New Mexico

Rare Plant Conservation Strategy

2017

PREFACE

The New Mexico Rare Plant Conservation Strategy is an integral part of the Forest Action Plan[1] developed by the Forestry Division of the State of New Mexico's Energy, Minerals, and Natural Resources Department (EMNRD). The Forest Action Plan identifies natural resource conditions, needs and opportunities across all land ownerships in the state and guides long-term Forestry Division (Division) management (EMNRD 2010). It also provides useful information to the many partners who work together to create and maintain sustainable forests and watersheds in the state. The Division's central purpose is to promote healthy, sustainable forests and watersheds in New Mexico for the benefit of current and future generations. This mission is accomplished by working with a variety of partners interested in improving the health of the state's forests and watersheds.

Established as the Forest Conservation Commission in 1957 to address fire protection on state and private land, the Division's mission soon expanded to include timber management and conservation efforts. Since then, the Division's role has further expanded into the areas of technical forestry assistance to private and state landowners, conservation of lands through easements and tax incentives, encouragement of forest industries, inmate work programs, conservation and recovery of endangered plants, urban forestry, restoration, and invasive plant programs.

The Division identifies proper watershed management as a top priority to achieve overall ecosystem health. To achieve its watershed management goals, the Division has taken a leadership role in crafting collaborative efforts with local, state, federal and tribal agencies, as well as private landowners, businesses and non-governmental organizations.

The Division is a major partner in rare and endangered plant conservation, recovery and research through its Endangered Plant Program. It is the only program within the state government that focuses on rare plant conservation and operates statewide. The Division has statutory responsibility for the State Endangered Plant Species List. Section 75-6-1 NMSA 1978 directs the Division to investigate all plant species in the state to establish a list of endangered plant species. Similar to federal land management agencies, the Division gathers information relating to population abundance, distribution, habitat requirements, threats, limiting factors, and other biological and ecological data to determine the status of endangered plants throughout New Mexico, regardless of land ownership. The information is then used to develop conservation measures necessary for the species' recovery and survival. The statute further directs the Division to establish a program necessary to promote the conservation of listed endangered plant species including research, inventory and monitoring, law enforcement, habitat maintenance, education, and propagation.

The 2010 Forest Action Plan is currently in the process of being updated. The Division plans to publish a fully updated Forest Action Plan in 2020, which will include the 2017 NM Rare Plant Conservation Strategy. The Strategy was identified as a priority and focus for the 2020 update of the Forest Action Plan. In the interim, the Division will post additions and changes made to clarify or revise outdated information on the State's Forest Action Plan web page, including the New Mexico Rare Plant Conservation Strategy at http://www.emnrd.state.nm.us/SFD/statewideassessment.html and at http://www.emnrd.state.nm.us/SFD/ForestMgt/NewMexicoRarePlantConservationStategy.html. The Strategy and Scorecard will also be available at http://nhnm.unm.edu/nm_rare_plant_conservation_strategy.

[1] Officially called the New Mexico Statewide Natural Resources Assessment, Strategy and Response Plan

Sacramento Mountains thistle (*Cirsium vinaceum*) and pollinator © Daniela Roth

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Shootingstar geranium (*Geranium dodecatheoides*) © Daniela Roth

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Front page photos (clockwise from top left): Mimbres figwort (*Scrophularia macrantha*), Gypsum Townsend's aster (*Townsendia gypsophila*), Lee's pincushion cactus (*Escobaria sneedii var. leei*), Todsen's pennyroyal (*Hedeoma todsenii*). © Daniela Roth

EXECUTIVE SUMMARY

New Mexico is one of the most biologically diverse states in the U.S. and supports the fourth highest plant diversity in the country. A total of 4,204 plant taxa have been documented in the state; this includes 235 rare and endangered plant species, of which 109 are endemic (i.e. they only occur in New Mexico and nowhere else in the world).

The New Mexico Rare Plant Conservation Strategy (Strategy) promotes stewardship of New Mexico's rare and endangered plants through active collaborative partnerships. The Strategy serves as a reference for priority actions needed to maintain and improve the status of rare plants in New Mexico and to strategically guide future plant conservation actions.

Implementation will help land managers, regulatory agencies, landowners, and other stakeholders better understand the status and needs of New Mexico's rare plants so they may actively support their conservation.

The primary target audience for the Strategy includes land managers, field office managers, district rangers, agency biologists and botanists, and regulatory agencies seeking guidance to help them prioritize and focus management efforts, evaluate endangerment, and direct funding.

The Strategy emphasizes a coordinated approach to address impacts to New Mexico's rare and endangered plants and provide for their long-term conservation and stewardship. The Strategy's proactive conservation measures and guidelines will provide more consistent protection and coordinated management of rare species, reducing potential conflicts and supporting current land use and resource management planning efforts in the state. It will promote stewardship of New Mexico's rare and endangered plants and provide conservation tools to document current population status, address population declines and habitat loss, and provide management tools and actions required to preclude the need for federal listing under the Endangered Species Act and to achieve recovery of some of the most imperiled species in the state.

The Division developed the Strategy in coordination with the New Mexico Rare Plant Conservation Partnership (NMRPCP) which includes state, federal, and tribal agencies, non-governmental organizations, and interested citizens. The Strategy aims to achieve results through a collaborative approach that is based on the best available science, close coordination, data sharing, and taking strategic action.

The Strategy is focused on the 235 rare and endangered plant species in New Mexico (the Strategy Species), including 109 species that only occur in New Mexico and nowhere else in the world. The Strategy Species include 13 federally listed species, 37 species listed as Endangered in the State of New Mexico, 15 species listed on the Navajo Nation Endangered Species List, 36 species listed as sensitive by the BLM, and 64 species listed as sensitive by the Forest Service.

Most of New Mexico's rare and endangered plants are considered rare because they are restricted to very specific, narrowly distributed habitats. Some species have such small distributions that they are highly vulnerable to stochastic extinction events which may be caused by flooding, fires, invasive species, predation, or human caused disturbances. Primary human caused threats include habitat destruction and alteration, climate change and related ecological changes, resource extraction, (e.g., energy development, mining, water development), urban development and expansion (including road construction and maintenance), recreation, and livestock overgrazing.

Climate change is not only expected to affect species directly, but also to have significant impacts on their habitats and the ecological systems on which they depend. This is likely to exacerbate the effects of other human activities on plants. Impacts associated with climate change include prolonged droughts, increased fire frequency and severity -- including severe habitat alteration caused by megafires -- and increases in invasive species (plants and animals); all of these can alter associated plant communities. The impacts are especially significant for small populations with restricted ranges, including many of the species endemic to New Mexico

One of the central issues impeding conservation of New Mexico's rare plant species is a general lack of baseline information (species abundance, distribution, and status) in addition to a lack of knowledge about the basic biological requirements (pollinators, seed dispersal, seed bank viability, etc.) of rare taxa. Without such documentation, land managers and regulatory agencies are not able to make meaningful decisions to protect and conserve New Mexico's most rare and endangered plant species.

This lack of information contributes to and is compounded by inadequate legal protection and enforcement; inadequate funding for botanical staff in land management agencies which may result in poor management decisions; and inadequate funding for conservation actions, surveys, monitoring, and research.

The overall goal of the New Mexico Rare Plant Conservation Strategy is to protect and conserve New Mexico's rare and endangered plant species and their habitats through collaborative partnerships between stakeholders and interested parties to aid and improve the conservation and management of rare plant species and to avoid federal listing.

Specific goals include:

1. Inventory, monitor, and research Strategy Species to inform management and regulatory decisions
2. Protect, manage, and restore Strategy Species and their habitats
3. Improve data management, storage, & dissemination
4. Develop ex-situ conservation and recovery strategies and implement where appropriate
5. Improve laws, regulations, and policies
6. Increase collaboration, education, and outreach
7. Improve funding, infrastructure, and rare plant programs

The Strategy serves as a reference for priority actions needed to maintain and improve the status of rare plants in New Mexico and to strategically guide future plant conservation actions. In addition, coordinated outreach and education efforts will increase public awareness on the status of rare and endangered plants and provide opportunities to help conserve New Mexico's rare plant species. As a result, it is anticipated that much needed programs and resources will be directed to support rare plant conservation efforts throughout the state. The Strategy is a call to action, highlighting conservation steps that federal, state, and local agencies, private groups, academic institutions, and others can take to assist with meeting the seven goals. The Strategy will be an integral part of the Division's Forest Action Plan and will be maintained by the partners to strategically guide future plant conservation efforts in the state.

INTRODUCTION

The Importance of Plants and their Conservation

"Without plants, there is no life. The functioning of the planet, and our survival, depends upon plants" (Vision: North American Botanic Garden Strategy for Plant Conservation 2011-2020). Plants constitute a significant part of the world's biological diversity and are essential for human existence on the planet. They are the foundation of all terrestrial and most marine ecosystems, playing a key role in maintaining basic ecosystem functions, including oxygen production, water purification, erosion, and climate control (GSPC 2010; USFWS 2012). Plants have significant economic and cultural importance, providing food, medicine, fuel, clothing and shelter for people throughout the world; 31,128 plant species have a current documented human use (GSPC 2011-2020; Royal Botanical Garden Kew 2016). In addition, plants are an essential component of the habitats for the world's animals (GSPC 2011-2020).

One in five plants are estimated to be at risk from extinction worldwide. (Royal Botanical Garden Kew 2016). In the United States, there are an estimated 18,804 native plant species, 31 % of which are considered at risk of extinction; Only a fraction of these receive protection under the Federal Endangered Species Act (Negron-Ortiz 2014; USFWS 2012). Plants comprise 56 % of all federally listed species (903 plant species) (USFWS 2016). An additional 164 plant species are either proposed for listing (45 species), candidates for listing (10 species), or petitioned for listing (109 species) (USFWS 2016). Despite this prevalence of plants on the federal Endangered Species list, plants do not receive the same protections as animals receive under the ESA and receive only a fraction of federal funding available for conservation and recovery (Roberson 2002; USFWS 2012, Evans et al. 2016). Federal protection for plants primarily applies only to plants occurring on lands under federal jurisdiction or where a federal nexus exists on other lands (i.e. federal funding or authorization); There is no ESA provision for "incidental take"[2] of plants and therefore, ESA "incidental take" conservation opportunities available for animals, such as USFWS Habitat Conservation Plans, have only limited applicability, or do not apply at all, to plants (USFWS Safe Harbor Agreements). In addition, less than a third of plants identified by NatureServe as critically imperiled or imperiled (3,049 plant species) are federally protected. The current proportion of federally listed plants is expected to increase as additional taxa are evaluated for listing under the ESA in response to current and future threats. (USFWS 2016, USFWS 2012; GSPC 2011-2020). Today's management direction and decisions pertaining to the conservation of rare and endangered plants will be critical for evaluating the need for potential listings. Preventing future listings will require increased management and cooperation among land managers and stakeholders.

[2] Endangered Species Act, Section 10 allows for the "incidental take" of endangered and threatened species of wildlife by non- Federal entities.

Plant Conservation Issues in New Mexico

New Mexico is one of the most biologically diverse states in the U.S. and supports the fourth highest plant diversity in the country (NM Biodiversity Consortium 2016). A total of 4,204 plant taxa have been documented, including 487 exotic species and 109 plant species endemic to the state (Allred 2012; NHNM 2017). Over 12% of the vascular plants in the state are considered at risk (Stein & Gravuer 2008). Natural Heritage New Mexico actively tracks the presence of 213 rare plant species in New Mexico, based on their overall rarity, conservation status, and threats (Appendix A). In addition, for 22 plant species with restricted distributions, sufficient information exists on their status and abundance to indicate they are stable in their current environment. These species are on the Watch List. All of these 235 rare and restricted plant species are addressed in the New Mexico Rare Plant Conservation Strategy (Strategy Species: Appendix A).

Federal agencies manage about a third (26 million acres) of the 77.6 million acres of New Mexico lands. These agencies include the National Park Service (NPS), Bureau of Land Management (BLM), U.S. Forest Service (USFS), Bureau of Reclamation (BOR), U.S. Fish & Wildlife Service (USFWS), Department of Energy (DOE) and the Department of Defense (DOD) (Table 1). The BLM and the USFS manage the majority of these lands. Approximately 9 million acres are National Forest public lands and approximately 13 million acres are BLM public lands. Forty-four percent of the land in New Mexico is privately owned, 11% is managed by various tribes and 12% is managed by the State Lands Office (Table 1). The remaining lands are managed by the State Agriculture Department, the NM Game and Fish Department (NMGF), and State Parks.

Rare and endangered plants, including federally listed species, receive limited or no protection on non-federal lands. Therefore, management responsibility lies largely with federal land managers. While federal, state, and tribal laws provide limited protection for plants, federal and tribal land management agencies have policies, regulations, and guidance pertaining to plant conservation, specifically addressing sensitive species management (BLM Manual 6840; USFS Manual 2670, National Park Service Management Policies 2006; Navajo Nation Resource Committee Resolutions). In addition, federal agency goals of sustainable resilient landscapes are intended to avoid crisis management, litigation, and federal listing of rare plant species.

Challenges

In New Mexico, the four main issues hindering plant conservation efforts are:

1. Lack of baseline information
2. Lack of botanical expertise
3. Lack of funding
4. Inadequacy of regulatory mechanisms

Other plant conservation strategies, including the Global Strategy for Plant Conservation, have identified similar issues impeding the conservation of rare and endangered plants and have provided strategic guidance and objectives to ensure the conservation of rare and endangered plants nationally and internationally (BGCI 2016; USFWS 2012; Neeley et al. 2009; GSPC 2002). Concurrent objectives to address the common goal of conserving the world's plant biodiversity include the need for baseline information, increased funding and botanical capacity, stronger protections, and outreach.

Lack of baseline information

Some of the most critical information needed on the plants of New Mexico includes baseline documentation on distribution, abundance, current status, population trends, and threats. All federal land managers are directed to gather information on population abundance, distribution, habitat requirements, threats, limiting factors, and other biological and ecological data to determine the status of sensitive and endangered plants, but little effort has been directed toward this management goal. Baseline information is critical to developing effective conservation measures necessary for recovery and survival.

Although some baseline information exists on federally listed plants, the state of knowledge for species that are not federally listed is significantly worse. This lack of adequate data has impeded management and recovery direction, as important management and regulatory decisions continue to be based on limited information and resources are inadequate to close critical information gaps (Heywood and Iriondo 2003). Even for federally listed plants, current baseline knowledge for most taxa is insufficient to adequately assess the status and threats to allow for informed listing and delisting decisions or for evaluating the recovery process (Schemske et al. 1994, Heywood and Iriondo 2003, Giam et al. 2011). With limited documentation on distribution, abundance, and threats, rare and endangered plant species may not be included on sensitive species lists and may therefore not be evaluated during environmental reviews, project planning, and management decisions. This can result in significant impacts to already small or declining populations, thereby contributing to eventual federal listing. Conversely, limited baseline information can lead to management and regulatory decisions which may result in potentially unnecessary listings and management actions. In addition to the lack of baseline information on status, distribution and threats, little information is available on management opportunities and effective mitigation measures to monitor trends and document and abate threats. Information on long term population trends and monitoring the response of rare and endangered plants to threats and management actions significantly contributes to the evaluation of recovery success and informs management decisions.

Lack of botanical expertise

Federal and state agencies are understaffed and lack the botanical capacity required to guide effective management and conservation of the nation's most imperiled plant species (Roberson 2002; Chicago Botanical Garden and Botanic Gardens Conservation International 2009; Kramer et al. 2013). Botanical capacity is the human, scientific, technological, organizational, institutional, and resource capability that supports botanically based education and training, research, monitoring and management (Kramer et al. 2013). It is a critical component of efforts to address current and future management challenges, including land management, habitat restoration, climate change mitigation, invasive species control, and the conservation of rare species. A recent nationwide survey of 1,600 members of the botanical community, including respondents from federal agencies (34%), found a severe shortage of botanical expertise in government agencies and an alarming decline in botanical degree programs and course offerings in colleges and universities (Kramer et al. 2013). Survey results document severe shortages of management and research staff with botanical degrees throughout all federal and state government agencies, with some of the most significant shortages found in agencies directly responsible for managing public lands, leading recovery efforts and carrying out regulatory functions (Kramer et al. 2013). In 2001, the BLM employed 68 botanists nationwide to manage botanical resources on 264 million acres and the USFS employed 128 botanists for 191 million acres and thousands of plant species (Roberson 2002). Many National Forests and BLM field offices employ no botanists at all. At the same

time, the USFS employed nearly 3,000 foresters nationwide, primarily to manage a small subset of USFS botanical resources, commercial timber (Roberson 2002).

Shortages in botanical expertise also exist in New Mexico, where none of the major universities offers an undergraduate degree in Botany and course offerings are severely limited. In addition, only a handful of state and federal botanists are employed throughout the entire state to guide botanical resource management including conservation, recovery, planning, management, and regulatory issues. In New Mexico, as of 2017, the U.S. Fish & Wildlife Service has no botanists on staff, the BLM employs four full time botanists to manage all botanical resources on 13.5 million acres, and the USFS has one botanist on one of its five national forests (Lincoln National Forest) and one botanist at the regional office, overseeing botanical resources in all 11 national forests of Arizona and New Mexico. The State of New Mexico's Endangered Plant Program, part of EMNRD Forestry Division, has one botanist to address all rare and endangered plants throughout the state.

Lack of funding

Funding for endangered species recovery is generally insufficient but has also been disproportionally distributed among taxonomic groups. Less than 4% of federal government spending on listed species is allocated to the conservation and recovery of listed plants (Negron-Ortiz 2014; USFWS 2012; Evans et al. 2016). Even less is allocated to non-listed rare and endangered plant species. While the State Wildlife Action Plans are directly tied to receiving federal funds for conservation actions for non-listed species through the State Wildlife Grants Program ($14 million between 2005 and 2015 in New Mexico), none of this funding can currently be used for the conservation of rare and endangered plants (Stein & Gravuer 2008). The State Wildlife Grants Program is currently the only federal program with the explicit goal of preventing listings under the Endangered Species Act. The State of New Mexico's Endangered Plant Program within the Forestry Division is primarily funded through another federal grant, under the Endangered Species Act; it focuses on plants already federally listed, not on preventing plants from getting listed. Lack of funding is also reflected in the absence of botanical expertise within the agencies, which in turn contributes to the lack of baseline information needed to make meaningful management and regulatory decisions for rare and endangered plants and to manage for the recovery of listed plants (Stein & Gravuer 2008; Roberson 2002; USFWS 2012; Evans et al. 2016; Negron-Ortiz 2014). Investing in the conservation of rare species before they need protection through the Endangered Species Act is far more cost effective than carrying out expensive measures needed to recover them once they have become threatened or endangered (Stein & Gravuer 2008).

Inadequacy of regulatory mechanisms

The inadequacy of regulatory mechanisms and laws protecting federal and state listed plants and other sensitive species is another major concern. Sensitive and endangered plants receive inadequate attention from federal, state, and private land managers, which may ultimately lead to the need for federal listing. In the absence of adequate regulations, impacts to sensitive plants are rarely addressed during the environmental review process and little effort is directed towards gathering baseline information to determine their status. Stronger laws and the implementation and enforcement of existing laws, regulations, and policies are needed to protect sensitive plant species throughout New Mexico.

Goodding's onion *(Allium gooddingii)* © Daniela Roth

Strategy Purpose and Target Audience

The Strategy will provide guidance to land managers and regulatory agencies to secure New Mexico's rare plant species through:

- Increased protection
- Improved data on status and distribution
- Clear management guidelines
- Increased dialog and coordination among land managers and conservation partners
- Promotion of education and stewardship opportunities
- Facilitating on-the-ground conservation and recovery actions

The primary target audience for the Strategy includes land managers, field office managers, district rangers, agency biologists and botanists, and regulatory agencies looking for guidance and focus areas to prioritize management, evaluate endangerment, and direct funding. The Strategy will not only provide more consistent protection and coordinated management of rare species, it also will reduce potential conflict by providing proactive conservation measures and guidelines and by supporting current land use and resource management planning efforts. Proactive conservation tools will help land managers document current population status, address population declines and habitat loss, and take action to recover of some of New Mexico's most imperiled plant species and preclude the need for new federal listings under ESA. It emphasizes a coordinated and proactive approach to provide for the long-term conservation and stewardship of New Mexico's rare and endangered flora.

Knowlton's cactus (*Pediocactus knowltonii*) ©Daniela Roth

New Mexico Rare Plant Conservation Partnership

The New Mexico Rare Plant Conservation Strategy aims to achieve results through a collaborative approach that is based on the best available science, close coordination, data sharing, and taking strategic action. The Strategy has been developed in coordination with many conservation partners, including state, federal, and tribal agencies, non-governmental organizations, and interested citizens. To support this effort, the **New Mexico Rare Plant Conservation Partnership (NMRPCP)** was formed and currently includes the Division, the BLM, the USFS, NHNM, the USFWS, the New Mexico Rare Plant Technical Council (NMRPTC), the Navajo Natural Heritage Program (NNHP, Navajo Nation Department of Fish & Wildlife), the Center for Plant Conservation (CPC), the Institute for Applied Ecology, the NM State Land Office (SLO), the NM Native Plant Society (NMNPS), and private individuals. Potential future partners include New Mexico universities and colleges, additional NM tribes and pueblos, additional federal and state agencies, local governments, conservation and other non-government organization such as botanical gardens, and additional private parties including land owners. Development of formal agreements between primary stakeholders is one of the Strategy objectives.

Partnership support comes in many forms and may include providing funding, volunteers, documentation and maps, or technical support; conducing research and sharing data; promoting the Strategy and rare plant conservation through art, outreach and education; coordinating conservation priorities and needs; and participation in the implementation of Strategy objectives and providing updates. There is currently no formal organizational agreement between the partners, but the development of more formal agreements between primary stakeholders is one of the Strategy objectives.

New Mexico's Diverse Ecoregions

New Mexico is the fifth largest state in the United States covering a land area of 121,412 square miles (WRCC 2016). The state shares its southern border with Mexico, and is surrounded by Arizona, Utah, Colorado, Oklahoma, and Texas. All the major land biomes of the world are found within the state, except arctic tundra and tropical rainforest (Allred 2012). Landscape features commonly found include canyons, valleys, floodplains, badlands, mesas and buttes, bajadas, eroded escarpments, volcanic calderas, necks, lava fields, ash flows, hogbacks, dikes, cuestas, sand dunes, bolsons, playas, alkali flats, Pleistocene lakebeds, karst sinkholes, and glaciated landforms (Allred 2012). New Mexico has hot and cold deserts; short and mid-grass prairies; oak and pinyon-juniper woodlands; pine, mixed-conifer, and spruce-fir forests; and alpine tundra. The highest point in the state is Wheeler Peak in Taos County (13,161 feet) and the lowest is Red Bluff Reservoir in Eddy County (2,817 feet). Temperature extremes can range from –50ºF to +116ºF throughout the state. Average annual precipitation varies from less than 10 inches in the southern deserts to more than 30 inches in the northern mountains (WRCC 2016). Eight ecoregions converge in the state, including Colorado Plateau, Southern Rockies, High Plains, Southwestern Tablelands, Chihuahuan Deserts, Madrean Archipelago, Arizona/New Mexico Plateau, and Arizona/New Mexico Mountains (Griffith et al. 2006, Level III; Figure 1). These ecoregions are defined by interacting patterns of the biota, geology, physiography, soils, land use, hydrology and climate.

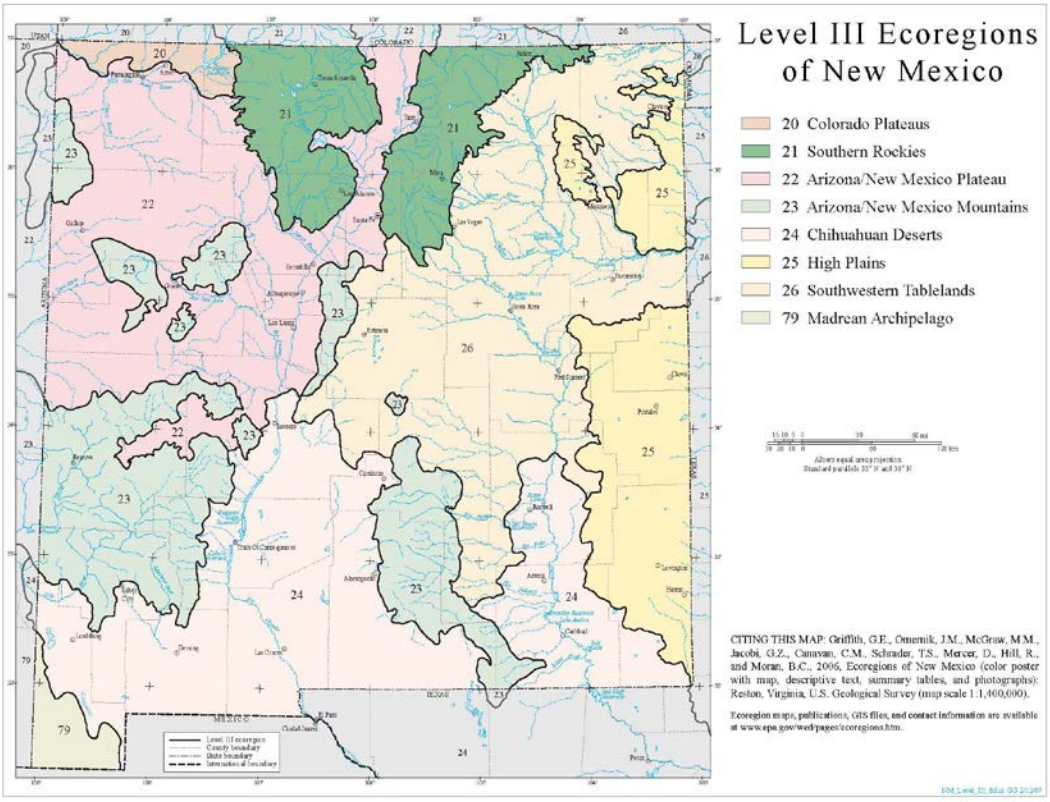


Figure 1. New Mexico Ecoregions

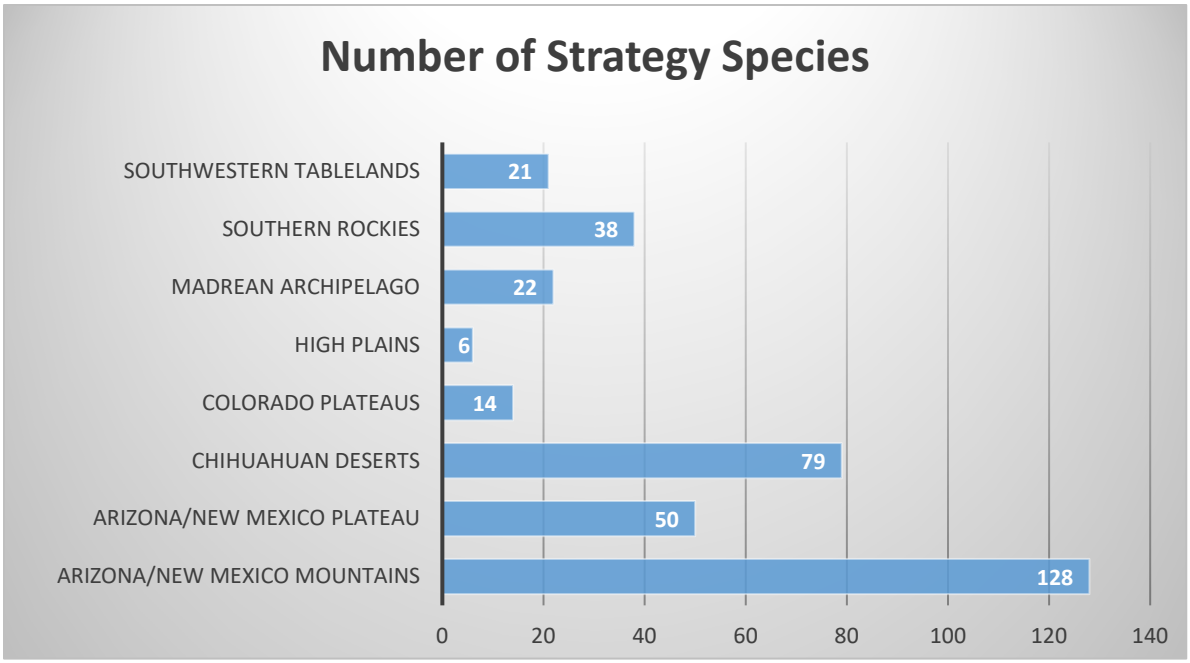


Figure 2. Number of Strategy Species in each of New Mexico's 8 Ecoregions.

Chihuahuan Desert Ecoregion, near Brokeoff Mountains, Otero County, NM.

Arizona-New Mexico Mountains Ecoregion, White Mountain Wilderness, Lincoln County, NM.

Arizona-New Mexico Plateau Ecoregion, near Cabezon Peak, Sandoval County, NM.

New Mexico's Rare and Endangered Plants

New Mexico's rare plants are an important and irreplaceable part of the state's natural heritage. The Strategy lists 235 plant species which are considered rare or endangered in the state (Strategy Species, Appendix A). Of these, 213 are actively tracked by Natural Heritage of New Mexico and 22 are on the Watch List. The New Mexico Rare Plant Technical Council identifies 200 of the Strategy Species as rare (http://nmrareplants.unm.edu/). NatureServe considers 103 of the 235 Strategy Species as globally imperiled, meaning they are at significant risk of extinction (G1 & G2). The Strategy Species list includes 13 federally listed species, 37 plant species listed Endangered in the State of New Mexico, 36 species listed as sensitive with the BLM, and 63 species listed with the Forest Service.

Forty-six percent of the Strategy Species are known to occur only in New Mexico and no other place in the world (109 species). The majority of Strategy Species occur on federal or private lands. Approximately 55 % of the 235 Strategy Species occur on Forest Service lands and 49 % occur on BLM lands. One-hundred-fifty-six Strategy Species are known to occur on private lands (66%) and 28 % are known from tribal lands (Table 1).

Table 1. Distribution of Strategy Species in New Mexico by land ownership (NHNM 2017). See Appendix E for ownership acronyms.

Ownership	No of Strategy Species	Percent of all Element Occurrences[3]	Land ownership in New Mexico (acres)
BLM	114	20.98%	13,485,536
BOR	5	0.18%	54,483
DOA	1	0.04%	109,464
DOD	33	12.04%	2,515,789
DOE	4	0.14%	36,491
USFS	130	27.02%	9,217,460
USFWS	17	1.26%	383,163
Tribal	65	8.89%	8,228,727
NPS	26	1.94%	475,185
Private	156	20.73%	34,019,743
State Land Office	57	5.86%	8,983,019
NMDGF	8	0.40%	199,577
NMSP	10	0.47%	118,917

[3] Element Occurrences (EOs) are groups of species locations that act as operational populations or sub-populations for tracking species-specific changes in distribution and population status and trends (NatureServe 2002). See Appendix B, Scorecard Methods.

The majority of New Mexico's rare plants occur in mountainous ecoregions (71%), primarily in the AZ/NM Mountains ecoregion (55%) (Figure 2). These ecoregions support large concentrations of highly endemic plants species and include many of New Mexico's most highly ranked Important Plant Areas (Figures 2, 3, & 4). Many of these species are restricted to the high elevations of sky islands, isolated mountain ranges surrounded by radically different lowland environments. These include the Mogollon Mountains, Black Range, White Mountains, San Andreas Mountains, Organ Mountains, and Sacramento Mountains of southern New Mexico, which contain the largest number of endemic plant species in the state. High elevation species with restricted ranges are considered most vulnerable to impacts associated with climate change, including prolonged drought, increases in fire frequency and severity, invasive species, and changes in community composition (Evans et. al. 2016; Enquist and Gori 2008; IPCC 2007). Thirty-four percent of Strategy Species occur in the Chihuahuan Deserts Ecoregion. Deserts are highly vulnerable to habitat alterations caused by climate change and associated impacts, livestock grazing, and water and energy development projects. The Chihuahuan Deserts Ecoregion is the most human impacted ecoregion in New Mexico, altered by urban expansion and development, livestock grazing, water development, agriculture, landscape wide herbicide treatments, and oil & gas development.

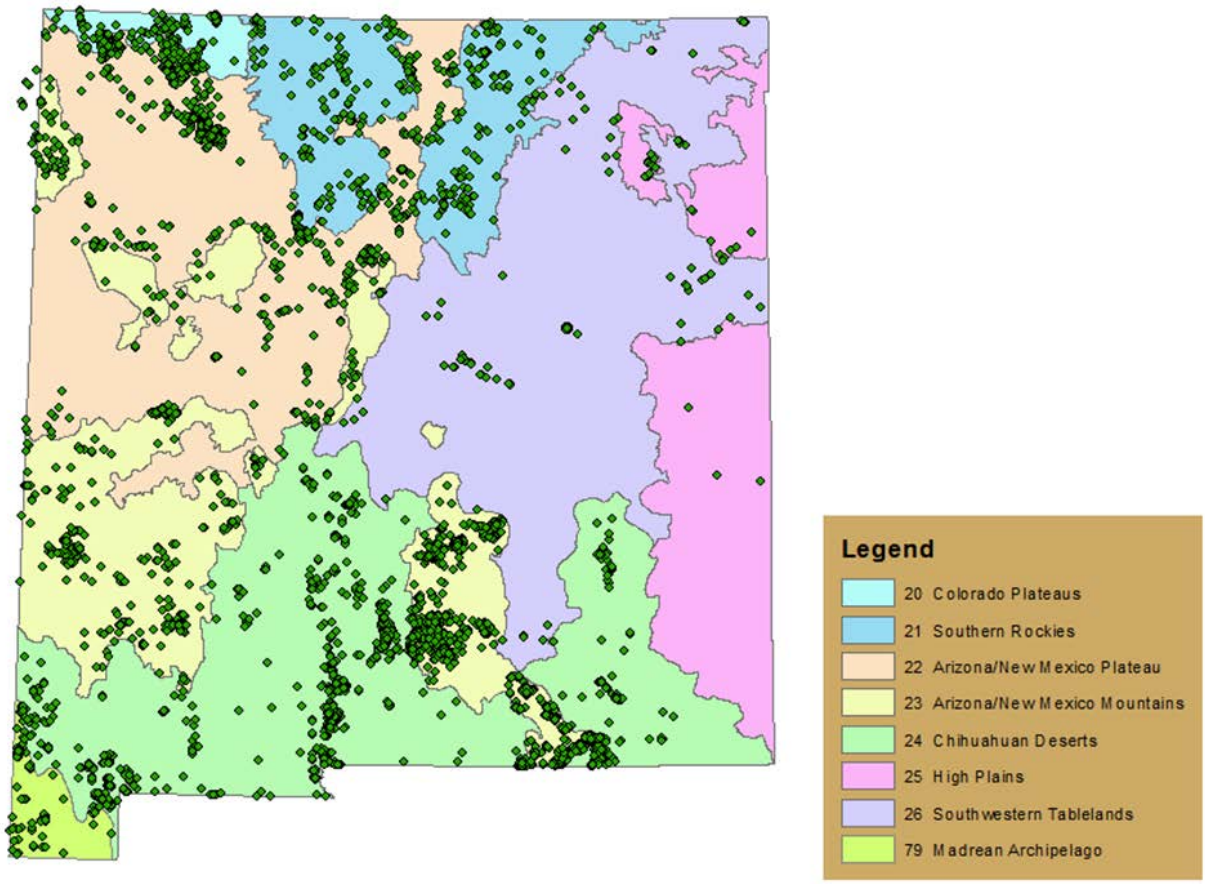


Figure 3. Distribution of Strategy Species across New Mexico's 8 Ecoregions (NHNM 2017).

Threats to Rare and Endangered Plants

One in five plants are estimated to be at risk from extinction worldwide (Royal Botanical Garden Kew 2016). Rare and endangered plants typically have small numbers of individuals worldwide, narrow geographic ranges, and a few localized populations (Neely et al. 2009). Some rare species are locally abundant over a very small range, or widely distributed in small populations. They are often threatened because of their inability to recover from random (stochastic) events such as severe fires, insect and disease outbreaks, drought, or flooding. They are also subject to significant human caused threats, such as habitat alteration, over-collection, and climate change. Rare plants often are at risk simply due to a lack of awareness regarding their precarious status. Species with low population density, low reproductive potential, and narrow geographic distributions generally are at a higher risk of extinction (Groves 2003).

Most of New Mexico's rare and endangered plants are considered rare because they are restricted to very specific, narrowly distributed habitats. Because these species occupy such small areas, awareness and species-specific planning is necessary to avoid placing these species at further risk of extirpation caused by human activities. All species are exposed to impacts associated with global climate change on a rangewide level (Scorecard 2017). Many species are exposed to widespread livestock impacts and habitat alteration throughout their limited range (Scorecard 2017). Some species have such small distributions they are highly vulnerable to stochastic extinction events which may be caused by flooding, fires, invasive species, predation, etc.

Documented threats to New Mexico's rare and endangered plants and their habitats include:

- Energy development and mineral mining
- Motorized and non-motorized recreational vehicles
- Urban development
- Agriculture (crop production)
- Roads (construction and maintenance)
- Altered hydrologic regimes
- Invasive plant species
- Climate change
- Logging and woodcutting
- Wildfire and fire suppression activities
- Herbivory/Grazing/Overgrazing
- Predation
- Disease
- Habitat fragmentation
- Collection (commercial or other)

- Small population size
- Stochastic events
- Inadequacy of regulatory mechanisms
- Lack of funding
- Lack of botanical expertise within land management agencies

Climate change is not only expected to affect species directly, but also to have significant impacts on their habitats and the ecological systems on which they depend. This is likely to exacerbate the effects of other human activities on plants (Evans et. al. 2016; Enquist and Gori 2008; IPCC 2007). Impacts associated with climate change include prolonged droughts, increased fire frequency and severity, increases in invasive species (plants and animals), changes in associated plant communities, and severe habitat alteration caused by megafires (IPCC 2007). This is especially significant for small populations with restricted ranges, including many of the species endemic to New Mexico (Treher et al. 2012). A 2012 report exploring vulnerability trends in response to climate change relating to geography, conservation status, and taxonomic affiliation on western BLM lands revealed that the greatest concentrations of taxa vulnerable to climate change are found in arid to semi-arid regions of the southwestern states (Treher et al. 2012). Statistical analyses of conservation status and vulnerability to climate change showed that taxa of conservation concern tend to show greater vulnerability to climate change than other native plant species. Taxa assessed in the Cactaceae appeared especially sensitive to changes in precipitation regimes.

Habitat degradation, fragmentation, and loss of habitat are major reasons why some plant species and their habitats are threatened in New Mexico. The primary contributors to habitat degradation for rare and endangered plants are resource extraction (e.g., energy development, mining, water development), recreation, livestock grazing, wildfire, climate change, invasive species, urban development, and road construction and maintenance.

Other risk factors may include loss of pollinators and their habitat and illegal collecting. These challenges are compounded by inadequate legal protection and enforcement, inadequate funding for botanical staff within land management agencies, which may result in poor management decisions, and lack of funding for conservation actions, surveys and monitoring, as well as research.

As discussed under the Challenges section of this document, one of the central issues impeding proactive conservation is a dearth of information regarding the abundance, distribution, and status of New Mexico's rare plant species. This absence of baseline information in combination with a lack of knowledge on basic biological requirements of rare taxa (basic habitat requirements, pollinators, seed dispersal, seed bank viability, etc.) exists for the majority of rare plants in New Mexico. Without baseline documentation, land managers and regulatory agencies are not able to make meaningful decisions to protect and conserve New Mexico's most rare and endangered plant species.

Agencies lack botanical expertise to document and research rare plant abundance, distribution and threats. This results in inadequate protection and has the potential to significantly contribute to the need for listing under the Endangered Species Act. There also exists a lack of funding opportunities for proactive conservation projects, including protecting habitat, education and outreach projects, genetics

research, threat modelling, ex-situ conservation, and research. Thus, the management focus often shifts from species of greatest conservation need to species for which funding may be more readily available (e.g. federally-listed species), thereby contributing to the need for additional federal listings.

In addition, New Mexico lacks adequate state level protection for state listed endangered plants and other rare and sensitive species despite rapidly growing threats. Currently New Mexico State law only regulates the removal, with the intention to possess, transport, export, sell, or offer for sale any of the 37 plants listed endangered, from the places where they naturally grow in the state of New Mexico (19.21.2. NMAC). Although federal land managers must follow federal guidance and policies addressing sensitive plant conservation, implementation is often inadequate. A stronger state law and more consistent implementation of federal policies are needed to provide meaningful protection for state listed endangered plants and sensitive species on a rangewide level. The Division's Endangered Plant Program and land management agencies need support and involvement from state government and stakeholders to help implement this Strategy and achieve the long-term goal of conserving New Mexico's rare and endangered plant species. Increased coordination, long-term funding, and on-the-ground action are all essential for effective plant conservation in New Mexico.

STRATEGY CONSERVATION PRIORITIES

The New Mexico Rare Plant Conservation Strategy outlines what needs to be accomplished to ensure the conservation of New Mexico's most rare and endangered plants and their habitats over the next 10 years. Compared to animals, rare plants are relatively easy to conserve because they typically occur in small numbers and over relatively small geographic areas. Thus, plants can often be protected with a relatively small investment of time and resources, through proper planning, voluntary and cooperative actions, and constructive dialogue and partnerships with developing interests. By coordinating and working together, landowners, land managers, and concerned partners can take proactive steps to improve the conservation status of New Mexico's rare and endangered plants. Such small investments have the potential to make large impacts on reducing the extinction risk of rare plant species.

It is an adaptive strategy that is intended to be updated as more data becomes available, conservation strategies are implemented, and conservation status changes over time. Accomplishing the conservation objectives and actions outlined in this Strategy will ensure the long-term survival of these rare species and their habitats. However, the NM Rare Plant Conservation Strategy Partners recognize that increased botanical capacity in the land management agencies, resources, and long-term funding mechanisms are essential for effective implementation of this Strategy. It is imperative that the state and its partners develop funding strategies and mechanisms to support the conservation objectives and to accomplish these essential conservation actions.

Ten Priority Conservation Actions

To help focus and direct implementation of the Strategy and set the stage for plant conservation in New Mexico, the NMRPCP identified these ten priority actions:

- Establish a list of conservation priority species and conservation actions needed using the Plant Conservation Scorecard.
- Collect baseline information for species identified on the Plant Conservation Scorecard B and C lists as lacking information to effectively evaluate their conservation status (inventory, monitoring, research).
- Improve data management through active data gathering and a centralized database.
- Establish a common website to facilitate information exchange on New Mexico's rare plants by updating and improving the existing NMRPTC website, or developing a new common website.
- Provide maps of New Mexico's Important Plant Areas to land managers and conservation groups to help identify and prioritize potential Conservation Opportunity Areas.
- Support the analysis and delineation of targeted Conservation Opportunity Areas from the Important Plant Areas map as the foundation for the establishment of permanent plant conservation areas.
- Provide botanical expertise within land management agencies through staffing, funding, data management, partnerships, and volunteers to implement conservation directed management.
- Work with public agencies to collect and share best available data for the protection and management of rare and endangered plants and incorporation into planning documents, develop and implement best management practices, and pursue special designations for rare and endangered plants and their habitats.
- Take conservation actions toward recovery of rare and endangered species, including seed banking, population augmentation and introductions, habitat protections, updating recovery plans, and developing recovery strategies and conservation plans.
- Generate a prioritized research list to guide project proposals by organizations and graduate students searching for potential research projects.

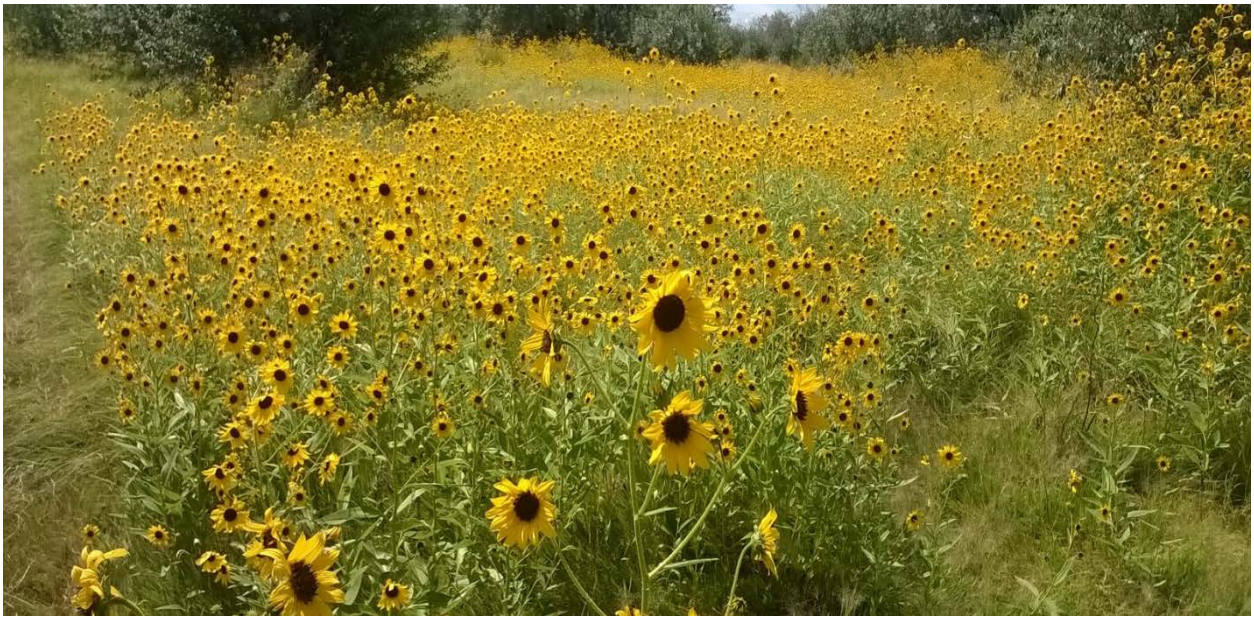
Scope of the Strategy

The Strategy is focused on 235 rare and endangered plant species in New Mexico, including one lichen (**Strategy Species,** Appendix A). Occurrences of the majority of Strategy Species (213 species) are tracked by Natural Heritage New Mexico (NHNM), which actively collects information on the distribution, status, and abundance of these species. They are primarily ranked critically imperiled (G1/S1), imperiled (G2/S2), or vulnerable (G3/S3) at a global or state level by NHNM and NatureServe (Appendix A). They are considered at risk throughout their range and are vulnerable to extinction. The status of some taxa in New Mexico is uncertain, but there is reason to believe they are at risk, or even extinct (NR, GQ, GH/SH). **For the purposes of the Strategy, we refer to these plant species interchangeably as sensitive, rare, or endangered.** See below for definitions of terms used in this Strategy.

- ***Critically Imperiled Species*** are those ranked G1 globally and/or S1 statewide by Natural Heritage New Mexico and NatureServe. A G1/S1 ranking is assigned because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction throughout its range, or in New Mexico. Typically, 5 or fewer occurrences, or very few remaining individuals (<1,000), acres (<2,000), or linear miles (<10).
- ***Imperiled Species*** are those ranked G2 globally and/or S2 statewide by Natural Heritage New Mexico and NatureServe. A G2/S2 ranking is assigned due to rarity or because of some factor(s) making it very vulnerable to extinction or elimination throughout its range, or in New Mexico. Typically, 6 to 20 occurrences, or few remaining individuals (1,000 to 3,000), acres (2,000 to 10,000), or linear miles (10 to 50).
- ***Vulnerable Species*** are those ranked G3 globally, and/or S3 statewide by Natural Heritage New Mexico and NatureServe. A G3/S3 ranking is assigned either because the species is very rare and local throughout its range, or in New Mexico, found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extinction or elimination. Typically, 21 to 100 occurrences, or between 3,000 and 10,000 individuals.
- ***Threatened or Endangered Species*** are those that are federally listed and protected under the U.S. Endangered Species Act (ESA) by the U.S. Fish and Wildlife Service.
- ***State Endangered Plants*** are those listed as Endangered by the State of New Mexico and are protected under state law.
- ***Navajo Nation Endangered Species*** are those listed by the Navajo Nation as threatened, endangered or candidates for listing and are protected by the Navajo Nation Endangered Species Act.
- ***Sensitive Species or Species of Concern*** are not necessarily included on the above lists, but may be included on lists of Sensitive Species by the U.S. Fish & Wildlife Service, the Division, the Navajo Nation, the U.S. Forest Service (USFS), the Bureau of Land Management (BLM), and other tribes and pueblos. Only the BLM and the USFS provide some protective measures for sensitive species and species of concern, including policies and guidelines.

- ***Endemic Species*** are those whose entire distribution is restricted to a relatively small geographic region. These species occur nowhere else in the world and are often, but not necessarily, vulnerable to extinction.

- ***Rare Species*** typically have small numbers of individuals worldwide, narrow geographic ranges, and/or few localized populations, making them more vulnerable to extinction than common species. These include all plants reviewed and listed by the New Mexico Rare Plant Technical Council.



Pecos sunflower (*Helianthus paradoxus*) © Daniela Roth

Plant Conservation Scorecard for Strategy Species

The New Mexico Plant Conservation Scorecard (Scorecard) provides an analysis of the current conservation status of the 235 Strategy rare plants including threats, degree of protection, and actions needed to conserve species (management actions, inventories, monitoring, taxonomic work, etc.). NHNM developed the New Mexico scorecard process based on the approach successfully implemented in Colorado by the Colorado Natural Heritage Program and The Nature Conservancy (Rondeau et al. 2011). Details about its development are found in Appendix B, Scorecard Methods.

Using a spreadsheet calculator, each species was evaluated with respect to its known distribution, the quality of the populations in terms size and viability, ecological conditions, threats, and the degree of current protection. This evaluation was used to arrive at an Overall Conservation Status (OCS) assessment of either Effectively Conserved, Moderately Conserved, Weakly Conserved, or Under Conserved (Appendices A & B).

The next step was to further evaluate the 235 Strategy Species by taking into consideration the quality and quantity of the observation data available on them to determine whether their OCS should be modified as a result. The species were then categorized into four working lists to support conservation planning (Appendix B):

List A – Species where there were sufficient, high quality observation data to generate an OCS score with moderate to very high confidence.

List B – Species which had sufficient observation data to generate an OCS score but confidence in the underlying data was limited (e.g. older records with lower positional accuracies). Accordingly, List B species are assigned a Modified Conservation Status two levels below the unmodified score. For example, a species assessed as Effectively Conserved with low confidence in the underlying data would be given a Modified Conservation Status of Weakly Conserved.

List C – Species that lacked sufficient observation data to generate an OCS score. Values for List C species scorecard metrics were assigned where possible based on expert knowledge and categorically classified as Weakly Conserved until further data are collected.

List D – A watch list of species that are regional endemics for which the data and knowledge of the species indicated they are stable and not a current conservation priority.

One hundred-sixty-three taxa had sufficient data to generate a conservation status from established methods (81 on List A with a full conservation status and 82 on List B with a modified conservation status) (Appendix A). There was not enough data available to generate a full conservation status for an additional 50 species on List C, and these are considered Weakly Conserved until additional information becomes available. Twenty-two species are on List D, the watch list, and are currently not of conservation concern.

With respect to Overall Conservation Status, among the 213 Strategy Species for which a conservation status could be generated (List A, B and C), 171 (80 %) were considered Under Conserved or Weakly Conserved. Only 15 species (7 %) were considered Effectively Conserved, and 27 species (13 %) are Moderately Conserved.

The primary use of the Scorecard is to help managers and researchers identify and prioritize target species for protection, conservation and management actions including surveys, monitoring, and filling of data gaps. In addition, the scorecard can be used to quickly identify documented and potential threats and assess the status of rare plant species.

The Scorecard can be sorted in a variety of ways to help establish a target list, including sorting by land ownership, agency status, conservation ranks, threats, ecoregion, or conservation actions needed. The Scorecard approach is standardized and flexible to allow for updates, edits and future additions. An electronic copy of the Scorecard (Excel file) and supporting materials are available from the NHNM New Mexico Rare Plant Conservation Strategy web page (http://nhnm.unm.edu/nm_rare_plant_conservation_strategy), from the Division, http://www.emnrd.state.nm.us/SFD/ForestMgt/NewMexicoRarePlantConservationStategy.html, or can be requested from the BLM State Office.

Important Plant Areas and Conservation Opportunity Areas

Important Plant Areas (IPAs) are specific places across New Mexico that support either a high diversity of sensitive plant species or are the last remaining locations of New Mexico's most endangered plants. The delineation of IPAs was based on the spatial modeling of the species observation data in a NHNM GIS database in combination with expert review (see details in Appendix D). Briefly, we used a one-mile hexagon grid across the state as a spatial framework and attributed each hexagon with respect to occupancy of the 235 Strategy Species. We then grouped hexagons into provisional IPAs based on proximity, landscape elements (geology and geomorphology), and a floristic similarity index. These were evaluated for consistency and coherency by experts and prioritized based on an IPA Biodiversity Rank (IPA B-Rank). The IPA B-Rank based Diversity Score (D-Score) was modified as needed to account for species that are both highly localized and very rare (S1/G1 and S1/G2 species). The Diversity Score is computed as the inverse Global/State Status Score (GS-Score) for a species times its percent occupancy in an a given IPA, summed for species in an IPA. The higher the value, the greater the biodiversity significance. For example, a S2/G3 species would have a GS Status Score of 4, and if 50% of the observations for that species occurred within the IPA, its Diversity Score would be 2. These scores are summed for all species in the IPA. Based on the sums, the IPAs are assigned B-Ranks. In addition, approximately 10% of the IPAs were assigned a modified B-Rank based on expert opinion, federal status of the species occurring within an IPA, and overall rarity.

The outcome was a set of 133 IPAs with IPA-Biodiversity Ranks that can be used to identify high priority areas for management actions (Figure 4; Appendix C & D). Detailed information for each IPA, including shape files, species lists, acreage, and county of occurrence will be made available to land managers and conservation partners on request to the Forestry Division http://www.emnrd.state.nm.us/SFD/ForestMgt/NewMexicoRarePlantConservationStategy.html, or Natural Heritage New Mexico (http://nhnm.unm.edu/nm_rare_plant_conservation_strategy).

Using IPAs as the template, the long-range goal is to identify and develop Conservation Opportunity Areas (COAs) that integrate biodiversity value with management and conservation options. That is, COAs are not only areas that reflect rare plant biodiversity value per the IPA B-Rank, but also levels of imperilment, urgency of management protection actions, and other opportunities such as funding and land ownership patterns. The COA boundaries will be based on the best estimate of the primary area supporting the long-term survival of targeted species within an IPA.

A COA is designed to identify a land area that can provide the habitat and ecological processes upon which a particular species population, or suite of species populations, depends for its continued existence (e.g., it may also include other sensitive plants, animals, or plant communities). The best available knowledge about each species' life history is used in conjunction with information about topographic, geomorphic, and hydrologic features; vegetative cover; and current and potential land uses. In developing the boundaries of a COA, a number of factors need to be considered, including, but not limited to:

- Ecological processes necessary to maintain or improve existing habitat conditions;
- Pollinators and pollinator habitat;

- Seed dispersal and seed banking;
- Maintenance of the hydrologic integrity of surface and ground water;
- Land intended to buffer the COA against future changes in the use of surrounding lands;
- Exclusion or control of invasive species;
- Suitable habitat necessary for management or monitoring activities;
- Coordination of other land use activities to the extent that they affect the integrity of the COA
- Unoccupied but suitable habitat for population expansion.

COA boundaries are meant to be used for conservation planning purposes and have no legal status. Proposed boundaries do not automatically recommend the exclusion of all activity. Rather, the boundaries designate ecologically significant areas in which land managers may wish to address how specific land use activities or land use changes within or near the COA affect sensitive plant species and their habitats. COA boundaries do not necessarily include the entire range of a species. They indicate the immediate, and therefore most important area to be considered for protection. Final designations and management responsibility for permanent conservation areas lie with the land managers and owners. Designations could include Areas of Critical Environmental Concern (ACEC), Research Natural Areas (RNA), Botanical Areas, Nature Preserves, Conservation Easements, Biological Preserves, and others. Continued landscape-level conservation efforts may be needed that extend far beyond COA boundaries. This involves regional efforts in addition to coordination and cooperation with private landowners, and tribal, state, and federal agencies.

Cornudas Mountains IPA © Daniela Roth

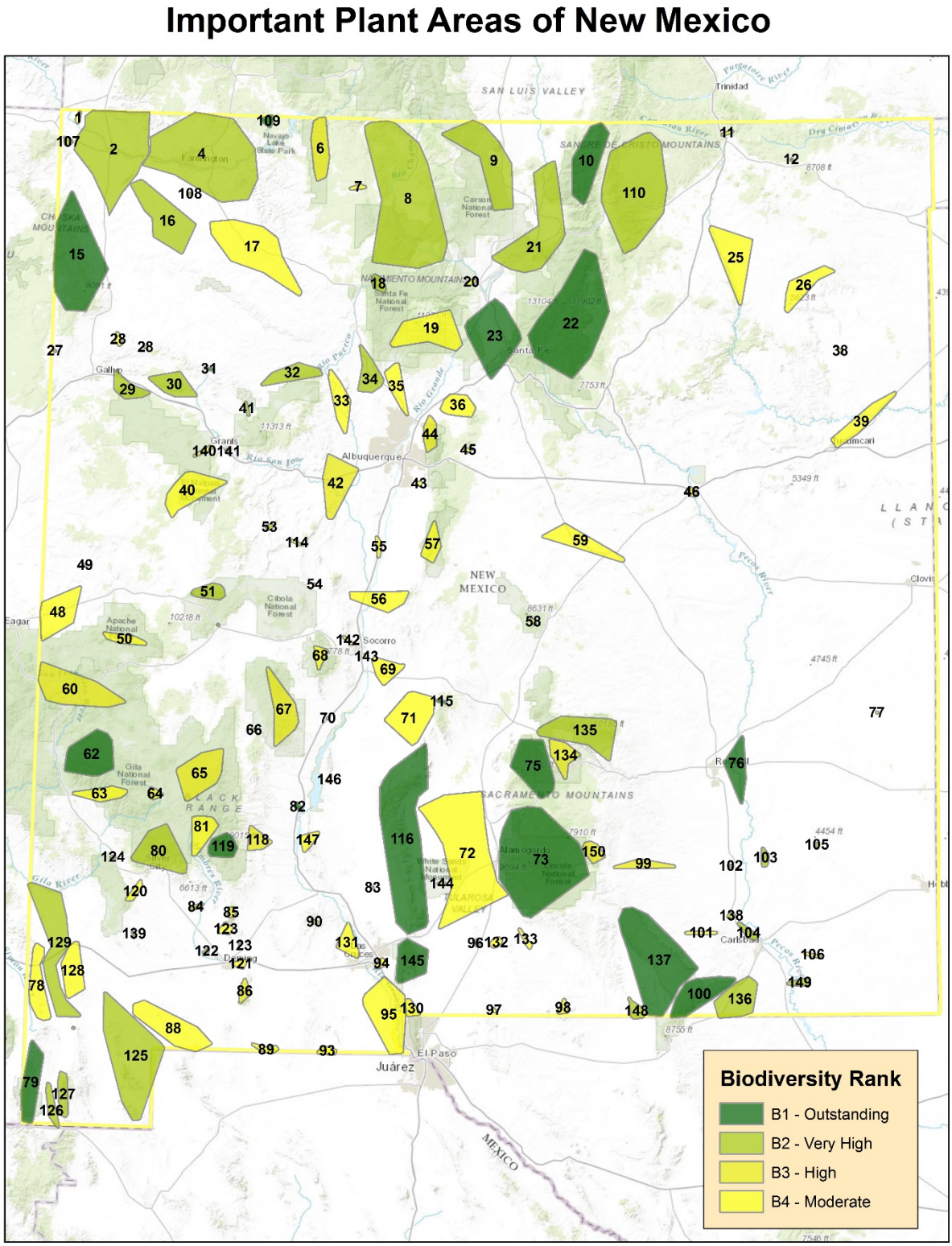


Figure 4. Important Plant Areas of New Mexico and their Biodiversity Rank (NHNM 2017). Detailed information for each IPA, including shape files, species lists, acreage, and county of occurrence is available to land managers on request to the Forestry Division. See Appendices C and D for details.

Sivinski's scorpionweed (*Phacelia sivinskii*) at the White Mesa IPA. © Daniela Roth

Sawtooth/Datil IPA © Daniela Roth

New Mexico stonecrop *(Rhodiola integrifolia ssp. neomexicana)* © Daniela Roth

STRATEGY GOALS AND OBJECTIVES

The overall goal of the New Mexico Rare Plant Conservation Strategy is to protect and conserve New Mexico's rare and endangered plant species and their habitats through collaborative partnerships between stakeholders and interested parties. It seeks to aid and improve plant conservation and management in order to avoid the need for additional federal listings of rare plant species.

Specific goals include:

1. Inventory, monitor, and research Strategy Species to inform management and regulatory decisions
2. Protect, manage, and restore Strategy Species and their habitats
3. Improve data management, accuracy, storage, & dissemination
4. Develop ex-situ conservation and recovery strategies and implement where appropriate
5. Improve laws, regulations, and policies
6. Improve collaboration, education, and outreach
7. Improve funding, infrastructure, and rare plant programs

Strategy goals are not listed in order of priority; they are intended to provide focus areas for conservation partners to participate in conservation actions consistent with their abilities and expertise. Each goal contains a list of objectives with conservation actions and opportunities that will contribute to reaching the overall Strategy goal over the long term. The list of conservation actions and opportunities will change over time as conservation actions are implemented and more information is known on how to effectively manage and protect rare plants. They are not meant to be accomplished by any one agency or institution, but may be accomplished by the combination of efforts by any party interested in pursuing plant conservation. These include land management agencies, regulatory agencies, academic institutions, NGOs, tribes, private land owners, local governments, volunteers, botanical gardens, and state government agencies. Successful implementation is contingent upon adequate resources and funding and a high level of coordination and information sharing among participants.

GOAL 1. Inventory, Monitor, and Research Strategy Species to Inform Management and Regulatory Decisions

Improve scientific understanding of distribution, natural history, and status through inventory, research, monitoring, and modeling to inform management and regulatory decisions and identify conservation actions needed.

OBJECTIVE 1: Inventory

- Prioritize survey needs based on scorecard results, management and regulatory needs and recommendations of the NM Rare Plant Technical Council.
- Conduct range-wide surveys to determine the status and distribution of Strategy Species.
- Develop and provide survey guidelines and surveyors qualification standards on a common website (see USFWS 2011 for example; also Goal 6: Objective 2).
- Provide training for Citizen Scientists to assist with survey needs.
- Prepare Strategy Species status assessments to provide a sound scientific foundation for management and regulatory decisions.
- Maintain and regularly update the list of Strategy Species in coordination with land managers, the NMRPTC, NHNM, and other knowledgeable parties.

OBJECTIVE 2: Monitor

- Support and evaluate existing monitoring projects and establish new monitoring efforts.
- Prioritize monitoring needs based on threats, perceived declines, rarity, management and regulatory needs, utilizing the Plant Conservation Scorecard and NM Rare Plant Technical Council recommendations.
- Determine types of monitoring needed to evaluate rare plant status (population trend, management response, threat response, reintroduction success, changes in habitat condition).
- Develop standardized monitoring plans and reporting to document population trends and evaluate management effectiveness (see USFWS 2011 for example).
- Provide monitoring plan samples and templates through a common website (include management triggers for threat-based monitoring).
- Provide training for Citizen Scientists to assist with monitoring needs.
- Track population trends of the most rare and endangered species, based on NHNM ranks and scorecard results.
- Track state-wide monitoring results in a centralized database.
- Update status through annual monitoring reports.
- Use monitoring results to develop management recommendations and actions.

OBJECTIVE 3: Research

- Encourage and facilitate collaboration between land managers, regulators, and research institutions to address research needs and questions.
- Work with researchers and funders to encourage applied studies that support conservation research.
- Prioritize research needs for each species based on Plant Conservation Scorecard, NMRPTC recommendations, management and regulatory needs, etc. Research areas may include taxonomy, habitat requirements, population trends, seed banks, seed dispersal, pollinators, distribution, predation, threats, molecular ecology, soil chemistry and microbiology.
- Focus on research that seeks to better understand how human activities, such as dust from energy development, Off-Road-Vehicle use, grazing, fires, or herbicide application impact rare and endangered plant species; use this information to inform avoidance and mitigation practices and recommendations.
- Conduct systematic and genetic research on those rare and endangered plants for which there are taxonomic questions (see Scorecard at http://nhnm.unm.edu/nm_rare_plant_conservation_strategy, http://www.emnrd.state.nm.us/SFD/ForestMgt/NewMexicoRarePlantConservationStategy.html).
- Support and conduct species-specific research to answer basic questions about the natural history of rare and endangered species, including their reproductive biology (e.g., pollination, breeding systems, and seed dispersal mechanisms), life history (e.g., seed banks, germination and establishment requirements), and ecology (e.g., soil requirements, fungal and bacterial relationships), as well as other important ecological processes such as fire or other disturbances needed for their survival.
- Provide access to research findings through a common website (see Goal 6: Objective 2).

OBJECTIVE 4: Predictive modeling for planning and evaluating management actions

- Acquire ecological data layers, including geology, soils, climate, and vegetation data necessary to develop suitable habitat models for planning purposes and to help prioritize survey focal areas.
- Develop predictive models to evaluate potential impacts of management activities (including travel management, grazing, logging, herbicide application, mining, oil, gas and renewable energy development, prescribed fires, etc.).
- Collect and compile data to develop population viability models to assess endangerment and management needs.

OBJECTIVE 5: Identify data gaps

- Fill data gaps to improve knowledge of range, distribution, population size, condition, threats, and current status of Strategy Species based on Scorecard results (see Scorecard at http://nhnm.unm.edu/nm_rare_plant_conservation_strategy, http://www.emnrd.state.nm.us/SFD/ForestMgt/NewMexicoRarePlantConservationStategy.html).

GOAL 2. Protect, Manage, and Restore Strategy Species and their Habitats

Secure on-the-ground, site-specific habitat protection, restoration, and/or management.

OBJECTIVE 1: Minimize the impacts of land uses and threats to Strategy Species

A. Project Planning

- Incorporate information regarding the protection and management of rare and endangered plants into planning and authorization documents, including resource management plans, land use plans, fire management plans, recreation plans, transportation plans, and environmental assessments.
- Involve stakeholders early in the planning and permitting process.
- Avoid and/or minimize negative impacts to rare and endangered plants through the use of existing data and models in conjunction with field surveys, comprehensive planning, good siting, best management practices, and no surface occupancy or controlled surface occupancy stipulations for oil & gas leases (see Elliot et al. for example).
- Provide best available data and botanical expertise to federal, state and tribal agencies, counties, and energy companies to guide decisions regarding use authorizations and development areas, including applications for drill permits, road construction, improvement and maintenance, prescribed fires, thinning projects, urban expansion, etc., to help avoid surface disturbance to rare plant occurrences.
- Ensure that federal, state, tribal, and local transportation agencies are aware of the potential occurrence of rare and endangered plants in road maintenance areas and inform management prescriptions that involve mowing and/or herbicide use.
- Develop survey protocols for all Strategy Species and standards for surveyor qualifications, based on USFWS guidance for New Mexico's listed plants (see USFWS 2011 for example).
- Establish policies that incorporate survey protocols and surveyor qualifications in planning and permitting processes.
- Make survey protocols and standards for surveyor qualifications available through a common website.

- Conduct field surveys for rare and endangered plants during the appropriate survey season to ensure maximum detection of rare and endangered plants in proposed project areas to facilitate proper planning.

B. Mitigation

- Mitigate the loss or degradation of rare and endangered plants and their habitat due to development and other land use activities.
- Develop mitigation measures including minimization, avoidance, and compensatory measures (see 2016 BLM mitigation handbook H-1794-1 and https://www.epa.gov/cwa-404/compensatory-mitigation#facts for compensatory mitigation).
- Develop Best Management Practices (BMPs) to minimize impacts to rare and endangered plants and work with land management agencies to implement them (energy development, sustainable collection, grazing, weed management, mining, road maintenance, recreation, etc.; see Elliot et al. 2011 for examples).
- Minimize the introduction and spread of invasive species in Important Plant Areas by working with the New Mexico Department of Agriculture, New Mexico Department of Transportation, weed management associations, and land managers.
- Control and manage existing noxious weed populations to minimize impacts to rare and endangered plants and their habitats by working closely with federal, state, and county weed experts to develop Best Management Practices (see Mui and Panjabi 2016 for example).
- Monitor the impacts of control efforts, including impacts of biocontrol on other related species, working with the New Mexico Department of Agriculture.
- Promote the use of locally adapted native seed in revegetation projects.
- Eliminate the use of introduced restoration species.
- Monitor rare and endangered plant occurrences that are potentially threatened by maintenance, resource development of other resource management activities.

C. **Conservation**

- Prioritize conservation actions for Strategy Species based on the Scorecard, management and regulatory needs, trends, listing/agency status and funding availability.
- Incorporate research and study findings to fill key data gaps, inform mitigation/BMPs, and reduce conflicts between maintenance and resource development projects and rare and endangered plants. Examples of needed research include pollination studies to inform buffer distances, rare plant habitat and threat modeling, climate change impacts, threat response monitoring, seed banking and seed dispersal mechanisms, herbicide application, competition with invasive species, impacts from recreation activities, prescribed burns, or secondary impacts such as dust deposition, habitat fragmentation, and erosion.
- Ensure that, if possible, rare and endangered plants are incorporated into the New Mexico Oil Conservation Commission rules for wildlife, reclamation, and restoration.

- Utilize existing funding sources more effectively and identify new sources of funding for habitat protection of rare and endangered plants at the federal, state, and local levels (U.S. Fish and Wildlife Service, Farm Bill, non-profit grants; etc.).
- Direct federal funding (e.g., U.S. Fish and Wildlife Service, Farm Bill Programs) to address management needs (e.g., fencing of rare and endangered species on private lands).
- Develop and promote new incentives for private landowners to participate in plant conservation activities.
- Encourage the purchase or transfer of development rights that would prioritize the conservation of rare and endangered plant habitat.

OBJECTIVE 2: Determine priority habitats to focus resources for protection, management, and restoration

A. Important Plant Areas

- Evaluate distribution of Strategy plants statewide and develop a list and maps of Important Plant Areas for NM.

B. Conservation Opportunity Areas

- Develop Conservation Opportunity Areas (COAs) from Important Plant Areas.
- Delineate meaningful, ecologically-based planning boundaries by describing methods and criteria for identifying COAs (i.e., intact landscapes, significant overlap w/high-quality rare plant occurrences and habitat). Conduct field visits to verify conditions and integrate data for co-occurring species of concern and plant communities.

C. Plant Conservation Areas

- Establish permanent plant conservation areas from COAs, based on management directives and opportunities (Areas of Critical Environmental Concern (ACEC), Research Natural Areas (RNA), Botanical Areas, Conservation Easements, Natural Areas, Nature Preserves, Biological Preserves, etc.).
- Develop stewardship/management plans for plant conservation areas, or incorporate specific management goals and objectives into resource management plans and land use plans.
- Seek increased federal- and state-level funding for the management of established plant conservation areas, including management of prescribed fires, livestock operations, wood cutting, recreational activities, travel, monitoring, and invasive species control.
- Seek increased protection of rare and endangered species and their habitats on private lands, working with land trusts and willing landowners to institute conservation easements and other on-the-ground protection tools.

OBJECTIVE 3: Protection on Private and Tribal Lands

- Provide information to private landowners, tribes, and local land trusts to get rare plants on the radar and increase protection.
- Identify and promote federal programs to help private landowners receive compensation for their land protection actions (e.g.: USFWS Recovery Land Acquisition Program (ESA Section 6), USFWS Partners Program, NRCS Conservation Programs).
- Promote tax credits to private landowners for the donation of conservation easements established for the protection of rare plants through the NM Land Conservation Incentives Act.
- Provide a page of links to resources available through a common website (see Goal 6: Objective 2).

OBJECTIVE 4: Habitat Management and Restoration

A. Conservation Action Plans

- Develop and implement Conservation Action Plans, including measurable goals and objectives, for each Strategy Species, or groups of Strategy Species.
- Incorporate ex-situ conservation measures
- Incorporate recovery actions if needed
- Prioritize species based on scorecard and management goals.
- Involve multiple partners in planning.

B. Coordinate planning efforts for Conservation Opportunity Areas (COAs)

- Identify areas of overlap and opportunities for collaboration with State Wildlife Action Plan, the State Forest Action Plan (Statewide Natural Resources Assessment and Strategy and Response Plan), and federal resource management plans.

C. Identify barriers and opportunities for management and restoration.

D. Restore impacted or degraded habitats working collaboratively with other agencies, tribes, organizations, and private landowners.

E. Develop resources for restoration, enhancement, and management of rare and endangered plants and their habitats

- Provide a supply of genetically and ecologically appropriate native seed for habitat restoration, including nectar species for pollinators.
- Consider soil biota conditions and plan restoration practices to take these into account or adjust for them.

- Expand literature base and expert knowledge to develop best restoration and management practices for each species.
- Provide a literature base and native seed distributor list via links and downloads through a common website (see Goal 6: Objective 2).

F. Build flexibility into proposals and plans to allow for adaptive management.

G. Provide Best Management Practices for development and maintenance projects within the habitat of rare plants (see Panjabi and Smith 2014 and Crane 2006 for examples).

H. Provide a list of unacceptable management and mitigation practices, including transplanting, using introduced species for restoration and revegetation, using herbicides in rare and endangered plant habitats, etc.

GOAL 3. Improve Data Management, Storage, and Dissemination

Improve scientific understanding of rare plant distribution, abundance, and status through coordinated data management

OBJECTIVE 1: Establish and maintain a NM Rare Plant Conservation Strategy Species List and data repository

- Maintain and update the NHNM database to build a central repository for all information on Strategy species in New Mexico to assure consistent and up-to-date rankings, including detailed justifications for ranking, using current NatureServe methodology.
- Add new data to the NHNM database, obtained from herbaria (SEINet), land management agencies, consultants, the Division, and other knowledgeable parties.
- Review species list as needed with the NMRPCP, the NM Rare Plant Technical Council (NMRPTC), and other experts to update the Plant Conservation Scorecard.
- Regularly update status ranks of Strategy Species as new data becomes available.
- Seek funding to support a web page to disseminate Strategy content from NHNM database.

OBJECTIVE 2: Improve data management capabilities to better prioritize species and focus habitat protection and restoration.

- Engage stakeholders. Provide outreach and training to facilitate input of rare plant information to the NHNM's web-enabled database (https://nhnm.unm.edu/data/contribute_data)
- Work with funders of conservation, research, and survey projects to require data be entered into the NHNM web-enabled database.

- Provide up-to-date species data to land managers and regulatory agencies on status, abundance, distribution, and threats for status evaluations and land-use and project planning.
- Secure funding for NHNM from partner agencies to maintain and update the database of rare plant occurrences and threats.
- Seek base funding for NHNM through State government.

GOAL 4. Develop Ex-situ Conservation and Recovery Strategies and Implement where Appropriate

OBJECTIVE 1: Collect seeds and other plant materials for long-term ex-situ conservation and restoration purposes.

A. Identify Strategy Species already in long-term storage and those with collection needs.

B. Prioritize Strategy Species to be collected based on conservation urgency and management needs.

C. Provide Citizen Science opportunities for trained volunteers to collect seed and assist with propagation and restoration projects. This could include schools working closely with an agency or conservation organization.

D. Develop seed collection protocols for each species.

- Follow and adapt procedures in the Genetic Sampling Guidelines for Conservation Collections of Endangered Plants by the Center for Plant Conservation (Falk et al. 1991; Guerrant et al. 2004) for sampling within a location to represent genetic diversity and ensure that associated data are recorded.
- Evaluate initial seed quality to help predict storage behavior. Periodically monitor viability during storage.
- Update or replenish collections. Determine a timeline for initial and subsequent collections.
- Store seeds at a Center for Plant Conservation participating institution, National Center for Germplasm Preservation, BLM or Forest Service plant propagation centers, or other appropriate facility.
- Collect voucher specimens and deposit them in New Mexico herbaria participating in SEINET (http://swbiodiversity.org/seinet/index.php).
- Make seed collection protocols available through a common website and share them with plant propagation centers and stakeholders (see Goal 6: Objective 2).

E. Develop propagation and storage protocols for taxa lacking viable seed sources such as propagation through tissue culture and storage through cryopreservation.

OBJECTIVE 2: Determine species' propagation needs.

- Assess feasibility and appropriateness of propagation.
- Determine knowledge gaps regarding propagation.
- Develop standardized germination protocols for all species collected to be readily available when seeds need to be germinated for conservation or restoration purposes.
- Develop propagation protocols and make them available through a common website and share with CPC and stakeholders (see Goal 6: Objective 2).
- Identify nurseries, botanical gardens, and other propagation facilities qualified to produce rare plant materials, if needed for restoration purposes.

OBJECTIVE 3: Augment and reintroduce rare and endangered plants where appropriate.

A. Acquire appropriate agency authorizations prior to planning and implementing restoration and augmentation activities.

B. Develop reintroduction plans that include detailed documentation, maps, experimental design, planting locations, number of plants introduced, source of plant materials, and a monitoring plan. Consult existing reintroduction guidelines (Guerrant 1996; Vallee et al. 2004; Maschinski et al. 2012b; IUCN 2013; CPC 2018).

C. Evaluate site criteria; this may include molecular ecology where appropriate -- i.e., habitat quality and species diversity, protected site (Maschinski et al 2012a).

D. Work with land managers or landowners to create a stewardship plan.

E. Remove or address threats and conduct restoration as needed to ensure stable habitat prior to rare plant introductions.

F. Monitor augmented and reintroduced sites.

- Establish a long-term monitoring plan, including measures of success.
- Provide annual reports following standard scientific reporting protocols, including introduction, methods, results, conclusion and recommendations
- Provide monitoring reports to the funding agency and stakeholders, and make publicly available through a common website.

GOAL 5. Improve Laws, Regulations, and Policies

Improve, develop and implement laws, regulations, and program policies to enhance the conservation of New Mexico's rare and endangered plants in cooperation with public land managers, private landowners, tribes, and other interested stakeholders.

OBJECTIVE 1: Identify regulatory mechanisms used in other states that would strengthen protection of endangered plants in New Mexico.

OBJECTIVE 2: Improve existing NM State endangered plant law and develop policies needed to increase protection for state listed endangered plants.

Work with elected officials and partners to improve the state statute to

- Update and improve the criteria and process by which the Division identifies and designates plants for inclusion on the State Endangered Plant List, using the best available science.
- Include a requirement to use a variety of mechanisms and resources to protect state listed endangered plants (e.g. avoidance, mitigation, environmental assessments and reviews, etc.).
- Establish an environmental review process or add state listed endangered plants to the existing State review process (NMDGF).

OBJECTIVE 3: Develop a programmatic framework that facilitates due diligence from federal, state, tribal, and local government entities emphasizing collaboration to guide the conservation of endangered plants with the goal of precluding federal listing.

- Involve federal agencies in rare plant conservation and provide input on federal government actions that may negatively impact state listed endangered plant species. Including the State Endangered Plant list in the federal decision-making processes will result in enhanced federal analysis of actions that may jeopardize the viability of state listed species (not solely federally listed species) and will trigger consideration of alternatives that could avoid damaging populations of state-designated plants.
- Facilitate state land management agency (SLO, NMSP, NM Mining and Minerals Division, and NM Department of Transportation) involvement in rare plant conservation to inform management actions that may negatively impact state listed endangered plant species (including the use of introduced species for reclamation and restoration purposes).
- Require an analysis of state listed endangered plant species and their habitat (through an established environmental review process) when operations performed, regulated or authorized by state agencies may impact species viability. Consider the impacts on state listed endangered plant species via an established, but streamlined, environmental review process. Require consideration of alternatives that will emphasize avoidance of sensitive species populations. This process is intended to ensure that state agencies conduct their operations

and carry out their responsibilities with the full knowledge and consideration of any designated rare plant population that may be affected.

- Engage tribes, local governments, and private landowners through a non-regulatory and service-oriented program that encourages stewardship of rare plants.
    - Offer technical and financial resources including assistance with the identification of rare plants, management recommendations (e.g., BMPs), and small grants on a cost-share and/or direct assistance basis as incentives for good stewardship.
    - Consider tax breaks for conservation actions.

- Work collaboratively with industry, academic, land management, conservation, and other non-governmental partners to evaluate landscape scale threats to state listed endangered plant populations and identify measures and practices that could be implemented in a cost-effective and practical manner to mitigate negative impacts.

GOAL 6. Increase Collaboration, Education, and Outreach

Work with conservation partners and engage the public through education and outreach to promote stewardship and conservation of New Mexico's rare plants.

OBJECTIVE 1: Collaboration

A. Develop and expand partnerships

- Engage a wide range of conservation partners and collaborators throughout New Mexico in Strategy development and implementation.
- Disseminate and publicize the Strategy to all stakeholders.
- Offer training on implementation of the Strategy, matching Strategy objectives and action items with stakeholder expertise and capacity.
- Promote communication and collaboration between private and public land managers, regulatory agencies, academic institutions, NMRPTC, botanists and other stakeholders. Coordinate research and conservation efforts and implement Strategy by sharing data, status information, research needs, data gaps, best management practices, survey protocols, propagation, and introduction protocols through New Mexico Rare Plant Conservation Partnership meetings, a ListServ, social media sites, and the Division, NHNM and NMRPTC websites, a common Strategy website, and Strategy appendices.
- Collaborate with and encourage academic institutions to focus taxonomic research on rare plants.
- Encourage New Mexico botanical gardens and parks to become participating institutions to promote the ex-situ conservation of New Mexico's rare and endangered plants through living collections, seed collection, storage, research and outreach.

B. Provide a vehicle for NMRPCP to establish formal relationships, and pool resources and funding to support rare plant conservation actions through cooperative agreements,

Memorandums of Understanding, etc. (examples include Cooperative Ecosystem Studies Units (CESU), Plant Conservation Alliance, Laukahi Network, Hawaii; UT Interagency Rare Plant Team, and Native Plant Conservation Campaign).

OBJECTIVE 2: Education and Outreach

A. Establish a common website to facilitate information exchange on New Mexico's rare plants by updating and improving the existing NMRPTC website, or developing a new common website (Plant Conservation Scorecard, Important Plant Areas, status reports, propagation information, survey and monitoring guidelines, mitigation measures, links to other websites, funding opportunities, volunteer opportunities, job opportunities, best management practices, new publications, etc.).

B. Publish a book on New Mexico rare plants (this could be an online book and/or app for use on mobile devices.)

C. Provide rare plant identification and survey training to agency biologists and biological technicians, consultants, volunteers, and other interested parties.

D. Support and expand rare plant exhibits to increase public awareness and support at the Albuquerque and Santa Fe Botanical Gardens and Living Desert State Park in Carlsbad.

E. Develop and distribute educational materials about rare and endangered plants, including brochures, apps, booklets, interpretive signs and posters, presentations, rare plant workshops and trainings.

F. Citizen Science

- Engage groups that might be interested in citizen science programs (i.e., Master Gardeners, NMNPS, schools, museums, Wilderness Alliance, Audubon Society, Sierra Club, etc.).
- Research and develop a collaborative, partner-supported citizen science program with a coordinator position (*e.g.*, Denver Botanical Garden, Colorado Natural Areas Program, California Native Plant Society Rare Plant Treasure Hunt, University of Washington Rare Plant Care and Conservation, New England Plant Conservation Program (New England Wildflower Society), Central Arizona Conservation Alliance, etc.).
- Provide training to volunteers (rare plant surveys and bio-blitzes, monitoring, seed collection, phenology networks, restoration projects, etc.).

G. Youth Programs

- Engage youth by incorporating conservation education into the science curriculum.
- Promote summer outdoor education programs through hands-on projects (surveys, monitoring, restoration projects), presentations, field trips and stewardship projects.

- Provide training and educational materials to teachers and Youth Conservation Corps crews.

H. Support and promote programs and incentives that assist private landowners in protecting and managing rare and endangered plants on their lands, such as the Farm Bill, USFWS Partners Program, and the New Mexico Land Conservation Tax Incentives Program.

I. Develop an annual Plant Conservation Awards program, working with the NM Native Plant Society. The awards would recognize and reward landowners, land managers, and others for good stewardship of rare and endangered plants and their habitats.

GOAL 7. Improve Funding, Infrastructure, and Rare Plant Programs

OBJECTIVE 1: Support and expand the NM State Forestry Endangered Plant Program

- Obtain consistent long-term funding for the Endangered Plant Program through general funding and/or cooperative interagency agreements to increase and support staff, enable education and outreach and create private landowner incentives and direct assistance for plant conservation efforts.

OBJECTIVE 2: Facilitate the development of rare plant programs in other agencies, tribes, non-governmental organizations, or institutions.

- Initiate a dialog between the Strategy partners and land managers to formally adopt the Strategy through cooperative agreements, Memorandum of Understandings, Standard Operating Procedures, planning documents, and the development of Best Management Practices.
- Promote the benefits of proactive rare plant conservation to land managers.
- Engage the public and nongovernment organizations to provide comments on plant conservation needs during land use planning revisions.
- Seek funding to promote ex-situ conservation programs through botanical gardens.
- Hire botanists in state and federal agencies to guide and support management and conservation of rare and endangered plants.
- Encourage the hiring of botanists in tribal natural resources departments, academic institutions, and conservation organizations.

Lee's pincushion cactus (*Escobaria sneedii var. leei*). © Daniela Roth

STRATEGY IMPLEMENTATION AND MEASURES OF SUCCESS

Achieving conservation of New Mexico's most rare and endangered plant species means that they are adequately protected, with low threats and high viability, and there is active recovery for high priority species. Implementation of recommended conservation actions is an ongoing process largely dependent on funding. The New Mexico Rare Plant Conservation Partnership will hold regular meetings to discuss Strategy implementation success as well as conservation needs and priorities, funding opportunities, and shared research (monitoring, surveys, seed collections, and volunteer opportunities).

Tracking progress and evaluating the effectiveness of conservation actions will provide the feedback needed to adjust priorities and objectives. Measuring results provides the basis for adaptive management in this conservation approach. Success indicators are proposed below.

The NMRPCP will evaluate the status of rare and endangered plants in New Mexico every 5 years by tracking changes using three primary indicators:

1. **Baseline Information**
   - Number of species surveys & inventories funded and status reports completed
   - Number of species moved from Scorecard lists B and C to Scorecard List A (i.e. data gaps filled)
   - Number of Strategy Species moved to D list
   - Number of species with established trend monitoring sites, monitoring plans and monitoring reports completed

2. **Protection/Conservation Status**
   - Number of Important Plant Areas considered by land managers as Conservation Opportunity Areas (COAs)
   - Number of Plant Conservation Areas established from COAs
   - Number of conservation action/projects completed
   - Number of Strategy Species with conservation plans
   - Improved protection of state listed plants through state legislation

- Increased funding for statewide rare plant conservation programs, projects, and staff
- Number of new botanists hired throughout New Mexico

3. Viability Status

- Number of rare and endangered plants ranked effectively conserved (Scorecard).
- Number of rare and endangered plants with ex-situ collections (seed banked).
- Number of plants with low threat ranks

Mogollon death camas (*Anticlea mogollonensis*) © Daniela Roth

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APPENDIX A. Strategy Species List

List A – Species where there were sufficient, high quality observation data to generate an OCS score with moderate to very high confidence.

List B – Species which had sufficient observation data to generate an OCS score but confidence in the underlying data was limited (e.g. older records with lower positional accuracies). Accordingly, List B species are assigned a Modified Conservation Status two levels below the unmodified score. For example, a species assessed as Effectively Conserved with low confidence in the underlying data would be given a Modified Conservation Status of Weakly Conserved.

List C – Species that lacked sufficient observation data to generate an OCS score. Values for List C species scorecard metrics were assigned where possible based on expert knowledge and categorically classified as Weakly Conserved until further data are collected.

List D – A watch list of species that are regional endemics for which the data and knowledge of the species indicated they are stable and not a current conservation priority.

SCIENTIFIC NAME	G Rank	S Rank	State	Fed	BLM	USFS	NN	Conservation Status	List
Abronia bigelovii	G3	S2	SOC	SOC	S	S		Under Conserved	B
Acarospora clauzadeana	G1G2	S1	SOC	SOC				Weakly Conserved	C
Agalinis calycina	G1	S1	SOC	SOC				Weakly Conserved	A
Agastache cana	G4	S3	SOC	SOC				Under Conserved	B
Agastache mearnsii	G3?	S2	SOC	SOC				Moderately Conserved	A
Agastache pringlei var. verticillata	G3G4T2	S2	SOC	SOC				Moderately Conserved	A
Aliciella cliffordi	G1	S1	SOC	SOC				Weakly Conserved	A
Aliciella formosa	G2	S2	E	SOC	S		Gp 4	Under Conserved	B
Allium gooddingii	G4	S2	E	SOC		S	Gp 3	Weakly Conserved	A
Amsonia fugatei	G2	S2	SOC	SOC	S			Moderately Conserved	A
Amsonia tharpii	G1	S1	E	SOC	S			Weakly Conserved	A
Anticlea mogollonensis	G3	S1	SOC	SOC		S		Weakly Conserved	A
Anulocaulis leiosolenus var. gypsogenus	G4	S4	SOC	SOC	S			None	D
Anulocaulis leiosolenus var. howardii	G4T2	S1	SOC	SOC				Under Conserved	B
Apacheria chiricahuensis	G2	S2	SOC	SOC				None	D
Aquilegia chrysantha var. chaplinei	G4T2	S2	SOC	SOC	S	S		Effectively Conserved	A
Argemone pinnatisecta	G2	S2	E	LE				Weakly Conserved	A
Asclepias ruthiae	G3G4	S1	SOC	SOC				None	D
Asclepias sanjuanensis	GNR	S2S3	SOC	SOC	S		Gp 4	Under Conserved	B
Asclepias uncialis	G3G4	S2S3	SOC	SOC		S		Weakly Conserved	A

SCIENTIFIC NAME	G Rank	S Rank	State	Fed	BLM	USFS	NN	Conservation Status	List
Astragalus accumbens	G3	S3	SOC	SOC		S		Under Conserved	B
Astragalus altus	G2	S2	SOC	SOC		S		Under Conserved	B
Astragalus castetteri	G3	S3	SOC	SOC				Moderately Conserved	A
Astragalus chuskanus	G3	S3	SOC	SOC				Under Conserved	B
Astragalus chuskanus var. spellenbergii	G3T2	S1	SOC	SOC				Weakly Conserved	C
Astragalus cliffordii	GNR	S1	SOC	SOC				Under Conserved	B
Astragalus cobrensis var. maguirei	G4T1	S1	SOC	SOC	S	S		Weakly Conserved	C
Astragalus cyaneus	G4	S4	SOC	SOC				Under Conserved	B
Astragalus feensis	G3	S3	SOC	SOC				Under Conserved	B
Astragalus gypsodes	G2	S2	SOC	SOC	S			Under Conserved	A
Astragalus heilii	G1?	S1	SOC	SOC			Gp 4	Weakly Conserved	A
Astragalus humillimus	G1	S1	E	LE			Gp 2	Under Conserved	A
Astragalus humistratus var. crispulus	G4G5T3?	S2	SOC	SOC		S		Under Conserved	B
Astragalus iodopetalus	G2	S2S3	SOC	SOC				Moderately Conserved	A
Astragalus kerrii	G2	S2	SOC	SOC		S		Weakly Conserved	B
Astragalus knightii	G2	S2	SOC	SOC	S			Under Conserved	B
Astragalus micromerius	G3	S2S3	SOC	SOC		S		Under Conserved	B
Astragalus missouriensis var. humistratus	G5T1	S1	SOC	SOC		S		Under Conserved	B
Astragalus monumentalis var. cottamii	G4T4	S3	SOC	SOC				Under Conserved	B
Astragalus naturitensis	G2G3	S2	SOC	SOC			Gp 3	Under Conserved	B
Astragalus neomexicanus	G3	S3	SOC	SOC				Under Conserved	B
Astragalus nutriosensis	G3?	SNR	SOC	SOC				Under Conserved	B
Astragalus oocalycis	G4	S3	SOC	SOC				Under Conserved	B
Astragalus puniceus var. gertrudis	G4T3?Q	S3?	SOC	SOC				Under Conserved	B
Astragalus ripleyi	G3	S3?	SOC	SOC	S	S		Weakly Conserved	B
Astragalus siliceus	G3	S3	SOC	SOC				Under Conserved	B
Astragalus waterfallii	G3?	S2	SOC	SOC				Under Conserved	B
Astragalus wittmannii	G3	S3	SOC	SOC		S		Under Conserved	B
Atriplex griffithsii	G2G3	S2	SOC	SOC				Weakly Conserved	A
Boechera zephyra	G2	S2	SOC	SOC				Weakly Conserved	C
Calochortus gunnisonii var. perpulcher	G5T4?	S4?	SOC	SOC		S		Under Conserved	B
Carex amplifolia	G4	S1	SOC	SOC				None	D
Carex ultra	G3?	S3?	SOC	SOC		S		Effectively Conserved	A

SCIENTIFIC NAME	G Rank	S Rank	State	Fed	BLM	USFS	NN	Conservation Status	List
Castilleja organorum	G2	S2	SOC	SOC				Under Conserved	B
Castilleja ornata	G1	S1	SOC	SOC				Weakly Conserved	C
Castilleja tomentosa	G1	S1	SOC	SOC				Weakly Conserved	C
Chaetopappa hersheyi	G3	S3	SOC	SOC				Moderately Conserved	A
Cirsium gilense	G3G5Q	S2	SOC	SOC		S		Effectively Conserved	A
Cirsium inornatum	G3	S3	SOC	SOC				Weakly Conserved	B
Cirsium vinaceum	G2	S1	E	LT				Weakly Conserved	A
Cirsium wrightii	G2	S2	E	C	S	S		Weakly Conserved	A
Cladium californicum	G4	S1	SOC	SOC				None	D
Cleome multicaulis	G2G3	SH	E	SOC				Weakly Conserved	C
Coryphantha robustispina ssp. scheeri	G4T3	S2	E	SOC				Weakly Conserved	B
Coryphantha robustispina var. uncinata	G4TUQ	S1	SOC	SOC				None	D
Crataegus wootoniana	G2	S2	SOC	SOC		S		Weakly Conserved	A
Cuscuta warneri	GH	S1	SOC	SOC				Under Conserved	B
Cylindropuntia viridiflora	G1Q	S1	E	SOC	S			Under Conserved	A
Cymopterus davidsonii	G2	S2	SOC	SOC				Weakly Conserved	C
Cymopterus spellenbergii	G2	S2	SOC	SOC				Under Conserved	B
Cypripedium parviflorum var. pubescens	G5T5	S2?	E	SOC		S	Gp 4	Effectively Conserved	A
Dalea scariosa	G4	S4	SOC	SOC				Under Conserved	B
Delphinium alpestre	G2	S2?	SOC	SOC		S		Under Conserved	B
Delphinium novomexicanum	G2	S2	SOC	SOC				Weakly Conserved	A
Delphinium robustum	G2G3	S2	SOC	SOC		S		Weakly Conserved	C
Delphinium sapellonis	G4?	S4?	SOC	SOC				Weakly Conserved	B
Dermatophyllum guadalupense	G1T1	S1	SOC	SOC	S	S		Weakly Conserved	C
Desmodium metcalfei	G3G4	S3?	SOC	SOC		S		Weakly Conserved	C
Draba heilii	G2?	S2?	SOC	SOC		S		Weakly Conserved	C
Draba henrici	G1	S1	SOC	SOC				Weakly Conserved	C
Draba mogollonica	G3	S3	SOC	SOC				Weakly Conserved	B
Draba smithii	G2	S1	SOC	SOC				Weakly Conserved	C
Draba standleyi	G2G3	S2	SOC	SOC				Under Conserved	B
Echinocereus fendleri var. kuenzleri	G4G5T1T2Q	S2	E	LE				Weakly Conserved	B
Echinocereus x roetteri	GNA	SNA	SOC	SOC	S			None	D
Epipactis gigantea	G4	S2?	SOC	SOC				None	D
Ericameria nauseosa var. texensis	G5T3	S2	SOC	SOC		S		Effectively Conserved	A

SCIENTIFIC NAME	G Rank	S Rank	State	Fed	BLM	USFS	NN	Conservation Status	List
Erigeron acomanus	G1G2	S1S2	SOC	SOC	S		Gp 3	Effectively Conserved	A
Erigeron hessii	G1	S1	E	SOC		S		Weakly Conserved	A
Erigeron rhizomatus	G2	S1	E	LT			Gp 2	Weakly Conserved	A
Erigeron rybius	G3	S3	SOC	SOC				None	D
Erigeron scopulinus	G3?	S3?	SOC	SOC				Effectively Conserved	A
Erigeron sivinskii	G2	S2	SOC	SOC		S	Gp 4	Weakly Conserved	B
Erigeron subglaber	G3	S1	SOC	SOC		S		Under Conserved	B
Eriogonum aliquantum	G3	S3	SOC	SOC				Under Conserved	B
Eriogonum gypsophilum	G1	S1	E	LT				Weakly Conserved	A
Eriogonum lachnogynum var. colobum	G4?T2	S2	SOC	SOC				Weakly Conserved	A
Eriogonum lachnogynum var. sarahiae	G4?T1	S1	SOC	SOC			Gp 4	Weakly Conserved	C
Eriogonum wootonii	G5T2	S2	SOC	SOC				None	D
Eryngium sparganophyllum	G1G2	SH	SOC	SOC				Weakly Conserved	C
Escobaria duncanii	G3T1T2	S1	E	SOC	S			Under Conserved	A
Escobaria guadalupensis	G1	S1	SOC	SOC				Weakly Conserved	C
Escobaria orcuttii	G3?	S3	SOC	SOC				Moderately Conserved	A
Escobaria orcuttii var. koenigii	G3T2	S1	SOC	SOC				Weakly Conserved	C
Escobaria organensis	G2	S2	E	SOC				Moderately Conserved	A
Escobaria sandbergii	G2	S2	SOC	SOC				Moderately Conserved	A
Escobaria sneedii var. leei	G2G3Q T2Q	S2	E	LT				Weakly Conserved	A
Escobaria sneedii var. sneedii	G2G3Q T2Q	S2	E	LE				Effectively Conserved	A
Escobaria villardii	G2Q	S2	E	SOC	S	S		Under Conserved	B
Euphorbia rayturneri	G1	S1	SOC	SOC				Weakly Conserved	A
Euphorbia strictior	G3	S3	SOC	SOC				Under Conserved	B
Eurybia horrida	G2?	S3	SOC	SOC				None	D
Fissidens littlei	G1?	S1	SOC	SOC				Under Conserved	B
Geranium dodecatheoides	G2	S2	SOC	SOC		S		Weakly Conserved	C
Grindelia arizonica var. neomexicana	G4T3?	SNR	SOC	SOC				Weakly Conserved	B
Grindelia decumbens var. subincisa	G4T3?	S3?	SOC	SOC				None	D
Grindelia havardii	G4	S3?	SOC	SOC				None	D
Hackelia hirsuta	G4	S4	SOC	SOC				Weakly Conserved	B
Hedeoma apiculata	G3	S3	SOC	SOC				Effectively Conserved	A
Hedeoma pulcherrima	G2	S2	SOC	SOC				Under Conserved	B

SCIENTIFIC NAME	G Rank	S Rank	State	Fed	BLM	USFS	NN	Conservation Status	List
Hedeoma todsenii	G2	S2	E	LE				Weakly Conserved	A
Helianthus arizonensis	G4?	SNR	SOC	SOC		S		Weakly Conserved	C
Helianthus paradoxus	G2	S2	E	LT				Moderately Conserved	A
Helianthus praetermissus	GHQ	SH	SOC	SOC				Weakly Conserved	C
Heuchera glomerulata	G3		SOC	SOC	S			None	D
Heuchera pulchella	G2	S2	SOC	SOC		S		Moderately Conserved	A
Heuchera woodsiaphila	G1	S1	SOC	SOC		S		Weakly Conserved	C
Heuchera wootonii	G3Q	S3	SOC	SOC		S		Moderately Conserved	A
Hexalectris arizonica	G5T2T4	S2	SOC	SOC		S		Under Conserved	B
Hexalectris colemanii	G2T2	S1	SOC	SOC				Weakly Conserved	C
Hexalectris nitida	G3	S1	E	SOC				Weakly Conserved	C
Hexalectris revoluta	G2	S1	SOC	SOC		S		Weakly Conserved	C
Hieracium brevipilum	G3	S2	SOC	SOC		S		Moderately Conserved	A
Hymenoxys ambigens var. neomexicana	G3?T2	S2	SOC	SOC				Under Conserved	B
Hymenoxys brachyactis	G3	S3	SOC	SOC				Under Conserved	B
Hymenoxys vaseyi	G2	S2	SOC	SOC				Weakly Conserved	C
Ionactis elegans	G2	S2	SOC	SOC		S		Moderately Conserved	A
Ipomopsis congesta ssp. matthewii	G5T3	SNR	SOC	SOC				None	D
Ipomopsis sancti-spiritus	G1	S1	E	LE				Under Conserved	A
Justicia wrightii	G2	S1	SOC	SOC				Under Conserved	B
Lepidospartum burgessii	G2	S1	E	SOC	S			Weakly Conserved	A
Leucosyris blepharophylla	G1	SH	SOC	SOC				Weakly Conserved	C
Lilium philadelphicum var. andinum	G5T4T5	S3?	E	SOC		S		Effectively Conserved	A
Limosella pubiflora	G1Q	S1	SOC	SOC		S		Weakly Conserved	C
Linum allredii	G1G2	S1S2	SOC	SOC	S			Weakly Conserved	C
Lorandersonia microcephala	G2	S2	SOC	SOC				Under Conserved	B
Lupinus sierrae-blancae	G3	S3	SOC	SOC				Weakly Conserved	B
Malaxis abieticola	G4	S1	SOC	SOC				Weakly Conserved	C
Mammillaria wrightii var. wilcoxii	G4T4	S2	E	SOC				Moderately Conserved	A
Mentzelia conspicua	G2	S2	SOC	SOC		S		Under Conserved	B
Mentzelia filifolia	G3	S1?	SOC	SOC				Under Conserved	B
Mentzelia humilis var. guadalupensis	G4T1T2	S1S2	SOC	SOC	S			Weakly Conserved	C
Mentzelia sivinskii	G3	S3	SOC	SOC				Under Conserved	B
Mentzelia springeri	G3	S3	SOC	SOC		S		Under Conserved	B

SCIENTIFIC NAME	G Rank	S Rank	State	Fed	BLM	USFS	NN	Conservation Status	List
Mentzelia todiltoensis	G1?Q	S3	SOC	SOC				Moderately Conserved	A
Microthelys rubrocallosa	GNR	S1	SOC	SOC		S		Moderately Conserved	A
Muhlenbergia villiflora var. villosa	G5T3	S1	SOC	SOC				Weakly Conserved	C
Nerisyrenia hypercorax	G1G2	S1S2	SOC	SOC	S			Weakly Conserved	C
Oenothera organensis	G2	S2	SOC	SOC				Moderately Conserved	A
Opuntia arenaria	G2	S2	E	SOC	S			Under Conserved	B
Packera cardamine	G3	S2	SOC	SOC		S		Moderately Conserved	A
Packera neomexicana var. metcalfei	G5T3?Q	S3?	SOC	SOC				Weakly Conserved	B
Packera spellenbergii	G2	S2	SOC	SOC		S		Under Conserved	B
Panicum mohavense	G2	S1	SOC	SOC				Moderately Conserved	A
Paronychia wilkinsonii	G2	S1	SOC	SOC	S			Weakly Conserved	C
Pediocactus knowltonii	G1	S1	E	LE				Under Conserved	A
Pediomelum pentaphyllum	G1G2	S1	E	SOC	S	S		Weakly Conserved	A
Peniocereus greggii var. greggii	G3G4T2	S3	E	SOC	S			Under Conserved	B
Penstemon alamosensis	G3	S3	SOC	SOC	S	S		Effectively Conserved	A
Penstemon bleaklyi	G1	S1	SOC	SOC				Weakly Conserved	C
Penstemon cardinalis ssp. cardinalis	G3T2	S2	SOC	SOC				Effectively Conserved	A
Penstemon cardinalis ssp. regalis	G3T2T3	S2	SOC	SOC	S	S		Effectively Conserved	A
Penstemon linarioides ssp. maguirei	G5T1	SH	SOC	SOC		S		Weakly Conserved	C
Penstemon metcalfei	G1G3	S1	SOC	SOC		S		Weakly Conserved	A
Penstemon neomexicanus	G4	S4	SOC	SOC				None	D
Penstemon pseudoparvus	G3?Q	S3?	SOC	SOC		S		Weakly Conserved	C
Perityle cernua	G2	S2	SOC	SOC	S			Weakly Conserved	A
Perityle lemmonii	G4	S2	SOC	SOC				None	D
Perityle quinqueflora	G4	S3	SOC	SOC				Under Conserved	B
Perityle staurophylla var. homoflora	G4T2	S2	SOC	SOC				Weakly Conserved	B
Perityle staurophylla var. staurophylla	G4T3T4	S3	SOC	SOC				Weakly Conserved	B
Phacelia cloudcroftensis	G1	S1	SOC	SOC		S		Under Conserved	A
Phacelia serrata	G3	S2	SOC	SOC				Under Conserved	B
Phacelia sivinskii	G3	S3	SOC	SOC				None	D
Phemeranthus humilis	G2	S2	SOC	SOC				Under Conserved	B
Philadelphus argyrocalyx	G4	S3	SOC	SOC				Under Conserved	B
Phlox caryophylla	G4	S2	SOC	SOC				Under Conserved	B

SCIENTIFIC NAME	G Rank	S Rank	State	Fed	BLM	USFS	NN	Conservation Status	List
Phlox cluteana	G3	SNR	SOC	SOC				Weakly Conserved	A
Phlox vermejoensis	G1	S1	SOC	SOC				Weakly Conserved	A
Physaria aurea	G2	S2	SOC	SOC				Moderately Conserved	A
Physaria gooddingii	G3?	S3	SOC	SOC				Under Conserved	B
Physaria lata	G1?Q	S1?	SOC	SOC				None	D
Physaria navajoensis	G2	S1	SOC	SOC			Gp 3	Under Conserved	B
Physaria newberryi var. yesicola	G3G4T1 T3	S2	SOC	SOC				Under Conserved	B
Physaria pruinosa	G2	S1	SOC	SOC				Weakly Conserved	C
Polygala rimulicola var. mescalerorum	G3T1	S1	E	SOC				Under Conserved	B
Polygala rimulicola var. rimulicola	G3T3	S2	SOC	SOC				Moderately Conserved	A
Potentilla sierrae-blancae	G2	S2	SOC	SOC		S		Moderately Conserved	A
Proatriplex pleiantha	G3	S3?	SOC	SOC	S			Under Conserved	B
Puccinellia parishii	G2G3	S1	E	SOC	S	S	Gp 4	Weakly Conserved	A
Rhodiola integrifolia ssp. neomexicana	G5T1	S2	SOC	SOC		S		Moderately Conserved	A
Ribes mescalerium	G4?	S4?	SOC	SOC				Weakly Conserved	C
Rosa stellata ssp. mirifica	G4T4	S3?	SOC	SOC				Weakly Conserved	C
Rumex orthoneurus	G3	S2?	SOC	SOC		S		Under Conserved	B
Rumex tomentellus	GH	SH	SOC	SOC				Weakly Conserved	C
Salix arizonica	G2G3	S1	SOC	SOC		S		Effectively Conserved	A
Salvia summa	G3?	S3?	SOC	SOC				Weakly Conserved	B
Sclerocactus cloveriae ssp. brackii	G3T1	S2	E	SOC	S		Gp 4	Under Conserved	A
Sclerocactus cloveriae ssp. cloveriae	G3T3	S3	SOC	SOC				Under Conserved	B
Sclerocactus mesae-verdae	G2	S2	E	LT			Gp 2	Under Conserved	A
Sclerocactus papyracanthus	G4	S4	SOC	SOC	S			None	D
Scrophularia laevis	G2	S2	SOC	SOC				Weakly Conserved	C
Scrophularia macrantha	G2	S2	SOC	SOC	S	S		Weakly Conserved	A
Senecio cliffordii	GNR	S2	SOC	SOC				Weakly Conserved	C
Senecio sacramentanus	G3	S3	SOC	SOC				Under Conserved	B
Senecio warnockii	G3Q	S2	SOC	SOC				Weakly Conserved	C
Sicyos glaber	G3	S1S2	SOC	SOC				Effectively Conserved	A
Silene plankii	G2	S2	SOC	SOC				Weakly Conserved	B
Silene thurberi	G4	S3?	SOC	SOC				Weakly Conserved	C
Silene wrightii	G3	S2	SOC	SOC				Weakly Conserved	B
Solidago capulinensis	G1	S1	SOC	SOC				Moderately Conserved	A

SCIENTIFIC NAME	G Rank	S Rank	State	Fed	BLM	USFS	NN	Conservation Status	List
Solidago wrightii var. guadalupensis	G4T3	S2	SOC	SOC		S		Weakly Conserved	B
Spermolepis organensis	G1	S1	SOC	SOC				Moderately Conserved	A
Sphaeralcea wrightii	G4?	S3?	SOC	SOC				Under Conserved	B
Spiranthes magnicamporum	G4	S3?	E	SOC				Weakly Conserved	A
Spiranthes romanzoffiana	G5	S2?	SOC	SOC				None	D
Stellaria porsildii	G1	S1	SOC	SOC		S		Weakly Conserved	C
Streptanthus sparsiflorus	G2Q	S2	SOC	SOC		S		Weakly Conserved	C
Synthyris oblongifolia	G2	S2	SOC	SOC				Weakly Conserved	A
Talinum brachypodum	GNRQ	S1	SOC	SOC				Weakly Conserved	C
Townsendia gypsophila	G2	S2	SOC	SOC	S			Moderately Conserved	A
Trifolium longipes var. neurophyllum	G2	S2	SOC	SOC		S		Weakly Conserved	C
Valeriana texana	G3	S3	SOC	SOC				Weakly Conserved	C
Viola calcicola	G3	S3	SOC	SOC				Under Conserved	B
Xanthisma viscidum	G2	S2	SOC	SOC				None	D

APPENDIX B. Scorecard Methods

New Mexico Rare Plant Conservation Strategy
Plant Conservation Scorecard[4]

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NM Plant Conservation Scorecard

As part of development of the New Mexico Plant Conservation Strategy, Natural Heritage New Mexico (NHNM) built the New Mexico Plant Conservation Scorecard reflecting the conservation status of 235 target species (Strategy Species). The scorecard factors and process are adopted from and mirror that of the Colorado Natural Heritage Program (CNHP) hierarchical rare plant scorecard methodology with minor modifications (Rondeau et al. 2012).

The primary use of the Plant Conservation Scorecard is to help managers and researchers to identify and prioritize target species for protection, conservation and management actions, surveys and monitoring, and filling of data gaps. In addition, the scorecard can be used to quickly identify documented and potential threats and assess the status of a rare plant species. The scorecard can be sorted in a variety of ways to help establish a target list, including sorting by ownership, agency status, conservation ranks, threats, ecoregion, conservation actions needed, etc. The scorecard approach is standardized and flexible to allow for updates, edits and future additions.

Species list and data

Underpinning the scorecard process is population data on 235 Strategy Species of conservation interest. The species list for the scorecard was generated from the Natural Heritage New Mexico (NHNM) database (Biotics) of tracked and watch-list species, and includes the Navajo Nation Endangered Species List, the NM State Endangered Species List, the Bureau of Land Management and the U.S. Forest Service sensitive species lists. An initial query was used to determine how much data was available for each species. For species where location and observation data in Biotics were not available or sparse, data from SEINet and the NHNM data entry backlog were added in the database.

Following NHNM protocols, species locations are grouped into Element Occurrences (EOs) that act as operational populations or sub-populations for tracking species-specific changes in distribution and population status and trends (NatureServe 2002). EO methodology for delineation and classification is used across the NatureServe network and identifies biologically meaningful features for monitoring efforts. EOs are delineated using known mapped locations of the plant that are grouped into a given EO

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based on inter-observation distances (separation distance) and habitat factors. Separation distances are 1 km for unsuitable habitat and 3 km for suitable habitat. For example, two mapped locations that are separated by 1.5 km of unsuitable habitat are considered separate EOs. For the scorecard, we used minimum bounding geometry in ArcGIS to generate EO polygons (Figure 1). EO polygons along with textual data (observer, date, population size, etc.) were used to assess the suite of scorecard factors outlined below.

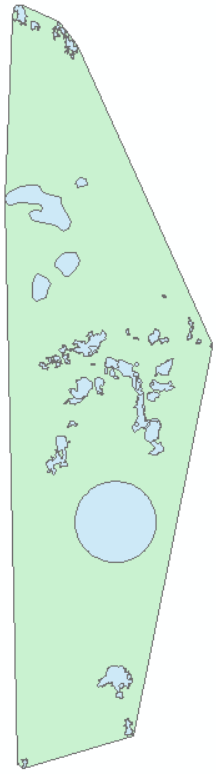

Figure 1. An example of Element Occurrence (EO) minimum bounding geometry representing a local population of Amsonia tharpii (green polygon). Blue polygons are known mapped locations of the plant that are grouped into an EO based on minimum inter-observation distances and habitat factors.

Scorecard Factors and Calculation

For each species on the scorecard, an Overall Conservation Status of the species is evaluated as a combination of biodiversity score, threat score, and protection score.

The biodiversity score (scale of 1 to 10; see Table 1, last column for classification of scores) is an average of the scores for three factors: size, quality, and landscape integrity with the landscape integrity score down-weighted by 0.5 to account for uncertainty/confidence in the accuracy of that layer (Rondeau et al. 2012, p. 112 and 183). If the quality score was Unknown, then the size score was substituted to get the average.

Size Score

Species size scores are based on the average of scaled scores for species range, occupied area, and number of occurrences. Range, occupied area, and number of occurrences are transformed to a scale of 1 to 10 using the equation for a line of best fit (see figures below) through the range of values used in Natural Heritage methodology (Rondeau et al. 2012, p. 181-182).

Species Range Score

All EO polygons are input into a GIS tool to generate a minimum bounding geometry that represents the documented range for each species in square miles. The range values are converted to Range Scores on a scale from 1 to 10 using the formula from CNHP (Rondeau et al. 2012, p. 185) in Figure 2.

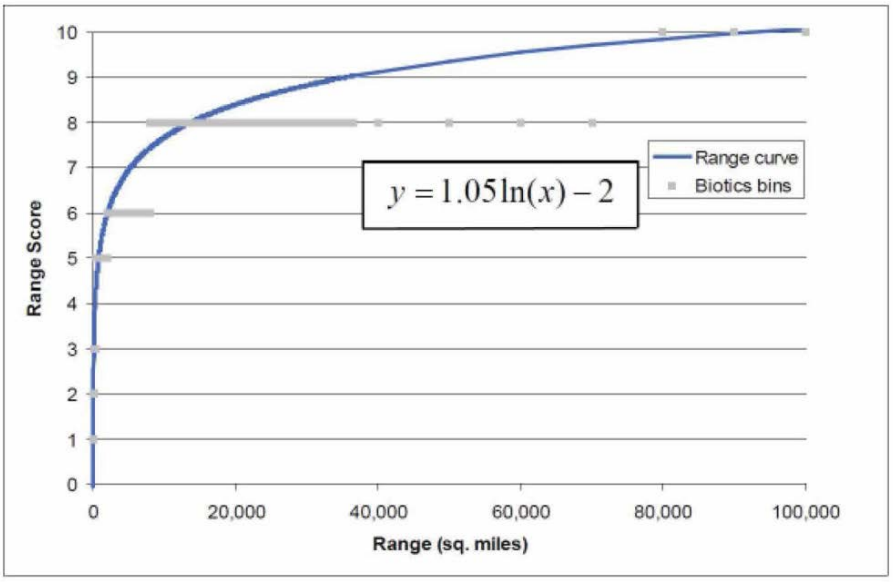

Figure 2. Line of best fit of species range values using NatureServe bins for species ranges scaled to a Range Score between one and ten (from CNHP 2012 Fig. E-6).

Occupied Area Score

The area of all EO polygons is summed per species to estimate occupied area in acres. These values are also converted to a score of 1 to 10 (see Table 1 for classification of scores) using the formula from CNHP (Rondeau et al. 2012, p. 184) in Figure 3.

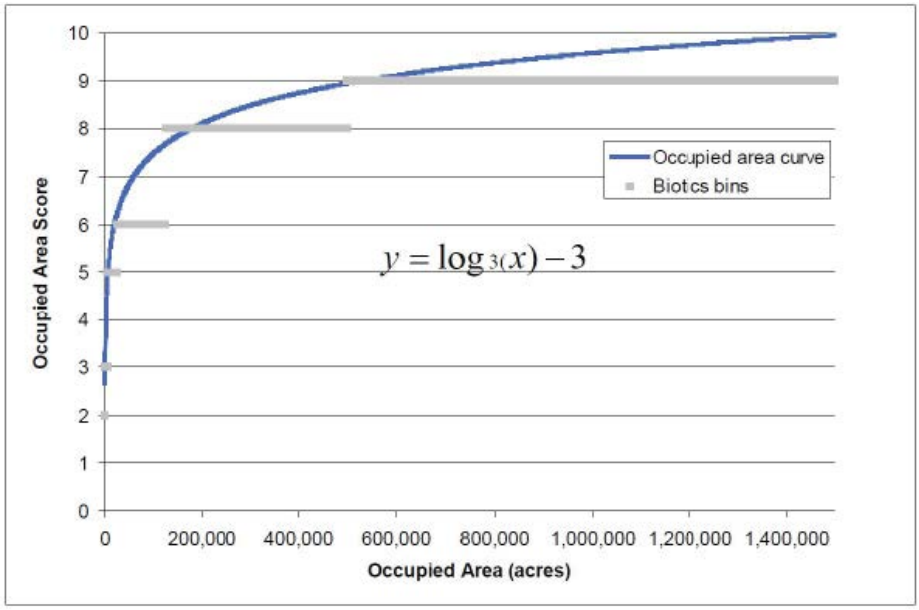

Figure 3. Line of best fit of species occupied area based on NatureServe values scaled to a Occupied Area Score between one and ten (from Rondeau et al. 2012; Fig .E-4).

Number of Occurrences

The number of EOs for each species (excluding extirpated EOs) is converted to a score using the formula from CNHP (Rondeau et al. 2012, p. 183) in Figure 4.

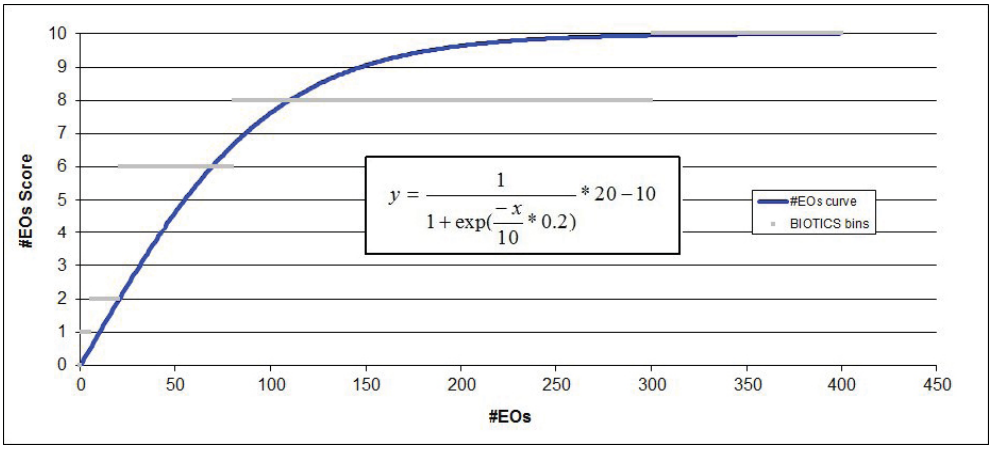

Figure 4. Line of best fit of number of species occurrences based on NatureServe values where the score is on a scale of one and ten (from Rondeau et al. 2012; Fig E-2).

Quality Score

EO quality is the proportion of EOs that have an EO rank of A or B. EO rank is assessed based on information provided about the threats and population size by observers (Hammerson et al. 2008). The proportion of EOs with A or B ranks is converted to a scale of 0 to 10 for scoring purposes by multiplying the proportion by 10. A score of 10 means 100% of EOs have an EO rank of A or B. If greater than 80% of

EOs had ranks of E (extant, not enough info to rank viability) or H (historic, last observation > 35 years old), then the quality was listed as Unknown.

An A-rank or Excellent Estimated Viability is assigned when the population is considered to have optimal numbers of individuals that are in excellent condition suggesting that the population can be sustained for the long term all else being equal;

B or Good Estimated Viability is assigned when numbers and conditions may not be optimal but the population is still considered viable.

C (Fair Estimated Viability) and D (Poor Estimated Viability) ranks are not counted in this score since they indicate lower quality EOs.

Landscape Integrity

We used the landscape integrity layer from the NMCHAT that was developed by NatureServe (Comer and Hak 2012), which captures the intensity of development (i.e. roads, urbanization, infrastructure). The values for intensity range from 0 to 10000. We used cutoffs to classify raster pixels into low (<500), medium (>500 and <4500), and high intensity (>4500). Cutoffs for classification of raster pixels were determined by inspection. EO polygons were intersected with the landscape integrity to get the percent of area per species that is in medium and high impact. These percentages were compared to Table E1 of CNHP (Rondeau et al. 2012) to score landscape integrity for each species (Figure 5).

Table E-1. Landscape Integrity Scores.

% acreage in High Impact	% acreage in Medium Impact	Interpretation	Score
50-100%	any	Poor integrity	0
25-50	50-100		1
25-50	25-50	Fair integrity	2
25-50	0-25		4
1-25	50-100	Good integrity	5
1-25	25-50		6
1-25	0-25	Very good integrity	8
<1	<5		10

Figure 5. Landscape integrity scoring table from CNHP (Rondeau et al. 2012).

Threat Score

The most severe/imminent *documented* threat for each species was identified from previous species conservation ranking efforts (East et al. 2016), expert opinion, survey and status reports, or the NM Rare Plant Technical Council website (NMRPTC) where available. The threat score is based on a combination of scope, severity, and immediacy for the documented threat. Scope, severity, and immediacy were classified according to rank calculator methodology (Faber-Langendoen et al. 2012, Table E-2/Figure 6). Scope is the proportion of the species affected by the threat. Severity is the degree to which the affected populations are impacted. Immediacy represents the time frame in which the threat is likely to be actualized. Table E-2 of CNHP (2012) was used to score each threat (Figure 6). If no threat information was available or the NMRPTC website indicated that there were no apparent threats for a species then this factor is classified as “No information” and given a score of 10.

Table E-2. Threat summary table from BIOTICS.

Scope	Severity	Immediacy	Score	Description
High	High	High	0	Moderate to high, imminent threat for most (>60%) of population, occurrences, or area
High	High	Moderate		
High	Moderate	High		
High	Moderate	Moderate		
Moderate	High	High	2	Moderate to high, imminent threat for a significant proportion (20-60%) of population, occurrences, or area
Moderate	High	Moderate		
Moderate	Moderate	High		
Moderate	Moderate	Moderate		
High	High	Low	4	Moderate to high, non-imminent threat for most (>60%) of population, occurrences, or area
High	Moderate	Low		
Moderate	High	Low	5	Moderate to high, non-imminent threat for a significant proportion (20-60%) of population, occurrences, or area
Moderate	Moderate	Low		
Low	High	High	6	Moderate to high threat for small proportion (<20%) of population, occurrences, or area
Low	High	Moderate		
Low	High	Low		
Low	Moderate	High		
Low	Moderate	Moderate		
Low	Moderate	Low		
High	Low	High	8	Low threat for most or significant proportion of population, occurrences, or area
High	Low	Moderate		
High	Low	Low		
Moderate	Low	High		
Moderate	Low	Moderate		
Moderate	Low	Low		
Low	Low	High	9	Low threat for a small proportion of population, occurrences, or area
Low	Low	Moderate		
Low	Low	Low		
Unthreatened (value resulting if scope, severity, or immediacy are considered "Insignificant") (Score = 10)				

Protection Score

We modified the Protected Area Database (PAD) GIS layer by clipping it to New Mexico and applying the methodology of Supples et al. (2007) to assess protection status per parcel of managed land. Protection scores are assessed as a combination of three indicators: management Intent, Tenure, and Potential Management Effectiveness (PME) (Supples et al. 2007). Intent is defined as the explicit objectives for protection and management of each land parcel. Tenure is a measure of protection permanence. PME is the ability of the land manager to implement actions as outlined in the management Intent. For each parcel, Intent is assigned as Very Good, Good, Fair or Poor (see Table 1 in Supples et al. 2007). Intent is inferred from GAP status codes in PAD or local knowledge. Tenure is assigned on the same scale as Intent and is also inferred from the GAP status codes (see Table 5 of Supples et al. 2007). PME is assigned on the same scale as the other two indicators but is assigned according to the perceived capacity of each 'managing entity' to take actions to fulfill designated intent (see Table 6 of Supples et al. 2007).

Scores for all three indicators are compared to the tables below to assign a Protection Score to each parcel (Table 2 and Table 3, from p. 16 of Supples et al. 2007). Protection statuses are Poor (score of 0), Unknown (2), Fair (4), Good (7), or Very Good (10). For example, BLM National Monuments are assigned Intent = Good, Tenure = Very Good, and PME = Good which becomes Protection Score = Very Good (10).

Table 2. This matrix represents the combination of *management intent* and *PME* scores (from Supples et al. 2007).

	Intent VG	Intent G	Intent F	Intent P
Pot mgmt VG	very good	Good	good	poor
Pot mgmt G	good	Good	fair	poor
Pot mgmt F	fair	Fair	poor	poor
Pot mgnt P	fair	Poor	poor	poor

Table 3. This matrix represents the relationships between the score in Table 2 and *conservation tenure* (from Supples et al. 2007).

	Tenure VG	Tenure G	Tenure F	Tenure P
Table 2: VG	CMS - very good	CMS – good	CMS - fair	CMS – poor
Table 2: G	CMS – very good	CMS – good	CMS - fair	CMS – poor
Table 2: F	CMS – fair	CMS – fair	CMS - poor	CMS – poor
Table 2: Poor	CMS – poor	CMS – poor	CMS - poor	CMS – poor

Finally, we intersected the EO Polygons with this modified PAD layer featuring protection scores to get an area-weighted average protection score per species.

Overall Conservation Status

To assign the Overall Conservation Status for each species, biodiversity, protection, and threat scores are color coded according to Table 1 and then those three color codes are referenced using the key in Table 2 developed by CNHP (2012, p.112-113)

Table 1. Color code key for assigning level of concern per factor (from p.112 of CNHP 2012).

Color code	Threats Score and Landscape Integrity Score	Size, Quality, Protection Status, and Energy Development Potential Scores
Red (most at risk)	0	0-1.9
Orange	2-4	2.0-2.9
Yellow	5-6	3.0-4.9
Green (least at risk)	8-10	5.0-10

Table 2. Key for assigning overall conservation status using the color codes assigned to threat status, biodiversity, and protection scores.

IF	AND	AND	THEN
Threat Status	Biodiversity	Protection	Overall Conservation Status
R	R O	R O	Under Conserved
R	Y G	R O	
R	R	Y G	
O	R	R O	
O	R	Y G	
O	O	R O	
O	O	Y G	Weakly Conserved
R	O	Y G	
R	Y G	Y G	
O	Y G	R O	
Y	R O	R O	
G	R O	R O	
G	Y	R O	
O	Y	Y	
O	G	Y	Moderately Conserved
O	Y	G	
O	G	G	
Y	R O	Y G	
Y	Y G	R O	
G	R O	Y G	
G	G	R O	
Y	Y	Y	
Y	G	Y	Effectively Conserved
Y	Y	G	
Y	G	G	
G	Y G	Y G	

Confidence

EO data accuracy and currency was assessed in three different categories (A, B, and C) to determine how much confidence we have in the underlying occurrence data.

Category A is the percent of EOs with uncertainty distance >1200 m (where uncertainty distance is a measure of mapping precision).
Category B is the percent of EOs that are historical (last observation >35 years). **Category C** is the % of EOs with an EO rank of Extant which indicates not enough information was available to assess quality (see Quality score above).

Confidence was then assigned for each species using the percentages of EOs in the above three categories:

Very High = A, B, and C <10%,
High = A, B, and C ≤10-30%,
Moderate =A, B, or C ≤30-50%,
Low = A, B, or C >50%.

Ancillary Factors

The following factors do not affect the estimation of overall conservation status as outlined above. These ancillary factors are provided as additional information that may help managers working to conserve the species in the list. These will appear at the end of the scorecard.

Actions Needed

We listed proposed actions to benefit species conservation goals by identifying where knowledge gaps existed and management needs were documented in NMRPTC species accounts (nmrareplants.unm.edu), identified by species specialists, or in species survey and status reports.

Potential Threats

Where information is available (see threat score above) additional threats to a given species were identified. For these threats, scope, severity, and immediacy are not attributed. Potential threats are based on knowledge about current land use patterns and biological and climatic factors that are assumed, but have not been properly documented (e.g. livestock impacts, pollinator decline, impacts from invasive species, climate change, predation, etc).

Percent Range NM

We estimated the percent of each species global range that was in New Mexico where global range estimates existed in NatureServe species accounts. The number of EOs and range in NM were compared to global range and/or EO numbers.

Ownership

In GIS, species locations (EOs) were intersected with an ownership layer to determine what percentage of known populations for a species fall under each major land owner's jurisdiction. The percentage of EOs per land owner is provided at the end of the scorecard with a column for each land owner (BLM = Bureau of Land Management, BOR = Bureau of Reclamation, DOA = U.S. Department of Agriculture, DOD

= U.S. Department of Defense, DOE = U.S. Department of Energy, FS = Forest Service, FWS = U.S. Fish and Wildlife Service, I = Tribal, NPS = National Park Service, P = Private, S = State Trust, NMDGF = New Mexico Department of Game and Fish, SP = New Mexico State Parks).

Oil and Gas Development Potential

A layer of oil and gas development potential from the Bureau of Land Management in New Mexico was used to assign a score from low to high for each species whose distribution overlaps oil and gas lease areas. The GIS layer from BLM include polygons with designations of expected development potential (high, moderate, or low) Surface ownership in the GIS layer coverage includes BLM, State, tribal, and private lands. We used ArcGIS to calculate the area-weighted average score per species. If no score is provided, then the species distribution lies outside of expected future BLM oil and gas development.

Oil and Gas – Current

Because the GIS layer for oil and gas potential does not incorporate existing leases and wells we acquired active well locations (New Mexico Energy, Minerals, and Natural Resources Department) and current BLM leases. The well locations were buffered by 100m and then well and lease polygons were intersected with plant EO data to get a list of species occurring in current oil and gas development. We scored each species as 'yes' or 'no' for occurrence within either existing well pads or current leases.

Wind Potential

We downloaded a GIS layer for wind energy potential based on models of annual mean wind speed (NREL 2010). We reclassified the wind power classes (1 through 7) into 0 = No or Low Potential (wind power classes 1 through 3) and 1 = Moderate to High Potential (wind power classes 4 through 7). Wind potential is based on modeled wind speed thus we intersected species occurrence data with the reclassified wind potential and scored each species as 'yes' or 'no' according to whether or not any occurrences were in moderate to high wind production areas.

Mining

Active and abandoned mine locations were obtained from New Mexico Energy, Minerals, and Natural Resources Department. We buffered point data by 1000m and then intersected plant EOs to score each species as 'yes' or 'no' for occurrence in areas of mining activity.

Grazing

Grazing allotments were acquired from the BLM state office and the online GIS portal for each U.S. Forest Service unit in New Mexico. Allotment polygons were intersected with plant EO data to score each species as 'yes' for grazing impacts. Species that occurred outside of grazing allotments on private, state, or tribal lands are scored as 'potential' in this column since grazing status is probable but unknown. Lastly, any species occupying habitats that are inaccessible to livestock or occur on lands known to be protected from grazing are listed as 'no' in this column.

Species Lists

Based on data availability and expert opinion we split the 235 species into 4 lists. List A contains species where there were sufficient data to use the scorecard methods above and for which there was moderate to very high confidence in the data (see section on confidence). List B contains species for which there were sufficient data to generate an overall conservation status but the confidence was low. List B species are assigned a Modified Conservation Status due to the uncertainty indicated by low confidence—the Modified Conservation Status is assigned as two levels below the unmodified score

such that if a species assessed as Effectively Conserved with a low confidence score is given a Modified Conservation Status of Weakly Conserved. List C contains species where there were not sufficient data to generate a conservation status using the methods above. List C species are classified as Weakly Conserved based on expert opinion until further data are collected. List D contains species that are regional endemics for which existing data indicates they are stable and not a current conservation priority.

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APPENDIX C. New Mexico Important Plant Areas

IPAs ordered by IPA No., corresponding to the map number in Figure 4 in the main text. Biodiversity significance is reflected by IPA Biodiversity Rank (B-Rank) and its corresponding IPA Diversity Score (D-Score). Counts of species are provided by NHNM Global/State Status Score (GS-1 highest; GS-4 lowest) and state and federal listing status (T&E). An interactive map of all IPAs can be found at **http://www.emnrd.state.nm.us/SFD/**

IPA No.	Important Plant Area Name	IPA Biodiversity Significance			Global/State Status Score				Listing Status	
		B-Rank	D-Score	No. Sp.	GS-1	GS-2	GS-3	GS-4	Fed.	State
1	Mancos	B2	4.2	2	0	1	1	0	0	0
2	Shiprock / Fruitland	B2	17.5	9	1	3	5	0	2	2
4	Farmington-Bloomfield Badlands	B1	11.1	9	0	3	6	0	0	2
6	American Mesa	B3	6.2	5	1	2	2	0	0	0
7	Cisneros Canyon	B4	0.4	1	0	0	1	0	0	0
8	Chama Watershed	B1	14.2	13	1	7	3	2	0	0
9	San Antonio Mtn	B1	6.2	4	1	1	1	1	0	0
10	Upper Rio Grande Watershed	B1	24.0	9	4	3	0	2	0	0
11	Raton	B4	0.4	1	0	1	0	0	0	0
12	Capulin Volcano	B1	5.1	2	1	0	0	1	0	0
15	Chuska Mtns	B1	26.0	16	5	7	2	2	2	5
16	Bisti Oil Field	B2	2.7	3	1	1	1	0	1	1
17	Nageezi Badlands	B4	5.0	5	0	3	2	0	0	1
18	San Pedro Parks	B4	1.5	3	1	0	1	1	0	0
19	Jemez Mtns	B4	5.0	8	0	1	4	3	0	2
20	Rio Del Oso	B4	0.0	1	0	0	0	1	0	0
21	Upper Rio Grande Valley	B1	16.3	10	1	3	3	3	0	1
22	Sangre De Cristo Mtns	B1	19.8	10	2	2	2	4	1	3
23	Espanola to La Cienega	B1	7.4	7	1	0	4	2	0	2

IPA No.	Important Plant Area Name	IPA Biodiversity Significance			Global/State Status Score				Listing Status	
		B-Rank	D-Score	No. Sp.	GS-1	GS-2	GS-3	GS-4	Fed.	State
25	Lower Canadian Watershed	B2	2.3	3	0	1	2	0	0	0
26	Kansas Valley	B1	4.0	1	0	1	0	0	0	0
27	Window Rock	B4	0.8	1	0	1	0	0	0	0
28	Tohatchi Flats	B4	3.3	3	0	2	0	1	0	0
29	Fort Wingate	B2	7.1	5	1	2	1	1	1	1
30	Fallen Timber Ridge	B2	10.5	5	2	3	0	0	0	0
31	Borrego Pass	B1	5.3	2	1	1	0	0	0	0
32	El Banquito	B4	2.2	1	1	0	0	0	0	1
33	Mesa Prieta	B1	4.0	3	0	2	0	1	0	0
34	White Mesa	B1	14.4	8	0	2	4	2	0	0
35	Lower Jemez River Valley	B4	0.9	2	0	0	2	0	0	0
36	Espinosa Ridge	B4	1.7	4	0	1	2	1	0	0
38	Ute Creek	B4	0.2	1	0	0	1	0	0	0
39	US 54 - Tucumcari to Logan	B4	1.6	1	0	0	1	0	0	0
40	El Malpais	B2	4.0	1	0	1	0	0	0	0
41	San Mateo Mesa	B4	0.5	2	1	1	0	0	0	1
42	Rio Puerco / Rio San Jose	B4	4.5	5	1	1	3	0	1	1
43	KAFB	B4	0.3	1	0	0	1	0	0	0
44	Sandia Mtns	B1	5.2	6	0	2	3	1	0	0
45	South Mtn	B4	0.5	1	0	0	1	0	0	0
46	Santa Rosa Cienega	B2	5.7	4	0	2	2	0	2	3
48	Nutrioso	B2	2.8	1	0	0	1	0	0	0
49	Zuni Salt Lake	B4	0.2	1	1	0	0	0	0	1
50	Gallo / Mangas Mtns	B4	2.2	2	0	1	1	0	0	0

IPA No.	Important Plant Area Name	IPA Biodiversity Significance			Global/State Status Score				Listing Status	
		B-Rank	D-Score	No. Sp.	GS-1	GS-2	GS-3	GS-4	Fed.	State
51	Sawtooth / Datil	B2	6.6	4	1	1	2	0	1	1
53	Blue Water Canyon	B4	1.7	1	1	0	0	0	0	0
54	Rio Salado at Riley	B4	0.0	2	0	0	2	0	0	0
55	Rio Grande at Belen	B4	0.4	1	0	0	1	0	0	0
56	Sevilleta Basin	B4	4.4	6	0	3	3	0	1	1
57	Manzano Mtns	B4	2.2	4	0	0	4	0	0	0
58	Red Cloud Canyon	B4	0.6	2	0	1	1	0	0	0
59	Encino to Vaughn	B2	2.9	2	0	1	1	0	0	0
60	San Francisco / Tularosa Mtns	B3	5.5	7	0	4	3	0	0	1
62	Mogollon Mtns	B1	33.3	18	1	9	8	0	0	2
63	Diablo Range	B4	3.5	6	0	2	3	1	0	1
64	Gila Cliff Dwellings	B4	1.1	3	0	0	2	1	0	1
65	East Fork Gila River Watershed	B3	5.7	10	0	3	7	0	0	0
66	Monticello Canyon	B2	0.7	5	0	3	2	0	1	1
67	San Mateo Mtns	B3	6.7	6	0	3	3	0	0	0
68	Magdalena Mtns	B4	2.3	3	0	0	3	0	0	0
69	Southern Quebradas	B2	3.4	3	0	1	1	1	0	0
70	I-25 near Fort Craig	B4	0.7	1	0	1	0	0	0	0
71	Northern Jornada Del Muerto	B4	0.2	2	0	1	0	1	0	1
72	Tularosa Basin	B4	1.2	1	0	0	0	1	0	0
73	Sacramento Mtns	B1	60.9	34	4	13	13	4	5	7
75	Sierra Blanca / Ruidoso	B1	39.6	23	1	11	9	2	0	1
76	Lower Pecos near Roswell	B1	12.0	5	2	2	0	1	2	2
77	Milnesand	B4	0.7	1	0	1	0	0	0	0

IPA No.	Important Plant Area Name	IPA Biodiversity Significance			Global/State Status Score				Listing Status	
		B-Rank	D-Score	No. Sp.	GS-1	GS-2	GS-3	GS-4	Fed.	State
78	Northern Peloncillo Mtns	B4	2.2	2	0	1	1	0	0	1
79	Southern Peloncillo Mtns	B1	25.8	15	3	6	6	0	0	2
80	Pinos Altos Range	B1	12.6	12	1	5	5	1	0	0
81	Upper Mimbres Watershed	B4	2.8	6	0	1	4	1	0	1
82	Mud Springs Mtns	B1	5.2	2	1	0	1	0	0	1
83	Antelope Flat - Jornada Experimental Range	B1	5.00	1	1	0	0	0	0	0
84	White Horse Mtns	B2	2.90	2	2	0	0	0	0	1
85	Cookes Peak	B4	2.14	5	0	3	2	0	0	0
86	Florida Mtns	B1	5.54	4	1	1	2	0	0	1
88	Cedar Mtns	B4	0.45	2	0	1	1	0	0	1
89	Columbus	B4	0.04	1	0	1	0	0	0	1
90	Sierra De Las Uvas	B4	1.50	1	0	1	0	0	0	0
93	Potrillo Mtns	B4	0.02	1	0	1	0	0	0	1
94	Tortuga Mtns	B4	0.23	2	0	1	1	0	0	2
95	Lower Mesilla Valley	B4	3.95	2	0	2	0	0	1	2
96	Jarilla Mtns	B2	0.00	1	0	0	0	0	0	0
97	Hueco Mtns	B4	1.17	2	0	2	0	0	0	0
98	Cornudas Mtns	B4	2.34	3	0	3	0	0	0	2
99	Hills West of Hope	B4	1.34	2	1	1	0	0	1	1
100	Guadalupe Ridge	B1	45.85	19	1	10	8	0	2	3
101	Bone Tank Draw	B4	1.23	3	0	2	1	0	0	0
102	Artesia	B4	0.67	1	0	1	0	0	0	0
103	Crow Flats East of Artesia	B4	3.37	2	1	1	0	0	0	1

IPA No.	Important Plant Area Name	IPA Biodiversity Significance			Global/State Status Score				Listing Status	
		B-Rank	D-Score	No. Sp.	GS-1	GS-2	GS-3	GS-4	Fed.	State
104	North Carlsbad	B1	5.90	3	1	2	0	0	0	1
105	Mescalero Ridge	B2	0.14	1	1	0	0	0	0	1
106	Forty-Niner Ridge	B4	0.47	1	0	1	0	0	0	1
107	Beclabito	B4	1.14	2	1	0	1	0	0	1
108	Gallegos Canyon	B4	0.20	1	1	0	0	0	0	1
109	Navajo Lake	B1	6.53	5	1	1	3	0	1	1
110	Upper Canadian Watershed	B2	11.10	7	0	4	1	2	0	0
114	Chicken Mtn Draw	B4	1.45	2	1	0	1	0	0	0
115	Oscura Mtns	B1	5.03	2	1	0	0	1	0	0
116	San Andres Mtns	B1	22.82	18	1	7	9	1	1	3
118	Hilsboro Hills	B2	5.07	3	0	1	2	0	0	0
119	Emory Pass	B1	12.84	11	1	5	5	0	0	0
120	Burro Mtns	B4	1.24	3	0	0	3	0	0	1
121	Lewis Flats	B4	1.18	1	0	1	0	0	0	0
122	Black Mtn	B4	1.26	2	0	1	1	0	0	1
123	Southern Cookes Range	B4	0.04	1	0	1	0	0	0	1
124	Mangas Springs	B4	1.59	3	0	1	2	0	0	1
125	Nachita Valley / Hatchita Mtns	B3	9.30	5	1	1	3	0	0	2
126	Southern Animas Valley	B1	13.75	3	3	0	0	0	0	0
127	Animas Mtns	B2	10.80	8	0	4	4	0	0	1
128	Pyramid Mtns	B4	0.83	4	0	2	2	0	0	2
129	Northern Animas Valley	B4	4.51	7	2	3	2	0	0	3
130	Franklin Mtns	B4	4.08	5	0	4	1	0	1	4
131	Robledo Mtns	B4	0.04	1	0	1	0	0	0	1

IPA No.	Important Plant Area Name	IPA Biodiversity Significance			Global/State Status Score				Listing Status	
		B-Rank	D-Score	No. Sp.	GS-1	GS-2	GS-3	GS-4	Fed.	State
132	Tularosa Basin - Fort Bliss	B4	0.05	1	0	0	0	1	0	0
133	Otero Mesa	B4	0.69	2	0	1	0	1	0	0
134	Fort Stanton	B4	4.47	5	1	2	1	1	1	1
135	Capitan Mtns	B1	15.80	13	2	6	4	1	1	1
136	Yeso Hills	B1	19.97	11	3	6	1	1	2	4
137	Guadalupe / Brokeoff Mtns	B1	35.87	18	8	6	4	0	1	2
138	Seven Rivers	B2	3.94	3	1	1	0	1	1	1
139	Southern Burro Mtns	B3	2.56	2	1	1	0	0	1	1
140	Zuni Canyon	B4	1.00	1	0	0	1	0	0	0
141	Grants Cienega	B4	0.11	1	0	1	0	0	1	1
142	Socorro and Strawberry Peaks	B4	0.47	1	0	1	0	0	0	0
143	Bosquecito	B4	0.16	1	0	1	0	0	1	1
144	Heart of the Dunes	B4	0.38	1	0	0	1	0	0	0
145	Organ Mtns	B1	38.06	17	1	12	4	0	1	3
146	Fra Cristobal Range	B4	0.69	3	0	2	1	0	0	0
147	Caballo Mtns	B4	1.03	3	0	0	3	0	0	0
148	Crow Flats near Dell City	B1	8.65	4	1	2	0	1	0	2
149	Malaga	B2	2.31	2	1	1	0	0	0	2
150	Elk	B4	1.38	2	1	1	0	0	1	1

IPAs ordered by Biodiversity Rank. IPA No. corresponds to the map number in Figure 4 in the main text. Biodiversity significance is reflected by IPA Biodiversity Rank (B-Rank) and its corresponding IPA Diversity Score (D-Score). Counts of species are provided by NHNM Global/State Status Score (GS-1 highest; GS-4 lowest) and state and federal listing status (T&E). An interactive map of all IPAs can be found at **http://www.emnrd.state.nm.us/SFD/**

IPA No.	Important Plant Area Name	IPA Biodiversity Significance			Global/State Status Rank				Listing Status	
		B-Rank	D-Score	No. Sp.	GS-1	GS-2	GS-3	GS-4	Fed.	State
73	Sacramento Mtns	B1	60.9	34	4	13	13	4	5	7
100	Guadalupe Ridge	B1	45.85	19	1	10	8	0	2	3
75	Sierra Blanca / Ruidoso	B1	39.6	23	1	11	9	2	0	1
145	Organ Mtns	B1	38.06	17	1	12	4	0	1	3
137	Guadalupe / Brokeoff Mtns	B1	35.87	18	8	6	4	0	1	2
62	Mogollon Mtns	B1	33.3	18	1	9	8	0	0	2
15	Chuska Mtns	B1	26.0	16	5	7	2	2	2	5
79	Southern Peloncillo Mtns	B1	25.8	15	3	6	6	0	0	2
10	Upper Rio Grande Watershed	B1	24.0	9	4	3	0	2	0	0
116	San Andres Mtns	B1	22.82	18	1	7	9	1	1	3
22	Sangre De Cristo Mtns	B1	19.8	10	2	2	2	4	1	3
119	Emory Pass	B1	12.84	11	1	5	5	0	0	0
76	Lower Pecos near Roswell	B1	12.0	5	2	2	0	1	2	2
23	Espanola to La Cienega	B1	7.4	7	1	0	4	2	0	2
109	Navajo Lake	B1	6.53	5	1	1	3	0	1	1
31	Borrego Pass	B1	5.3	2	1	1	0	0	0	0
82	Mud Springs Mtns	B1	5.2	2	1	0	1	0	0	1
12	Capulin Volcano	B1	5.1	2	1	0	0	1	0	0
115	Oscura Mtns	B1	5.03	2	1	0	0	1	0	0
136	Yeso Hills	B1	19.97	11	3	6	1	1	2	4
2	Shiprock / Fruitland	B1	17.5	9	1	3	5	0	2	2

IPA No.	Important Plant Area Name	IPA Biodiversity Significance			Global/State Status Rank				Listing Status	
		B-Rank	D-Score	No. Sp.	GS-1	GS-2	GS-3	GS-4	Fed.	State
21	Upper Rio Grande Valley	B1	16.3	10	1	3	3	3	0	1
135	Capitan Mtns	B1	15.80	13	2	6	4	1	1	1
34	White Mesa	B1	14.4	8	0	2	4	2	0	0
8	Chama Watershed	B1	14.2	13	1	7	3	2	0	0
126	Southern Animas Valley	B1	13.75	3	3	0	0	0	0	0
80	Pinos Altos Range	B1	12.6	12	1	5	5	1	0	0
110	Upper Canadian Watershed	B1	11.10	7	0	4	1	2	0	0
4	Farmington-Bloomfield Badlands	B1	11.1	9	0	3	6	0	0	2
127	Animas Mtns	B1	10.80	8	0	4	4	0	0	1
30	Fallen Timber Ridge	B1	10.5	5	2	3	0	0	0	0
125	Nachita Valley / Hatchita Mtns	B1	9.30	5	1	1	3	0	0	2
148	Crow Flats near Dell City	B1	8.65	4	1	2	0	1	0	2
29	Fort Wingate	B1	7.1	5	1	2	1	1	1	1
51	Sawtooth / Datil	B1	6.6	4	1	1	2	0	1	1
9	San Antonio Mtn	B2	6.2	4	1	1	1	1	0	0
104	North Carlsbad	B2	5.90	3	1	2	0	0	0	1
83	Antelope Flat - Jornada Experimental Range	B2	5.00	1	1	0	0	0	0	0
129	Northern Animas Valley	B2	4.51	7	2	3	2	0	0	3
138	Seven Rivers	B2	3.94	3	1	1	0	1	1	1
103	Crow Flats East of Artisia	B2	3.37	2	1	1	0	0	0	1
84	White Horse Mtns	B2	2.90	2	2	0	0	0	0	1
16	Bisti Oil Field	B2	2.7	3	1	1	1	0	1	1
139	Southern Burro Mtns	B2	2.56	2	1	1	0	0	1	1

IPA No.	Important Plant Area Name	IPA Biodiversity Significance			Global/State Status Rank				Listing Status	
		B-Rank	D-Score	No. Sp.	GS-1	GS-2	GS-3	GS-4	Fed.	State
149	Malaga	B2	2.31	2	1	1	0	0	0	2
32	El Banquito	B2	2.2	1	1	0	0	0	0	1
53	Blue Water Canyon	B2	1.7	1	1	0	0	0	0	0
18	San Pedro Parks	B2	1.5	3	1	0	1	1	0	0
107	Beclabito	B2	1.14	2	1	0	1	0	0	1
41	San Mateo Mesa	B2	0.5	2	1	1	0	0	0	1
49	Zuni Salt Lake	B2	0.2	1	1	0	0	0	0	1
108	Gallegos Canyon	B2	0.20	1	1	0	0	0	0	1
105	Mescalero Ridge	B2	0.14	1	1	0	0	0	0	1
67	San Mateo Mtns	B2	6.7	6	0	3	3	0	0	0
6	American Mesa	B2	6.2	5	1	2	2	0	0	0
46	Santa Rosa Cienega	B2	5.7	4	0	2	2	0	2	3
65	East Fork Gila River Watershed	B3	5.7	10	0	3	7	0	0	0
86	Florida Mtns	B3	5.54	4	1	1	2	0	0	1
60	San Francisco / Tularosa Mtns	B3	5.5	7	0	4	3	0	0	1
44	Sandia Mtns	B3	5.2	6	0	2	3	1	0	0
118	Hilsboro Hills	B3	5.07	3	0	1	2	0	0	0
42	Rio Puerco / Rio San Jose	B3	4.5	5	1	1	3	0	1	1
134	Fort Stanton	B4	4.47	5	1	2	1	1	1	1
114	Chicken Mtn Draw	B4	1.45	2	1	0	1	0	0	0
150	Elk	B4	1.38	2	1	1	0	0	1	1
99	Hills West of Hope	B4	1.34	2	1	1	0	0	1	1
19	Jemez Mtns	B4	5.0	8	0	1	4	3	0	2
17	Nageezi Badlands	B4	5.0	5	0	3	2	0	0	1

IPA No.	Important Plant Area Name	IPA Biodiversity Significance			Global/State Status Rank				Listing Status	
		B-Rank	D-Score	No. Sp.	GS-1	GS-2	GS-3	GS-4	Fed.	State
56	Sevilleta Basin	B4	4.4	6	0	3	3	0	1	1
1	Mancos	B4	4.2	2	0	1	1	0	0	0
130	Franklin Mtns	B4	4.08	5	0	4	1	0	1	4
33	Mesa Prieta	B4	4.0	3	0	2	0	1	0	0
26	Kansas Valley	B4	4.0	1	0	1	0	0	0	0
40	El Malpais	B4	4.0	1	0	1	0	0	0	0
95	Lower Mesilla Valley	B4	3.95	2	0	2	0	0	1	2
63	Diablo Range	B4	3.5	6	0	2	3	1	0	1
69	Southern Quebradas	B4	3.4	3	0	1	1	1	0	0
28	Tohatchi Flats	B4	3.3	3	0	2	0	1	0	0
59	Encino to Vaughn	B4	2.9	2	0	1	1	0	0	0
48	Nutrioso	B4	2.8	1	0	0	1	0	0	0
81	Upper Mimbres Watershed	B4	2.8	6	0	1	4	1	0	1
98	Cornudas Mtns	B4	2.34	3	0	3	0	0	0	2
68	Magdalena Mtns	B4	2.3	3	0	0	3	0	0	0
25	Lower Canadian Watershed	B4	2.3	3	0	1	2	0	0	0
50	Gallo / Mangas Mtns	B4	2.2	2	0	1	1	0	0	0
78	Northern Peloncillo Mtns	B4	2.2	2	0	1	1	0	0	1
57	Manzano Mtns	B4	2.2	4	0	0	4	0	0	0
85	Cookes Peak	B4	2.14	5	0	3	2	0	0	0
36	Espinosa Ridge	B4	1.7	4	0	1	2	1	0	0
124	Mangas Springs	B4	1.59	3	0	1	2	0	0	1
39	US 54 - Tucumcari to Logan	B4	1.6	1	0	0	1	0	0	0
90	Sierra De Las Uvas	B4	1.50	1	0	1	0	0	0	0

IPA No.	Important Plant Area Name	IPA Biodiversity Significance			Global/State Status Rank				Listing Status	
		B-Rank	D-Score	No. Sp.	GS-1	GS-2	GS-3	GS-4	Fed.	State
122	Black Mtn	B4	1.26	2	0	1	1	0	0	1
120	Burro Mtns	B4	1.24	3	0	0	3	0	0	1
101	Bone Tank Draw	B4	1.23	3	0	2	1	0	0	0
121	Lewis Flats	B4	1.18	1	0	1	0	0	0	0
97	Hueco Mtns	B4	1.17	2	0	2	0	0	0	0
72	Tularosa Basin	B4	1.2	1	0	0	0	1	0	0
64	Gila Cliff Dwellings	B4	1.1	3	0	0	2	1	0	1
147	Caballo Mtns	B4	1.03	3	0	0	3	0	0	0
140	Zuni Canyon	B4	1.00	1	0	0	1	0	0	0
35	Lower Jemez River Valley	B4	0.9	2	0	0	2	0	0	0
128	Pyramid Mtns	B4	0.83	4	0	2	2	0	0	2
27	Window Rock	B4	0.8	1	0	1	0	0	0	0
146	Fra Cristobal Range	B4	0.69	3	0	2	1	0	0	0
133	Otero Mesa	B4	0.69	2	0	1	0	1	0	0
66	Monticello Canyon	B4	0.7	5	0	3	2	0	1	1
70	I-25 near Fort Craig	B4	0.7	1	0	1	0	0	0	0
77	Milnesand	B4	0.7	1	0	1	0	0	0	0
102	Artesia	B4	0.67	1	0	1	0	0	0	0
58	Red Cloud Canyon	B4	0.6	2	0	1	1	0	0	0
45	South Mtn	B4	0.5	1	0	0	1	0	0	0
106	Forty-Niner Ridge	B4	0.47	1	0	1	0	0	0	1
142	Socorro and Strawberry Peaks	B4	0.47	1	0	1	0	0	0	0
88	Cedar Mtns	B4	0.45	2	0	1	1	0	0	1
7	Cisneros Canyon	B4	0.4	1	0	0	1	0	0	0

IPA No.	Important Plant Area Name	IPA Biodiversity Significance			Global/State Status Rank				Listing Status	
		B-Rank	D-Score	No. Sp.	GS-1	GS-2	GS-3	GS-4	Fed.	State
55	Rio Grande at Belen	B4	0.4	1	0	0	1	0	0	0
144	Heart of the Dunes	B4	0.38	1	0	0	1	0	0	0
11	Raton	B4	0.4	1	0	1	0	0	0	0
43	KAFB	B4	0.3	1	0	0	1	0	0	0
38	Ute Creek	B4	0.2	1	0	0	1	0	0	0
94	Tortuga Mtns	B4	0.23	2	0	1	1	0	0	2
71	Northern Jornada Del Muerto	B4	0.2	2	0	1	0	1	0	1
143	Bosquecito	B4	0.16	1	0	1	0	0	1	1
141	Grants Cienega	B4	0.11	1	0	1	0	0	1	1
132	Tularosa Basin - Fort Bliss	B4	0.05	1	0	0	0	1	0	0
123	Southern Cookes Range	B4	0.04	1	0	1	0	0	0	1
131	Robledo Mtns	B4	0.04	1	0	1	0	0	0	1
89	Columbus	B4	0.04	1	0	1	0	0	0	1
20	Rio Del Oso	B4	0.0	1	0	0	0	1	0	0
54	Rio Salado at Riley	B4	0.0	2	0	0	2	0	0	0
93	Potrillo Mtns	B4	0.02	1	0	1	0	0	0	1
96	Jarilla Mtns	B4	0.00	1	0	0	0	0	0	0

APPENDIX D. New Mexico Important Plant Areas - Methods

Important Plant Areas (IPAs) are specific places across New Mexico that support either a high diversity of sensitive species or are the last remaining locations of our most endangered plants. The IPAs were developed using a combination of spatial modeling of the Strategy Species observation data in a GIS and expert review followed by the assignment of a Biodiversity Rank (Table 1) to assist in prioritizing areas for conservation planning.

IPA Delineation

We downloaded Strategy plant observation data from NHNM Biotics on February 1, 2017 and intersected all Strategy Species occurrences with a one-mile hexagonal grid covering the state of New Mexico. This resulted in about 3,000 occupied hexagons attributed by Strategy Species composition. This dataset was the foundation for aggregating spatially proximal and compositionally similar hexagons into coherent IPAs.

Initial clusters representing incipient IPAs were created by visually grouping hexagons in close physical proximity to each other. We deliberately made the initial clusters small with the goal of combining initial clusters into larger clusters in later steps. Hexagons that were completely isolated (>5km from the nearest hexagon) were given their own group identities.

To reduce the number of small isolated hexagons, we removed any hexagons that fit the following criteria: (1) >5km from the nearest hexagon, (2) no more than 1 Strategy Species occurring in the hexagon with a (2) NHNM G-rank of 4 or 5 and an S-rank of 3, 4, or 5. This effectively removed isolated hexagons with low species richness that lacked highly-ranked species.

We summarized plant occurrence data per initial group as simple presence/absence data for each of the Strategy Species. We calculated the geometric centroid of each initial group by calculating the mean x and y coordinates of all hexagons within that group. We then calculated the physical distance between each initial group and every hexagon in the state. Additionally, we estimated the floristic distance between each initial group and every hexagon in the state by using a Euclidean distance metric based on all species. We flagged as potential outliers hexagons within a group that were further than 5,000 m from the geometric center of group and that had a floristic distance to their own group >50. For each of these hexagons, we estimated the next best grouping using a combination of physical and floristic distance and reassigned the hexagons as needed.

Final hexagon groupings were created using expert knowledge of local geography and general Strategy Species habitat requirements, while taking into account pairwise floristic and physical distances. After assigning hexagons into final groups, we used Fixed r Local Convex Hulls in ArcGIS to define the final IPA boundaries. We estimated the *r* parameter individually for each group by calculating the median of all pairwise distances between hexagons within each group. This allowed a more inclusive wrapping for hexagons that were spread over a large geographic area and tighter, more exclusive wrapping for hexagons that were tightly clumped. We hand edited individual IPA boundaries to prevent adjacent IPAs from overlapping.

IPA Biodiversity Significance

The biodiversity significance of an IPA was characterized by an IPA Biodiversity Rank (IPA B-Rank) based Diversity Score (D-Score) modified as needed to account for species that are both highly localized and very rare (S1/G1 and S1/G2 species). The Diversity Score is computed as the inverse Global/State Status Score for a species times its percent occupancy in an a given IPA, summed for species in an IPA (Tables 2 & 3). The higher the value, the greater the biodiversity significance. For example, a S2/G3 species would have a GS Status Score of 4, and if 50% of the observations for that species occurred within the IPA, its Diversity Score would be 2. These scores are summed for all Strategy Species in the IPA. Based on the sums, the IPAs are initially assigned B-Ranks per Table 1. In addition, approximately 10% of the IPAs were assigned a modified B-Rank based on expert opinion, federal status of the species occurring within an IPA, and overall rarity.

Table 1. Biodiversity Significance Ranks (B-Ranks).

B1 – Outstanding concentration of Strategy species (IPA Diversity Index > 20) or specific very rare species targets
B2 – Very high concentration of Strategy species (IPA Diversity Index 10 to 20) or specific rare species targets
B3 – High concentration of Strategy species (IPA Diversity Index 1 to 10) or specific rare species targets
B4 – Moderate concentration of Strategy species (IPA Diversity Index <1) or specific rare species targets
B5 – General interest/open space with no Strategy species.
B? – Unknown

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Table 2. Global/State Status Score scoring matrix based NHNM/NatureServe (NS)species status ranks.

GS-Score	NHNM State Status Rank				
NS Global Rank	S1	S2	S3	S4	S5
G1	5				
G2	5	4			
G3	4	4	3		
G4	3	3	3	2	
G5	2	2	2	2	1

Table 3. Assignment table for IPA Biodiversity Ranks based on the IPA Diversity Score (D-Score).

B-rank	D-Score
B1	>20
B2	10 to 20
B3	1 to 10
B4	<1

APPENDIX E. Acronym Names

BLM = US Bureau of Land Management

BOR = US Bureau of Reclamation

COA = Conservation Opportunity Area

CPC = Center for Plant Conservation

NMDFG = New Mexico Department of Game and Fish

DOA = US Department of Agriculture

DOD = US Department of Defense

DOE = US Department of Energy

EMNRD = New Mexico Energy, Minerals, and Natural Resources Department

ESA = Endangered Species Act

IPA = Important Plant Area

NHNM = Natural Heritage New Mexico

NNHP = Navajo Natural Heritage Program

NMNPS = New Mexico Native Plant Society

NMRPTC = New Mexico Rare Plant Technical Council

NMRPCP = New Mexico Rare Plant Conservation Partnership

NMSP = New Mexico State Parks

NPS = US National Park Service

SLO = New Mexico State Land Office

SWAP = State Wildlife Action Plan

USFS = US Forest Service

USFWS = US Fish and Wildlife Service