and the reported data are made available to the public in October of each year. In addition, the EPA's Facility Level Information on GreenHouse gases Tool (FLIGHT), provides GHG emission information filtering by facility, industry, location, or gas type.

2.1.11: Cultural Resources

BLM POC: Garrett Leitermann

Topic: **Peña Blanca Survey and Inventory**

Principal Investigators: Rani Alexander and Kelly Jenks, New Mexico State University (NMSU)

NMSU performed an archaeological survey and documentation of 120 acres in the Peña Blanca Area on the Organ Mountains-Desert Peaks National Monument. During survey, NMSU students and staff recorded rock shelters and other archaeological sites that are increasingly threatened by recreational use and vandalism. A final report of this inventory's findings was completed early in 2020 (Cowell and Jenks 2020). This inventory was part of the BLM NM RMP Support for Organ Mountains-Desert Peaks and Prehistoric Trackways National Monument project, a BLM and NMSU assistance agreement.

Topic: **Peña Blanca Excavations**

Principal Investigators: Steadman Upham, Ph.D., New Mexico State University (NMSU)

In the 1980s NMSU conducted the survey, recording, and excavation of a number of rock shelters in and around Peña Blanca. Over several summer field sessions, tens of thousands of archaeological materials were recovered from the Peña Blanca rock shelters. The excavations and subsequent limited analysis of collections has provided crucial insight into the development and origins of maize agriculture in the American Southwest (Johnson and Upham 1985; Upham et al 1987; Upham and MacNeish 1993). A final comprehensive report of the excavations and the associated collections was never produced. While several conference papers, journal articles, and master theses have stemmed from the research at Peña Blanca, the collections produced by NMSU still retain extensive research potential.

Topic: **Excavations of Chavez Cave**

Principal Investigators: C. Burton Cosgrove, Peabody Museum of Archeology and Ethnology, and Thomas O'Laughlin, Ph.D., University of Texas El Paso Centennial Musuem

In the 1930s, C. Burton Cosgrove and his wife, Harriet Cosgrove, conducted limited excavations at Chavez Cave, a prehistoric site situated on the eastern flank of the Robledo Mountains. The excavations by the Cosgroves provided some of the earliest research regarding organic artifacts and ceremonial practices within the Jornada Mogollon region of southern New Mexico (Cosgrove 1947). Decades later, Thomas O'Laughlin with the Centennial Museum at the University of Texas El Paso performed limited testing and excavation from the cave (O'Laughlin 2003). Collections from Chavez Cave are currently housed at the University Museum, New Mexico State University, the Centennial Museum at the UTEP, and the Peabody Museum at Harvard University. As of 2020, the rather brief summaries of the excavations by the Cosgroves and O'Laughlin are the only direct sources of archaeological data derived from the excavated materials. The collections from Chavez Cave retain great potential for contributing meaningful data for future archaeological research.

Topic: **Cultural Resources, Archaeology and History of the Proposed Organ Mountains-Desert Peaks National Monuments, Doña Ana County, New Mexico.**

Principal Investigators: Rebecca Proctor, New Mexico Office of Archaeological Studies, Jean Fulton, Cornerstones, and Polly Schaafsma, Independent Rock Art Researcher

In 2013, in support of designating the Organ Mountains and the Desert Peaks as a National Monument, several cultural specialists produced a report highlighting the diversity and uniqueness of the proposed Monument's cultural resources. The report provided an overview of human history within the proposed Monument from earliest periods of human history to modern day. Highlighted within the report were several key cultural resources including El Camino Real de Tierra Adentro, Apollo Mission training sites, numerous Native American rock art sites, the Butterfield Trail, and Billy the Kid's hideout amongst others. Research for the report included reviewing historical and archaeological documentation and incorporating data from several local researchers (Proctor et al. 2013). This document played a vital role in demonstrating to local, state, and federal leaders the importance and uniqueness of the proposed Monument's cultural heritage. A redacted version of the document is available for public viewing and distribution.

Topic: **Cultural Resources Overview, Desert Peaks Complex of the Organ Mountains – Desert Peaks National Monument, Doña Ana County, New Mexico.**

Principal Investigators: Myles Miller, Lawrence L. Loendorf, Tim Graves, Mark Sechrist, Mark Willis, and Margaret Berrier, Sacred Sites Research, Inc.

In 2017, Sacred Sites Research Inc, produced an overview of cultural resources within the Sierra de las Uvas and Robledo Mountains of the Organ Mountains-Desert Peaks National Monument. The cultural overview highlighted the diversity of cultural remains within the Desert Peaks unit including well known resources such as Broad and Valles Canyons, Geronimo's Cave, WWII bombing targets, and the Butterfield Trail. Research for the overview consisted of reviewing available documentation of known archaeological sites, consulting with regional archaeologists, and conducting a series of reconnaissance surveys to targeted areas and sites (Miller et al. 2017). A redacted version of the document is available for public viewing and distribution.

Topic: **Excavations of La Cueva**

Principal Investigators: Donald J. Lehmer, University of Arizona, and Thomas O'Laughlin, Ph.D., University of Texas El Paso Centennial Museum

The prehistoric rock shelter known as La Cueva is located within Dripping Springs Natural Area to the east of Las Cruces. The first archaeological excavation of La Cueva was performed by Donald Lehmer in the 1940s when he trenched portions of the cave. In the 1960s and 70s, Thomas O'Laughlin also conducted a number of test units and trenches within La Cueva. Both excavations revealed stratified deposits dating back to the Archaic and Formative periods of prehistory. The stratified deposits and temporally diagnostic materials at La Cueva proved crucial in refining the chronology of the Archaic period in the region (MacNeish 1993). While both Lehmer and O'Laughlin wrote brief summaries of their findings at La Cueva, the collections produced by these excavations have not been fully analyzed, thus retaining the potential for future research.

Topic: **Rock Art Studies in Broad and Valles Canyons**

Principal Investigator: Judith McNew, New Mexico State University

The walls of Broad and Valles Canyons are home to hundreds of petroglyphs made over the course of hundreds if not thousands of years. While rock art studies in Broad and Valles Canyons have been conducted in years prior to McNew's 1997 work, McNew was the first to produce a comprehensive volume of her research. As part of her research, McNew compared the rock art in the canyons with other rock art sites throughout the region. By conducting comparative studies, McNew sought to tie the images with specific temporal periods and offer potential interpretations of the images. One of the features of McNew's work included drawings and sketches of the rock art that she studied within the canyons. These images have proven useful in documenting changes in the condition of the images over time since McNew's research (McNew 1997).

Topic: **Research on the Archaic in the Region of Las Cruces**

Principal Investigator: Richard S. MacNeish, Andover Foundation for Archaeological Research

Over the course of several decades Richard MacNeish performed several archaeological excavations and surveys in southcentral New Mexico. Amongst the several sites that MacNeish excavated during the course of his research were Todsen Cave and the North Mesa site, both of which are located within the Monument (Beckett and O'Laughlin 1968). Currently it is unknown where these collections are stored and if these collections still exist. In addition, MacNeish utilized existing datasets and collections from Monument related sites including La Cueva and several rock shelters at Peña Blanca for his research. The research conducted by MacNeish was critical in defining the cultural sequence for various phases of the Archaic period and in understanding the development of agriculture in the Jornada Mogollon region (MacNeish 1993).

Topic: **Class III Cultural Inventories**

Principal Investigators: Various

Since the passage of the National Historic Preservation Act in 1966, Class III cultural inventories have been a cornerstone of the federal review process in order to meet compliance standards set forth in Section 106 (36 CFR 800). Class III cultural inventories identify and record archaeological sites and isolated manifestations within a defined area by means of intensive pedestrian survey. The records produced by these inventories include site forms and GIS data that allow cultural specialists to make informed decisions in regards to the management of archaeological sites. While such investigations are not research in the strictest sense of the term, they have provided the majority of the currently available data on archaeological sites throughout the Monument. Currently, only 2% of the Monument has been formally inventoried for cultural resources.

2.1.12: Wilderness

BLM POC: Edna Flores

Within the Monument are 10 Wilderness areas that were established when S. 47, the John D. Dingell, Jr. Conservation, Management, and Recreation Act of 2019 was signed into law in March 2019 (Dingell Jr. 2019). Seven of the ten areas had been previously designated and managed as Wilderness Study Areas but had no known scientific studies related to their designation.

2.1.13 Recreation

BLM POC: Edna Flores

Topic: **Recreation Experience Baseline Study**

Principal Investigator: Tim Casey, Colorado Mesa University

The Recreation Experience Baseline Study was conducted in the OMDPNM in the Spring of 2017 by the University of Alaska Fairbanks, New Mexico State University, and Colorado Mesa University. The study was an effort to assess characteristics, desired experiences, desired benefits, and management of visitors to the Monument. The data gathered would be incorporated into the Resource Management Plan for the Organ Mountains-Desert Peaks National Monument. The study concluded that the majority of visitors have had positive experiences and were satisfied with their visit. However, visitors noted that services could be improved with the addition of restroom facilities, visitor centers, developed campgrounds, and more BLM-provided information (Fix et al 2018). The completed published report can be found on the Natural Resource Center website of Colorado Mesa University at http://www.coloradomesa.edu/natural-resource-center/NRC-Reports/national-conservation-lands.html.

2.1.14: Socioeconomics

BLM POC: Michael Johnson

Topic: **National monuments and economic growth in the American West**

Principal Investigator: Margaret Walls, Ph.D., Resources for the Future

National monuments in the United States are protected lands that contain historic landmarks, historic and prehistoric structures, or other objects of historic or scientific interest. Their designations are often contentious. The authors used panel data on all business establishments in the eight-state Mountain West region to estimate economic impacts of 14 monument designations over a 25-year period. They found that monuments increased the average number of establishments and jobs in areas near monuments; increased the average establishment growth rate; had no effect, positive or negative, on the number of jobs in establishments that existed pre-designation; and had no effect on mining and other industries that use public lands. On net, protecting lands as national monuments has been more help than hindrance to local economies in the American West. (Wells et al. 2020)

https://advances.sciencemag.org/content/6/12/eaay8523

https://www.resourcesmag.org/archives/national-monuments-can-boost-economy-american-west/

Topic: **TriCounty RMP/EIS and the Organ Mountains-Desert Peaks National Monument RMP/EIS: Baseline Socioeconomic Report**

Principal Investigator: Mara Weisenberger, Monument Manager, OMDPNM, BLM

Prepared by: U.S. Department of the Interior, Bureau of Land Management, Las Cruces District Office, Las Cruces, New Mexico. 2018.

This baseline socioeconomic study provides descriptive social, economic, demographic, and population data for the area of Doña Ana, Otero, Luna, and Sierra Counties, New Mexico, and El Paso County, Texas. The Organ Mountain-Desert Peaks National Monument lies entirely within that study area, and was included as a consideration in the report. The report also identifies specific environmental justice populations of concern within the study area, and addresses possible outreach methods for those populations. Otero and El Paso Counties were included in the study specifically to encompass user populations outside of the immediate planning area.

Topic: **Organ Mountains-Desert Peaks National Monument Outcomes-Focused Management (OFM) Recreation Focus Group Study, 2016 - 2017.**

Principal Investigator: Tim Casey, Colorado Mesa University

This document is a final report of the results of multiple focus groups led by the investigators to determine public uses, perceptions, and values associated with the OMDPNM. These data illustrate seasonality of use, preferred uses, preferred use areas, and user characteristics. Also addressed are intensity and duration of use episodes (Casey et al. 2018).

Topic: **Organ Mountains-Desert Peaks National Monument Outcomes-Focused Management (OFM) Recreation Study, Spring 2017.**

Principal Investigators: Tim Casey, Colorado Mesa University

This report provides analysis and interpretation of both on-site and mailed surveys of users of OMDPNM. User demographics, preferences, and perceptions of the Monument are captured in order to inform management decisions concerning use areas, user numbers, and access points (Fix et al. 2017).

Topic: **The Economic Importance of National Monuments to Communities**

Principal Investigator: Headwaters Economics

This economic impact analysis of 17 recently designated National Monuments, including OMDPNM, provides a useful general summary of community economic benefits deriving from monument designations (Headwaters Economics 2017).

2.2: Ongoing research and science on Organ Mountains-Desert Peaks National Monument

Notable ongoing research projects on the OMDPNM are highlighted in Table 1.

Table 1. Ongoing Research in the Organ Mountains-Desert Peaks National Monument

Science Area	Research Topic/Question	Research Description
Fish, Wildlife, and Habitat	*None*	None beyond what is described in section 2.1
Special Status Species	Taxonomy of the Sneed's pincushion species complex	A project using genetic data to resolve taxonomic uncertainty in this species complex was initiated in 2019. J. Mark Porter is leading this research, which is co-funded by USFWS and the BLM. Tissue samples are being collected in 2020, and collection of genetic data is expected to begin in late 2020 or early 2021.
	Occurrence and Habitat use by Leptonycteris bats in the Southwest	Principal Investigator: Kathryn E. Stoner, Ph.D., Colorado State University. This is a funded BPSS project proposal by Marikay Ramsey, originally in conjunction with New Mexico State University. The study is now through Colorado State University. The current Assistance Agreement for the work extends through 2022. The study consists of long-term monitoring of populations of Leptonycteris spp. In New Mexico, as well as their roost sites, and their main plant resources (agave) in this region, in order to determine the effects of climate change on this endangered species. This project is in the Bootheel, outside of OMDPNM boundaries.
	Genetics of Organ Mountains evening primrose	Bing Li, a graduate student with Kay Havens at Chicago Botanic Garden, is working on a project that involves comparing genetic diversity of wild populations to cultivated plants in botanic gardens. Plant materials are being collected in 2020.
	Habitat Selection by the Organ Mountains Colorado Chipmunk.	Principal Investigators: Brittany R. Schweiger and Jennifer K. Frey, NMSU. There is a need to better understand this endangered and iconic chipmunk's ecology and habitat selection in order to evaluate threats and make informed management decisions. See section 2.1.2 for additional information

Science Area	Research Topic/Question	Research Description
Vegetative Communities	*None*	None beyond what is described in section 2.1
Livestock Grazing	*None*	None beyond what is described in section 2.1
Wildland Fire Ecology and Management	*None*	None beyond what is described in section 2.1
Geological Resources	Geologic research at Aden Crater, Kilbourne Hole, and Vicinity	Jose Miguel Hurtado, UTEP Jacob Bleacher and Kelsey Young, NASA Goddard Space Flight Center Authorized from 2019 through 2025, They intend to learn more about the processes that formed Kilbourne Hole and to determine the number of eruptive events as well as the water-magma interactions that occurred. This will be done with non-destructive scientific instruments, such as gravimeters and ground penetrating radar. However, small samples will be collected to calibrate the field measurements using precision laboratory methods.
	Metapelitic xenolith research at Kilbourne Hole	PI: Roberta Rudnick and Mary Ringwood, University of California, Santa Barbara Department of Earth Science Authorized FY 2019. They intend to learn more about the processes by which sediments are transported to the lower crust of stable continental regions by studying metamorphosed mud xenoliths (metapelites) found at Kilbourne Hole. Potentially this would allow them to test the “relamination hypothesis,” which states that subducted continental crust undergoes density separation, with mafic material entering the mantle while fesic material buoyantly rises and adheres to the base of the crust. Methods used to test this hypothesis include radiometric dating, specimen thin-sectioning, and whole rock geochemistry using x-ray fluorescence.
Paleontological Resources	*None*	None beyond what is described in section 2.1
Soil Resources	Cryptogam Inventory	In Fiscal Years 2018 and 2019 field and laboratory work was conducted on cryptogams collected on the OMDPNM. See section 2.1.8.

Science Area	Research Topic/Question	Research Description
Water Resources	Groundwater Monitoring	PIs: Alex Rinehart and Ronni Grapenthin, NMBGMR. Authorized in 2018, two monitoring stations were installed, one on the edge of the Afton Lava Flow and the other near DPNA. Will study how the ground surface subsides in response to the removal of water at depth using a technique that is based on GPS. Potentially this would allow them to learn about aquifer parameters and groundwater storage on a basin-wide scale without the need to drill wells.
Air Quality	*None*	None beyond what is described in section 2.1
Cultural Resources	Prehistoric Maize Cultivation Study	New Mexico State University is performing a study of the morphological and genetic variation of ancient maize in order to understand how new landraces developed that could survive in colder and drier climates, thus allowing maize agriculture to spread across the deserts, into the higher latitudes, and eventually across the continent.
	Peña Blanca Collections	New Mexico State University is currently reexamining archaeological collections excavated from the rock shelters in and around the Peña Blanca area from the 1980s. The collections have not been seriously studied since the 1980s/1990s and still retain valuable data regarding Archaic and Formative period lifeways and adaptations in the Organ Mountains.
	Rock Art Study and Inventory	Since the Monument's designation, BLM volunteers and the Doña Ana Archaeological Society's Rock Art Recording team have been actively reporting and recording all known rock art sites within OMDPNM. Such inventories provide researchers with an ever-growing data set.
Wilderness	*None*	None beyond what is described in section 2.1
Recreation	*None*	None beyond what is described in section 2.1
Socioeconomics	*None*	None currently.

3: MANAGEMENT DECISIONS AND SCIENCE NEEDS

Table 2 describes desired future science needs and associated management decisions, with the following Priority Levels:

High: Research that is critical to inform management decisions on NLCS units within 1-3 years.
Medium: Research that could be relevant to future management of NLCS units.
Low: Research that will advance the scientific understanding of NLCS units, but that is not immediately relevant for management decisions.

Table 2. Science Needs in the Organ Mountains-Desert Peaks National Monument

Science Area	Desired Research Topic	Priority level	Description/ Pertinent Management Decisions
Fish, Wildlife, and Habitat	Raptor surveys	High	Conduct raptor surveys within the Rough and Ready Hills, Doña Ana Mountains, and Sugarloaf within the Organ Mountains. With the increase in recreational rock climbing and the expressed interest in commercial rock climbing the need is imperative to ensure nesting is not being affected.
	Bat Survey Work	Low	Using North American Bat protocols gather monitoring data to assess changes in bat distributions and abundances on OMDPNM. Locate active roosts, determine population trends, and forage ranges, to protect and maintain a healthy ecosystem.
Special Status Species	No priority research for animals currently identified	Low	Additional research related to wildlife special status species is currently a low priority due to ongoing studies with the Organ Mountain Colorado Chipmunk and the Dona Ana Talussnail Other research will be considered if a species requires special management consideration to promote their conservation and reduce the liklihood and need for future listing under the ESA.
Vegetative Communities	Noxious Weed Surveys.	Medium	Monitor and manage noxious weed species per the Noxious Weed Management Act of 1998. Many locations of noxious weeds are known within the Monument. However, additional surveys would help determine additional areas not frequented as often, monitor existing populations and potential spread.
Livestock Grazing	Compatibility of grazing with monument ROVs	Medium	There is little research indicating what level of livestock forage utilization would be consistent with management that prioritizes the ecological condition of the vegetation-related ROVs identified in the monument.
Wildland Fire Ecology and Management	Monitor AIM plots and photo points in Dripping Springs prescribed burn unit every 2-3 years	Medium	AIM protocol calls to read plots every 5 years, but to more closely monitor fire effectiveness as a safe zone and potential nonnative plant invasions, recommend data collection for existing AIM plot and photo points be every two to three years.

Science Area	Desired Research Topic	Priority level	Description/ Pertinent Management Decisions
Geological Resources	Olivine at Kilbourne Hole	High	The mantle olivine and peridot found at Kilbourne Hole is one of a handful of locations on Earth where they are found. Understanding the rates of casual and research collecting are needed to manage the resource for future generations.
	Organ Mountains and Doña Ana Calderas	Low	Continued research of the formation, composition, and age of the Calderas.
	General Geologic Research	Low	Many aspects of all geologic formations can be studied.
	Cave Inventory	High	Little is known about the locations or conditions of the many caves within OMDPNM. Per the Federal Cave Protection Act, caves on federal lands must be assessed for significance, and then managed in a manner which protects and maintains, to the extent practical, significant caves.
	Geo Research Database	Low	Create a geodatabase that complies study areas of all previous research, including where samples were collected, and stratigraphic sections measured. This will help track what has been accomplished and help analyze cumulative effects.

Science Area	Desired Research Topic	Priority level	Description/ Pertinent Management Decisions
Geological Resources, cont.	Geologic map coverage at 1:24,000 scale	Low	The following 7.5' quadrangles contain portions of OMDPNM but have yet to be fully geologically mapped at 1:24,000: • Hockett • Goodsight Peak NE • Organ • Lazy E Ranch • Las Cruces • Organ Peak • Cambray • Mount Aden • San Miguel • Bishop Cap • X-7 Ranch • Mount Aden SW • Aden Crater • Afton • La Mesa • Newman SW • P O L Ranch • Potrillo Peak • Mount Riley • Kilbourne Hole • Camel Mountain • Guzmans Lookout Mountain • Mount Riley SE • Potrillo

Science Area	Desired Research Topic	Priority level	Description/ Pertinent Management Decisions
Paleontological Resources	Paleontological Resource Inventories	High	Much of OMDPNM lacks official inventory for fossil resources, despite having many areas of high potential.
	Detailed Paleozoic Marine Inventory	Low	Most previous studies of Paleozoic formations have broadly discussed the marine invertebrates found, but few if any systematic studies have been conducted to fully understand the complete paleofauna.
	Detailed Cretaceous Marine Inventory	Low	Most previous studies of the limited exposures have broadly discussed the marine invertebrates found, but few if any systematic studies have been conducted to fully understand the complete paleofauna.
	Biostratigraphy	Low	The collection and study of microfossils, such as conodonts and fusulinids, will refine the relative geologic ages of the marine sediments, broadly aiding all other geologic studies.
	Collections Management I (Inventory)	Medium	Paleo resources have been collected from federal land over the last 100 years, but we do not understand the location and condition of these far-flung collections.
	Collections Management II (Curation)	Low	Some materials that have been collected are not fully curated and therefore cannot be researched. These materials need to be curated and research-ready
	Collections Management III (Research)	Low	The previously collected materials have not been fully described or researched in general, limiting our understanding of the paleofauna
	Assessing known and future paleontological resources for threats	High	The general condition of localities is known, but not the condition trend. Threatened localities may need mitigation.
	Further inventory of Jerry MacDonald's localities not in NMMNHS database	High	Monitoring/resource protection and future research requires accurate locations of paleontological resources. Many of these sites have not been evaluated for research/education/interpretation qualities

Science Area	Desired Research Topic	Priority level	Description/ Pertinent Management Decisions
Soil Resources	Update OMDPNM Soil Map Unit Polygons. Update/ Rewrite/ Write Ecological Sites associated with the Updated Soil Map Unit Polygons; The U.S. Department of Agriculture Natural Resources Conservation Service Soil Survey Office is currently updating the Mesilla and Jornada bolsons, which include a part of the OMDPNM.	High	Most of the major field work for the Doña Ana County Soil Survey was done between 1961 and 1975, with soil names and descriptions approved and finalized in 1977. Soil taxonomy, soil concepts and soil techniques have changed in the past forty years. Soil map unit concepts identified and approved in 1977, require updating . Soil map units are the basic building block for soil survey because soil interpretations are derived from soil map units. Soil interpretations predicts soil behavior for specific soil uses and under specified soil management practices. Soil map units generally consists of one or more major soil, but a few map units are made of miscellaneous areas. Miscellaneous areas have little or no soil material and, therefore, do not have soil interpretations associated with them. Within the Doña Ana County soil survey there are eight soil map units that have the Rock Outcrop miscellaneous area as a component, comprising approximately 288,988 acres (60%) of the OMDPNM. To follow BLM's Standards for Public Land Health and Guidelines for Livestock Grazing detailed soils' spatial and attribute information is required to make management decisions. The map units with Rock Outcrop miscellaneous area lack detailed attribute information and this includes ecological site descriptions.
Air Quality	None currently identified	NA	New Mexico Environment Department Air Quality Bureau has a robust monitoring plan in place
Cultural Resources	Pedestrian Inventory of OMDPNM for Cultural Resources	High	Current data indicates that approximately only 11,000 acres of the nearly 500,000 acres of OMDPNM have been systematically surveyed for cultural resources. Targeted surveys of locations in OMDPNM that have known unrecorded sites or a high probability for archaeological sites should be a priority.
	Condition Assessment, Ground Truthing, and Re-Recording of Known Archaeological Sites	High	Many of the known archaeological sites within OMDPNM were originally identified and recorded several decades ago. Many of these sites suffer from GIS misplotting and associated records typically contain poor quality information regarding the nature and condition of the sites. Updating site information and records would provide a more robust dataset for researchers and management.

Science Area	Desired Research Topic	Priority level	Description/ Pertinent Management Decisions
Cultural Resources, cont.	Identify and Contact Museums and Universities that Maintain Archaeological Collections from OMDPNM	Low	Several archaeological sites around OMDPNM have been subjected to either limited or systematic excavation. In many instances, formal reporting of these excavations and a detailed analysis of the artifact assemblages were never completed. In some cases, the condition and whereabouts of these collections are unknown. Making such collections available for public research and viewing should be a priority.
	Collaboration and Consultation with Affiliated Native American Tribes	Medium	OMDPNM encompasses lands and archaeological sites that 12 federally recognized Native American nations claim historical and cultural affiliation with. By building rapport and relationships with the tribal nations OMDPNM should aspire to collaborate with tribes to identify traditional cultural properties and sacred sites. OMDPNM should partner and consult with tribal nations to devise the best possible management practices and strategies for the continued preservation and protection of historic properties of indigenous origin. In addition, tribal consultation may aid in identifying potential research topics that are of interest and important to the affiliated tribes.
	Oral History/History of OMDPNM	Low	An extensive oral history with local ranchers, tribal elders/members, historians, and local persons of interest should be conducted in order to produce a comprehensive history of OMDPNM from the perspective of its local residents. The study would focus on how different groups conceptualize the lands of OMDPNM along with the stories and memories they associate with the landscape. May also hold the potential to identify areas of cultural significance or previous unknown archaeological sites. The publications stemming from this research would be for public consumption and enjoyment. Such research would ideally be done in partnership with New Mexico State University and local historical societies.

Science Area	Desired Research Topic	Priority level	Description/ Pertinent Management Decisions
Cultural Resources, cont.	Comprehensive Research and Inventory of Dripping Springs Natural Area.	Medium	Dripping Springs Natural Area (DSNA) is home to several historic properties that are important to local and regional history: La Cueva, Modoc Mine, Boyd's Sanitarium, Van Patten's Mountain Camp, and the A.B. Cox Ranch. While there is a substantial amount of documentation related to these sites, there has yet to be an effort to compile all relevant information into a comprehensive document. Research for DSNA should include compiling historical photos, filling out and updating Laboratory of Anthropology forms and HCPI Forms, mapping and site recording, preparation of maps in GIS, and conducting oral histories. As DSNA is one of the most heavily visited areas with OMDPNM, further research will aid in future management decisions.
	Development of Site Monitoring Programs	Medium	A routine monitoring program for archaeological sites within OMDPNM should be developed in collaboration with local friends groups and organizations. A monitoring program for select archaeological sites will be able to answer research questions regarding the nature and extent of potential impacts that increasing recreation has on cultural resources within the Monument. Such research will aid in the development of protective and mitigative strategies for the resources in a timely fashion.
Wilderness	Wilderness Characteristics Baseline Report	High	Develop Wilderness area baseline conditions report for future monitoring efforts and Wilderness Management Plans.
Recreation	Carrying capacity studies for recreation sites and recreation hot spots throughout areas in the monument.	High	Carrying capacity study would provide BLM with information on the relationship with overcrowding and its effects on the resources.
Socioeconomics	Survey of user experience for comparative use with initial user preference studies done in 2016-2017.	Medium	Results would inform management decisions on how user perceptions change over time.

4: MEETING SCIENCE NEEDS

An effective internal organization is necessary to strategically identify and address science at OMDPNM. The internal organization is effective if it promotes **interdisciplinary** awareness among staff and scientists. Specifically, communication around management on the Monument among scientists and management specialists in different disciplines is critical for successful incorporation of science.

4.1: Science Needs Responsibilities

The Monument Manager and District Manager will serve as the overarching managers of scientific inquiries on the Monument. The role of Organ Mountains-Desert Peaks Science Coordinator will be filled by the Monument Paleontologist. The Science Coordinator will work directly with the Monument Manager and District Manager to assist in this process, collaborating with appropriate BLM staff in the Las Cruces District Office (LCDO) and science partners. The roles of the Science Coordinator in relation to scientific inquiries on OMDPNM are:

- Serving as the point of contact for scientific inquiries, from both internal and external sources. Scientific inquiry proposals must be submitted in writing. Requests for destructive analysis of museum property must be coordinated with the NMSO for archaeological collections; this authorization is not delegated below the Deputy State Director for Resources.
- Distributing information about new and ongoing research to the Interdisciplinary (ID) Team.
- Coordinating the processing of research permits for the Monument, working with resource specialists on OMDPNM to (if applicable): identify the issues in conducting the research; ensure appropriate planning and environmental reviews are in place; and ensure appropriate mitigation measures and research permit stipulations are implemented. If appropriate, the Organ Mountains-Desert Peaks Science Coordinator will also prepare the research permit for signature by the Monument Manager. Note that there may be instances when issuance of a permit for scientific research is best issued by a specific resource specialist, under whom the research areas falls. For example, Paleontological Resource Use permits are issued by the Regional Paleontologist in NMSO. Cultural resources use permits and Archaeological Resources Protection Act

permits are issued by the NMSO and signed by the Deputy State Director of Resources, Lands and Realty.

- Coordinating internal/external scientific inquiries with the Monument Manager.
- Coordinating the inquiry process with the applicant and other scientific partner, if necessary.
- When appropriate, coordinating the process of requesting, administering, and utilizing BLM funds for proposed inquiries.

4.2. Collaboration and Partnerships

- Collaboration and open communication with existing and potential science partners is critical to the success of implementing of the Science Plan. This collaboration will ensure that research on Organ Mountains-Desert Peaks National Monument is pertinent to the protection of Monument objects and future management decisions.
- Cooperative Ecosystem Study Units (CESUs) enable effective collaboration with universities. The Las Cruces District Office and OMDPNM are part of the Desert Southwest CESU Network, along with New Mexico State University. Specifically there is a financial assistance agreement in place.
- Current Scientific Partnerships with OMDPNM:
    - There is a financial assistance agreement under a CESU for cultural resources studies with New Mexico State University
    - New Mexico State University currently has archaeological collections that are under the control of the BLM and are managed as federal museum property.
    - Las Cruces Museum of Nature and Science
    - New Mexico Museum of Natural History and Science (Albuquerque), which is the repository for OMDPNM collections.
    - County Museum of Los Angeles.
    - Smithsonian Institution - National Museum of Natural History

5: SCIENCE PROTOCOLS

5.1. General Science Guidelines

- Integrate the goals of 'Advancing Science in the BLM: An Implementation Strategy' whenever possible (BLM strives to further science in all we do and to link the National science plan with other science plans).
- Scientific inquiries will comply with current and relevant agency laws and regulations.
- Scientific research should not detrimentally impact the long term health or sustainability of NCA objects or other resources of OMDPNM.
- Scientists initiating research projects within OMDPNM must be aware of existing data within the BLM and should incorporate these data into projects whenever possible.
- Proposed research will follow guidelines in the DOI's "Integrity of Scientific and Scholarly Activities" policy established in Departmental Manual Part 305 Chapter 3.
- External scientific projects, including UAV data collection, must apply for and receive a research permit from the Monument Manager in order to proceed (see section 5.2).
- All scientific inquiries will be presented to the ID team for review.

5.2. Authorization and tracking process

- Proposals, including those from the Research and Stewardship Partnership, will be submitted to the OMDPNM Science Coordinator.
    - The proposal (not to exceed 3 pages) will include the following:
        - Contact information of the principal investigator;
        - Background information of the question being studied (including any existing research);
        - Site locations, including any geospatial information;
        - Rationale for research;
        - Methods of conducting the research;
        - Timeline for field work;
        - Deliverables; and,
        - Outline of public outreach effort, if appropriate.
- If the proposal includes destructive analysis of federal museum property, this request must be processed by the appropriate NMSO specialist (i.e., Regional paleontologist for paleontological collections or the Cultural Resources program lead for archaeological collections).

- The Monument Manager will review the proposal for completeness and consult with the appropriate BLM resource specialist(s) to determine the scientific validity and integrity of the proposal, and potential impacts to resources and resource uses.

- The Monument Manager will brief the District Manager upon receipt of request to conduct research. In coordination with the Monument Manager, the District Manager will determine whether the proposal:
    - Is consistent with this Science Plan;
    - Meets OMDPNM scientific mission (see Section 1);
    - Conforms with the Mimbres RMP (USDI, BLM 1993); and,
    - Is consistent with other current and relevant agency laws and regulations.
    - In addition, for proposals from the Research and Stewardship Partnership, the District Manager and Monument Manager will coordinate with the partnership to ensure it meets the goals and objectives of the partnership.

- If the proposal is not accepted, the Monument Manager will provide written notification and justification to the applicant of the decision as soon as practical.

- If the proposal is accepted:
    - The Monument Manager will determine what, if any, NEPA analysis is required to carry out inquiry.
    - If a Categorical Exclusion or Environmental Assessment is needed, the Monument Manager will assign an ID Team (including a team lead/project manager) comprised of appropriate resource specialists.
    - Resource specialists will review the proposal to determine what mitigation or stipulations need to be included in the authorization (i.e. research permit).
    - When appropriate, the OMDPNM Science Coordinator will prepare a research permit for the applicant to be approved by the Monument Manager.
        - For paleontology specifically, permitting is handled by the Regional Paleontologist (currently in NM State Office). following the BLM 8270 Manual and Handbook for Paleontological Resource Management

    - The research permit will be sent to the applicant for review and signature. The permit will be returned to the Monument Manager for final signature and approval.
    - Reporting for all scientific investigations will require:
        - Annual progress reports to be filed with the Monument Manager and appropriate BLM resource specialist.
        - A final report that includes an executive summary, research background and results; results' relevance to OMDPNM management; public outreach efforts; and copies of published papers resulting from the scientific inquiry.

- If permit stipulations are not adhered to, the research permit can be canceled, in writing, by the Monument Manager.

6: ORGANIZATION AND COMMUNICATION OF COMPLETED SCIENCE

6.1 Scientific Background Needed for Updates

- Section 2 of this report provides a brief summary of the scientific background of the unit, and provides citations to the relevant reports in the bibliography (Section 9) of this science plan. At every revision of the science plan, these sections will be updated.

6.2. Internal Communications and Tracking

- All reports described in Section 5 will be stored, organized, and shared on a share drive or sharepoint site, accessible to all staff on the LCDO. The Science Coordinator should strive to organize periodic presentations of scientific results to District Office staff.
  - Options to consider:
    - Put final science reports into state-level drive (once developed, i.e. not cultural resources/site locals).
    - Consider putting reports into the “Common Folder”
- All internal communications will be shared with the ID team.

6.3. Communication to the Broader BLM Organization

- The Monument Manager will comply, in a timely manner, with all requests for completed scientific investigations (e.g. reports, publications, etc.) from BLM Field, District, State, and Washington offices.
- OMDPNM Science Coordinator will upload final science reports into state-level drive (once developed, i.e. not cultural resources/site locals).
- Ongoing studies will be documented in the Monument annual report.

6.4. Communication of Scientific Results to the Public

- The Monument Manager, in coordination with the LCDO Public Affairs Officer and/or the State Public Affairs Specialist, will strive to make information on science projects within OMDPNM accessible to the general public. This includes posting updates on OMDPNM’s website in formats such as written descriptions of scientific inquiries or citations of published research; press releases; using social media websites like Facebook or Twitter; brown bag lunch presentations; leading field tours; participating in community outreach events, etc.
- LCDO has one of the only locally-managed Facebook pages, which could be an outlet for science communication.

7: INTEGRATING SCIENCE INTO MANAGEMENT

7.1. Communications

- Direct communication between the District Manager, Monument Manager, Science Coordinator, scientists, and ID team.
- It is the responsibility of the Science Coordinator to ensure that scientific findings are communicated to the local resource specialist, the relevant State Office resource specialist, the State Office Science Coordinator, the Monument Manager and the District Manager via methods outlined in Section 6. Subsequently, the managers will be able to use the scientific information, as appropriate, in management decisions related to OMDPNM.

7.2. Integration

- Integrating scientific findings into management decisions should not end scientific inquiry into a specific topic.
- Science will be integrated into management decisions, particularly during the NEPA process, contract specifications, and terms and conditions language on permitting, to the best ability while working within existing policy and regulatory guidelines.
- Using science in the decision making process should provide an opportunity to identify future science needs to adaptively manage for certain objectives.

8: SCIENCE PLAN REVIEW AND APPROVAL

SIGNATURE PAGE

I affirm that I have read, understood, and approved the 2020 Science Plan for the Organ Mountains-Desert Peaks National Monument.

This plan will be used as the basis for conducting science in Organ Mountains-Desert Peaks National Monument. “Science” is defined in Section 1 of this plan.

As a living document, this plan will be updated as needed. Scientific needs that emerge during the course of implementing this plan may be added to the plan on an as-needed basis to meet the needs of the Organ Mountains-Desert Peaks National Monument, and the Bureau of Land Management.

WILLIAM CHILDRESS Digitally signed by WILLIAM CHILDRESS Date: 2020.09.03 11:22:09 -06'00'

William Childress Date
District Manager
Las Cruces District Office, Bureau of Land Management

MARA WEISENBERGER Digitally signed by MARA WEISENBERGER Date: 2020.09.03 12:28:59 -06'00'

Mara Weisenberger Date
Monument Manager
Las Cruces District Office, Bureau of Land Management

MCKINNEY BRISKE Digitally signed by MCKINNEY BRISKE Date: 2020.09.03 14:00:20 -06'00'

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11: UNIT’S LEGISLATION

Administration of Barack Obama, 2014

Proclamation 9131—Establishment of the Organ Mountains-Desert Peaks National Monument

May 21, 2014

By the President of the United States of America, A Proclamation

In southern New Mexico, surrounding the city of Las Cruces in the Río Grande's fertile Mesilla Valley, five iconic mountain ranges rise above Chihuahuan Desert grasslands: the Robledo, Sierra de las Uvas, Doña Ana, Organ, and Potrillo Mountains. These mountain ranges and lowlands form the Organ Mountains-Desert Peaks area.

The Organ Mountains-Desert Peaks area is important for its ruggedly beautiful landscape and the significant scientific, historic, and prehistoric resources found there. The abundant resources testify to over 10,000 years of vibrant and diverse human history of many peoples.

Objects left behind by this multi-layered history and spread throughout this geologically and ecologically diverse landscape enhance the experience of visitors to the area and represent a vital resource for paleontologists, archaeologists, geologists, biologists, and historians.

Archaeologically rich, the Organ Mountains-Desert Peaks area features hundreds of artifacts, rock art, dwellings, and other evidence of the Native peoples of the area. Three of the many rock art areas are in the Las Valles Canyon in the Sierra de las Uvas, the Providence Cone area in the Potrillo Mountains, and the Doña Ana Mountains. Scattered Paleo Indian artifacts, including those from the Folsom and Clovis cultures, represent the first people who lived in southern New Mexico and have been found in the Robledo and Potrillo Mountains as well as the Las Uvas Valley. The majority of the cultural items known to be in the Organ Mountains Desert Peaks area are from the Chihuahuan Archaic period between 8,000 and 2,000 years ago. Diverse rock art images, along with ceramic fragments, demonstrate that the area was the scene of many cross-cultural interactions as the region's early occupants transitioned over time from roaming hunters to semi-permanent villagers.

The deeply creviced peaks of the Organ Mountains, named in 1682 by early European explorers for their resemblance to organ pipes, conceal numerous ancient dwellings, including La Cueva, and other caves where smoke-blackened ceilings evidence long-extinguished campfires. The Native people of these mountains used natural overhangs for shelter and food storage, and their obsidian points, basket fragments, and food remains are still present. Small caves and pit-house villages can be found across the landscape, including ruins of a ten-room pueblo in the Robledo Mountains.

El Camino Real de Tierra Adentro National Historic Trail memorializes an early trading route linking numerous pre-existing Native American footpaths to connect Spanish colonial capitals. The Trail, used through the 19th century by travelers, traders, settlers, soldiers, clergy, and merchants, skirts the Organ Mountains-Desert Peaks area as it follows the Río Grande Valley. Explorers and travelers along the Trail documented the marvels of this area in their journals and explored the mountains in search of mineral riches and game. Historians continue to study the southernmost portion of the area, which was acquired in 1854 as part of the Gadsden Purchase, the final territorial acquisition within the contiguous United States.

In the 1800s, the Organ Mountains-Desert Peaks area was central to several battles among the Apaches, Spanish, Mexicans, and Americans, and between Union and Confederate troops. The first Civil War engagements in New Mexico were fought in the Organ Mountains when Confederate soldiers used Baylor Pass Trail to outflank Union soldiers. In a Robledo Mountains legend, the famed Apache leader Geronimo is said to have entered a cave to avoid U.S. soldiers; while the soldiers stood guard at the only entrance of what is now known as "Geronimo's Cave," the Apache leader mysteriously disappeared without a trace. An 1880s U.S. military heliograph station, the remains of which still stand at Lookout Peak in the Robledo Mountains, transmitted Morse code messages during the Army's western campaigns.

In the late 1850s, John Butterfield developed the Butterfield Overland Trail, a mail and passenger stagecoach service from Memphis and St. Louis to San Francisco. Butterfield set upon improving the segments of the Trail in southern New Mexico that had been previously used by Spanish explorers, the Mormon Battalion, and western settlers. Crossing the Organ Mountain-Desert Peaks area are about 20 miles of the Trail, along which sit the remains of at least one stage stop.

Visitors to the Organ Mountains can still see remnants of Dripping Springs, a once-popular resort and concert hall, built in the 1870s and converted into a sanatorium before its abandonment and decay. In the late 19th century, the infamous outlaw Billy the Kid (William H. Bonney) repeatedly traversed this area. While hiding in the Robledo Mountains, "the Kid" inscribed his signature, which is still visible today, on what is now known as "Outlaw Rock." During World War II, the Army Corps of Engineers constructed 18-acre bombing targets, the remains of which still dot the landscape.

The long, diverse, and storied history of this landscape is not surprising given its striking geologic features and the ecological diversity that they harbor. The dramatic and disparate mountain ranges of the Organ Mountains Desert Peaks area tower above the surrounding grasslands and deserts of the Río Grande watershed, while the Río Grande winds through the valley between the ranges. From the sedimentary deposits of the Robledo Mountains in the west, where the story of ancient life and activity is recorded in fossilized footprints, to the needle-like spires of the Organ Mountains in the east and the ancient volcanic fields and lava flows in the south, these peaks trace the region's varied geologic history.

The Sierra de las Uvas, the westernmost of the peaks, are low volcanic mountains that bear the red tint of the lava from which they formed over 10 million years ago. The tallest, Magdalena Peak, is a lava dome rising 6,509 feet above sea level. For millennia, the ridges, cliffs, and canyons of the rugged Sierra de las Uvas have defined the movement and migration patterns of humans and wildlife alike. The Robledo Mountains, which are composed of alluvial limestone bedrock and contain numerous caves, have long been an important site for research on the formation of desert soils and sedimentary rock, including geological studies of sedimentation and stratigraphy.

The Potrillo Mountains and volcanic field are testament to the area's violent geologic history of seismicity and volcanism. Millions of years after the Cenozoic tectonics that opened the Río Grande Rift, volcanic activity left its mark on the surface, which is punctuated by cinder cone and shield volcanoes, thick layers of basalt, craters, and lava flows. The Potrillo volcanic field contains over 100 cinder cones, ranging in age from 20,000 to one million years old. The Aden Lava Flow area is characterized by lava tubes, steep-walled depressions, and pressure ridges that memorialize the flow of lava that created this unique landscape.

The volcanic field also contains five maars, or low-relief volcanic craters. Kilbourne Hole, a maar with unique volcanic features that the Secretary of the Interior designated as a National Natural Landmark in 1975, is over a mile wide and over 300 feet deep. The sparkling yellow and green olivine glass granules found inside rocks blown from the crater attract amateur and professional geologists to this site, and its resemblance to the lunar landscape provides scientists and visitors with other-worldly experiences, as it did for the Apollo astronauts who trained there. A slightly smaller maar, Hunt's Hole, brings visitors and geologists to the southeastern corner of the Potrillo Mountains complex. The wide range of unique and exemplary volcanic features in the Potrillos makes this area a center for research in geology and volcanology.

The iconic Doña Ana Mountains include limestone ridges, hogbacks, and cuestas topped by monzonite peaks, including Summerford Mountain and Doña Ana Peak, the highest of these at nearly 6,000 feet. To the east, the steep, needle-like spires of the Organ Mountains rise to over 9,000 feet and have been a landmark for travelers for centuries. These block- faulted, uplifted mountains expose geologically significant Precambrian granite and metamorphic basement rocks.

Much of the area is ripe for paleontological discovery. For example, Shelter Cave in the Organ Mountains is a well-documented fossil site, including fossil remnants of ancient ground sloths, birds, and voles. The Robledo Mountains are also an important site for paleontological research; the fossilized tracks and remains of prehistoric creatures preserved there play a vital role in our understanding of the Permian period. This area, along with the Organ Mountains, also contains abundant invertebrate fossils. The congressionally designated Prehistoric Trackways National Monument is adjacent to, and shares its paleontologically rich geologic formations with, the Organ Mountains-Desert Peaks area, suggesting that this landscape could yield many more significant fossil discoveries. Among the volcanic cones in the Potrillo Mountains is Aden Crater, a small shield cone where a lava tube housed the 11,000-year old skeleton of a ground sloth, one of few ever recovered with skin and hair preserved and a key to understanding the extinction of this and other species.

The diverse geology underlies an equally wide array of vegetative communities and ecosystems, which range from low-elevation Chihuahuan grasslands and scrublands to higher elevation stands of ponderosa pine. Seasonal springs and streams in the mountains and canyon bottoms create rare desert riparian ecosystems. These communities provide habitat for many endemic and special status plant and animal species.

Throughout the area, the characteristic plants of the Chihuahuan desert are evident.

Tobosa grasslands can be found in the desert flats, punctuated by creosote bush and mesquite, as well as sacahuista, lechuguilla, and ferns. In the Sierra de las Uvas Mountains, black grama grasslands appear on the mesas while juniper woodlands and Chihuahuan vegetation give way to higher elevation montane communities. Formed by a series of alluvial fans, bajadas extend out from the base of the area's mountains and provide purchase for oak species, Mexican buckeye, prickly pears, white fir, willow, catsclaw mimosa, sotol, agave, ocotillo, flowering cactus, barrel cactus, brickellbush, and tarbush. The Potrillo Mountains are home to desert shrub communities that also include soaptree yucca and four winged saltbush.

These species are emblematic of the Chihuahuan Desert, and the diversity of plant and animal communities found here is stunning. The transitions among vegetation zones found in the Sierra de las Uvas and Potrillos make this area an important resource for ecological research. Similarly, the Doña Ana Mountains abut one of the Nation's long-term ecological research areas, making them an important feature of many studies in wildlife biology, botany, and ecology.

The Organ Mountains are home to alligator juniper, gray oak, and mountain mahogany, as well as the endemic Organ Mountain evening primrose, Organ Mountains giant hyssop, Organ Mountains paintbrush, Organ Mountains pincushion cactus, Organ Mountain figwort, Organ Mountains scaleseed, night-blooming cereus, Plank's Catchfly, and nodding cliff daisy, and likely the endangered Sneed's pincushion cactus.

The area also supports diverse wildlife. Across the Organ Mountains-Desert Peaks landscape, many large mammal species can be found, such as mountain lions, coyotes, and mule deer. The Organ Mountains were also historically home to desert bighorn sheep. Raptors such as the golden eagle, red-tailed hawk, and endangered Aplomado falcon soar above the area's grasslands and foothills, where they prey on a variety of mice, rock squirrels, and other rodents, including the Organ Mountains chipmunk.

The area's exceptional animal diversity also includes many migratory and grassland song birds and a stunning variety of reptiles, such as black-tailed, western diamondback, and banded rock rattlesnakes; whipsnakes and bullsnakes; and tree, earless, Madrean alligator, and checkered whiptail lizards. Birds such as Gambel's quail, black-throated sparrow, ladder- backed woodpecker, verdin, black-tailed gnatcatcher, lesser nighthawk, Scott's oriole, and cactus wren also make their homes here, along with many species of bats. Other mammals, including black-tailed jackrabbits, cactus mice, and kangaroo rats, inhabit the area. One of several species of rare terrestrial snails in the area, the Organ Mountain talussnail, is also endemic.

The protection of the Organ Mountains-Desert Peaks area will preserve its cultural, prehistoric, and historic legacy and maintain its diverse array of natural and scientific resources, ensuring that the prehistoric, historic, and scientific values of this area remain for the benefit of all Americans.

Whereas section 2 of the Act of June 8, 1906 (34 Stat. 225, 16 U.S.C. 431) (the "Antiquities Act") authorizes the President, in his discretion, to declare by public proclamation historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest that are situated upon the lands owned or controlled by the Government of the United States to be national monuments, and to reserve as a part thereof parcels of land, the limits of which in all cases shall be confined to the smallest area compatible with the proper care and management of the objects to be protected;

Whereas it is in the public interest to preserve the objects of scientific and historic interest on the Organ Mountains-Desert Peaks lands;

Now, Therefore, I, Barack Obama, President of the United States of America, by the authority vested in me by section 2 of the Antiquities Act, hereby proclaim the objects identified above that are situated upon lands and interests in lands owned or controlled by the Government of the United States to be the Organ Mountains-Desert Peaks National Monument (monument) and, for the purpose of protecting those objects, reserve as part thereof all lands and interests in lands owned or controlled by the Government of the United States within the boundaries described on the accompanying map, which is attached to and forms a part of this proclamation. These reserved Federal lands and interests in lands encompass approximately 496,330 acres, which is the smallest area compatible with the proper care and management of the objects to be protected.

All Federal lands and interests in lands within the boundaries of the monument are hereby appropriated and withdrawn from all forms of entry, location, selection, sale, leasing, or other disposition under the public land laws, including withdrawal from location, entry, and patent under the mining laws, and from disposition under all laws relating to mineral and geothermal leasing, other than by exchange that furthers the protective purposes of the monument.

The establishment of the monument is subject to valid existing rights. Lands and interests in lands within the monument's boundaries not owned or controlled by the United States shall be reserved as part of the monument upon acquisition of ownership or control by the United States.

The Secretary of the Interior (Secretary) shall manage the monument through the Bureau of Land Management (BLM) as a unit of the National Landscape Conservation System, pursuant to applicable legal authorities, including, as applicable, the provisions of section 603 of the Federal Land Policy and Management Act (43 U.S.C. 1782) governing the management of wilderness study areas, to protect the objects identified above.

For purposes of protecting and restoring the objects identified above, the Secretary, through the BLM, shall prepare and maintain a management plan for the monument and shall provide for maximum public involvement in the development of that plan including, but not limited to, consultation with tribal, State, and local governments.

Except for emergency or authorized administrative purposes, motorized vehicle use in the monument shall be permitted only on designated roads, and non-motorized mechanized vehicle use shall be permitted only on roads and trails designated for their use; provided, however, that nothing in this provision shall be construed to restrict the use of motorized vehicles in wilderness study areas beyond the requirements of section 603 of the Federal Land Policy and Management Act. No additional roads or trails shall be established for motorized vehicle or non-motorized mechanized vehicle use unless necessary for public safety or protection of the objects identified above.

Nothing in this proclamation shall be construed to preclude the Secretary from renewing or authorizing the upgrading of existing utility line rights-of-way within the physical scope of each such right-of-way that exists on the date of this proclamation. Other rights-of-way shall be authorized only if they are necessary for the care and management of the objects identified above. However, watershed restoration projects and small-scale flood prevention projects may be authorized if they are consistent with the care and management of such objects.

Nothing in this proclamation shall be deemed to enlarge or diminish the rights of any Indian tribe or pueblo. The Secretary shall, in consultation with Indian tribes, ensure the protection of religious and cultural sites in the monument and provide access to the sites by members of Indian tribes for traditional cultural and customary uses, consistent with the American Indian Religious Freedom Act (92 Stat. 469, 42 U.S.C. 1996) and Executive Order 13007 of May 24, 1996 (Indian Sacred Sites).

Laws, regulations, and policies followed by the BLM in issuing and administering grazing permits or leases on lands under its jurisdiction shall continue to apply with regard to the lands in the monument, consistent with the protection of the objects identified above.

Nothing in this proclamation shall be deemed to enlarge or diminish the jurisdiction of the State of New Mexico, including its jurisdiction and authority with respect to fish and wildlife management.

Nothing in this proclamation shall be deemed to affect the provisions of the 2006 Memorandum of Understanding between the U.S. Department of Homeland Security, the U.S. Department of the Interior, and the U.S. Department of Agriculture regarding "Cooperative National Security and Counterterrorism Efforts on Federal Lands along the United States' Borders."

Nothing in this proclamation shall be deemed to revoke any existing withdrawal, reservation, or appropriation; however, the monument shall be the dominant reservation.

Nothing in this proclamation shall preclude low level overflights of military aircraft, the designation of new units of special use airspace, or the use or establishment of military flight training routes over the lands reserved by this proclamation.

Warning is hereby given to all unauthorized persons not to appropriate, injure, destroy, or remove any feature of the monument and not to locate or settle upon any of the lands thereof.

In Witness Whereof, I have hereunto set my hand this twenty-first day of May, in the year of our Lord two thousand fourteen, and of the Independence of the United States of America the two hundred and thirty-eighth.

BARACK OBAMA

[Filed with the Office of the Federal Register, 8:45 a.m., May 27, 2014]

NOTE: This proclamation and its attached annex were published in the *Federal Register* on May 28.

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