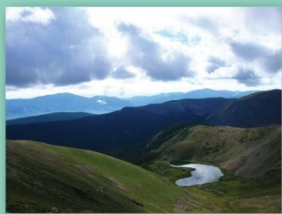
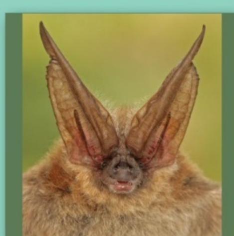
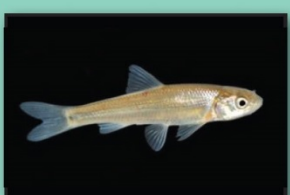
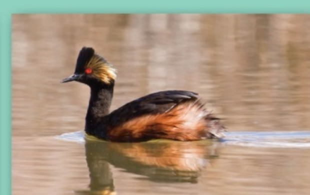
Department of Game and Fish

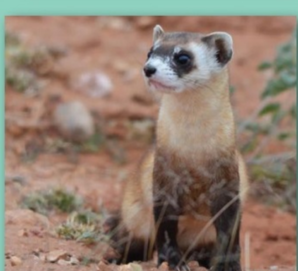
     

# STATE WILDLIFE ACTION PLAN for New Mexico

22 November 2016

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**State Wildlife Action Plan for New Mexico**

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# Preface

This State Wildlife Action Plan (SWAP) represents the 2016 revised assessment of New Mexico's wildlife and their habitats by the New Mexico Department of Game and Fish. It is based on a review and revision of the 2006 Comprehensive Wildlife Conservation Strategy for New Mexico (CWCS). Both the CWCS and SWAP are non-regulatory planning documents that rely on the best available science, including the expert opinion of Department biologists, to provide a high level view of the needs for and opportunities to conserve New Mexico's wildlife and their habitats. It looks at the variety of species and the range of habitats, their status, potential threats or constraints, and potential conservation actions to keep species secure. By synthesizing this information, the Department hopes to provide conservation practitioners with a document that can help them to recognize needs, identify opportunities, and develop actions that can help conserve and enhance wildlife populations and their habitats in New Mexico. This document also qualifies the Department to participate in the US Fish and Wildlife Service's State Wildlife Grants (SWG) Program.

The SWAP addresses, and is organized around, the eight required elements identified by the SWG Program. The main components include: a brief overview of New Mexico; an identification and assessment of wildlife species and key habitats; a review of threats and potential conservation actions; an overview of climate change; detailed descriptions of the six ecoregions that make up the State; a review of monitoring efforts; plans for implementing the SWAP; literature cited; and appendices. The key themes of the document include wildlife species that warrant heightened attention (Species of Greatest Conservation Need-SGCN), the full suite of habitats found within New Mexico, what can be done to conserve them, and Conservation Opportunity Areas (COAs) where conservation efforts could be especially beneficial.

The Department staff reached out to interested entities and agencies with significant land management, government, or educational responsibilities in New Mexico. Eleven state and federal agencies and entities participated in a Core Team that met regularly and helped guide resource evaluation and assessment, planning, organization, preparation, and draft SWAP review. The various members of the Core Team brought diverse perspectives on species and habitat conservation planning, institutional mandates, stakeholder opinions, and desired outcomes from the document. The members of the Core Team are identified in the Acknowledgements and Appendix B.

Information about SGCN is found in Chapter 2, Chapters 5-11, and Appendices F and G. Key habitat information is introduced in Chapter 2, detailed habitat descriptions and the distribution of habitats within each COA can be found in Chapters 5-10. This document is organized around ecoregions which are described in Chapter 2 and detailed in Chapters 5-10. Threats to species and habitats are described in Chapter 3 and referenced in Chapters 5-10. Climate change is considered at a statewide level and is described and analyzed in Chapter 4. General conservation actions to address threats to habitats and species are described for each threat in Chapters 5-10. This document layout helps users to approach conservation from the perspectives of species, habitats, ecoregions, threats and/or conservation actions.

# Executive Summary

New Mexico is one of the most biologically diverse states in the nation, home to over 6,000 species of animals that occupy habitats from hot deserts to alpine tundra. Maintaining the viability of every species is difficult and some have declined and are now listed as Threatened or Endangered under the Endangered Species Act. The State Wildlife Grants (SWG) and Tribal Wildlife Grants Programs were initiated by Congress as proactive and collaborative means to keep common species common. The New Mexico Department of Game and Fish (Department) began participating in SWG in 2002, when work began on the Department's Comprehensive Wildlife Conservation Strategy (CWCS). The CWCS was approved by the US Fish and Wildlife Service (USFWS) in 2006. The CWCS and this revised State Wildlife Action Plan (SWAP) address eight required elements and fulfill SWG legislative requirements. The elements include:

1. the distribution and abundance of species of wildlife, including low and declining populations as each State fish and wildlife agency deemed appropriate, that are indicative of the diversity and health of wildlife of the State (in subsequent discussions, these species were referred to as Species of Greatest Conservation Need or SGCN);
2. the location and relative condition of key habitats and community types essential to the conservation of each State's SGCN;
3. the problems which may adversely affect SGCN or their habitats, and priority research and surveys needed to identify factors which may assist in restoration and improved conservation of SGCN and their habitats;
4. the actions necessary to conserve SGCN and their habitats and establish priorities for implementing such conservation actions;
5. the provisions for periodic monitoring of SGCN and their habitats, for monitoring the effectiveness of conservation actions, and for adapting conservation actions as appropriate to respond to new information or changing conditions;
6. each State's provisions to review its Plan at intervals not to exceed 10 years;
7. each State's provisions for coordination during the development, implementation, review, and revision of its Plan with Federal, State, and local agencies and Indian Tribes that manage significant areas of land or water within the State, or administer programs that significantly affect the conservation of species or their habitats; and
8. each State's provisions to ensure public participation in the development, revision, and implementation of its Plan.

The SWAP is a non-regulatory planning document that provides a high level overview of the status of species and habitats in New Mexico and will allow the State to receive federal aid to help secure the status of SGCN. The Department relied on the best available science, including species experts, to assess and select species, habitats, threats, and conservation actions. The process began with review of the status of >1400 species catalogued in the Biota Information System of New Mexico (BISON-M; www.bison-m.org). As a result of this assessment, 241 species (including 154 arthropods) were removed and 24 species were added to the original 2006 CWCS SGCN list. Species were included on the revised list if they were declining, vulnerable, endemic, disjunct, and/or keystone. Each SGCN was then placed into one of five categories to provide guidance regarding the timing and approach for implementing conservation actions. The new SGCN list includes 39 Category I (Immediate Priority), 52

Category H (Limited Habitat), 52 Category S (Susceptible), 55 Category D (Data Needed), and 37 Category F (Federally-listed) species .

New Mexico's size and biodiversity make statewide conservation planning and implementation impractical. Thus, threats and conservation actions were identified for each ecoregion. Conservation actions include: determining trends, distribution, and status of SGCN; restoring habitats and SGCN populations and gaining public support for these actions; reducing habitat fragmentation and anthropogenic disturbance; and controlling and eradicating invasive species.

| **Ecoregion** | **Areas of Concern and Conservation Actions** |
|---|---|
| **Colorado Plateaus** is dominated by sagebrush steppe and piñon-juniper woodlands. | Impact of industrial development, restoring suitable flows and riverine and riparian habitat for SGCN, and cheatgrass management. |
| **Southern Rocky Mountains** dominated by montane forests and supports the most cold water streams. | Habitat loss and fragmentation from development and restoring the natural role of fire in forests. |
| **High Plains and Tablelands** are dominated by shortgrass prairie. | Balancing cost-effective livestock production with adequate habitat for SGCN, impacts of industrial development, and conserving and restoring aquatic and riparian habitats, especially playas. |
| **Chihuahuan Desert** is dominated by desert and semi-desert grasslands and shrublands. | Balancing cost-effective livestock production with SGCN habitat, impact of industrial development, and conserving and restoring aquatic and riparian habitats. |
| **Madrean Archipelago** is dominated by desert and semi-desert grasslands and shrublands and supports unique Madrean forests and woodlands. | Balancing cost-effective livestock production with adequate habitat for SGCN, groundwater withdrawal, restoring the natural role of fire, and effects of border enforcement activities. |
| **Arizona-New Mexico Mountains** is dominated by conifer forests and woodlands. | Aquatic and riparian habitat conservation and restoring the role of fire in forest ecosystems. |

New Mexico's SWAP serves as a blueprint for conservation and catalogs the state of our knowledge about native wildlife, threats to their habitats, and strategies to mitigate or manage those threats. Thus, the SWAP is comprehensive in scope and strategic in nature. The issues addressed and the actions outlined in this plan cross political, jurisdictional, and ecological boundaries. Commitment, coordination, and communication among the diverse parties involved are critical to the collaborative success that the SWAP describes and aims to achieve.

The Department engaged the public through presentations to the New Mexico State Game Commission, reviewing a draft list of SGCN at a workshop at a Joint Annual Meeting of the Arizona and New Mexico Chapters of The Wildlife and American Fisheries Societies, hosting five public meetings and continued stakeholder meetings, and posting drafts for public comment.

The Commission approved Plan was submitted to USFWS for review and approval on 30 November 2016. Once approved, the Department became eligible to receive SWG funds to implement the Plan through 2025.

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# Acknowledgments

Members of the Core Team included M. Wunder, C. Hayes, L. Pierce, V. Seamster, M. Watson, R. Jankowitz, K. Cunningham, R. Kellermueller, and M. Volke, New Mexico Department of Game and Fish (Department); D. Sarabia and A. Franklin, New Mexico Environment Department; C. Montoya-Hendricks, New Mexico State Land Office; E. Muldavin and R. McCollough, Natural Heritage New Mexico (NHNM), University of New Mexico; K. Boykin, Center for Spatial Ecology, and S. Smallidge, Range Improvement Task Force, New Mexico State University; M. Porter, US Army Corps of Engineers; K. Granillo and L. Bonner, US Fish and Wildlife Service; B. Dykstra, US Forest Service (USFS); M. Ramsey, Bureau of Land Management; M. Wrigley, National Park Service; and B. Dunn, contracted consultant/writer.

B. Dunn served as the primary author of the Plan except for Chapter 4 (Climate Change - written by M. Friggens, USFS, and C. Hayes, V. Seamster, and M. Volke), Preface and Chapter 12 (Implementation, Review, and Revision – written by M. Wunder), and Chapter 11 (Monitoring – written by M. Wunder and M. Watson). E. Muldavin reviewed and revised the Habitat Descriptions in Chapters 5 through 10. L. Pierce and C. Hayes produced Appendix F. Maps were created by M. Horner (NHNM; aquatic habitats, Conservation Opportunity Areas (COAs)), K. Boykin (terrestrial habitats and ecoregions), and L. Tyson and M. Volke (Department; land stewardship, threats to SGCN, and climate change). R. McCollough provided needed data about Species of Greatest Conservation Need and reviewed COA narratives. M. Horner developed and used a geospatial model to identify COAs. K. Bagne and J. Triepke (USFS) contributed to climate change assessments. Additional contributors included K. Madden, P. Darr, K. Patten, M. Ruhl, D. Weybright, J. Stuart, S. Liley, and D. Trujillo, Department.

M. Watson contributed photos of habitats, black-throated gray warbler, gray vireo, pinyon jay, pygmy nuthatch, and Virginia's warbler. J. Stuart contributed black-tailed prairie dog and juniper titmouse photos. The Arizona treefrog photo is courtesy of C. Painter, Department. E. Gilbert, T. Kennedy, B. Lang, Z. Morcarski, E. Rominger, J. Stuart, and M. Watson, Department each contributed photos that appear on the cover designed by L. Cumiskey, Department.

# Acronyms

| Acronym | Name |
| --- | --- |
| ACOE | US Army Corps of Engineers |
| AGFD | Arizona Game and Fish Department |
| BLM | US Bureau of Land Management |
| BOR | US Bureau of Reclamation |
| COA | Conservation Opportunity Area |
| Commission | New Mexico State Game Commission |
| CWCS | Comprehensive Wildlife Conservation Strategy |
| Department | New Mexico Department of Game and Fish |
| DoD | US Department of Defense |
| EEP | Ecological and Environmental Planning Division |
| EMNRD | New Mexico Energy, Minerals, and Natural Resources Department |
| EPA | US Environmental Protection Agency |
| ESA | Endangered Species Act |
| IUCN | International Union for the Conservation of Nature |
| NHD | National Hydrography Dataset |
| NHNM | Natural Heritage New Mexico |
| NMDOT | New Mexico Department of Transportation |
| NMED | New Mexico Environment Department |
| NMOSE | New Mexico Office of the State Engineer |
| NMSP | New Mexico State Parks |
| NMSU | New Mexico State University |
| NPS | US National Park Service |
| NRCS | US Natural Resources Conservation Service |
| NWR | National Wildlife Refuge |
| OHV | Off-Highway Vehicles |
| SFD | New Mexico State Forestry Division |
| SGCN | Species of Greatest Conservation Need |
| SLO | New Mexico State Land Office |
| SWAP | State Wildlife Action Plan |
| SWG | State Wildlife Grants |
| TNC | The Nature Conservancy |
| UNM | University of New Mexico |
| USFS | US Forest Service |
| USFWS | US Fish and Wildlife Service |
| USGS | US Geological Survey |
| USNVC | US National Vegetation Classification |
| WSMR | White Sands Missile Range |

# Chapter 1: A New Mexico State Wildlife Overview

## Biodiversity

New Mexico is the fifth largest state in the US and one of the top five most biologically diverse. Within its 315,194 km$^2$ (121,589 mi$^2$), which span elevations of 867-4,013 m (2,844 -13,161 ft), are hot and cold deserts; short and mid-grass prairies; oak and piñon-juniper woodlands; pine, mixed-conifer, and spruce-fir forests; and alpine tundra. Although relatively arid, the state also supports a variety of aquatic environments including 11,058 km (6,011 mi) of cold water, and 9,474 km (5,921 mi) of warm water, perennial streams, and 134 publicly-accessible lakes, reservoirs, and ponds (Figure 4, Figure 5). In total, New Mexico's terrestrial and aquatic ecosystems support 3,783 species of vascular plants (Allred and Ivey 2012) and over 6,000 species[1] of animals (www.bison-m.org/). Included among the animals are species, such as the jaguar (*Panthera onca*), with large ranges of which New Mexico is part of the boundary. The jaguar's historic breeding range extended from South America into southern New Mexico. The state also hosts many narrowly endemic species with extremely small ranges. These include the White Sands pupfish (*Cyprinodon tularosa*), whose entire range is in the Tularosa Basin of south-central New Mexico.

## Conservation Challenges

The Department is mandated to conserve, regulate, propagate, and protect wildlife and fish within the State. This is a complex task considering the diversity of land stewards (Figure 1), limited budgets, and the challenge of mitigating the influence of nearly 2.1 million New Mexicans. Thirty percent of these citizens reside in metropolitan Albuquerque and half reside in 10 cities, leaving most of the state relatively sparsely populated. In addition to resident New Mexicans, millions of people visit the State each year, many of whom find wildlife and their habitats positive components of the landscape but the presence of these visitors also influences wildlife and their habitats. Despite the fact that most human activity occurs in urban areas, wildlife still can be adversely affected throughout the State, particularly through land uses that degrade or eliminate wildlife habitat. As a result, some species populations may decline enough to jeopardize their continued existence. If this happens, it could result in the species being considered for listing as Threatened or Endangered through the New Mexico Wildlife Conservation Act or federal Endangered Species Act. Land use and human activities within designated critical habitat of federally-listed species may be restricted. Because of this,

[1] In this document, the term species refers to both species and sub-species.

additional species listings and subsequent actions to recover them can become controversial, contentious, and expensive.

Currently, over 1500 animal and plant taxa are listed as Threatened or Endangered in the United States under the federal Endangered Species Act and over 50 are being considered as candidates for listing in the United States (http://www.fws.gov/endangered). These statistics certainly indicate the need for an alternative adaptive management approach, one in which species can be conserved at levels where listing and costly recovery actions are not needed.

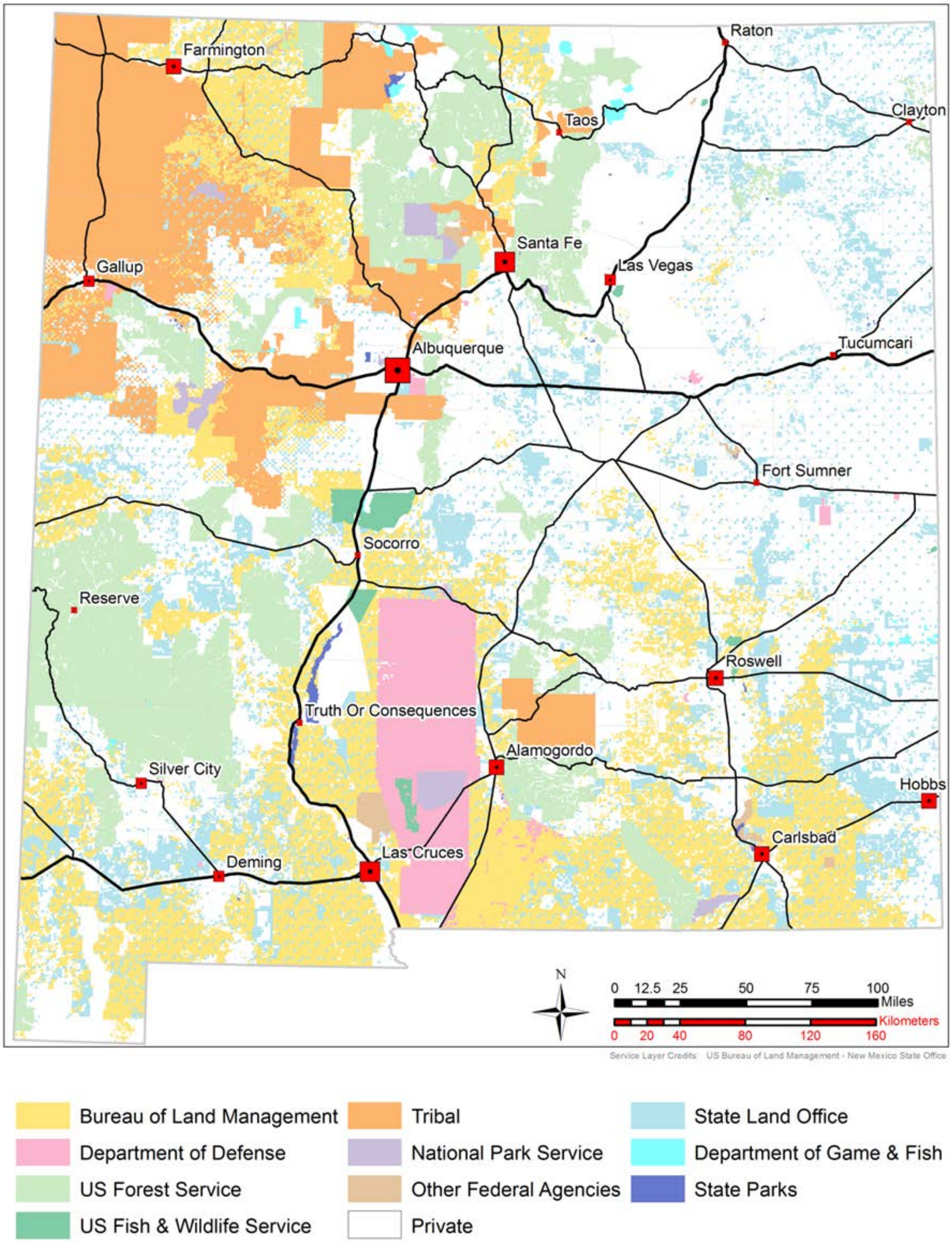



Figure 1. Land stewardship: owners and managers of New Mexico's land.

# The State and Tribal Wildlife Grants Program

An alternative adaptive management approach for New Mexico's wildlife came into existence in 2001 when Congress passed legislation creating the State Wildlife Grants (SWG) Program. This program is a proactive, collaborative effort to provide guidance and assistance in conserving species at population levels that ensure long-term persistence, thereby preventing the need for federal species listing decisions. From Fiscal Years 2002-2015, $815 million were allocated to states for this purpose. These funds were apportioned to states on the basis of state land area and population (https://wsfrprograms.fws.gov/subpages/grantprograms/swg/swg.htm). Funds available to New Mexico averaged about $1 million per year. Full participation by the Department in SWG began in October 2005 with completion of a Comprehensive Wildlife Conservation Strategy (CWCS) and approval of that plan in 2006 by the US Fish and Wildlife Service (USFWS). Over the past nine years, the Department has had the opportunity to use SWG resources to benefit Species of Greatest Conservation Need (SGCN). The CWCS provided: (1) a strategy that interested federal, tribal, state, and local governments and private entities could consider when planning their conservation efforts; (2) important insight about long-term needs of New Mexico's wildlife; (3) an ecologically-based, strategic approach to conservation that helps maintain populations at sustainable levels; and (4) a venue for public engagement necessary to ensure involvement in, as well as acceptance and implementation of, conservation strategies.

# Accomplishments

There have been many specific accomplishments as a result of guidance provided by the New Mexico's CWCS from 2006 to 2014. About $800,000 of $13.8 million of SWG funds expended by the Department were matched with state funds through the Department's Share with Wildlife (SwW) program; 75% of those dollars funded research for SGCN and their habitats. Projects supported by SWG funds matched with other state monies benefitted invertebrates (two survey/research projects), fish (13 survey/research, one restoration, one management), mammals (five survey/research, one habitat conservation), birds (one survey/research, one habitat conservation), reptiles (one survey/research), amphibians (one survey/research, one habitat conservation), and multiple taxa (three survey/research). Also funded were two riparian habitat restoration projects, purchase of lands and easements for conservation, and preparation, revision, and administration of the CWCS.

### Securing the Future for Gray Vireos

The gray vireo (*Vireo vicinior*) is an insectivorous songbird found mainly in juniper savannas and oak chaparral (NMDGF 2007) and is listed as Threatened by the Department. Populations have declined in northern New Mexico and are characterized by relatively low densities (DeLong and Williams 2006). This species' patchy distribution makes populations especially vulnerable to further isolation through fragmentation of juniper woodlands from energy development, firewood harvest, and clearing of land for grazing. Additionally, nest parasitism by cowbirds can greatly decrease recruitment. From 2006-14, SWG funds were used to create a recovery plan, host a workshop on species conservation, complete three monitoring projects, and create a database to house new information and track conservation efforts. These steps set a solid foundation to secure a stable future for gray vireos in New Mexico.

# Required Elements of the Plan

Each state is required to revise its Plan at least once every 10 years. This State Wildlife Action Plan (SWAP) for New Mexico is the first review and revision of the CWCS and will address the eight elements required by the SWG Program.

1. the distribution and abundance of species of wildlife, including low and declining populations as each State fish and wildlife agency deemed appropriate, that are indicative of the diversity and health of wildlife of the State (in subsequent discussions, these species were referred to as Species of Greatest Conservation Need or SGCN);
2. the location and relative condition of key habitats and community types essential to the conservation of each State's SGCN;
3. the problems which may adversely affect SGCN or their habitats, and priority research and surveys needed to identify factors which may assist in restoration and improved conservation of SGCN and their habitats;
4. the actions necessary to conserve SGCN and their habitats and establish priorities for implementing such conservation actions;
5. the provisions for periodic monitoring of SGCN and their habitats, for monitoring the effectiveness of conservation actions, and for adapting conservation actions as appropriate to respond to new information or changing conditions;
6. each State's provisions to review its Plan at intervals not to exceed 10 years;
7. each State's provisions for coordination during the development, implementation, review, and revision of its Plan with Federal, State, and local agencies and Indian Tribes that manage significant areas of land or water within the State, or administer programs that significantly affect the conservation of species or their habitats; and
8. each State's provisions to ensure public participation in the development, revision, and implementation of its Plan.

# SWAP Development Process

In January 2014, one regional, six federal, and five state government entities, seven academic institutions, and 22 Native American tribes were invited to join a Core Team which would directly contribute to developing the Plan (Appendix A). Thirty-eight individuals attended at least one Core Team meeting; over 20 individuals actively participated on the Core Team throughout the revision process (see Acknowledgments and Appendix B). Contributing agencies and universities included: US Forest Service (USFS), US Bureau of Land Management (BLM), US Fish and Wildlife Service (USFWS), US National Park Service (NPS), US Bureau of Reclamation (BOR), US Army Corps of Engineers (ACOE), New Mexico State University (NMSU), University of New Mexico (UNM), Natural Heritage New Mexico at the University of New Mexico's Museum of Southwestern Biology (NHNM), New Mexico Environment Department (NMED), New Mexico State Land Office (SLO), New Mexico State Parks (NMSP), and the Department.

Data gathering for the SWAP began in January 2014 when the Department and NHNM reviewed and revised the criteria for selecting SGCN. The Core Team evaluated the taxonomy and legal status of the over 6,000 species catalogued in the Biota Information System of New Mexico (BISON-M, [www.bison-m.org/](http://www.bison-m.org/)). The Department determined species distributions across New Mexico based upon data from the 2006 CWCS and from NHNM databases of species occurrences within the state. Approximately 1,400 species of wildlife found in New Mexico, for which the Department has management authority, including mammals, birds, reptiles, fish, amphibians, molluscs, and crustaceans were selected to evaluate for consideration as SGCN. From June-November 2014, Department staff and cooperators evaluated species as to their potential to be SGCN (Appendix C). The Core Team agreed on selection criteria and a draft list of SGCN in November 2014. The list was reviewed a second time by Department and external experts and then presented to 54 participants at a workshop during the Joint Annual Meeting of the Arizona and New Mexico Chapters of The Wildlife Society and American Fisheries Society in February 2015 (Appendix D). Comments received from workshop participants by March 2015 were considered by the Department during a final review[2]. The Core Team approved the draft SGCN list in April 2015.

The Department informed the New Mexico State Game Commission and public about progress and direction of the Plan in June and August 2015. In July 2015, the Department notified 3,810 individuals and organizations in New Mexico, based on contact information in a Departmental database, and hosted five public meetings, two in Albuquerque (one for the general public and one specifically for Native American tribes) and one each in Taos, Roswell, and Las Cruces. The purpose of these meetings was to explain the background and process for creating the SWAP, provide an overview of components of a partially completed draft Plan, and solicit comments from participants. A completed draft was made available for public comment from 2 October through 2 November 2015. The draft was revised based on the comments received

[2] Comments are on file with NHNM

(Appendix E) and then presented to the State Game Commission for approval on 19 November 2015.

The Commission requested additional work on the draft Plan to provide further definition of conservation concerns that could be reasonably addressed during the SWAP’s ten-year term, and the Department continued consultation and revision. In early 2016, Department staff met with stakeholder groups to get additional input. As a result of correspondence and meetings with key groups, the Department reassessed the list of SGCN and revised the threat assessments. The Department briefed the Commission during meetings in April, June, August, and October of 2016. The revised document was presented for public review and comment from 2-31 August 2016. The Department reviewed comments (Appendix E) and made revisions from 1 September through 14 October. A revised draft was provided to entities that commented on a previous draft and on 17 November the SWAP was presented to the State Game Commission for approval.

Finally, the Department submitted the final Commission approved Plan to USFWS for review and approval on 30 November 2016. Once approved, the Plan ensures that the Department is eligible to receive available SWG funds through 2025. Underlying these efforts will be continued assessment of SGCN and adaptation of actions to address evolving conservation challenges. The Department commits to revising the SWAP by 2025 as per SWG Program requirements.

# Summary of Changes from the CWCS

The SWAP represents a substantive evolution from the 2006 CWCS. Updates and improvements in content, scope, and approach led to a materially different document. The significant changes in the Plan are described in Table 1 below.

Table 1. Summary of changes from the CWCS to the SWAP.

| Subject | Comprehensive Wildlife Conservation Strategy (Feb. 2006) | State Wildlife Action Plan (Nov. 2016) | For More Information See: |
|---|---|---|---|
| Action necessary to conserve SGCN and their habitats | Expert review of SGCN, habitats, factors influencing both, information gaps, monitoring needs, and desired future outcomes to determine conservation actions (see CWCS Figure 2-2) | Actions determined for each “Threat” category as defined by Salafsky et al. (2008) with updates from the International Union for the Conservation of Nature and Conservation Measures Partnership (IUCN 2016) | Chapter 3, Chapters 5-10 |
| Climate Change | Discussed in various parts of document | Expanded to a separate chapter, including analyses of the potential impacts of climate change on two SGCN | Chapter 4 |
| Conservation Opportunity Areas | Not developed | Analyses identified areas of state that provide superior potential for the conservation of SGCN | Chapter 3 |
| Ecoregions | Document organized around The Nature Conservancy’s seven ecoregions for the State of New Mexico | Document organized around six Level II ecoregions following Griffith et al. (2006); some ecoregion names adjusted for usability (Figure 3, Table 6) | Chapter 2, Chapters 5-10 |
| Habitats | Subset of key habitats based upon Southwest regional GAP analysis program | All macrogroups from US National Vegetation Classification System for the state of New Mexico considered | Chapter 2, Chapters 5-10 |
| Problems which may adversely affect SGCN or their habitats | Framework followed Salafsky et al. (2003); termed "Factors Influencing Species and Habitats" | Framework follows Salafsky et al. (2008) with updates from the International Union for the Conservation of Nature and Conservation Measures Partnership (IUCN 2016); termed “Threats” | Chapter 3, Chapters 5-10 |
| SGCN | 452 species, including arthropods | 235 species; 87 species removed from CWCS list, 24 added; arthropods removed | Chapter 2, Chapters 5-10 |
| SGCN Categories | None | SGCN assigned to one of five categories | Chapter 2 |

# Roadmap to the Elements

The SWAP addresses the eight required elements using both species- and habitat-based approaches. This section summarizes where information on each of the eight required elements is found (Table 2). Information on cross-relationships between species and their habitats is provided in the ecoregion chapters (Table 11, Table 15, Table 19, Table 23, Table 27, Table 31).

Table 2. Roadmap to the eight required elements.

| Element and sub-element | Location |
|---|---|
| 1. Select species indicative of diversity and health of wildlife of the State. | |
| A. Cite sources on abundance and distribution. | Chapter 2 & Appendix F |
| B. Provide information on abundance and distribution for species in all major groups. | Chapters 2, 5, 6, 7, 8, 9, 10, & Appendix F |
| C. Identify low and declining populations. | Chapters 2, 5, 6, 7, 8, 9, 10, & Appendix F |
| D. Describe process for identifying SGCNs. | Chapter 2 |
| 2. Describe location and relative condition of key habitats essential to SGCN. | |
| A. Explain level of detail. | Chapter 2 |
| B. Describe key habitats and conditions well enough to prescribe conservation actions. | Chapters 2, 5, 6, 7,8, 9, & 10 |
| 3. Determine problems which may adversely affect SGCN or their habitats and efforts needed to address restoration. | |
| A. Cite sources of information on threats. | Chapters 3, 4, & Appendix F |
| B. Describe threats well enough to develop focused conservation actions. | Chapters 3, 4, 5, 6, 7, 8, 9, 10, & Appendix F |
| C. Consider all threats relevant to species and habitats of the state. | Chapters 3, 4, 5, 6, 7, 8, 9, 10, & Appendix F |
| D. Identify efforts to obtain needed information if it is currently insufficient to describe threats. | Chapter 11 |
| E. Describe priority research and survey needs as well as resulting products well enough to develop projects. | Chapters 5, 6, 7, 8, 9, 10, & 11 |
| 4. Determine and prioritize actions necessary to conserve SGCN and their habitats. | |
| A. Plan identifies how conservation actions address threats to SGCN and their habitats. | Chapters 3, 5, 6, 7, 8, 9, & 10 |
| B. Describe conservation actions sufficiently to guide implementation of actions. | Chapters 3, 5, 6, 7, 8, 9, & 10 |
| C. Link conservation actions to objectives and indicators that will facilitate monitoring. | Chapters 3, 5, 6, 7, 8, 9, & 10, & 11 |
| D. Describe conservation actions that federal agencies or regional, national, or international partners could address. | Chapters 3, 5, 6, 7, 8, 9, & 10 |

| Element and sub-element | Location |
|---|---|
| E. Identify research needs to obtain sufficient information for conservation actions. | Chapters 3, 5, 6, 7, 8, 9, 10, & 11 |
| F. Prioritize conservation actions. | Chapters 3, 5, 6, 7, 8, 9, &10 |
| 5. Periodically monitor SGCN and their habitats, the effectiveness of conservation actions, and adapt conservation actions to respond to new information or changing conditions. | |
| A. Describe plans for monitoring species. | Chapter 11 |
| B. Describe how conservation actions will be monitored. | Chapter 11 |
| C. Explain where and why monitoring is not appropriate, necessary, or possible. | Chapter 11 |
| D. Plan monitoring for one of several levels: individual, species, guilds, or natural communities. | Chapter 11 |
| E. Explain how monitoring utilizes or builds on existing systems or explains how monitoring will be accomplished to determine effectiveness of actions. | Chapter 11 |
| F. Consider appropriate geographic scale for monitoring species status and effectiveness of conservation actions. | Chapter 11 |
| G. The Plan is adaptive. Conservation actions can be evaluated and implemented accordingly. | Chapter 11 |
| 6. Describe procedures to review the Plan at intervals not to exceed 10 years. | |
| A. Describe process to review the Plan within 10 years. | Chapter 12 |
| 7. Describe plans to coordinate development, implementation, review, and revision of the Plan with federal, state, and local agencies and Indian tribes that manage significant land and water or administer programs that significantly affect SGCN and their habitats. | |
| A. Describe efforts to coordinate with and involve federal, state, and local agencies, and tribes in development of the Plan. | Chapters 1, 12, & Appendices A, B, C, D, & E |
| B. Describe continued coordination with agencies and tribes in implementation, review, and revision of the Plan. | Chapter 12 |
| 8. Describe public participation in the development, revision, and implementation of the Plan. | |
| A. Describe efforts to involve the public in development of the Plan. | Chapters 1, 12, & Appendix E |
| B. Describe public involvement in implementation and revision of the Plan. | Chapters 1, 12, & Appendix E |

# Chapter 2: Species of Greatest Conservation Need, Ecoregions, and Habitats

## Species of Greatest Conservation Need (SGCN)

Species considered for inclusion as SGCN had to occur within the state (www.bison-m.org/) and meet at least one of the following conditions:

**Declining:** Species that have experienced substantial long-term declines in habitat or numbers.

**Vulnerable:** Species in which some aspect of their life history and ecology makes them disproportionately susceptible to decline within the next 10 years. Factors include, but are not limited to, concentration to small areas during migration or hibernation; low reproductive rates; susceptibility to disease, inability to respond to changing climate conditions, habitat loss, wildfire, and overexploitation for anthropogenic purposes.

**Endemic:** Species that are limited to New Mexico.

**Disjunct:** Species that have populations geographically isolated from other populations of the same species and are thereby disproportionately susceptible to local decline or extirpation.

**Keystone:** Species that are crucial to the integrity and the functioning of their ecosystems. These species may represent more value to conservation of biological diversity than the size of their population or their distribution would suggest.

Some species met at least one of the above conditions but were not considered as SGCN because they (1) had life history and habitat requirements similar to other SGCN, (2) were common or widespread, (3) had no known conservation concerns, or (4) were legally harvestable with statutory protection as game animals or sport fish, unless they were simultaneously designated as Threatened or Endangered. Once species were selected as SGCN, they were grouped into five categories that reflect their status in New Mexico. Table 3 describes the attributes that were used to group SGCN into these five categories.

Table 3. Criteria used to group Species of Greatest Conservation Need (SGCN).

**Immediate Priority Species (I)**

These are species for which the Department has identified conservation needs and/or projects to be implemented as soon as resources are available. This category may include species with conservation efforts that have already been initiated, or that are currently undergoing planning and scheduling for out-year implementation. Considerations include species status and trends in New Mexico, complimentary management efforts that have been initiated or funded, and opportunities to improve the overall status of the species. This category includes species that have completed a 12-month review for listing under the federal Endangered Species Act (ESA) and are Proposed or Candidate species for listing under ESA, and thus may be subject to state conservation actions attempting to preclude the need for federal listing.

**Specialized or Limited-Habitat Species (H)**

This category represents species with limited areas of occupied habitat in New Mexico. This may include endemic/geographically-restricted species, or habitat specialists that utilize very specific, narrowly-distributed, or highly fragmented patches of habitat. Distributions of habitat-limited species are generally restricted to only a portion of a single ecoregion, or they are strongly associated with habitat features that tend to be disjunct and small in size compared to surrounding habitats, such as vertical cliffs or river/arroyo banks, waterfalls, talus slopes, or at established burrows/cavities. These species may or may not be considered to be declining or in need of additional conservation measures now. Although abundances may not be linearly related to occupied habitat area, the status of these species is inherently linked to changes in habitat quantity or condition (e.g., snails inhabiting only a single spring). Habitat-limited species may become a higher management priority if such changes occur.

**Susceptible Species (S)**

This category includes species that may not represent immediate priorities for management actions under current conditions. However, their life histories or population demographics make them vulnerable to changes such as shifting environmental conditions or disease outbreaks (e.g., cave-roosting bats). These species exhibit traits such as breeding or migratory concentrations, or low reproductive capacity, which are associated with the potential for rapid population changes that would elevate them to a higher management priority. While baseline conditions may be known, these species warrant additional population monitoring and readiness to implement conservation actions as needed to secure their status within the state.

**Species with Conservation Data Gaps (D)**

This category includes species for which there is some conservation concern, but the primary conservation needs are to obtain additional biological data and information. More complete knowledge will facilitate developing more comprehensive assessments of their current status within New Mexico and refining understanding of existing conservation needs. Management actions for these species may include implementing expanded or updated survey or monitoring efforts to better assess their status and opportunities for conservation enhancement.

**Federally-listed Species (F)**

These species represent a component of the state's biological diversity whose population status was assessed by the US Fish and Wildlife Service during the process of designation as Threatened or Endangered under ESA. Federal resources and protections may already be available for listed species, and therefore they may not require or be the focus of projects funded using State Wildlife Grants. State-level initiatives for these species could include implementing conservation actions that will expedite down-listing or delisting under the ESA.

A total of 235 species were selected to be SGCN for this Plan (Table 4, Table 5, http://bison-m.org/documents/48800_SWAP2016_SpeciesofGreatestConservationNeedList.pdf). The State of New Mexico has no regulatory authority for implementing conservation or management actions for arthropods, so none were designated as SGCN within this Plan. However, Conservation Actions could address arthropods as a component of dietary needs for SGCN, and actions that enhance habitats for SGCN would likely create similar benefits to the arthropods that comprise a large proportion of the fauna within New Mexico's biological communities. In addition to arthropods, 87 species identified as SGCN in the CWCS were removed from the list and 24 other species were added (Table 4). Most of the additions to the list of SGCN were birds which had the largest number of species in category I (chronologically the first group to receive conservation actions). However, fish (31%) and mammals (37.5%) contained the highest proportion (47%) of their SGCN in category I. The majority of amphibians (52%) known to occur in New Mexico are identified as SGCN. Conversely, only 14% of birds and 11% of mammals in New Mexico are SGCN. Overall, 17% of all New Mexico species reviewed were designated as SGCN.

Plant species in need of conservation are not covered by the SWG Program. However, New Mexico supports 243 vascular plants for which data are collected by Natural Heritage New Mexico (NHNM) due to concerns about their conservation status. Information about these species is provided so projects that improve SGCN habitats may also benefit these plants. Conservation needs for individual plant species are not discussed in detail here, but should be addressed within a forthcoming statewide plant conservation plan. A complete of list of these tracked plants is available at http://nhnm.unm.edu/bcd/query.

Table 4. Taxonomic distribution of SGCN by conservation category.

| Category / Taxon[3] | I | H | S | D | F | Total |
|---|---|---|---|---|---|---|
| Amphibians | 1 | 4 | 5 | 2 | 2 | 14 (+0, -1) |
| Birds | 18 | 10 | 30 | 9 | 5 | 72 (+17, -19) |
| Crustaceans | 0 | 1 | 0 | 27 | 2 | 30 (+0, -2) |
| Fish | 9 | 2 | 5 | 0 | 13 | 29 (+1, -9) |
| Mammals | 9 | 3 | 3 | 3 | 6 | 24 (+3, -21) |
| Molluscs | 1 | 26 | 3 | 10 | 6 | 46 (+2, -22) |
| Reptiles | 1 | 6 | 6 | 4 | 3 | 20 (+1, -13) |
| Total | 39 | 52 | 52 | 55 | 37 | 235 (+24, -87) |

[3] Taxonomically, six of seven taxonomic groups listed are classes; mollusc is a phylum.

Table 5. Taxon, common, and scientific names for Species of Greatest Conservation Need.

| Taxon | Common Name | Scientific Name |
|---|---|---|
| Amphibians | Boreal Toad | *Anaxyrus boreas* |
| Amphibians | Sonoran Desert Toad | *Incilius alvarius* |
| Amphibians | Western Narrow-mouthed Toad | *Gastrophryne olivacea* |
| Amphibians | Lowland Leopard Frog | *Lithobates yavapaiensis* |
| Amphibians | Sacramento Mountain Salamander | *Aneides hardii* |
| Amphibians | Boreal Chorus Frog | *Pseudacris maculata* |
| Amphibians | Arizona Treefrog | *Hyla wrightorum* |
| Amphibians | Northern Leopard Frog | *Lithobates pipiens* |
| Amphibians | Plains Leopard Frog | *Lithobates blairi* |
| Amphibians | Rio Grande Leopard Frog | *Lithobates berlandieri* |
| Amphibians | Arizona Toad | *Anaxyrus microscaphus* |
| Amphibians | Eastern Barking Frog | *Craugastor augusti latrans* |
| Amphibians | Chiricahua Leopard Frog | *Lithobates chiricahuensis* |
| Amphibians | Jemez Mountains Salamander | *Plethodon neomexicanus* |
| Birds | White-tailed Ptarmigan | *Lagopus leucura* |
| Birds | Flammulated Owl | *Psiloscops flammeolus* |
| Birds | Mexican Whip-poor-will | *Antrostomus arizonae* |
| Birds | Lewis's Woodpecker | *Melanerpes lewis* |
| Birds | Gray Vireo | *Vireo vicinior* |
| Birds | Pinyon Jay | *Gymnorhinus cyanocephalus* |
| Birds | Juniper Titmouse | *Baeolophus ridgwayi* |
| Birds | Bendire's Thrasher | *Toxostoma bendirei* |
| Birds | Sprague's Pipit | *Anthus spragueii* |
| Birds | Painted Redstart | *Myioborus pictus* |
| Birds | Grace's Warbler | *Setophaga graciae* |
| Birds | Black-throated Gray Warbler | *Setophaga nigrescens* |
| Birds | Red-faced Warbler | *Cardellina rubrifrons* |
| Birds | Virginia's Warbler | *Oreothlypis virginiae* |
| Birds | Black-chinned Sparrow | *Spizella atrogularis* |
| Birds | Arizona Grasshopper Sparrow | *Ammodramus savannarum ammolegus* |
| Birds | Chestnut-collared Longspur | *Calcarius ornatus* |
| Birds | McCown's Longspur | *Rhynchophanes mccownii* |
| Birds | Gould's Wild Turkey | *Meleagris gallopavo mexicana* |
| Birds | Eared Grebe | *Podiceps nigricollis* |
| Birds | American Bittern | *Botaurus lentiginosus* |
| Birds | Bald Eagle | *Haliaeetus leucocephalus* |
| Birds | Peregrine Falcon | *Falco peregrinus* |
| Birds | Boreal Owl | *Aegolius funereus* |
| Birds | Burrowing Owl | *Athene cunicularia* |
| Birds | Black Swift | *Cypseloides niger* |

| Taxon | Common Name | Scientific Name |
|---|---|---|
| Birds | Bell's Vireo | *Vireo bellii* |
| Birds | Bank Swallow | *Riparia riparia* |
| Birds | Lesser Prairie-Chicken | *Tympanuchus pallidicinctus* |
| Birds | Mountain Plover | *Charadrius montanus* |
| Birds | Snowy Plover | *Charadrius nivosus* |
| Birds | Long-billed Curlew | *Numenius americanus* |
| Birds | Neotropic Cormorant | *Phalacrocorax brasilianus* |
| Birds | Common Ground-dove | *Columbina passerina* |
| Birds | Whiskered Screech-Owl | *Megascops trichopsis* |
| Birds | Common Nighthawk | *Chordeiles minor* |
| Birds | Costa's Hummingbird | *Calypte costae* |
| Birds | Violet-crowned Hummingbird | *Amazilia violiceps* |
| Birds | Williamson's Sapsucker | *Sphyrapicus thyroideus* |
| Birds | Gila Woodpecker | *Melanerpes uropygialis* |
| Birds | Red-headed Woodpecker | *Melanerpes erythrocephalus* |
| Birds | Northern Beardless Tyrannulet | *Camptostoma imberbe* |
| Birds | Olive-sided Flycatcher | *Contopus cooperi* |
| Birds | Thick-billed Kingbird | *Tyrannus crassirostris* |
| Birds | Loggerhead Shrike | *Lanius ludovicianus* |
| Birds | Clark's Nutcracker | *Nucifraga columbiana* |
| Birds | Pygmy Nuthatch | *Sitta pygmaea* |
| Birds | Mountain Bluebird | *Sialia currucoides* |
| Birds | Western Bluebird | *Sialia mexicana* |
| Birds | Lucy's Warbler | *Oreothlypis luciae* |
| Birds | Yellow-eyed Junco | *Junco phaeonotus* |
| Birds | Baird's Sparrow | *Ammodramus bairdii* |
| Birds | Cassin's Sparrow | *Peucaea cassinii* |
| Birds | Sagebrush Sparrow | *Artemisiospiza nevadensis* |
| Birds | Vesper Sparrow | *Pooecetes gramineus* |
| Birds | Varied Bunting | *Passerina versicolor* |
| Birds | Cassin's Finch | *Haemorhous cassinii* |
| Birds | Evening Grosbeak | *Coccothraustes vespertinus* |
| Birds | Clark's Grebe | *Aechmophorus clarkii* |
| Birds | Common Black Hawk | *Buteogallus anthracinus* |
| Birds | Elf Owl | *Micrathene whitneyi* |
| Birds | Broad-billed Hummingbird | *Cynanthus latirostris* |
| Birds | Lucifer Hummingbird | *Calothorax lucifer* |
| Birds | Elegant Trogon | *Trogon elegans* |
| Birds | Botteri's Sparrow | *Peucaea botterii* |
| Birds | Abert's Towhee | *Melozone aberti* |
| Birds | Brown-capped Rosy-Finch | *Leucosticte australis* |

| Taxon | Common Name | Scientific Name |
|---|---|---|
| Birds | Aplomado Falcon | *Falco femoralis* |
| Birds | Least Tern | *Sternula antillarum* |
| Birds | Yellow-billed Cuckoo | *Coccyzus americanus* |
| Birds | Mexican Spotted Owl | *Strix occidentalis lucida* |
| Birds | Southwestern Willow Flycatcher | *Empidonax traillii extimus* |
| Crustaceans | Conchas Crayfish | *Orconectes deanae* |
| Crustaceans | BLNWR cryptic species Amphipod | *Gammarus* sp. |
| Crustaceans | Sitting Bull Spring cryptic species Amphipod | *Gammarus* sp. |
| Crustaceans | Western Plains Crayfish | *Orconectes causeyi* |
| Crustaceans | Southern Plains Crayfish | *Procambarus simulans* |
| Crustaceans | Moore's Fairy Shrimp | *Streptocephalus moorei* |
| Crustaceans | Brine Shrimp | *Artemia franciscana* |
| Crustaceans | Colorado Fairy Shrimp | *Branchinecta coloradensis* |
| Crustaceans | Versatile Fairy Shrimp | *Branchinecta lindahli* |
| Crustaceans | Alkali Fairy Shrimp | *Branchinecta mackini* |
| Crustaceans | Packard's Fairy Shrimp | *Branchinecta packardi* |
| Crustaceans | Sublette's Fairy Shrimp | *Phallocryptis subletti* |
| Crustaceans | Knobblip Fairy Shrimp | *Eubranchipus bundyi* |
| Crustaceans | Dumont's Fairy Shrimp | *Streptocephalus henridumontis* |
| Crustaceans | Bowman's Fairy Shrimp | *Streptocephalus thomasbowmani* |
| Crustaceans | Great Plains Fairy Shrimp | *Streptocephalus texanus* |
| Crustaceans | Mexican Beavertail Fairy Shrimp | *Thamnocephalus mexicanus* |
| Crustaceans | Beavertail Fairy Shrimp | *Thamnocephalus platyurus* |
| Crustaceans | Mexican Clam Shrimp | *Cyzicus mexicanus* |
| Crustaceans | Swaybacked Clam Shrimp | *Eocyzicus concavus* |
| Crustaceans | Straightbacked Clam Shrimp | *Eocyzicus digueti* |
| Crustaceans | Fuzzy Cyst Clam Shrimp | *Eulimnadia antlei* |
| Crustaceans | Cylindrical Cyst Clam Shrimp | *Eulimnadia cylindrova* |
| Crustaceans | Diversity Clam Shrimp | *Eulimnadia diversa* |
| Crustaceans | Clam Shrimp | *Eulimnadia follismilis* |
| Crustaceans | Texan Clam Shrimp | *Eulimnadia texana* |
| Crustaceans | Short Finger Clam Shrimp | *Lynceus brevifrons* |
| Crustaceans | Lynch Tadpole Shrimp | *Lepidurus lemmoni* |
| Crustaceans | Socorro Isopod | *Thermosphaeroma thermophilum* |
| Crustaceans | Noel's Amphipod | *Gammarus desperatus* |
| Fish | Rio Grande Chub | *Gila pandora* |
| Fish | Headwater Chub | *Gila nigra* |
| Fish | Roundtail Chub | *Gila robusta* |
| Fish | Peppered Chub | *Macrhybopsis tetranema* |
| Fish | Gray Redhorse | *Moxostoma congestum* |

| Taxon | Common Name | Scientific Name |
|---|---|---|
| Fish | Blue Sucker | *Cycleptus elongatus* |
| Fish | Rio Grande Sucker | *Catostomus plebeius* |
| Fish | Pecos Pupfish | *Cyprinodon pecosensis* |
| Fish | White Sands Pupfish | *Cyprinodon tularosa* |
| Fish | Greenthroat Darter | *Etheostoma lepidum* |
| Fish | Bigscale Logperch (native pop.) | *Percina macrolepida* |
| Fish | Southern Redbelly Dace | *Phoxinus erythrogaster* |
| Fish | Suckermouth Minnow | *Phenacobius mirabilis* |
| Fish | Desert Sucker | *Catostomus clarkii* |
| Fish | Sonora Sucker | *Catostomus insignis* |
| Fish | Mexican Tetra | *Astyanax mexicanus* |
| Fish | Chihuahua Chub | *Gila nigrescens* |
| Fish | Gila Chub | *Gila intermedia* |
| Fish | Loach Minnow | *Rhinichthys (Tiaroga) cobitis* |
| Fish | Rio Grande Silvery Minnow | *Hybognathus amarus* |
| Fish | Arkansas River Shiner (native pop.) | *Notropis girardi* |
| Fish | Pecos Bluntnose Shiner | *Notropis simus pecosensis* |
| Fish | Spikedace | *Meda fulgida* |
| Fish | Colorado Pikeminnow | *Ptychocheilus lucius* |
| Fish | Zuni Bluehead Sucker | *Catostomus discobolus yarrowi* |
| Fish | Razorback Sucker | *Xyrauchen texanus* |
| Fish | Gila Trout | *Oncorhynchus gilae* |
| Fish | Pecos Gambusia | *Gambusia nobilis* |
| Fish | Gila Topminnow | *Poeciliopsis occidentalis occidentalis* |
| Mammals | American Mink | *Vison vison* |
| Mammals | North American River Otter | *Lontra canadensis* |
| Mammals | Organ Mountains Colorado Chipmunk | *Tamias quadrivittatus australis* |
| Mammals | Oscura Mountains Colorado Chipmunk | *Tamias quadrivittatus oscuraensis* |
| Mammals | Peñasco Least Chipmunk | *Tamias minimus atristriatus* |
| Mammals | Black-tailed Prairie Dog | *Cynomys ludovicianus* |
| Mammals | Gunnison's Prairie Dog | *Cynomys gunnisoni* |
| Mammals | Arizona Montane Vole | *Microtus montanus arizonensis* |
| Mammals | White-sided Jackrabbit | *Lepus callotis* |
| Mammals | Arizona Shrew | *Sorex arizonae* |
| Mammals | Least Shrew | *Cryptotis parva* |
| Mammals | American Pika | *Ochotona princeps* |
| Mammals | Pale Townsend's Big-eared Bat | *Corynorhinus townsendii* |
| Mammals | Spotted Bat | *Euderma maculatum* |
| Mammals | Pacific Marten | *Martes caurina* |
| Mammals | Mexican Long-tongued Bat | *Choeronycteris mexicana* |

| Taxon | Common Name | Scientific Name |
|---|---|---|
| Mammals | Western Yellow Bat | *Lasiurus xanthinus* |
| Mammals | Southern Pocket Gopher | *Thomomys umbrinus* |
| Mammals | Mexican Long-nosed Bat | *Leptonycteris nivalis* |
| Mammals | Lesser Long-nosed Bat | *Leptonycteris yerbabuenae* |
| Mammals | Mexican Gray Wolf | *Canis lupus baileyi* |
| Mammals | Jaguar | *Panthera onca* |
| Mammals | Black-footed Ferret | *Mustela nigripes* |
| Mammals | New Mexico Meadow Jumping Mouse | *Zapus hudsonius luteus* |
| Molluscs | Texas Hornshell | *Popenaias popeii* |
| Molluscs | New Mexico Hot Springsnail | *Pyrgulopsis thermalis* |
| Molluscs | Gila Springsnail | *Pyrgulopsis gilae* |
| Molluscs | Pecos Springsnail | *Pyrgulopsis pecosensis* |
| Molluscs | Tularosa  Springsnail | *Juturnia tularosae* |
| Molluscs | Star Gyro | *Gyraulus crista* |
| Molluscs | New Mexico Ramshorn Snail | *Pecosorbis kansasensis* |
| Molluscs | Lang Canyon Talussnail | *Sonorella painteri* |
| Molluscs | Shortneck Snaggletooth Snail | *Gastrocopta dalliana* |
| Molluscs | Ovate Vertigo Snail | *Vertigo ovata* |
| Molluscs | Ruidoso Snaggletooth Snail | *Gastrocopta ruidosensis* |
| Molluscs | Cross Holospira Snail | *Holospira crossei* |
| Molluscs | Animas Mountains Holospira Snail | *Holospira animasensis* |
| Molluscs | Mineral Creek Mountainsnail | *Oreohelix pilsbryi* |
| Molluscs | Hacheta Grande Woodlandsnail | *Ashmunella hebardi* |
| Molluscs | Cooke's Peak Woodlandsnail | *Ashmunella macromphala* |
| Molluscs | Sangre de Cristo Woodlandsnail | *Ashmunella thomsoniana* |
| Molluscs | Jemez Woodlandsnail | *Ashmunella ashmuni* |
| Molluscs | Silver Creek Woodlandsnail | *Ashmunella binneyi* |
| Molluscs | Doña Ana Talussnail | *Sonorella todseni* |
| Molluscs | New Mexico Talussnail (Big Hatchet Mountains) | *Sonorella hachitana* |
| Molluscs | New Mexico Talussnail (Florida Mountains) | *Sonorella hachitana flora* |
| Molluscs | Paper Pondshell | *Utterbackia imbecillis* |
| Molluscs | Swamp Fingernailclam | *Musculium partumeium* |
| Molluscs | Lilljeborg's Peaclam | *Pisidium lilljeborgi* |
| Molluscs | Lake Fingernailclam | *Musculium lacustre* |
| Molluscs | Long Fingernailclam | *Musculium transversum* |
| Molluscs | Obese Thorn Snail | *Carychium exiguum* |
| Molluscs | False Marsh Snail | *Deroceras heterura* |
| Molluscs | Texas Liptooth Snail | *Linisa texasiana* |
| Molluscs | Wrinkled Marshsnail | *Stagnicola caperata* |
| Molluscs | Creeping Ancylid Snail | *Ferrissia rivularis* |

| Taxon | Common Name | Scientific Name |
|---|---|---|
| Molluscs | Vallonia Snail | *Vallonia sonorana* |
| Molluscs | Metcalf Holospira Snail | *Holospira metcalfi* |
| Molluscs | Fringed Mountainsnail | *Radiocentrum ferrissi* |
| Molluscs | Woodlandsnail | *Ashmunella amblya cornudasensis* |
| Molluscs | Animas Peak Woodlandsnail | *Ashmunella animasensis* |
| Molluscs | New Mexico Talussnail (Peloncillo Mountains) | *Sonorella hachitana peloncillensis* |
| Molluscs | Animas Talussnail | *Sonorella animasensis* |
| Molluscs | Sangre De Cristo Peaclam | *Pisidium sanguinichristi* |
| Molluscs | Alamosa Springsnail | *Pseudotryonia alamosae* |
| Molluscs | Chupadera Springsnail | *Pyrgulopsis chupaderae* |
| Molluscs | Koster's Springsnail | *Juturnia kosteri* |
| Molluscs | Roswell Springsnail | *Pyrgulopsis roswellensis* |
| Molluscs | Socorro Springsnail | *Pyrgulopsis neomexicana* |
| Molluscs | Pecos Assiminea | *Assiminea pecos* |
| Reptiles | Western River Cooter | *Pseudemys gorzugi* |
| Reptiles | Slevin's Bunchgrass Lizard | *Sceloporus slevini* |
| Reptiles | Dunes Sagebrush Lizard | *Sceloporus arenicolus* |
| Reptiles | Mountain Skink | *Plestiodon callicephalus* |
| Reptiles | Gray-checkered Whiptail | *Aspidoscelis dixoni* |
| Reptiles | Giant Spotted Whiptail | *Aspidoscelis stictogramma* |
| Reptiles | California Kingsnake | *Lampropeltis californiae* |
| Reptiles | Sonoran Mud Turtle | *Kinosternon sonoriense* |
| Reptiles | Reticulate Gila Monster | *Heloderma suspectum suspectum* |
| Reptiles | Gray-banded Kingsnake | *Lampropeltis alterna* |
| Reptiles | Green Rat Snake | *Senticolis triaspis* |
| Reptiles | Arid Land Ribbonsnake | *Thamnophis proximus* |
| Reptiles | Rock Rattlesnake | *Crotalus lepidus* |
| Reptiles | Arizona Black Rattlesnake | *Crotalus cerberus* |
| Reptiles | Big Bend Slider | *Trachemys gaigeae* |
| Reptiles | Plain-bellied Water Snake | *Nerodia erythrogaster* |
| Reptiles | Desert Massasauga | *Sistrurus catenatus* |
| Reptiles | Mexican Gartersnake | *Thamnophis eques* |
| Reptiles | Narrow-headed Gartersnake | *Thamnophis rufipunctatus* |
| Reptiles | New Mexico Ridge-nosed Rattlesnake | *Crotalus willardi obscurus* |

# Ecoregions

New Mexico's size and biodiversity make conservation planning and implementation on a statewide basis impractical. To resolve this, Level II ecoregions mapped in Griffith et al. (2006) were selected to focus conservation strategies within specific ecoregions. The ecoregion designations used are part of a four level nested system (Level I (continental scale) through IV (sub-regional scale)) developed by The Commission for Environmental Cooperation (1997) to provide uniform classification of areas with similar ecological characteristics throughout North America.

New Mexico encompasses parts of six Level II ecoregions, the most of any state. These ecoregions extend south to central Mexico and north to Canada and include desert (Cold Desert, Warm Desert, and Western Sierra Madre Piedmont), montane (Western Cordillera, Upper Gila Mountains), and prairie (South-Central Semi-arid Prairie) ecosystems (Figure 2, Figure 3). In this Plan, modified Level III ecoregion names were used that are more descriptive and recognizable to natural resource managers than the Level II names (Table 6). Level III ecoregion narratives are derived from Griffith (2010).

Table 6. Names used in this report for six Level II ecoregions found in New Mexico.

| Names Used in This Plan | Level II Ecoregions | | Level III Ecoregions |
|---|---|---|---|
| | **Code**[4] | **Name** | **Name** |
| Colorado Plateaus | 10.1 | Cold Deserts | Colorado Plateaus |
| | | | Arizona/New Mexico Plateaus |
| Southern Rocky Mountains | 6.2 | Western Cordillera | Southern Rocky Mountains |
| High Plains and Tablelands | 9.4 | South Central Semi-arid Prairie | High Plains |
| | | | Southwestern Tablelands |
| Chihuahuan Desert | 10.2 | Warm Deserts | Chihuahuan Desert |
| Madrean Archipelago | 12.1 | Western Sierra Madre Piedmont | Madrean Archipelago |
| Arizona/New Mexico Mountains | 13.1 | Upper Gila Mountains | Arizona/New Mexico Mountains |

[4] Also shown are classification codes and names from Griffith (2010). Level III ecoregions listed are those found within New Mexico.

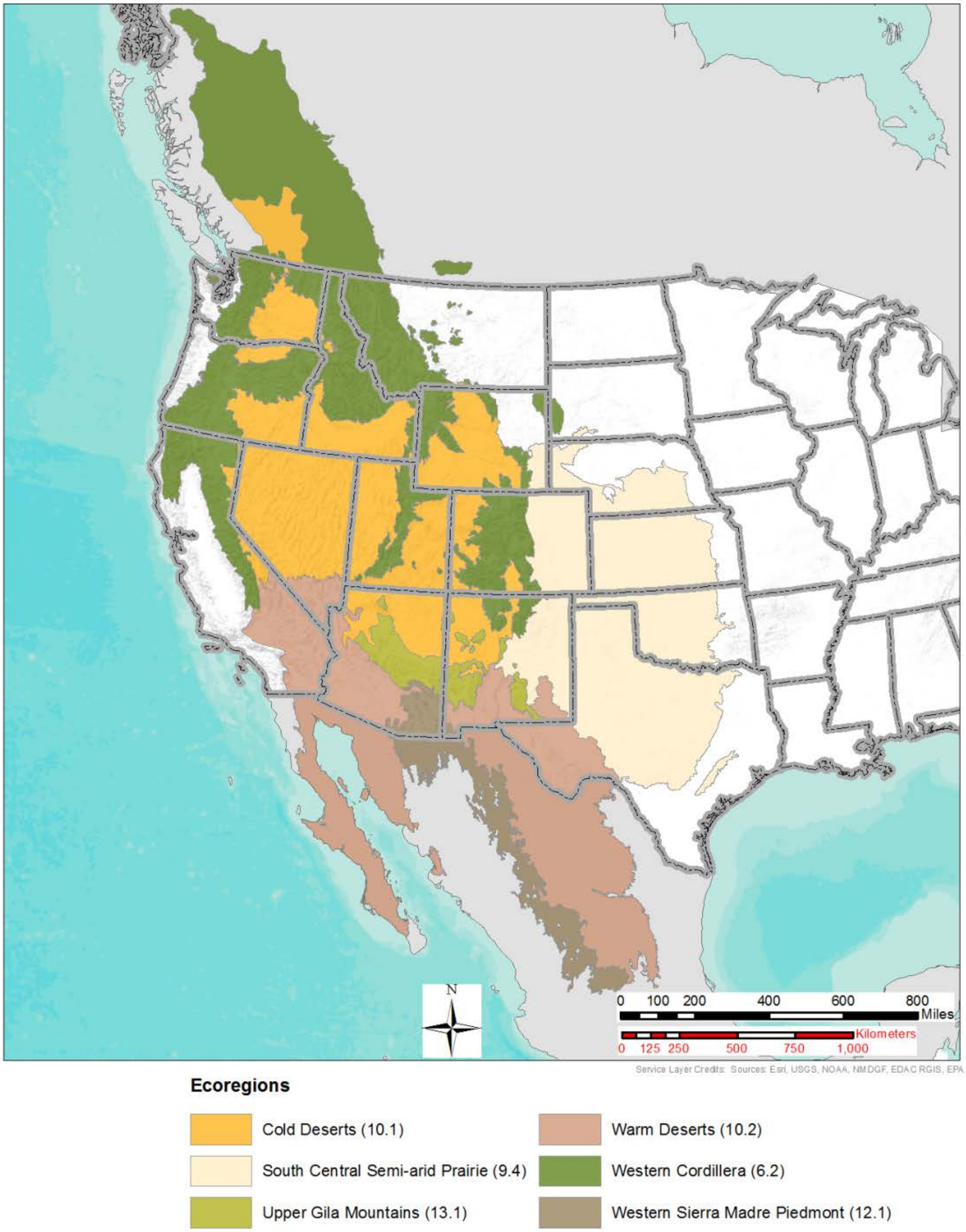



Figure 2. New Mexico at the crossroads of diversity.

Six ecoregions meet in New Mexico (the most of any state) and extend across 16 states, Canada, and Mexico. Classification codes used in most ecoregion maps are shown in parentheses.

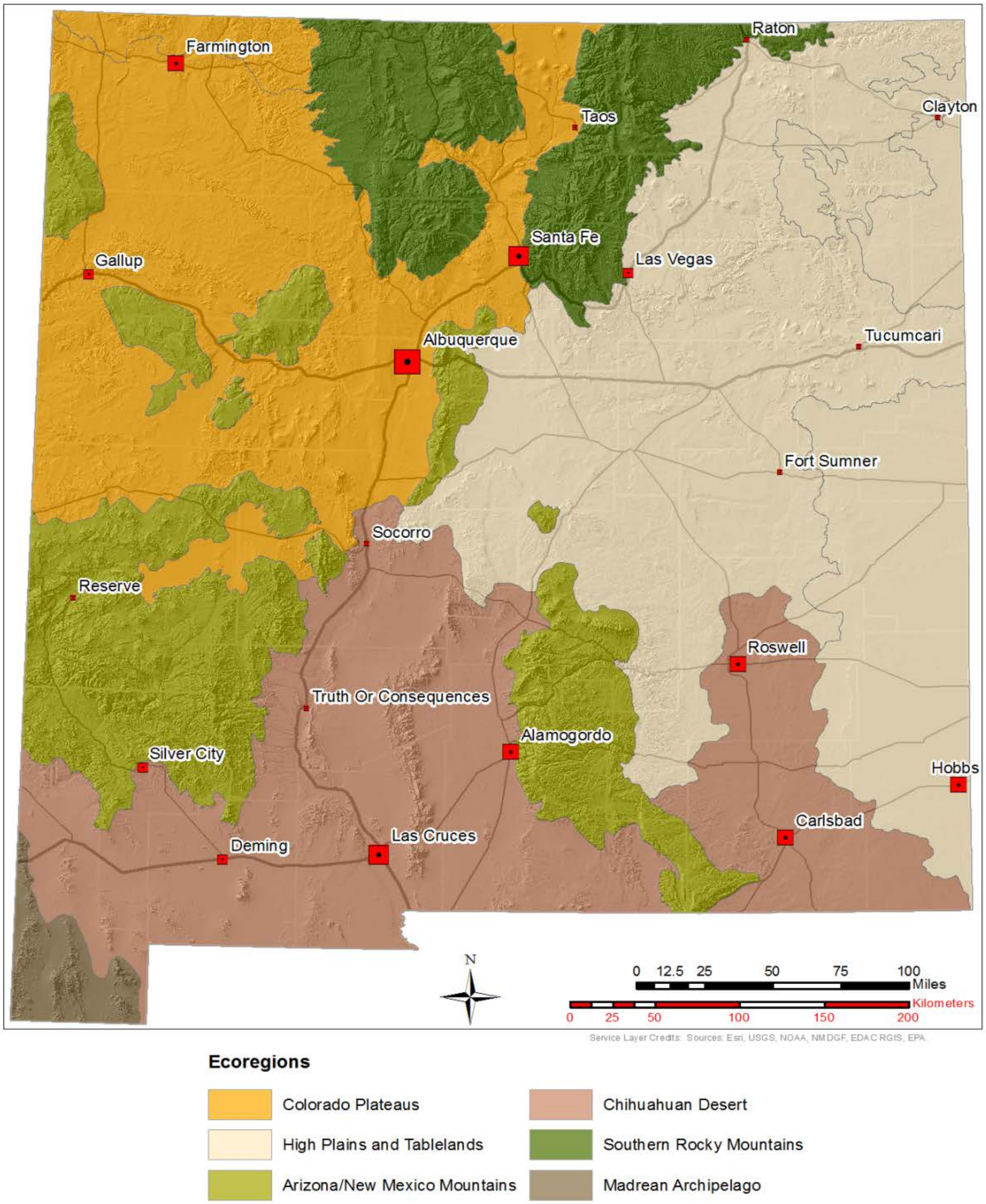



Figure 3. Ecoregions of New Mexico.

These are the main geographic units for the organization of this Plan and are based on Griffith et al. (2006).

# Terrestrial Habitats

Terrestrial habitats were classified using the US National Vegetation Classification System (USNVC), an eight level, standardized, international system for grouping vegetation by shared floristic or physiognomic characteristics (Jennings et al. 2009; USNVC 2016). Macrogroups (hereafter “habitats”) are used for the naming convention, a mid-level classification based on dominant and diagnostic growth forms and species composition similarity. Landcover classes from the Southwest Regional Gap Analysis (SWReGAP; http://swregap.nmsu.edu/) were added that were not identified as USNVC macrogroups because they were devoid of natural vegetation. The GIS landcover layer of SWReGAP was used to map habitats. Each landcover class was associated with the USNVC habitat with which it most closely shared floristic and physiognomic characteristics.

Habitats were then grouped into one of five tiers that reflect their habitat value and needs for conservation (Tier 1 through 4: most to least urgent; Tier 5: non-habitat). Tiers were based on rankings within the United States according to the NatureServe Conservation Status Assessment (http://www.natureserve.org/conservation-tools/conservation-status-assessment) and the spatial pattern of the habitat. The NatureServe assessment is comprised of five ranks: critically imperiled (N1), imperiled (N2), vulnerable (N3), apparently secure (N4), and secure (N5). Spatial patterns are: matrix (extensive and contiguous, 2,000-10,000 ha (4,942-24,710 ac), wide ecological tolerance, disturbances encompass <5%); large patch (50-2000 ha (124-4,942 ac) of uninterrupted vegetation, disturbances may encompass >20% of individual patches); small patch (distribution limited by local environmental features, 1-50 ha (2.47-124 ac)); and linear (often ecotonal between terrestrial and aquatic ecosystems, 0.5-100 km (0.3-62 mi) long) (Faber-Langendoen et al., 2009). Using these criteria, tiers are as follows: Tier 1 = N1, N2, or N3 small patch/linear; Tier 2 = N3 large patch or N4 small patch/linear; Tier 3 = N3 matrix or N4 large patch; Tier 4 = N4 matrix; Tier 5 = non-habitat.

Thirty-nine terrestrial habitats (33 USNVC macrogroups plus six SWReGAP landcovers) were delineated and grouped into eight categories for descriptive purposes: (1) Alpine and Montane Vegetation (10 habitats); (2) Plains-Mesa Grasslands (3 habitats); (3) Desert Grasslands and Scrub (6 habitats); (4) Cliff, Scree, and Rock Vegetation (1 habitat); (5) Arroyo Riparian (2 habitats); (6) Riparian Woodlands and Wetlands (8 habitats); (7) Introduced and Semi-natural vegetation (3 habitats); and (8) Other Land Cover (6 habitats from SWReGAP) (Figure 4). Because of their very limited extent and disproportionate importance to many species of wildlife, the Department decided that all riparian woodlands and aquatic habitats would be ranked as Tier 1 (top priority for habitat conservation) whereas all introduced and semi-natural vegetation habitats and barren land covers were ranked as Tier 5 (limited value habitat) (Table 7).

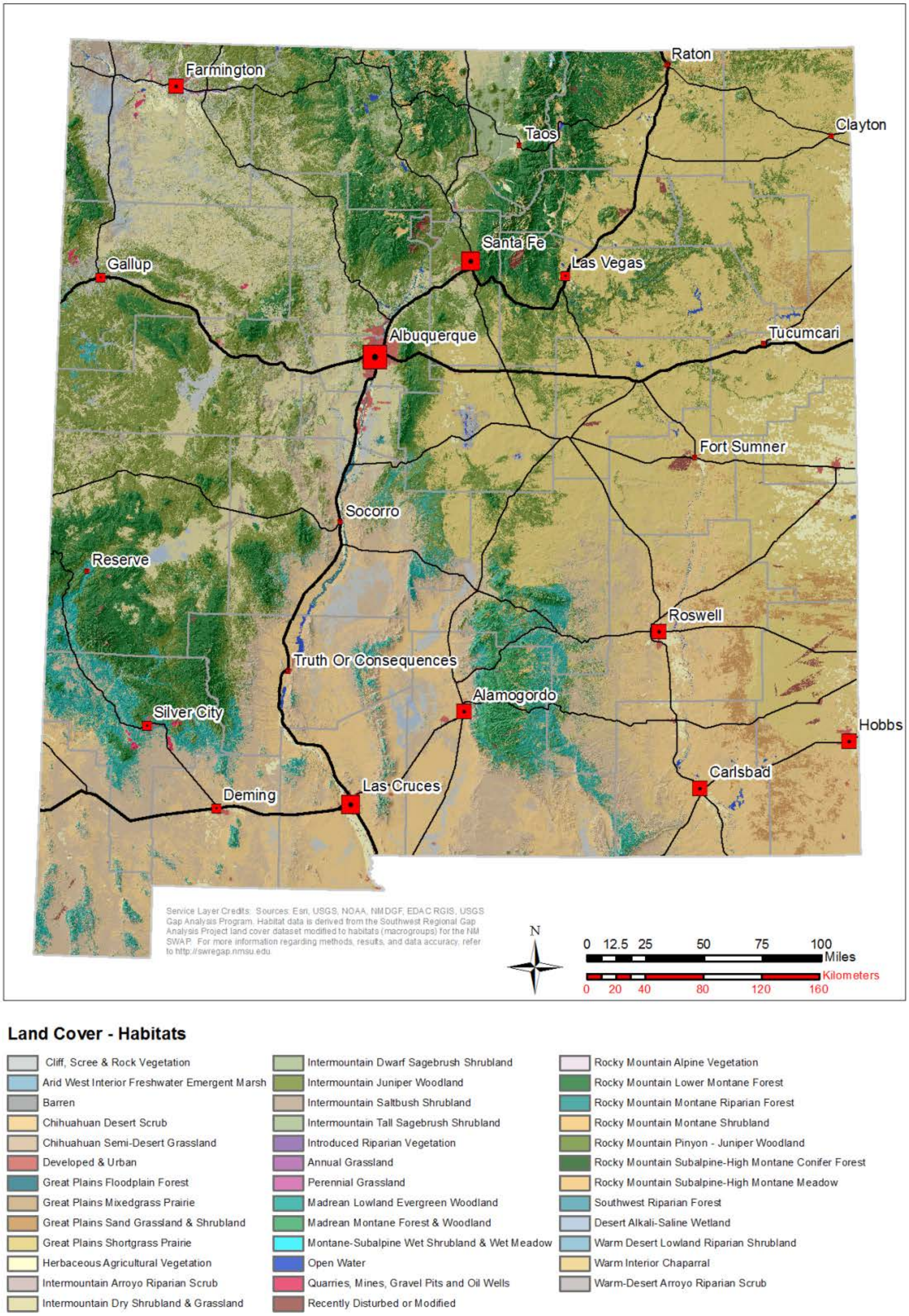



Figure 4. Terrestrial habitat map.

An overview of each habitat, derived from descriptions provided by USNVC (2016), is presented in the ecoregion chapter where the habitat is a dominant component. Exceptions to this are six land covers (**herbaceous agricultural vegetation**; **barren ground**; **recently disturbed or modified cover**; **open water**; **quarries**, **mines**, **gravel pits**, **and oil wells**; and **developed and urban lands**) which are not described because they are devoid of natural vegetation and have limited value as wildlife habitat. Three other exceptions are habitats dominated by introduced and semi-natural vegetation, which are described here because they can be found throughout New Mexico.

***Introduced Riparian Vegetation*** is a low-elevation riparian habitat dominated by Russian olive (*Elaeagnus angustifolia)* and tamarisk (also known as salt cedar; *Tamarix* spp.) or wet meadows and emergent marshes dominated by redtop (*Agrostis gigantea*)*,* Canada thistle (*Cirsium arvense*), common reed (*Phragmites australis*)*,* and Kentucky bluegrass *(Poa pratensis)*. Native species represent less than 10% relative cover. Sites are typically streambanks and benches, floodplains and canyons with permanent, intermittent or temporary water flow. Soils may be compacted, missing upper horizons, or unnaturally enriched or depleted because of incompatible grazing or other severe anthropogenic disturbance.

***Annual grasslands*** are exotic dry grasslands, forb-dominated meadows, or shrublands that occur in cool semi-arid climates of semi-desert basins, piedmonts, and foothills (possibly extending into lower montane zones on warm aspects). Vegetation may be a monoculture of a single non-native graminoid species, or a mix of several non-native forbs and graminoids. The dominant graminoids are crested wheatgrass (*Agropyron cristatum*) and cheatgrass (*Bromus tectorum)*. Other non-native forb species include herb sophia (*Descurainia sophia*), redstem stork's bill (*Erodium cicutarium*), and saltlover (*Halogeton glomeratus*). Native ruderal species may dominate due to anthropogenic disturbance. Stands occur on flat to moderately steep ground and can cover large areas or narrow strips adjacent to roadsides or under powerlines and other disturbed areas. Soils mostly are mineral, well-drained, and may be compacted and eroded with biological crusts absent because of disturbance.

***Perennial grasslands*** are exotic-dominated grasslands found in prairies and warm, semi-arid deserts They are dominated by exotic grasses, forbs, or deciduous shrubs that become abundant after significant disturbances such as developing improved pastures, temporary tilling, long-term, unsustainable grazing, and/or a disruption of the natural regime of regular fires. Vegetation may be a monoculture of a single non-native graminoid species, or a mix of several non-native forbs and graminoids. Common species in the north include crested wheatgrass*,* smooth brome (*Bromus inermis*)*,* cheatgrass*,* quackgrass (*Elymus repens*) *(on more moist sites),* timothy *(Phleum pratense),* and Kentucky bluegrass. In the south, common species include yellow bluestem (*Bothriochloa ischaemum* var. *songarica*)*,* buffalograss (*Buchloe dactyloides*) (a native favored by heavy grazing), weeping lovegrass (*Eragrostis curvula*)*,* Lehmann lovegrass (*E. lehmanniana*), bufflegrass (*Pennisetum ciliare*)*,* crimson fountaingrass (*P. setaceum*), and Johnsongrass (*Sorghum halepense*) (mesic sites). Common forbs include nodding plumeless thistle (*Carduus nutans*)*,* knapweeds (*Centaurea* spp*.*), Canada thistle (*Cirsium arvense*)*,* and field bindweed (*Convolvulus arvensis*). Dense stands of native ruderal species resulting from anthropogenic disturbance such as carelessweed (*Amaranthus palmeri*) or silverleaf nightshade (*Solanum elaeagnifolium*) and non-native shrubs such as

Rooseveltweed (*Baccharis neglecta*), downy hawthorn (*Crataegus mollis*), green hawthorn (*C. viridis*), and prairie sumac (*Rhus lanceolata*). This habitat may be on mesic to dry sites on a variety of soils where disturbances have altered them sufficiently (e.g., compaction and erosion) to allow the establishment of the exotic species. Size of stands may vary from large areas ($\geq$100 ha (250 ac)) to narrow strips adjacent to roadsides or under powerlines and in other disturbed areas. Stands of weeping lovegrass or Lehmann lovegrass, resulting from artificial seeding as part of grassland restoration projects, may be exceptionally large.

Table 7. Terrestrial habitats[5].

| Habitat Category | Habitat Name | Area (km²) | Area (mi²) | Spatial Pattern | Tier | USNVC Code | USNVC Macrogroup Name | Ecoregions | Description Location |
|---|---|---|---|---|---|---|---|---|---|
| Alpine and Montane Vegetation | Rocky Mountain Subalpine-High Montane Conifer Forest | 3,670 | 1,417 | Matrix | 4 | M020 | Rocky Mountain Subalpine-High Montane Conifer Forest | 1, **2**, 4, 5, **6** | 2 |
| | Rocky Mountain Lower Montane Forest | 25,639 | 9,899 | Matrix | 4 | M022 | Southern Rocky Mountain Lower Montane Forest | 1, **2**, 3, 4, **6** | 2 |
| | Madrean Montane Forest & Woodland | 2,397 | 925 | Large Patch | 3 | M011 | Madrean Montane Forest & Woodland | 1, 2, 3, 4, 5, **6** | 6 |
| | Madrean Lowland Evergreen Woodland | 10,765 | 4,156 | Matrix | 4 | M010 | Madrean Lowland Evergreen Woodland | 1, 2, 3, 4, 5, **6** | 5 |

[5] Terrestrial habitats were derived from macrogroups of the US Natural Vegetation Classification System (USNVC) except for the last five landcovers listed, which originated from the Southwest Regional Gap Analysis Program (Southwest ReGAP). The Southwest ReGAP GIS landcover layer was used to delineate the geographic boundaries of all habitats. Tiers reflect the priority for conservation and are based on the degree of imperilment within the United States according to the NatureServe Conservation Status Assessment (http://www.natureserve.org/conservation-tools/conservation-status-assessment) and the spatial pattern of the habitat. Ranks: N1 = critically imperiled; N2 = imperiled; N3 = vulnerable; N4 = apparently secure; N5 = secure. Spatial patterns: linear, small patch, large patch and matrix. Tier 1: N1, N2, N3 small patch/linear; Tier 2: N3 large patch or N4 small patch/linear; Tier 3: N3 matrix or N4 large patch; Tier 4: N4 matrix; Tier 5: limited value. Ecoregions: 1= Colorado Plateaus; 2 = Southern Rocky Mountains; 3 = High Plains and Tablelands; 4 = Chihuahuan Desert; 5 = Madrean Archipelago; 6 = Arizona/New Mexico Mountains. Bold print identifies ecoregions where habitat primarily occurs. Habitats are described in the profile of the ecoregion listed in the last column.

| Habitat Category | Habitat Name | Area (km$^2$) | Area (mi$^2$) | Spatial Pattern | Tier | USNVC Code | USNVC Macrogroup Name | Ecoregions | Description Location |
|---|---|---|---|---|---|---|---|---|---|
| | Rocky Mountain Piñon-Juniper Woodland | 20,275 | 7,828 | Matrix | 4 | M027 | Southern Rocky Mountain Two-needle Piñon - One-seed Juniper Woodland | **1**, **2**, **3**, 4, 5, 6 | 2 |
| | Intermountain Juniper Woodland | 29,181 | 11,267 | Matrix | 4 | M026 | Intermountain Singleleaf Piñon - Utah Juniper - Western Juniper Woodland | **1**, 2, 3, 4, **6** | 1 |
| | Rocky Mountain Alpine Vegetation | 26 | 10 | Matrix | 3 | M099 | Rocky Mountain & Sierran Alpine Scrub, Forb Meadow & Grassland | **2** | 2 |
| | Rocky Mountain Subalpine-High Montane Meadow | 2,006 | 775 | Small Patch | 2 | M168 | Rocky Mountain & Vancouverian Subalpine-High Montane Mesic Meadow | 1, **2**, 3, 4, 6 | 2 |
| | Rocky Mountain Montane Shrubland | 2,154 | 832 | Large Patch | 3 | M049 | Southern Rocky Mountain Montane Shrubland | 1, **2**, **3**, 4, 6 | 2 |
| | Warm Interior Chaparral | 964 | 372 | Large Patch | 4 | M091 | Warm Interior Chaparral | 1, 3, **4**, 5, **6** | 6 |
| Plains-Mesa Grasslands | Great Plains Mixedgrass Prairie | 701 | 271 | Large Patch | 2 | M051 | Great Plains Mixedgrass & Fescue Prairie | **1**, **2**, **3**, 4, 6 | 2 |
| | Great Plains Sand Grassland & Shrubland | 5,210 | 2,012 | Large Patch | 3 | M052 | Great Plains Sand Grassland & Shrubland | 2, **3**, **4** | 3 |
| | Great Plains Shortgrass Prairie | 69,284 | 26,751 | Matrix | 3 | M053 | Great Plains Shortgrass Prairie | 1, 2, **3**, 4, 6 | 3 |

| Habitat Category | Habitat Name | Area ($km^2$) | Area ($mi^2$) | Spatial Pattern | Tier | USNVC Code | USNVC Macrogroup Name | Ecoregions | Description Location |
|---|---|---|---|---|---|---|---|---|---|
| Desert Grassland and Scrub | Intermountain Saltbush Shrubland | 3,792 | 1,464 | Matrix | 4 | M093 | Great Basin Saltbush Scrub | **1**, 2, 3, 4, 6 | 1 |
| | Intermountain Tall Sagebrush Shrubland | 4,217 | 1,628 | Matrix | 3 | M169 | Great Basin & Intermountain Tall Sagebrush Shrubland & Steppe | **1**, **2**, 3, 4, 6 | 1 |
| | Intermountain Dwarf Sagebrush Shrubland | 329 | 127 | Large Patch | 4 | M170 | Great Basin & Intermountain Dwarf Sagebrush Shrubland & Steppe | **1**, 2, **3**, 4, 6 | 1 |
| | Intermountain Dry Shrubland & Grassland | 31,104 | 12,009 | Large Patch | 2 | M171 | Great Basin & Intermountain Dry Shrubland & Grassland | **1**, 2, 3, 4, 6 | 1 |
| | Chihuahuan Desert Scrub | 43,454 | 16,778 | Matrix | 4 | M086 | Chihuahuan Desert Scrub | 1, 3, **4**, 5, 6 | 4 |
| | Chihuahuan Semi-Desert Grassland | 36,149 | 13,957 | Matrix | 2 | M087 | Chihuahuan Semi-Desert Grassland | 1, 2, 3, **4**, 5, 6 | 5 |
| Cliff, Scree & Rock Vegetation | Cliff, Scree & Rock Vegetation | 8,210 | 3,170 | Small Patch | 4 | M887 | Western North American Temperate Cliff, Scree & Rock Vegetation | **1**, 2, 3, **4**, 5, 6 | 6 |
| Arroyo Riparian | Warm-Desert Arroyo Riparian Scrub | 199 | 77 | Linear | 2 | M092 | North American Warm-Desert Xeric-Riparian Scrub | 1, 3, **4**, 5, 6 | 4 |
| | Intermountain Arroyo Riparian Scrub | 3 | 1 | Linear | 2 | M095 | Great Basin & Intermountain Xeric-Riparian Scrub | **1** | 1 |

| Habitat Category | Habitat Name | Area ($km^2$) | Area ($mi^2$) | Spatial Pattern | Tier | USNVC Code | USNVC Macrogroup Name | Ecoregions | Description Location |
|---|---|---|---|---|---|---|---|---|---|
| Riparian Woodlands and Wetlands | Arid West Interior Freshwater Emergent Marsh | 86 | 33 | Small Patch | 1 | M888 | Arid West Interior Freshwater Emergent Marsh | 1, 2, **3**, **4**, 5, 6 | 4 |
| | Montane-Subalpine Wet Shrubland & Wet Meadow | 239 | 92 | Small Patch | 1 | M075 | Western North American Montane-Subalpine Wet Shrubland & Wet Meadow | **1**, **2**, 3, 4, 6 | 2 |
| | Rocky Mountain Montane Riparian Forest | 793 | 306 | Linear | 1 | M034 | Rocky Mountain & Great Basin Montane Riparian Forest | **1**, **2**, 3, 4, **6** | 1 |
| | Southwest Riparian Forest | 319 | 123 | Linear | 1 | M036 | Southwest Riparian Forest | 3, **4**, 5, **6** | 4 |
| | Great Plains Floodplain Forest | 855 | 330 | Linear | 1 | M028 | Northern & Central Great Plains Floodplain Forest | **1**, 2, **3**, 4, 6 | 3 |
| | Great Plains Wet Meadow, Marsh, & Playa | 1 | 0.39 | Small Patch | 1 | M071 | Great Plains Wet Meadow, Marsh, & Playa | **3** | 3 |
| | Warm Desert Lowland Riparian Shrubland | 3 | 1 | Small Patch | 1 | M076 | Warm Desert Lowland Freshwater Shrubland, Meadow, & Marsh | **4**, **5** | 5 |
| | Desert Alkali-Saline Wetland | 2,846 | 1,099 | Small Patch | 1 | M082 | Warm & Cool Desert Alkali-Saline Wetland | **1**, 2, 3, **4**, 6 | 1 |

| Habitat Category | Habitat Name | Area ($km^2$) | Area ($mi^2$) | Spatial Pattern | Tier | USNVC Code | USNVC Macrogroup Name | Ecoregions | Description Location |
|---|---|---|---|---|---|---|---|---|---|
| Introduced and Semi-Natural Vegetation | Introduced Riparian Vegetation | N/A | N/A | N/A | 5 | M302/ M298 | Interior West Ruderal Flooded & Swamp Forest (M298) and Western North American Ruderal Wet Shrubland, Meadow & Marsh (M302) | N/A | N/A |
| | Annual grassland | N/A | N/A | N/A | 5 | M499 | Western North American Cool Semi-Desert Ruderal Scrub & Grassland (M499) | N/A | N/A |
| | Perennial grassland | N/A | N/A | N/A | 5 | M512/ M498 | North American Warm Desert Ruderal Scrub& Grassland (M512) and Great Plains Ruderal Grassland & Shrubland (M498) | N/A | N/A |
| Other Land Cover | Herbaceous Agricultural Vegetation | 6,012 | 2,321 | N/A | 5 | N/A | Herbaceous Agricultural Vegetation | N/A | N/A |
| | Barren | 54 | 21 | N/A | 5 | N/A | Miscellaneous Type | N/A | N/A |
| | Recently Disturbed or Modified | 814 | 314 | N/A | 5 | N/A | Miscellaneous Type | N/A | N/A |
| | Quarries, Mines, Gravel Pits and Oil Wells | 182 | 70 | N/A | 5 | N/A | Miscellaneous Type | N/A | N/A |
| | Developed & Urban | 2,083 | 804 | N/A | 5 | N/A | Miscellaneous Type | N/A | N/A |

# Aquatic Habitats

Flowline and water body files of the National Hydrography Dataset (NHD) Model v. 2.2 (http://nhd.usgs.gov/data.html) were used to map streams, and most lakes and reservoirs (Figure 5). Some lakes and reservoirs were mapped from digital orthophotography (1 m resolution) produced in 2011-14 by the National Agriculture Imagery Program (http://www.fsa.usda.gov/programs-and-services/aerial-photography/imagery-programs/naip-imagery/). Definitions of persistence (perennial, ephemeral, intermittent) were from New Mexico Administrative Code 20.6.4, "Standards for Interstate and Intrastate Surface Waters" (http://164.64.110.239/nmac/parts/title20/20.006.0004.htm). Surface water temperature (warm, cold) was assigned based in part on New Mexico Water Quality Standards (http://164.64.110.239/nmac/parts/title20/20.006.0004.htm) and in part on management and priority species information from the Department. These indicate the major classes of aquatic life (i.e., cold or warm) which the New Mexico Water Quality Control Commission designated as appropriate for those reaches. The Water Quality Standards have been developed and refined over decades based on elevation, field observations of temperature, terrestrial habitat in which they were located, and records of species occupancy. Persistence (i.e., ephemeral or perennial) is based in part on Water Quality Standards segment definitions and in part on records of species occupancy and field indictors of perennial conditions.

New Mexico has 134 perennial lakes and reservoirs that are accessible to the public; most support warm water aquatic life (26 lakes/reservoirs; 28,576 ha (70,583 ac)) or warm water fish in summer and cold water fish in winter (43 lakes/reservoirs; 8,825 ha (21,798 ac)). Cold water lakes/reservoirs are most numerous (65), but cover the least area (5,477 ha (13,529 ac)). Total length of perennial streams was less for warm water (9,529 km (5,921 mi)) than cold water (9,674 km (6,011 mi)) temperature regimes.

The aquatic habitats found in New Mexico do not function in isolation from adjoining terrestrial habitat. Extreme events such as post-fire flooding, where ash is washed down into streams and into lakes and reservoirs, will impact the chemistry and morphology of the aquatic habitat. If a strictly aquatic SGCN is susceptible to changes in the chemistry of the water (e.g., Texas Hornshell Mussel, *Popenias popeii*, is susceptible to high levels of salinity), the quality of adjoining terrestrial habitat can greatly influence the status of that species. Riparian habitat can provide shade and cover for many fish species. Therefore, while the fish SGCN habitat associations are presented in each ecoregion strictly for their required aquatic habitats, the terrestrial associations likely should be considered as well. Following are descriptions of eight types of aquatic habitats found in New Mexico.

*Perennial Cold Water Streams* [**PCWS**] are natural courses of flowing water containing dissolved and suspended nutrients and other materials that normally support communities of plants and animals within the channel and the riparian vegetation zone. Water temperatures are generally cold enough to support species such as trout.

*Perennial Warm Water Streams* **[PWWS]** are natural courses of flowing water containing dissolved and suspended nutrients and other materials that normally support communities of plants and animals within the channel and the riparian vegetation zone. Water temperatures generally are too warm to support trout, but instead support species such as bass and catfish.

*Perennial Lakes, Cirques, Ponds* **[PLCP]**: A lake is a natural body of fresh or saline water > 8 ha (20 ac) that is completely surrounded by land, holds water year round, and remains relatively unchanged across years. A cirque is a body of standing water that occurs where valleys are shaped into structures resembling amphitheaters by the action of freezing and thawing ice. These formations are usually found in the upper portion of a glaciated area in mountains and always contain water. A pond is a natural or artificial body of standing water usually < 8 ha (20 ac) and characterized by a high ratio of littoral (shallow) zone relative to open water.

*Perennial Marshes/Cienegas/Springs/Seeps* **[PMCSS]**: Perennial marshes or cienegas are water-saturated, poorly drained wetlands permanently inundated up to a depth of 2 m (7 ft). They support an extensive cover of emergent non-woody vegetation without peat-like accumulations (marshes). They are associated with perennial spring and seep systems in isolated arid basins of the Southwest (cienegas). A perennial spring occurs where an underground source of water emerges from the ground, generally from a single point of origin, forming a stream, pond, marsh, or other type of water body. A seep is a generally small area where water percolates slowly to the ground surface, typically without a well-defined point of origin. Seeps generally have a lower flow rate than springs and rarely have enough water volume to form a substantial water body.

*Perennial Cold Water Reservoirs* **[PCWR]** are human-created impoundments where water is collected, stored, regulated, and released for human use. Water temperatures generally are cold enough to support fish species such as trout. Examples include Heron, El Vado, and Eagle Nest Lakes.

*Perennial Warm Water Reservoirs* **[PWWR]** are human-created impoundments where water is collected, stored, regulated, and released for human use. Water temperatures are generally too warm to support trout, but instead support species such as bass and catfish. Examples include Elephant Butte, Caballo, Ute, Conchas, Avalon and Brantley Reservoirs.

*Ephemeral Marshes/Cienegas/Springs* **[EMCS] :** Marshes and cienegas are water-saturated poorly drained wetlands periodically inundated up to a depth of 2 m (7 ft). They support an extensive cover of emergent non-woody vegetation without peat-like accumulations (marshes), and are associated with ephemeral spring and seep systems in isolated arid basins of the Southwest (cienegas). Ephemeral springs are areas where groundwater intermittently flows naturally from a rock or soil substrate to the surface to form a stream, pond, marsh, or other body of water.

Tinaja

*Ephemeral Catchments* **[EC]** (playas, pools, tinajas, kettles, and tanks) are bodies of standing water formed in depressions, basins or in streams. A playa is an internally drained lake found in a sandy, salty, or muddy flat floor of an arid basin, usually occupied by shallow water only after prolonged heavy precipitation. A pool is formed in a small depression found in a marsh or on a floodplain. A tinaja is a pool in a seasonal stream that may support a flora upon desiccation. A kettle is formed in a depression by melting ice blocks deposited in glacial drift or in the outwash plain. A tank is an artificial pond built to hold water for livestock and wildlife (sometimes fish) that contain water for short and irregular periods of time, usually after a heavy precipitation.

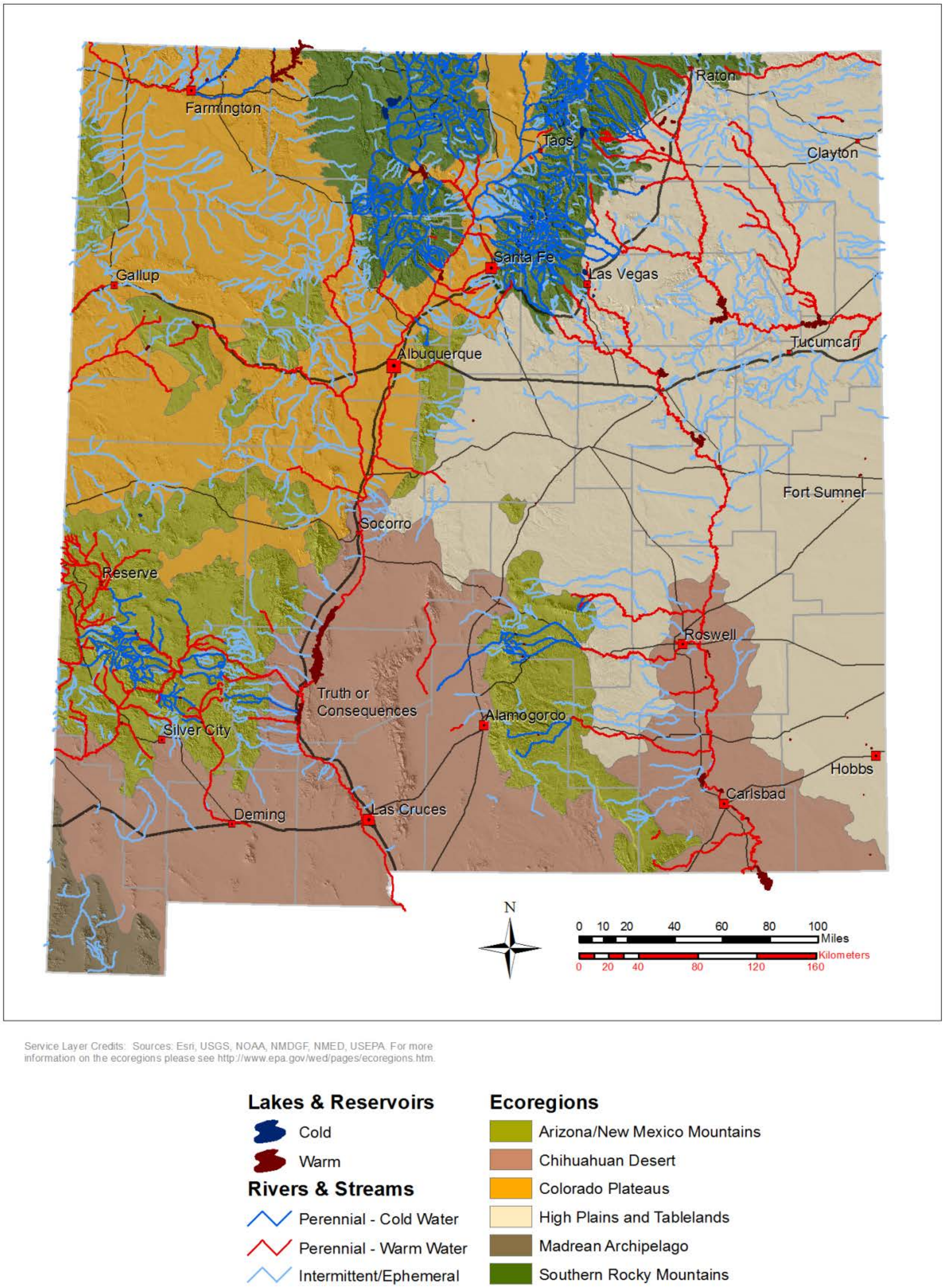



Figure 5. Aquatic habitats.

Data were from the National Hydrography Dataset v. 2.2 and National Agriculture Imagery Program. Temperature and persistence designations were based on data from the New Mexico Environment Department and New Mexico Department of Game and Fish

# Chapter 3: Threats, Conservation Actions, and Opportunities

Threats are defined as factors that can adversely affect the long-term persistence of Species of Greatest Conservation Need (SGCN). Many are anthropogenic but they also may be associated with natural processes. Additionally, human activities may be positive or neutral for some species under certain conditions. Whether activities are positive or negative depends on the length of occurrence (both intra- and inter-annual), period of the year in which a particular activity occurs, location where it occurs, its spatial extent, and its intensity. How severely a negative activity impacts a SGCN is also dependent on the ability of the affected species to respond and adapt to the activity such that survival and reproduction is unaffected.

Conservation actions are measures that reduce, eliminate, or mitigate threats, thereby increasing the probability of persistence for affected SGCN. Threats and actions listed in the Comprehensive Wildlife Conservation Strategy for New Mexico (CWCS) were reviewed for currency and relevance. Threats and actions were categorized based on the hierarchy of threats developed by Salafsky et al. (2008) as adapted by the International Union for Conservation of Nature (IUCN) and the Conservation Measures Partnership (CMP) to classify threats to species throughout the world (IUCN 2016).

## Threats

Most species of wildlife and habitats in New Mexico have been influenced by humans and likely will continue to be. Arguably, the role of conservation is to reduce or manage those influences to achieve, to the maximum extent possible, healthy and naturally functioning (i.e., neither assisted nor inhibited by humans) ecosystems that allow wildlife populations to persist. The challenge is: one human impact may encompass a suite of interacting factors (e.g., mine development encompasses noise from machinery, human activity, habitat fragmentation from roads, toxins leaching from waste rock) and the effect of these may be additive (severity increases with number of impacts), cascading (one impact leads to initiation of another) or compensatory (one replaces the effect of another). The cause and effect relationship between human activities and wildlife responses may be neither clear nor direct. Residential development at the edges of Albuquerque does not directly impact Rio Grande silvery minnows. However, increased demand for water by additional residents may reduce flows in the Rio Grande, which negatively impacts the ability of silvery minnows (*Hybognathus amarus*) to survive and reproduce.

This section addresses nine of 10 categories of human activities identified by IUCN that potentially threaten the persistence of SGCN in New Mexico (Table 8; Appendix F). The tenth potential threat category, climate change, is discussed separately in Chapter 4. Positive and neutral impacts of some activities are discussed, but the focus is on negative impacts because they must be addressed with conservation actions to ensure recovery and persistence of SGCN.

Table 8. List of International Union for the Conservation of Nature (IUCN) and Conservation Measures Partnership (CMP) threats potentially effecting Species of Greatest Conservation Need (SGCN).

| IUCN Level I and Level II Categories[6] | Description | Factors that could Adversely Affect SGCN in New Mexico |
|---|---|---|
| **1. Residential and Commercial Development**<br>1.1 Housing and Urban Areas<br>1.2 Commercial and Industrial areas | Human settlements or other non-agricultural land uses with a substantial footprint. Includes cities, towns, and settlements and factories and other commercial centers. | Habitat loss/fragmentation/degradation, including of riparian areas, and behavior modification from noise and activity associated with: urban areas, suburbs, vacation homes, manufacturing plants, military bases, power plants, and airports. |
| **2. Agriculture and Aquaculture**<br>2.3 Livestock Farming and Ranching | Farming and ranching, including silviculture, mariculture and aquaculture. Includes domestic terrestrial animals raised either in one farmed location or that utilize natural habitats. | Loss of nutrition and cover and habitat fragmentation associated with cattle feed lots, dairy farms, and cattle ranching. |
| **3. Energy Production and Mining**<br>3.1 Oil and Gas Drilling<br>3.2 Mining and Quarrying<br>3.3 Renewable Energy | Production of non-biological resources including exploration, development, and production of petroleum and other liquid hydrocarbons, minerals, rocks, and renewable energy. | Habitat loss/fragmentation, behavior modification from noise and activity, and direct mortality from collisions with wind turbines or burns associated with solar concentrator power tower facilities (Lovich and Ennen 2011). Includes impacts of oil and gas wells, (including both surface impacts and effects to groundwater), coal mines, rock quarries, wind farms, and solar farms. |

[6] Threats are listed in the order presented by the International Union for the Conservation of Nature (IUCN) and Conservation Measures Partnership (CMP). The order does not reflect the relative severity of threats found in New Mexico. Categories developed by Salafsky et al. (2008) and maintained by the IUCN and CMP (IUCN 2016) as standards for determining threats to imperiled species worldwide. Categories used here are based on the2016 version from CMP. Only those threats relevant to conservation of SGCN in New Mexico are listed. Descriptions and examples draw from both IUCN and CMP. Threats listed in this document are generalizations that do not support conservation action without appropriate site specific information.

| IUCN Level I and Level II Categories | Description | Factors that could Adversely Affect SGCN in New Mexico |
|---|---|---|
| **4. Transportation and Service Corridors**<br>4.1 Roads and Railroads<br>4.2 Utility and Service Lines | Long, narrow transport corridors, including roadways, utility lines, and pipelines, for transporting people, energy, and products. Includes impacts from vehicles using these corridors and of fencing along corridors. | Habitat fragmentation, behavior modification from noise and activity, spread of invasive species, direct mortality from collisions with vehicles and utility lines, and raptor electrocution. Corridors include highways, secondary roads, logging roads, railroads, power-lines, cell phone towers connected by access roads, and oil and gas pipelines. |
| **5. Biological Resource Use**<br>5.1 Hunting, Collecting Terrestrial Animals<br>5.3 Logging and Wood Harvesting | Consumptive use of non-cultivated biological resources, including both deliberate and unintentional harvesting effects. Includes killing or trapping animals for commercial, recreation, subsistence, or research purposes and associated accidental mortality. Also includes harvesting trees for timber, fiber, or fuel and associated forestry management practices. | Habitat loss/fragmentation, and population perturbation from direct mortality and associated, indirect effects on other species. Includes poaching, trophy hunting, fur trapping, predator and pest control, commercial logging, and fuel wood collection.. |
| **6. Human Intrusions and Disturbance**<br>6.1 Recreational Activities<br>6.2 War, Civil Unrest and Military Exercises<br>6.3 Work and Other Activities (e.g., field research) | Human activities that may alter, destroy or disturb habitats and species associated with non-consumptive uses of biological resources. Does not usually lead to permanent habitat destruction. Includes vehicle travel outside of transport corridors; people spending time in nature for work, recreation, or illegal activities; actions by military forces outside of permanent military bases. | Habitat modification/disturbance and behavior modification from noise and activity. Activities include the use of off-highway vehicles, motorboats, jet-skis, snowmobiles, mountain bikes, ultralight planes, hangliders, and tanks and other military vehicles. Also include hiking, birdwatching, caving, rock-climbing, military training exercises, field-based species research and law enforcement, and illegal activities including vandalism. |
| **7. Natural System Modifications**<br>7.1 Fire and Fire Suppression<br>7.2 Dams and Water Management/Use<br>7.3 Other Ecosystem Modifications<br>7.4 Removing/Reducing Human Maintenance | Actions that convert or degrade habitat in order to manage natural or semi-natural systems for the benefit of humans. Includes fire suppression, inappropriate management of fires, modification of water flow patterns such that deviate from their natural range of variation, and loss or reduction of maintenance activities that promote healthy ecosystems. | Habitat loss/fragmentation/modification, loss of nutrients and cover, erosion, sediment loss, and hydroperiod alteration. Impacts associated with fire suppression to protect property, escaped fires, arson, the construction and operation of dams and associated water releases, surface water diversion, groundwater pumping, channelization, snag removal from streams, and reduction in controlled burns. |

| IUCN Level I and Level II Categories | Description | Factors that could Adversely Affect SGCN in New Mexico |
|---|---|---|
| **8. Invasive and Problematic Species**<br>8.1 Invasive Non-native Species<br>8.2 Problematic Native Species<br>8.3 Introduced Genetic Material<br>8.4 Pathogens and Microbes | Non-native and native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction or increase in abundance. Includes harmful organisms introduced or spread as a result of human activities; organisms and genes altered or transported by humans; and disease-causing agents such as bacteria, viruses, prions, and fungi. | Habitat loss/fragmentation/degradation, pollution of gene pools of native species through hybridization with non-native species, population reduction through competition, disease, and predation. Harmful organisms can include feral horses, unrestrained pets, non-native mussels, non-native grasses and riparian plants, native woody plants that spread into grassland areas. Diseases include chytrid fungus in amphibians, the fungus that causes white-nose syndrome in bats, plague, rabies, hantavirus, tularemia, chronic wasting disease, and West Nile virus. |
| **9. Pollution**<br>9.1 Household Sewage and Urban Wastewater<br>9.2 Industrial and Military Effluents<br>9.3 Agricultural and Forestry Effluents<br>9.4 Garbage and Solid Waste<br>9.5 Airborne Pollutants<br>9.6 Excess Energy | Introduction of exotic and/or excess materials or energy from point and nonpoint sources. Includes sewage, nutrients, toxic chemicals, or sediment in runoff from housing and urban areas, industrial areas (including mines), and agricultural areas. Also includes solid waste that may entangle wildlife, atmospheric pollutants, and generation of excess heat, light, or sound from sources such as power plants, urban areas, and highways. | Habitat degradation, behavior modification from noise, direct mortality/reduced fecundity, loss of food and water. Sources of pollution include leaking septic and fuel tanks, untreated sewage, oil or sediment on roads, lawn and agricultural fertilizers and herbicides, illegal chemical dump sites, mine tailings, and manure on feed lots. Road-side litter and construction-site debris may entangle wildlife. Air pollution can result from smoke from forest fires, wind erosion from disturbed areas/bare ground, vehicle and industrial emissions. Excess heat, light, or sound can be released by highways, airplanes, power plants, and lights in urban areas. |
| **11. Climate Change**<br>11.1 Ecosystem Encroachment<br>11.2 Changes in Geochemical Regimes<br>11.3 Changes in Temperature Regimes<br>11.4 Changes in Precipitation and Hydrological Regimes<br>11.5 Severe/Extreme Weather Events | Long-term climatic changes, which may be linked to increases in atmospheric greenhouse gases, and other severe climatic/weather events that are outside of the natural range of variation. Include effects of ecosystem shifts; changes in geochemical conditions, including increasing greenhouse gas concentrations; changes in the mean, extreme values, and seasonality of both temperature and precipitation; and changes in the frequency, timing, and intensity of storms and severe weather events. | Habitat loss/fragmentation, loss of food and cover, and direct mortality from drought and extreme temperatures. Ecosystem encroachment can include desertification while changes in geochemical regimes can include increases in atmospheric carbon dioxide concentrations. Frequency, magnitude, and intensity of heat waves, cold spells, droughts, tornados, hailstorms, dust storms, floods, and thunderstorms may all be affected by climate change. |

## *Residential and Commercial Development*

New Mexico has two important characteristics favorable for conservation of wildlife: it has a large land area and the human population is relatively small and localized (half reside in 10 cities). Thus, urban sprawl and industrial development are relatively minor compared to smaller and/or more populous states. Nevertheless, when development does occur, it is more likely to do so in and near cities because of available infrastructure. Thus, species and habitats adjacent to or near metropolitan areas likely would be more vulnerable to loss due to development than those in more remote areas. However, the impacts of increasing residential and commercial development reverberate well beyond city boundaries. For example, water imported from the Colorado River basin to meet the needs of Santa Fe and Albuquerque residents contributes to reductions in amount and timing of flows in the San Juan River. Changes in flow have been linked to the near extirpation of native Colorado pikeminnow (*Ptyochocheilus lucius*) (Franssen et al. 2007).

Growth of New Mexico's cities also has made formerly isolated wildlands readily accessible to more people, thereby exposing wildlife to more disturbances. More people are building homes in rural areas, thus directly eliminating, fragmenting, and more broadly degrading adjacent wildlife habitat. Disturbances that once were non-existent or temporary have become permanent.

## *Agriculture*

Agriculture in New Mexico has a long and rich history starting with subsistence crop production by Native Americans thousands of years ago. Agricultural production diversified with the intermingling of Native American cropping and European settler knowledge, leading to the advent of new agricultural practices for crops and livestock (Schickedanz 1980). Currently, livestock grazing is broadly distributed across New Mexico, while crop production is more localized and relies upon irrigation water delivered along historic acequias, large scale diversion and ditches, or by modern high-efficiency irrigation systems pumping groundwater from aquifers.

Agricultural activities involve land uses such as tilling, draining, seeding, intercropping, rotation, weed and pest control, grazing, and irrigation that have significant implications for lands that serve as habitats for wildlife. Some species of wildlife may benefit from these changes to the landscapes, while others do not. Agricultural lands may provide more suitable habitat for native wildlife than fragmented and extensively modified urban or suburban lands. Such lands often serve as a buffer between natural areas and more highly altered landscapes, providing food, cover, breeding habitat, and enabling movement and exchange of plant and animal populations (Freemark et al. 2002; Kerr and Cihlar 2004; Blann 2006). Livestock grazing programs, when managed sustainably, can provide multiple benefits to wildlife even while legacy effects of historic agricultural practices on wildlife habitats remain. Lands managed as part of a range livestock operation remain relatively free from development and conversion to alternate land uses that are not compatible with wildlife. For example, New Mexico wildlife utilize millions of acres of habitat on relatively undeveloped private rangelands, State Trust Lands, and federal public land, and can benefit from wildlife-friendly artificial water sources. Agricultural lands provide important food sources to migratory waterfowl and sandhill cranes (*Grus canadensis*) during migration and overwintering periods and wildlife compatible cattle tanks and stock ponds may serve to increase the distribution of water sources on the landscape. However, wildlife inhabiting agricultural areas must be able to withstand the perturbations associated with managing land for human food production, and/or find additional spaces on the landscape to supply their life history needs. Wildlife species utilizing agricultural lands may be limited directly by the disturbance of grazing, planting and harvesting, and indirectly by the reduced availability of plant and insect foods (McLaughlin and Mineau 1995). Wild animals must also limit consumption of crops and livestock to a level that agriculture producers perceive as tolerable, or be the subject of control efforts to eradicate or reduce populations of wildlife on these working lands. The degree of compatibility between agricultural production and wildlife habitat depends upon a variety of factors, including the habitat requirements of the species involved, the sustainability of agricultural practices employed, and the willingness of land managers to allow for the presence of wildlife that may sometimes compromise maximum agricultural production. Science and understanding regarding the long-term viability of different types of agricultural operations has improved over time. Consequently, current approaches emphasize more sustainable uses of rangelands, irrigation water, and other resources.

Domestic livestock have been an important component of New Mexico's agricultural economy since the arrival of Spanish settlers. Although cattle, sheep, goats, and horses accompanied early Spanish expeditions into the American southwest, the intentional introduction of livestock for production occurred with Oñate's colonization of New Mexico in 1598. Widespread livestock influences on the rangelands of the southwest were not significant until the late 1700s (Jemison and Raish 2000). With approximately 98% of New Mexico's land being considered unsuitable for crop production by early European settlers, domestic sheep grazing served as the primary use of the land through the late 19$^{th}$ century (Beck 1962). In the late 1800s, the development of railroads enabled ranchers to ship livestock to new and expanding markets, which led to intensified production of sheep and cattle (Jemison and Raish 2000). This period marked a decline in sheep husbandry and an increase in the cattle industry. Between 1880 and 1889, the number of cattle in New Mexico increased from about 137,000 to 1,380,000 (Wooten 1908). From 1891 to 1893 a severe drought resulted in high mortality of livestock on southwestern rangelands and a collapse of the cattle industry. While livestock numbers had peaked in 1891, livestock grazing exceeded the carrying capacity of southwestern plant communities from the 1880s through early 1900s (Milchunas 2006). US Forest Service land was heavily grazed through 1906 (Bahre 1991), and heavy grazing on BLM lands continued until enactment of the Taylor Grazing Act in 1934 (Milchunas 2006).

Milchunas and Lauenroth (1993) identified a global pattern where rangeland habitats are more sensitive to large herbivore grazing when they lack an evolutionary history of grazing and/or with increased aridity. From a wildlife habitat management perspective, there are habitats where livestock grazing should be encouraged in the absence of large native herbivores, and other habitats where livestock grazing should be conservatively managed because these habitats are more sensitive (Milchunas 2006). Prairie grasslands of eastern New Mexico developed with the evolutionary influence of bison (*Bison bison*) as the primary, but not only, large herbivore present. Large herds of bison were mobile and grazed grassland habitats, both broadly and intensively, in some areas. Therefore prairie grasslands of the High Plains and Tablelands ecoregion are probably more adapted to, and tolerant of, widespread intensive grazing by livestock (Milchunas 2006). Although grazing and browsing large herbivores are present throughout the state, most of New Mexico's other plant communities did not evolve with widespread and continuous grazing and generally were not exposed to higher levels of grazing pressure until Spanish settlers introduced and constrained domestic livestock in the mid-1500's. However, from a production standpoint light to moderate grazing can be sustainable in the southwest (Milchunas 2006), especially when responsive to variable precipitation.

Ecosystem degradation in the southwest during the late 1800's to the 1930's resulted from a combination of overstocking of livestock, changes in plant species composition, and a suppression of the natural fire regime that resulted from reduction of fine fuels that carry fires (Savage and Swetnam 1990, Swetnam 1990, Swetnam and Baisan 1996, Jemison and Raish 2000). The loss of fine fuels provided by grasses limited shrub-killing fires. In the absence of fires, successional processes were altered and woody shrubs and less palatable plants increased across the landscape (Schlesinger et al. 1990, Jemison and Raish 2000, Whitford 2002).

In ponderosa pine forests of the Jemez Mountains and other southwestern forests, tree ring fire scar data indicates that high frequency low intensity fires essentially stopped after the arrival of railroads in the Southwest. Although livestock grazing was not the sole cause of a decrease in low intensity fires, intensive grazing contributed to the loss of fine fuel grasses, and tree densities greatly increased in the absence of grass competition (Allen 1989, Bogan et al. 1998). This steep decline in fire frequency occurred several decades before organized fire suppression activities began (Allen 1989, Touchan et al. 1995).

High stocking levels continued into the 1930s. In 1934, regulatory management of public rangelands began under the Taylor Grazing Act, and assistance to private landowners was provided by the Soil Conservation Service through programs now considered as part of the Farm Bill. Despite efforts to reverse the impacts of intensive grazing, plant species and community restoration has proven to be slow. Many of the detrimental vegetation changes and much of the erosion attributed to grazing that we observe today occurred before these programs were implemented.

The Bureau of Land Management (BLM) administers livestock grazing on allotments according to the New Mexico Standards for Public Land Health and Guidelines for Livestock Grazing Management. Standards describe conditions needed for healthy and sustainable public rangelands, and were developed for upland and riparian habitats, and Threatened, Endangered, and special status species. Guidelines for livestock grazing include management tools, methods, strategies, and techniques designed to maintain or achieve standards. These standards and guidelines were officially adopted in 2001, amending BLM Resource Management Plans covering the approximate 13.5 million acres of BLM land in New Mexico (BLM 2001).

Similarly, livestock grazing on the approximately 9.2 million acres of National Forest System lands in New Mexico is managed under the Organic Act of 1897 and subsequent planning rules to provide for timber production, forest and watershed protection and wildlife habitat. The Forest Planning Rule, 36 CFR Part 219, requires that forest plans include standards and guidelines to maintain or restore ecological conditions that contribute to maintaining viable populations of species of conservation concern within the plan area. Implementation of grazing standards and guidelines on public lands thereby benefits a broad spectrum of native wildlife species.

New Mexico's arid climate presents challenges and opportunities for working with private landowners and managers to achieve wildlife conservation goals. Opportunities include developing innovative and effective initiatives that may attract private landowners to implement conservation measures while maintaining sustainable agricultural practices. The 2014 reauthorization of the Farm Bill, officially known as the Agricultural Act of 2014, provides voluntary conservation funds for farmers to protect wildlife habitat, control soil erosion. and reduce polluted runoff. Funding can be used for a variety of practices to benefit SGCN and other species, including establishing preferred vegetative cover for wildlife, protecting native wetlands and grasslands, prairie or forest restoration, and improving conservation practices within pastures, croplands, rangelands, or forests being actively managed for agricultural production (Figure 6).

Within arid and semiarid areas, Holechek et al. (2006) reviewed grazing studies that compared carefully controlled intensity, timing, and frequency of grazing with grazing exclusion, and concluded that, "…grazing can have positive impacts on forage plants compared with exclusion if average long-term use levels do not exceed 40%." For example, plant and wildlife communities in one Chihuahuan Desert study were more diverse where the range was moderately (1/3 of the current year's growth) grazed than where it was ungrazed (Smith et al. 1996). Properly managed livestock grazing also creates a mosaic of vegetative cover that benefits multiple species with a range of habitat requirements. Vavra (2005) reports that livestock grazing use often results in a patchiness of utilization from ungrazed to relatively heavily grazed areas across large pastures common in the western United States. This habitat mosaic created from variable levels of utilization can benefit more wildlife species as long as key habitats, such as riparian areas, are not disproportionately impacted.

In order for range livestock operations to remain economically viable, a scientifically-based grazing program is required to ensure the land will continue to provide habitat needed to sustain both livestock and wildlife into the future. Poorly managed grazing can cause continued decreases in plant vigor, exacerbate soil erosion, and promote homogeneity of plant communities (Milchunas 2006). Cessation of grazing (with the possible exception of riparian communities) will do little to change the state of degraded plant communities (Milchunas 2006). Instead, moderate grazing should occur during periods that will not reduce reproduction and recruitment of both plants and wildlife (Smith et al. 1996, Holechek et al. 1998). Such an approach can result in mutual benefits to land management goals for agricultural production and wildlife management.

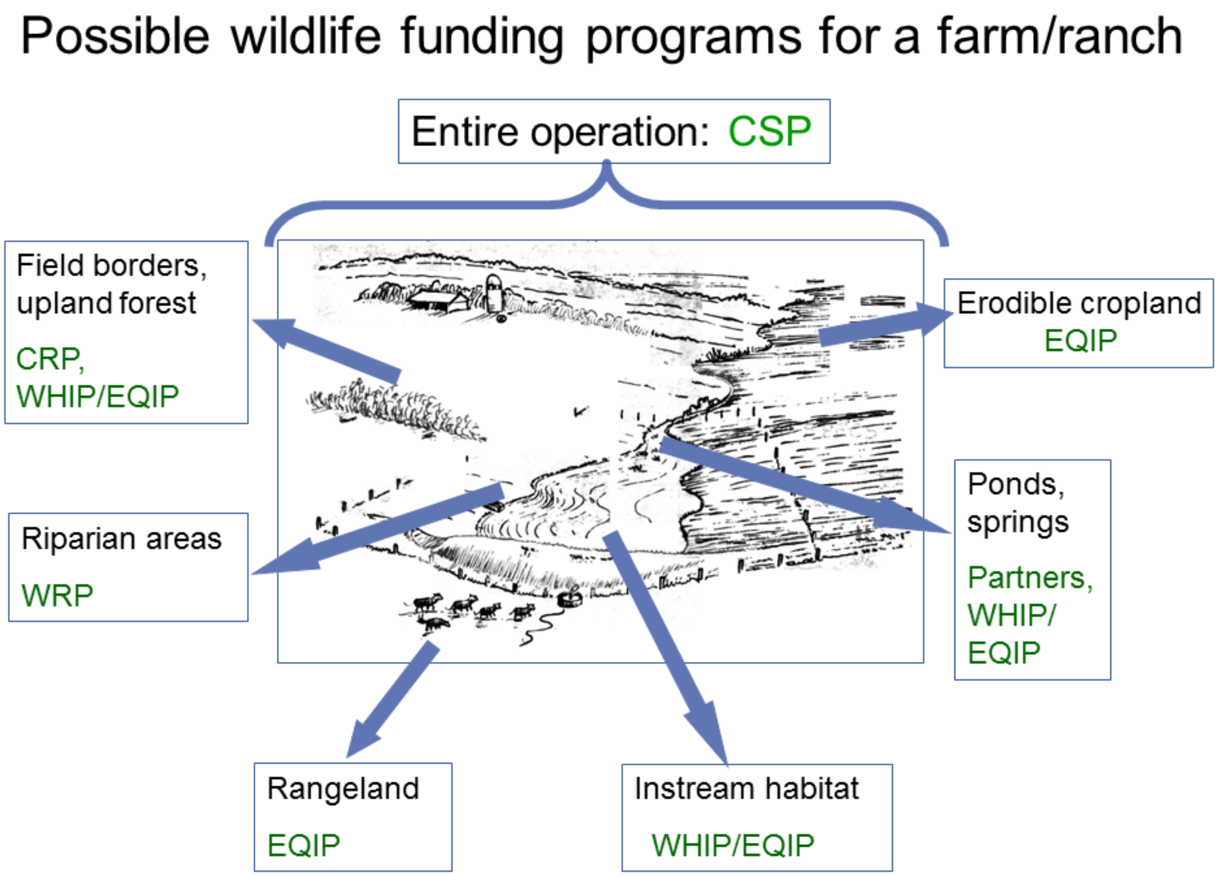



Figure 6. Farm Bill and other funding programs for wildlife conservation on a farm or ranch.

Program abbreviations are as follows: CRP = Conservation Reserve Program; CSP = Conservation Security Program; EQIP = Environmental Quality Improvement Program; Partners = US Fish and Wildlife Service Partners for Fish and Wildlife Program; WHIP = Wildlife Habitat Incentives Program (combined into EQIP in 2014 Farm Bill); WRP = Wetlands Reserve Program.

## *Energy Production and Mining*

Large amounts of oil and natural gas (currently ~54,000 active wells providing three and 10% of the United States' total production of oil and natural gas, respectively (http://octane.nmt.edu/gotech/Petroleum_Data/General.aspx) are extracted from the San Juan and Permian Basins in northwestern and southeastern New Mexico (Figure 8). Federal and state regulations, along with the use of closed-loop drilling techniques, have significantly reduced the number of open wastewater pits associated with well development. In addition, oil and gas companies have consolidated the number of open wastewater pits by developing multi-well fluid management ponds where produced water from numerous well sites can be collected prior to disposal. When they do occur, open wastewater pits and ponds are potentially detrimental to waterbirds that cannot fly well or thermoregulate when their feathers have oil on them (Custer et al 1994). Additionally, ingested petrochemicals can be toxic to both adults and embryos (Flickinger 1981, Hoffman 1990). Other potential impacts of well development are spills of oil, gas, and contaminated water from production. These spills may serve as sources of contamination that can impact soil, vegetation, and water bodies. Adherence to appropriate producer policies and state and federal regulations can reduce the incidence of spills and potential impacts of those releases.

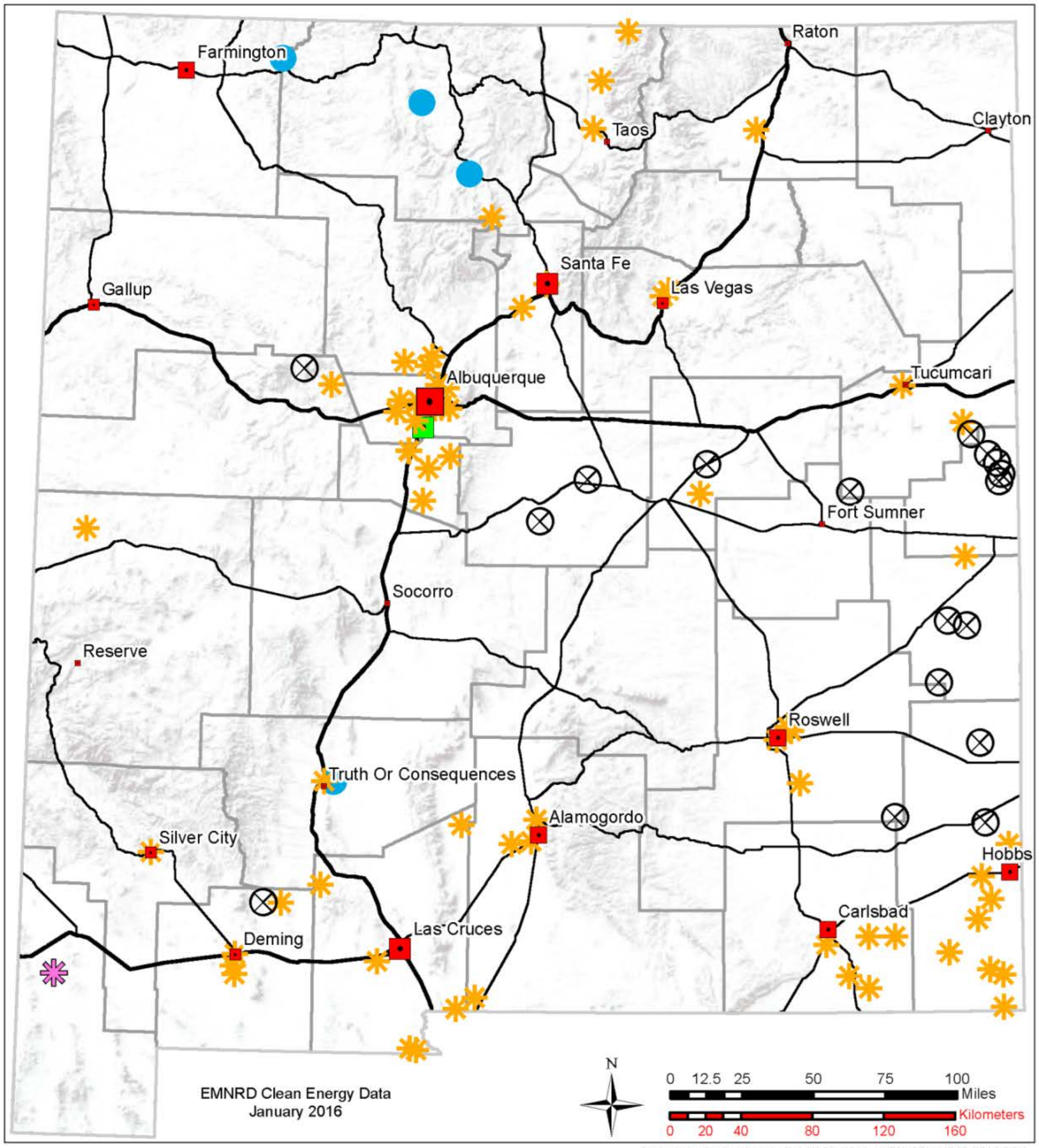
The evolution of best management practices, more restrictive lease requirements, and coordinated conservation efforts such as the WAFWA Lesser Prairie-Chicken Range-Wide Plan have mitigated some of the impacts of energy development on lesser prairie-chicken and dunes sagebrush lizard. Still, some aspects of energy development are problematic for wildlife such as high densities of wells (up to 6 wells/km$^2$ (16 wells/mi$^2$)), access roads, and utility lines. Large patches of contiguous habitat are divided into small parcels making resident species vulnerable to discovery by predators. Noise and disturbance from traffic and energy extraction elicit vigilance and flight behavior that needlessly taxes energy reserves of individuals (Hobbs 1989). Given this, wildlife may abandon these areas or become locally extinct because of poor recruitment and elevated mortality.

Hydropower is generated at four sites (Navajo, El Vado, Abiquiu, Elephant Butte) in New Mexico (Figure 7). The dams that produce it can adversely impact already limited stream habitat required by many aquatic SGCN such as Colorado pikeminnow (Franssen et al. 2007).

The potential for wind energy lies mostly on the east side of the state. Ten active commercial sites produce 878 megawatts (MW). Each site disturbs or directly eliminates on average 23 ha (58 ac) of habitat. Seven more sites now under construction will more than double (952 MW) the State's energy produced by wind; each will impact or eliminate approximately 43 ha (107 ac) of habitat. The impact of wind energy development is not restricted to habitat loss; turbines can cause direct mortality to birds and bats, which can vary from 0 to 30 mortalities per turbine per year (Kuvelsky et al. 2007). The height of blades of newer wind turbines intersects the travel height of some bats and birds, thereby increasing the threat of mortality (Barclay et al. 2007). Factors affecting mortality rates include the speed of blades, weather, prey abundance, time and routes of migration, proximity to thermals used by soaring raptors, and speed of wind when turbines begin to operate (McCrary et al. 1983, Erickson et al. 2005, Hoover and Morrison 2006, Kuvlesky et al. 2007, Arnett et al. 2010). Changing initiation of blade movement from wind speeds of 3 m/second (6.7 mph) to 5-6.5 m/second (11.2-14.5 mph) resulted in a 44-93% reduction in bat mortalities with $\leq$1% loss of power generation (Arnett et al. 2010).

Currently, New Mexico has 47 commercial solar power generation sites in New Mexico that produce >1 MW energy. Those on undeveloped lands encompass on average 24 ha (60 ac) each; 13 more sites under construction will on average cover 66 ha (165 ac) of habitat each (M. Gaiser, Energy, Minerals, and Natural Resources Department, pers. comm.). Thus, solar sites, like wind farms, impact a relatively small amount of habitat. However, that habitat may be critical to ground-dwelling species that have small, localized ranges (especially amphibians and reptiles). Additionally, solar sites can disrupt the orientation and navigation of flying insects and birds, as well as killing individuals by burning (Lovich and Ennen 2011, Kagan et al. 2014).

Shafts of abandoned underground mines can provide valuable roosting habitat for bats (Altenbach and Pierson 1995), although gates erected to prevent entry by humans can deter bats from entering and leaving (Spanjer and Fenton 2005). Direct loss of habitat from open-pit mines is relatively localized (hardrock more so than coal), but impacts of these mines extends beyond their boundaries. Access roads with attendant noise and disturbance can contribute to significant habitat fragmentation and abandonment by wildlife. Retention ponds and pits collecting water from mining operations may contain toxins particularly hazardous for wildlife.




| Energy Source | Total Capacity | Facilities |
|---|---|---|
| Geothermal | 1.6 MW | 1 |
| Hydro | 78.0 MW | 4 |
| Solar | 1,292.9 MW | 66 |
| Waste to Energy | 6.4 MW | 1 |
| Wind | 1,831.6 MW | 17 |

Figure 7. Renewable energy sources.

Solar and Wind sites shown are those that produce ≥ 1 MW of energy. Data obtained from Clean Energy Program, New Mexico Energy, Minerals, and Natural Resources Department

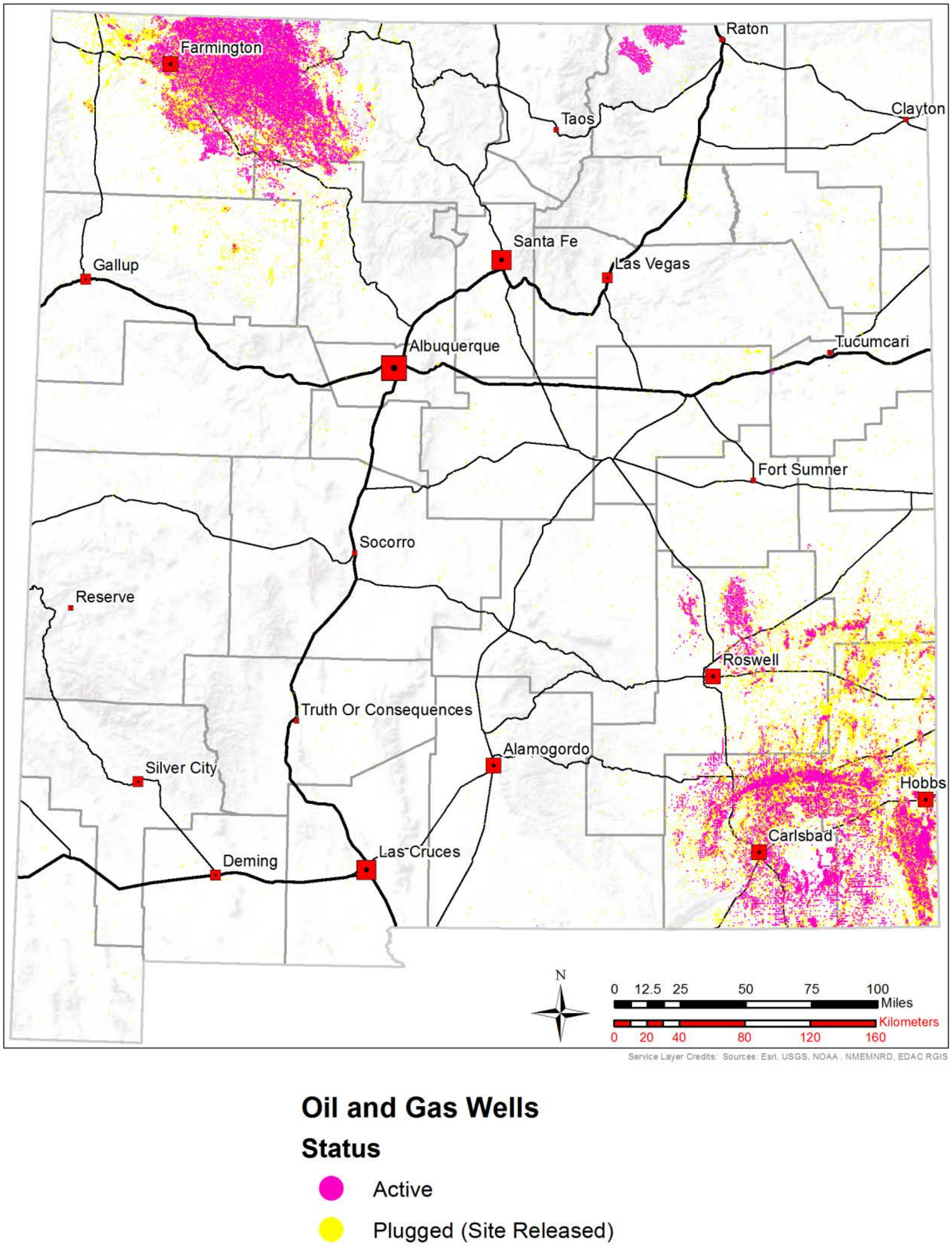



Figure 8. Oil and gas production wells.

## *Transportation and Utility Corridors*

Transportation and utility corridors present several problems for wildlife and the habitats they occupy. The first is a problem of geometry. Natural landscapes have a high degree of diversity per unit area (e.g., a mosaic of habitats), convoluted boundaries resulting in gradual transitions between patches of different habitats, and similar shapes and patterns across scales (e.g., characteristics of tributaries are similar to those of the main stream they feed (Dunn et al. 2011)). Conversely, human-dominated landscapes are characterized by rectilinear shapes and straight, smooth boundaries. This results in the loss of nuances and subtleties of patterns, which may disrupt the natural processes that created those patterns. For example, convoluted boundaries between woodlands and meadows provide safe access to more forage for grazing wildlife. Meandering streams provide areas of flow resistance where nutrients are deposited that benefit plants and animals both within and adjacent to the stream (Malard et al. 2002).

Straight-line transportation corridors (Figure 9) are typically the most efficient means to transport goods and services for humans. This approach may have long term net costs if modified ecosystems need to be restored to a more natural state to provide services (e.g., flood and erosion control provided by wetlands) (Dahm et al. 1995).

Transportation and utility corridors are reservoirs and conduits for invasive and problematic species, particularly plants in arid environments (Gelbard and Belnap 2003). Vehicles are a continuous source of non-native (particularly crop) seeds. Rights-of-ways are particularly fertile grounds for weedy species that germinate and seed quickly. These areas receive supplemental water from pavement runoff and are subject to frequent disturbance (especially road and vegetation maintenance); these characteristics inhibit establishment of slower developing native species (Hansen and Clevanger 2005, Christen and Matlack 2007). Habitats adjacent to rights-of-ways can resist invasion if their plant communities are healthy, although grasslands are more susceptible to the spread of invasives than forested areas (Hansen and Clevenger 2005).

Disturbance of native vegetation when utility lines are built can provide a foothold for aggressive exotics such as cheatgrass *(Bromus tectorum)* in arid environments (Rafferty and Young 2002). Removing woody vegetation underneath utility lines for fire protection contributes to habitat fragmentation and may create a barrier to movement for some forest-dependent organisms (Burnett 1992, Bevanger 1998).

Collisions with electric utility and distribution lines have been estimated to kill >170 million birds each year, with many mortalities occurring when utility lines cross, or are near, where birds concentrate, such as wetlands and migration corridors (Brown 1992, Erickson et al. 2005). Birds that are particularly vulnerable have heavy bodies and small wings not designed for rapid maneuverability (e.g., grouse), do not fly in flocks (which afford increased detection), or tend to fly at the level of the utility lines (e.g., cranes) (Bevanger 1998, Jenkins et al. 2010). Casualty rates are substantially reduced when ground wires are removed and large markers with highly visible colors are placed on lines that intersect bird flight paths (Brown and Drewien 1995, Jenkins et al. 2010).

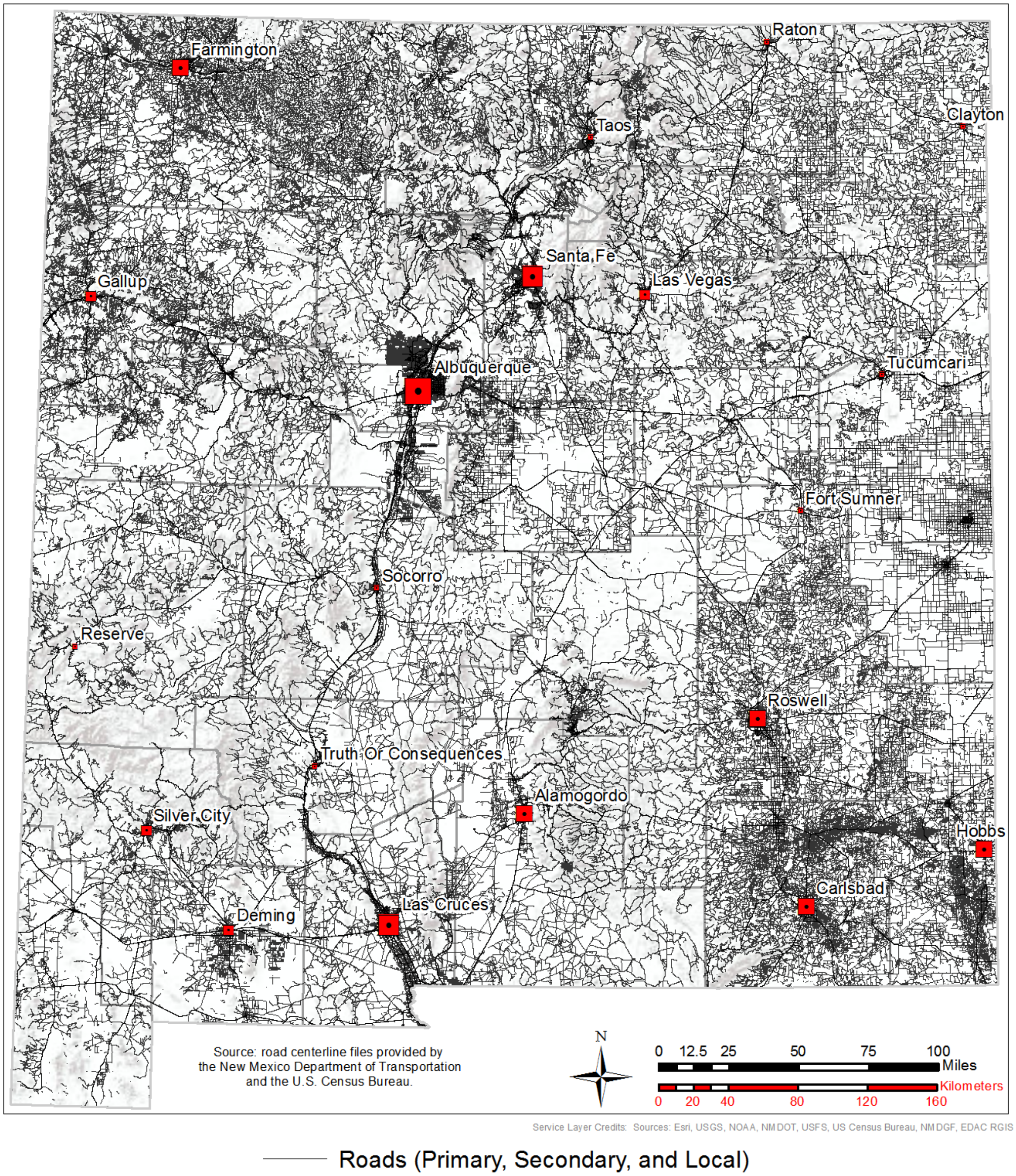



Figure 9. Roads.

Lines represent all roads from unimproved dirt to interstate highways. Data obtained from New Mexico Department of Transportation, US Census Bureau, and US Forest Service.

Electrocution occurs when a bird touches two phase conductors simultaneously or a phase conductor and a grounded device on electric distribution lines (Bevanger 1998). Birds most susceptible to electrocution are raptors who favor high structures to perch and search for prey, and who possess wingspans that allow simultaneous contact with more than one conductor/grounded device (Bevanger 1998). Juveniles and sub-adults suffer higher mortality than adults (Benson 1980).

## *Biological Resource Use*

Biological resource use is defined as consumptive use of non-cultivated biological resources such as forest and woodland habitats, including both deliberate and unintentional harvesting effects.

Over the last century, tree density, structure and species composition of New Mexico's forests have been significantly altered by the combined effects of commercial logging, fire suppression, livestock grazing, and climatic events, all of which favored dense conifer regeneration (Covington and Moore 1994a, Covington et al. 1997, Dahms and Geils 1997).

The characteristic pre-European settlement density of ponderosa pine forests were more open (~57 trees/ha (23 trees/ac)) and park-like. These forests were dominated by widely-spaced, large diameter trees where recruitment of seedlings was limited by low intensity surface fires in 2-5 year intervals, competition with understory grass and forbs, and by drought (Covington and Moore 1994a, Bailey and Covington 2002).

In the late 1800s, ponderosa pine forests began changing to dense stands (>2000 trees/ha (800 trees/ac)) that are more susceptible to high intensity fire (Covington and Moore 1994b, Dahms and Geils 1997). Livestock grazing removed understory grasses that provided fine fuels for frequent low-intensity fires and competitively excluded tree seedlings (Covington and Moore 1994a, Covington et al. 1997, Dahms and Geils 1997).

Large-scale timber harvesting in the late 19$^{th}$ century through the early 20$^{th}$ century removed many large diameter trees (Covington and Moore 1994a, Covington et al. 1997, Dahms and Geils 1997). Timber harvest levels on National Forest System lands in the southwest steadily increased from the early 1900s through the 1980s, and then began declining in the 1990s (Dahms and Geils 1997).

Some researchers believe that fire suppression activities began altering forest structure and fire regimes by the early 1900s (Covington and Moore 1994a). Woodlands, ponderosa pine and drier mixed conifer forests with historically frequent, low intensity fires are thought to have initially been more affected by fire exclusion caused by fire suppression activities (Covington and Moore 1994b, Dahms and Geils 1997). However, Wallenius (2011) calls into question whether fire suppression activities led to a reduction in fire frequency and total area burned in coniferous forests in western North America.

Large scale high severity wildfires kill wildlife and destroy wildlife habitat, and can result in habitat conversion from forest to shrub or grassland habitats. Loss of old growth stands by logging and high severity fire negatively impacts the persistence of forest-dependent species such as the Mexican spotted owl (*Strix occidentalis lucida*) (USFWS 2013).

In forests and woodlands, logging and fuelwood cutting has reduced the abundance of large diameter snags important for cavity nesting birds, bats, and other wildlife (Thomas et al. 1979, Hejl 1994, Bogan et al. 1998), and reduced downed decaying logs important for wildlife cover and ecosystem function (USFWS 2013). Logging and fuelwood cutting is facilitated by existing or newly developed roads that promote vehicle traffic, fragment habitat and increase wildlife disturbance.

Piñon and juniper woodlands are harvested for firewood and building products across ecoregions in New Mexico. Thinning unnaturally dense piñon and juniper woodlands to produce a mosaic of patches of different density woodlands can be positive for wildlife if done outside of the migratory bird nesting season. Conversely, it may adversely affect wildlife if it removes cover needed for successful reproduction by SGCN such as gray vireos (*Vireo vicinior*) (Stake and Garber 2008).

Despite the impacts of historical logging, well-planned forest restoration and fuels reduction projects benefit New Mexico forests and the wildlife that occupy them when combined with frequent low intensity prescribed burns or wildfire. Together, these management strategies decrease fuels that contribute to destructive crown fires, increase productivity of grasses, and enhance soil nutrients. Restoration and fuels treatments should be designed to restore conditions to the historic range of variability and allow fire to return to its natural role (Covington et al.1997, Bailey and Covington 2002).

There is limited biological harvesting of some SGCN (e.g., Gould's wild turkey, *Meleagris gallopavo mexicana*) and some amphibians and reptiles are commercially collected. Hunting and fishing are tightly regulated and limits are based on population monitoring and take that does not affect long-term viability of the species. Collecting amphibians and reptiles requires a State permit, but the number taken is not regulated for species that are not State listed or are not on the NMDGF Director's commercial collection list. Most commercial collecting occurs along roads and is therefore very limited.

## *Human Intrusions and Disturbance*

Human intrusions lead to habitat disturbances related to off-highway vehicle use (OHV), military activities, and recreational use. Recreational OHV use occurs across the entire state. The long-term effects of OHV use on habitats and SGCN are poorly understood. In the short-term, OHV travel can cause damage to soils and vegetation (Holechek et al. 1998) and impact wildlife by destroying and fragmenting habitat, causing some direct mortality of wildlife, or altering behavior through stress and disturbance (Busack and Bury 1974, Brattstrom and Bondello 1983). The Forest Service published rules designating routes and areas for OHV use (USFS 2005). When the regulations are observed and enforced, negative impacts can be reduced.

The Department of Defense (DoD) manages 4% of the land in New Mexico. White Sands Missile Range (WSMR) is the largest DoD installation in New Mexico, covering approximately 0.9 million ha (2.2 million ac). It operates primarily for the support of research, development, testing, and evaluation of weapon and space systems, subsystems, and components. Other DoD installations in New Mexico contain sites for: live bombing; air defense missile firing; mechanized brigade training exercises; battalion-size or smaller training exercises; ballistic missile testing; aircraft takeoff, landings, and training courses; maintenance of fighter wing capabilities; and general military training exercises. While restricted access to most military lands provides substantial benefits to many species of wildlife, military land uses can also destroy or fragment existing habitats for some species.

Border security measures are implemented throughout the New Mexico/Mexico borderlands region to intercept illegal drug shipments, illegal immigrants, and other unauthorized activities (ACOE 2000). Associated road building and traffic in the borderlands region causes additional habitat loss and fragmentation, reduces usable habitat for wildlife populations, increases road kill, poaching, illegal collecting of wildlife and general habitat destruction (Forman et al. 2003). The impacts of border patrol activities are highly visible and pervasive, however these activities may serve to reduce the damage associated with unauthorized entry. The covert movement of people across the border results in dispersed human presence throughout the more remote sections of the border area. People covertly moving in these areas disrupt wildlife, leave trash, and increase the potential for wildfires which can significantly impact wildlife habitats. The combination of control and evasion activities has significant impacts throughout the border area.

Skiing, hiking, mountain biking, rock climbing, camping, sightseeing, bird watching, and picnicking are popular non-consumptive recreational pursuits in New Mexico (Conner et al. 1990). The overall impact of these activities is not fully understood. These activities are dispersed across the landscape in time and space and are generally reasonably quiet and do not significantly disturb wildlife activity. It is unclear how much and which combinations of recreational use can be tolerated before there are adverse effects on wildlife and/or wildlife habitat. However, recreational activities are increasing and their potential effects on habitats and species should be considered in conservation planning (Conner et al. 1990).

## *Natural System Modifications*

Fire was an integral component in the evolution of both forests and prairie grassland ecosystems in New Mexico. The frequency and size of forest fires are related to elevation (e.g., 6-10 year interval in mixed conifer forests and 4-5 year interval in ponderosa pine forests) and inter-annual variation in precipitation (Swetnam 1990, Swetnam and Betancourt 2010).

With settlement, heavy grazing reduced grass cover, which served as ignition fuel when dry, so fire frequency decreased and tree and shrub densities increased. This was exacerbated with efforts beginning in the 1930s to suppress all fires as quickly as possible. Ultimately, fire frequency decreased, but intensity increased with the development of ladder fuels that carried the fire into the canopy. High severity fires can cause forests that historically were a mixture of young and mature trees to become dominated by shrubs (Hessburg and Agee 2003). Higher spring and summer temperatures and earlier snowmelt associated with climate change have added to intensity and size of fires. Further, individual fires occurring from 1986-present, during which time substantial warming was documented, have averaged four times larger in area and lasted four weeks longer than those fires ignited during the 1970-86 period (Westerling et al. 2006). Even in the last 14 years, there has been an increase in average fire size in New Mexico (Figure 10). Transition of landscapes from tree to shrub canopy may have adverse ramifications for forest-obligate species that have limited ranges such as the Jemez Mountains salamander (*Plethodon neomexicanus*). In recent decades, where the lack of infrastructure permits, the role of fire has been reintroduced through low intensity prescribed fires and by allowing natural fires to burn and re-create a more natural mosaic of vegetative types and age classes.

Historically, fire has not occurred frequently or consistently in desert grasslands due to low biomass and discontinuity of fine fuels (Hastings and Turner 1965, York and Dick-Peddie 1969). However, it was more prevalent in the shortgrass prairies with greater rainfall and higher biomass production (Swetnam and Betancourt 1990). In particular, interaction between grazing and fire was a key characteristic of natural functioning prairie ecosystems (Knopf 1994). Bison and other large herbivores focused grazing on new growth of recently-burned patches. Meanwhile, grass and litter increased in the patches they bypassed, resulting in growing fuel loads easily ignited by lightning. The result was a shifting mosaic of patches with varying plant composition, diversity, and productivity that supported a diversity of wildlife (Milchunas et al. 1988, Hobbs et al. 1991, Fuhlendorf and Engle 2001). The elimination of large wild grazers and European settlement essentially ended this process, resulting in increasingly homogeneous plant communities (Knopf 1994).

A large proportion of observed climate change induced impacts on wildlife habitat are a result of changing fire regimes. Increasing spring and summer temperatures, reduced soil and fuel moisture, and drought contribute to increased wildfire activity (Ryan et al. 2008). Wildfires are larger, more frequent, and more intense under recent conditions characterized by higher temperatures and drought (Westerling et al. 2006, Lettenmaier 2008). Future wildfire potential is expected to increase dramatically in southwestern forests (see climate change discussion in Chapter 4) as a result of projected drier and hotter conditions (Brown et al. 2004, Spracklen et al. 2009). Increasing temperatures are likely to increase the number of burn days and acres burned (McKenzie et al. 2004). Though drought conditions tend to lead to increased frequency and extent of wildfires, they may also reduce wildfire risk through reduction of fine fuels (Ford et al. 2012).

Changes in wildfire regimes have many potential implications for New Mexico wildlife habitats. Drought-fire interactions are very likely to disproportionately adversely affect lowland forest communities. Where fires are very large, forests and woodlands may suffer a loss of regeneration potential, leading to significant changes in forest composition and structure (Williams et al. 2010). Increased wildfire is likely to encourage the establishment of exotic grass species in fire sensitive shrubland and desert habitats (Crist et al. 2014). Recently burned areas are at an increased risk of erosion from wind and rain, particularly in areas with high slopes (Enquist and Gori 2008). Not all systems are equally impacted by fire, however, and increased wildfire may be beneficial for some grassland habitats (Ford et al. 2012).

Dams and their associated reservoirs provide important benefits for society (irrigation, electricity, recreation, water for municipalities) but impose costs to some native fish, wildlife, and vegetation dependent on the affected riverine ecosystems. Most apparent are a substantial loss of riparian and aquatic habitat and fragmentation of fish populations by the impenetrable barriers dams create. Fragmenting populations can be especially deleterious for rare or imperiled fish, which already suffer from reduced genetic diversity. Water flow through dams tends to be highly regulated with substantially less volume and variability than natural flows. Lack of flow variability is a primary reason for the decline of native fish in the southwest (Richter 1997). One reason is that high spring flows act as cues for spawning (Franssen et al. 2007).

Special planned releases of water from Navajo Dam on the San Juan River that mimicked the natural timing, amplitude and volume of spring flows resulted in increased recruitment of native fish, and in some cases suppressed recruitment of competing non-native fish (Propst and Gido 2004). Lastly, dams adversely impact downstream riparian habitat by reducing sediment flows needed to replenish bank structure and maintain channel profile.

Groundwater depletion also has taken a toll on riparian and aquatic ecosystems. Technology to extract large volumes of groundwater became available in the mid-20th century and resulted in rapid growth of cities and agriculture (Konikow and Kendy 2005). Over the past 60 years, groundwater depletion nationwide has totaled 1,000 $km^3$ (240 $mi^3$), enough to fill Lake Erie twice (Konikow and Kendy 2005). Depletion has been most severe in the Ogallala aquifer of the western Great Plains, which includes eastern New Mexico. The 6% decrease in its water volume may seem minor, but it has already been enough to make irrigation cost-prohibitive in some locales (Dennehy et al. 2002). In New Mexico, seven aquifers that were investigated all shrank between 1900-2008 (Konikow 2013). After the Ogallala, aquifers most depleted were the middle Rio Grande and Hueco Bolson aquifers, where Albuquerque and Las Cruces/El Paso are located, respectively (Konikow 2013). Withdrawals were highest during the past decade for four of the seven aquifers, but depletion matched replenishment in the middle Rio Grande and Mimbres aquifers.

Growth of cities and agriculture spurred by access to groundwater has reduced valuable SGCN habitat, especially surface water and attendant habitats where these resources are most rare. The San Simon Cienega in the Madrean Archipelago ecoregion of southwestern New Mexico is a prime example. It was once an isolated, but thriving, 486 ha (1,200 ac) wetland in a desert ecoregion, but virtually dried up by the mid-1980s due to groundwater pumping for irrigation (Hendrickson and Minckley 1984, Dinerstein et al. 2000). When it was functional, a wide variety of SGCN were recorded at this cienega including Bell’s vireo (*Vireo bellii*), Abert’s towhee (*Melozone aberti*), yellow-billed cuckoo (*Coccyzus americanus*, federally-listed as Threatened), Mexican spotted owl (federally-listed as Threatened), western yellow bat (*Lasiurus xanthinus*), common black hawk (*Buteogallus anthracinus*), lowland leopard frog (*Lithobates yavapaiensis*), common ground-dove (*Columbina passerina*, federally-listed as Endangered), Lucy’s warbler (*Oreothlypis luciae*), Gila woodpecker (*Melanerpes uropygialis*), roundtail chub (*Gila robusta*), and Mexican gartersnake (*Thamnophis eques*, federally-listed as Threatened).

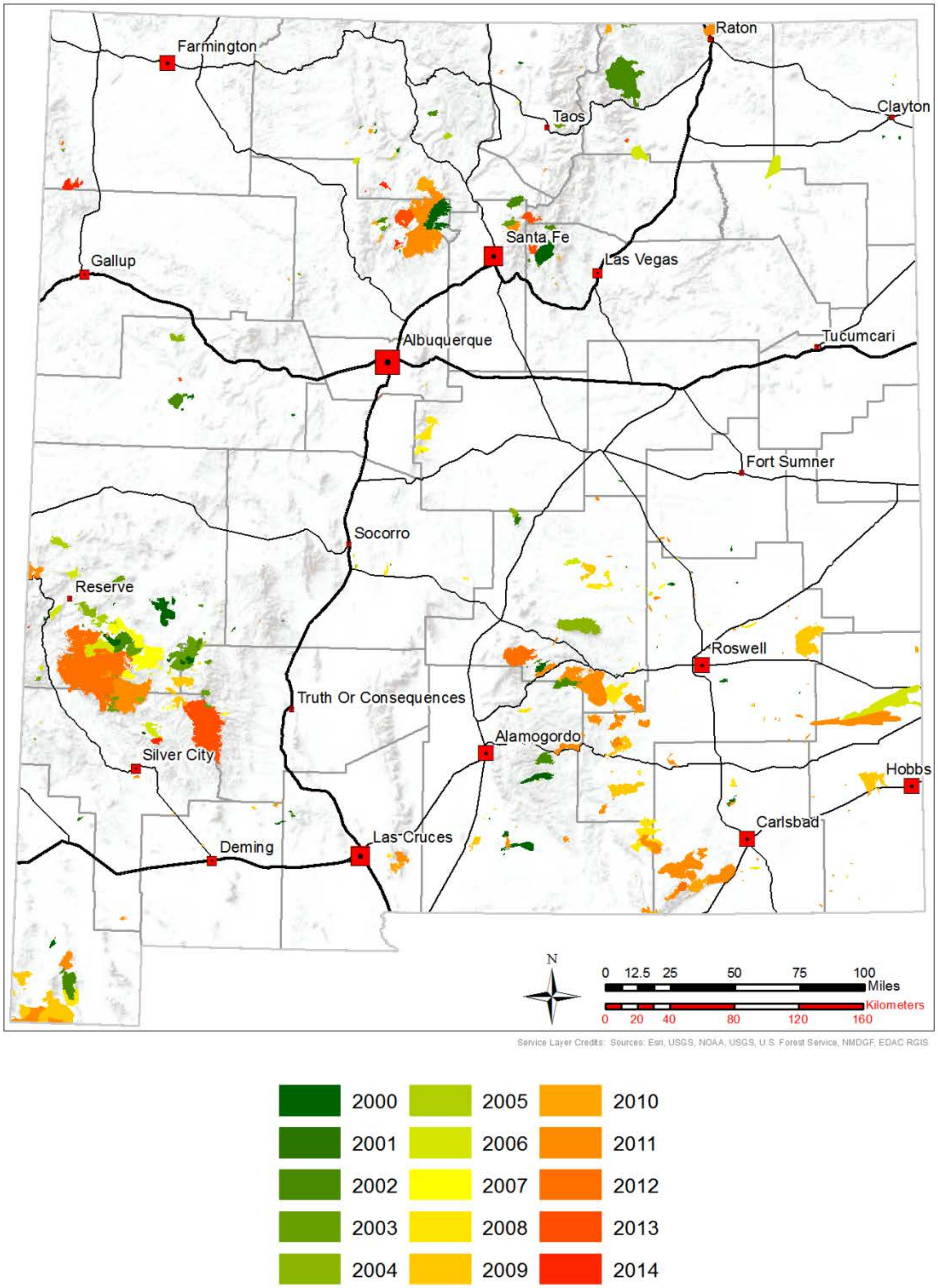



Figure 10. Recent large wildfires.

## *Invasive and Problematic Species*

Invasive species enter ecosystems and establish viable populations where they did not previously occur. Their arrival may be a result of natural immigration, but more frequently it is human-caused, either deliberate or accidental (Brown and Sax 2004). Often, but not always, invasive species are non-native and reproduce prodigiously (Molles 2008).

Many ecologists recognize the problems caused by the introduction and potential invasion of non-native species into communities or ecosystems and the associated negative effects on global patterns of biodiversity (Stohlgren et al. 1999). Once established, many invasive species have the ability to displace native plant and/or animal species (including Threatened and Endangered species), disrupt nutrient and fire cycles, and alter the character of the community by enhancing additional invasions (Cox 1999, DeLoach et al. 2000, Zavaleta et al. 2001, Osborn et al. 2002).

Noxious weed infestations are now the second leading cause of native species being listed as Threatened or Endangered nationally. As of 1998, non-native species have been implicated in the decline of 42% of species federally-listed under the Endangered Species Act (Flynn-O'Brien et al. 1999). In addition to environmental problems, invasive plants also pose a considerable economic concern. Rangelands infested with spotted knapweed (*Centaurea maculosa*), a serious problem in New Mexico, typically suffer reductions in livestock carrying capacity of 50% or more. The State Forest and Watershed Health Plan devotes significant planning to the management of non-native invasive phreatophytes (EMNRD 2004).

Non-native aquatic species can have considerable effects on native fish, molluscs, and crustaceans in New Mexico's aquatic habitats. The populations of native fauna are negatively affected by non-native species through resource competition, predation, hybridization, habitat alteration, and the introduction of diseases and toxins. Concern over aquatic invasive species, particularly zebra (*Dreissena polymorpha*) and quagga mussels (*D. bugensis*), as well as "rock snot" (*Didymosphenia geminate*) led the New Mexico State Legislature to approve the creation of a new position with the New Mexico Department of Game and Fish, an Aquatic Invasive Species Coordinator, in 2013.

Non-native species invasions often cause both extinction of native species and disruptions to ecosystem processes that support native species. For example, a non-native ant species replaced native South African ants that had been the main seed dispersers in a scrub community. Cessation of seed dispersal resulted in wholesale changes in plant community composition that adversely affected a host of native animal species adapted to the original community (Christian 2001).

Problematic species cause changes that are unwanted, and often unanticipated. Not all invasive species are entirely problematic: for example, while rainbow trout have contributed to extirpation of native Rio Grande cutthroat (*Oncorhynchus clarkii virginalis*) from several watersheds in New Mexico, they were introduced because of their high value as gamefish (Sublette et al. 1990). Likewise, problematic species are not necessarily non-native. Some native species may become problems because they co-occur, their populations grow too large, and/or their behavior is incompatible, with humans. Sometimes in these cases, regulated harvest has the potential to reduce conflicts.

## Exotic Phreatophytes

Tamarisk (also known as salt cedar; *Tamarix* spp.) is a non-native shrub or tree that was intentionally introduced to the United States from Eurasia in the 1800s, originally as an ornamental plant, and later for erosion control in the arid west (Robinson 1965). Due to its deep root system, tolerance for saline conditions, and prolific seed production, tamarisk has naturalized throughout riparian areas, reservoir margins, and other wetlands of the west, particularly where hydrologic modifications (e.g., dams, withdrawals, diversions) have created conditions unfavorable for native riparian vegetation (e.g., cottonwood and willow; Lovich and De Gouvenain 1998, Glenn and Nagler 2005, Shafroth et al. 2005). Tamarisk is now the second most dominant riparian tree species in the western United States (Friedman et al. 2005), and is considered a noxious weed in many states, including New Mexico (NMDOA 2009). While tamarisk has expanded its range and dominance, native riparian woodlands have sharply declined due to agricultural conversion, urbanization, poorly managed grazing, and hydrologic alterations (Knopf et al. 1988, Graf 1992, Busch and Smith 1995). In some areas tamarisk can form large monotypic stands that cover thousands of hectares (e.g., Pecos River), and can establish and survive and in highly altered rivers where native riparian trees cannot (Shafroth et al. 2008, Stromberg et al. 2009, Nagler et al. 2010). The loss of native riparian vegetation has been linked to a decline in many southwestern riparian wildlife populations, particularly breeding and migratory birds (McGrath and van Riper 2005, McGrath et al. 2008, Johnson et al. 2010).

Although tamarisk likely has lower habitat value than native riparian vegetation, it can provide important habitat for some species, especially where degraded riparian conditions inhibit establishment and survival of native vegetation (USFWS 2002, Walker 2006). Forty-nine species of birds are known to use tamarisk as breeding habitat, and in Arizona and New Mexico, 11 bird species of regional or national concern breed in tamarisk (Sogge et al. 2008). Critical habitat for the endangered southwestern willow flycatcher (*Empidonax traillii extimus*) and threatened western yellow-billed cuckoo (*Coccyzus americanus*) populations includes tamarisk-dominated riparian woodland (USFWS 2005, USFWS 2014), with approximately 28 percent of known southwestern willow flycatcher territories found in such habitat (Durst et al. 2007). Mammals and herptofauna also occur in tamarisk (Hink and Ohmart 1984, Ellis et al. 1997, Bateman et al. 2008a, Bateman et al. 2008b, Bateman et al. 2009, Bateman and Ostoja 2012, Longland 2012), although the composition of these communities can be different from those found in pure stands of native riparian vegetation. There is evidence that tamarisk use by wildlife is most frequent among common riparian generalists (Sogge et al. 2008, Bateman et al. 2013a). Although wildlife species diversity and abundance may be lower in tamarisk when compared to strictly native riparian vegetation, tamarisk may support larger local regional wildlife populations than would otherwise occur in the absence of native vegetation (Hunter et al. 1988).

Tens of millions of dollars have been spent and are proposed to be spent on tamarisk control across the western United States, including New Mexico (Hart et al. 2005, Pearce 2006, NMWTB 2015). The primary stated reasons for controlling tamarisk are to increase water yield, improve wildlife habitat, restore native vegetation, and decrease riparian wildfire frequency and severity (Shafroth et al. 2005, Shafroth et al. 2008). In many cases, these objectives are difficult to achieve without rigorous restoration planning and implementation that considers tamarisk removal merely as a first step in a multi-factor, multi-phase restoration process. For example, follow-up treatments for multiple years are often necessary to control tamarisk re-sprouts. Additionally, detectable increases in water yield following tamarisk removal may not always occur and appear to be highly dependent upon replacement vegetation (Cleverly 2013, Nagler and Glenn 2013, Shafroth et al. 2005).

Tamarisk removal may have unintended consequences, including habitat loss and expansion of other exotic species (Zavaleta et al. 2000, Sogge et al. 2008). Removal sites may be unsuitable for the desired replacement vegetation if environmental conditions favoring tamarisk (e.g., soil salinity, deep groundwater, infrequent or absent flooding) preclude establishment and survival of native riparian plants (Briggs 1996, Glenn and Nagler 2005). Likewise, tamarisk removal may facilitate colonization or expansion of other exotic plants such as kochia (*Kochia scoparia*) that provide little habitat value (D'Antonio and Meyerson 2002, Harms and Hiebert 2006, Shafroth et al. 2008, Ostoja et al. 2014). Moreover, if desired replacement vegetation is not restored in the near-term, tamarisk removal could lead to temporary habitat loss and a reduction or loss of local wildlife populations (Fleishman et al. 2003). For rare or endangered species, even temporary habitat loss may jeopardize recovery (Paxton et al. 2011). Thus, tamarisk removal projects should include additional measures to ensure successful establishment and survival of high-quality native riparian vegetation (Shafroth et al. 2008).

Russian olive (*Elaeagnus angustifolia*) and Siberian elm (*Ulmus pumila*) are exotic tree species that also commonly occur in New Mexico's riparian and wetland areas. Restoration projects regularly include removal of these tree species in addition to tamarisk. Like tamarisk, Russian olive and Siberian elm can provide wildlife habitat, especially in areas where native riparian trees are scarce or absent. Projects that remove these species should consider the impacts on wildlife, and include plans to restore desirable replacement vegetation. Tamarisk removal projects may facilitate expansion of Russian olive (Bloodworth et al. 2016) and Siberian elm.

The tamarisk beetle (*Diorhabda* spp.) was introduced to the southwestern United States in 2001 as a biocontrol for tamarisk. Tamarisk beetles are specialist herbivores that feed exclusively on tamarisk leaves, resulting in desiccated foliage that eventually falls from the tree (Lewis et al. 2003, Bloodworth et al. 2016). Repeat defoliations (over ~2-7 years) may result in tamarisk mortality, though mortality rates are highly variable and dependent on local site conditions. Plants exposed to additional stressors such as drought or highly saline soils may be more likely to die (Bloodworth et al. 2016).

The tamarisk beetle now occupies the majority of New Mexico's major waterways and its range in the state continues to expand (Tamarisk Coalition 2016). Although the beetle is expected to reduce tamarisk populations and may help improve riparian habitat over time, it also can degrade or destroy large areas of existing habitat, especially where tamarisk is the dominant vegetation type or has completely replaced native riparian vegetation. Decreased tamarisk cover has been linked to a hotter drier microclimate (Bateman et al. 2013b), which may lead to reduced abundance and diversity of herptofauna (Bateman et al 2013b, Bateman et al. 2015) and avifauna. Studies have documented a decline in the fledgling success of endangered southwestern willow flycatchers and yellow warblers in areas affected by the beetle (Dobbs et al. 2012). Defoliation can be an ecological trap for birds that nest in leafy tamarisk early in the summer, then fail after beetle defoliation due to changes in microclimate, increased exposure to predators, or other related factors. Thus, wildlife species that use tamarisk extensively may experience significant population declines due to biocontrol (Paxton et al. 2011).

Unfortunately, beetle-defoliated and beetle-killed sites are often unsuitable for natural recruitment of native vegetation, and require intensive restoration efforts to recover habitat (Harms and Hiebert 2006, Shafroth et al. 2008). Studies have shown that even active revegetation is likely to fail without further maintenance and management (Briggs et al. 1994, Bay and Sher 2008). Moreover, beetle-induced mortality of tamarisk can occur rapidly (within ~2-7 years) leaving little time to plan and implement habitat restoration at affected sites (Bloodworth et al. 2016). For example, the beetle arrived on the Department's William S. Huey Waterfowl Area along the Pecos River in 2014, and by the end of 2015, there was near complete mortality of tamarisk on the property. Additionally, defoliated or beetle-killed tamarisk creates an elevated fire risk that further threatens riparian habitat (Hultine et al. 2010, Drus 2013). There is now an urgent need to restore habitat formerly and currently occupied by tamarisk to maintain local wildlife populations and prevent degradation of adjacent aquatic habitat, especially in the most hydrologically altered river systems where native riparian vegetation is in short supply.

## Diseases and Pathogens

Diseases and pathogens are a growing concern for amphibian and reptile SGCN (Langwig et al. 2015). A particular form of a chytrid fungus (*Batrachochytrium dendrobatidis*) has been identified as being responsible for massive die-offs of amphibians in South and North America, including such SGCN as Chiricahua leopard frog (*Lithobates chiricahuensis*) and boreal toad (*Anaxyrus boreas*) (Wake and Vredenburg 2008). Recently, another form of chytrid fungus has been identified as being lethal to salamanders which, as yet, has not reached New Mexico (Martel et al. 2014). Other pathogens, such as various ranaviruses, which have led to massive die-offs in frogs and turtles, and snake fungal disease (*Chrysosporium* spp.), are also of concern (Allender et al. 2011, Lesbarreres et al. 2012).

Whirling disease in rainbow trout (*Oncorhynchus mykiss*) was confirmed in New Mexico the spring of 1999. Since then, four of the six New Mexico state hatcheries, several private ponds and salmonid populations in the San Juan, Rio Grande, Canadian, and Pecos drainages in New Mexico tested positive for the disease. As a result, routine testing and remediation procedures have begun in New Mexico's hatcheries and a testing program has been initiated for 173 cold water streams and reservoirs that may have been inadvertently stocked with infected rainbow trout or through transmission by natural or anthropogenic vectors. Although New Mexico has adopted a "no tolerance" policy that bans the stocking or importation of fish infected with whirling disease, the potential for accidental introduction still exists. The most devastating potential of the disease lies in the threat it poses to native salmonid populations that rely on natural reproduction.

Many of the bird and mammal SGCN are affected by diseases such as West Nile virus, rabies, hantavirus, pasturella, pneumonia, and bubonic plague. The growing wildland-urban interface exposes wildlife to potentially infected domestic pets and may contribute to the spread of these diseases. Increased exposure to refuse, pesticides or other toxins, and parasites may also affect wildlife at this interface and more broadly across the State. A fungus (*Pseudogymnoascus destructans*) that has caused massive die-off of millions of bats in eastern North America, commonly known as White-nose Syndrome, which, as yet, has not reached New Mexico but is of sufficient concern to prompt development of a multi-stakeholder White-nose Syndrome Response Team.

Phytophagous (plant-eating) insect outbreaks cause tree mortality and reduced growth in New Mexico's forests and woodlands (Haack and Byler 1993). Bark beetles and inner bark borers are primary tree killers (Haack and Byler 1993). Altered forest conditions have likely increased the frequency, intensity, and extent of insect outbreaks and diseases (Haack and Byler 1993, Wilson and Tkacz 1994, EMNRD 2004). Environmental stresses such as drought, late spring frosts, wind throw, and air pollution can encourage insect outbreaks (Haack and Byler 1993). Although insect outbreaks occur naturally in forest ecosystems, they can cause shifts in plant composition and structure (Haack and Byler 1993). Further, certain phytophagous insects are attracted to fire-damaged or fire-killed trees and their build-up in weakened host trees can threaten adjacent unburned stands (USFS 1999). The magnitude of disturbance from an outbreak depends upon the particular insect or pathogen and on the condition of the forest ecosystem affected (Wilson and Tkacz 1994). Closely spaced host trees are likely to trigger outbreaks of phytophagous insects and pathogens. In compositionally and structurally diverse forests, however, potential host trees can be harder for insects to locate among non-host trees, and vulnerable host trees may be relatively resistant to the small numbers of insects that find them (Waring and Pitman 1983, Hunter and Aarssen 1988).

The distribution of both native and exotic invasive species will be influenced by climate change. Some plant invasive species, like drought-tolerant tamarisk (*Tamarix* spp.), may be favored under future conditions, while others, like Russian olive (*Elaeagnus angustifolia*), may begin to retreat from hot areas (Perry et al. 2012). Within aquatic systems, warmer waters may help establish aquatic invasive species such as the zebra and quagga mussels and simultaneously reduce the effectiveness of biological and chemical control agents (Hellmann et al. 2008). Warming waters may facilitate the spread of cold-limited invasive fish species. On the other hand, increased fragmentation of water bodies may act to reduce or slow the spread of some exotic species (Hellmann et al. 2008). Drought may increase the susceptibility of higher-elevation ecosystems to invasion by exotic grasses, which in turn increases wildfire risk (Ford et al. 2012). Increases in fire and insects also favor invasive plant species that dominate disturbed habitats. Changes in the timing of precipitation (from summer to winter-dominated rainfall) and increasing carbon dioxide ($CO_2$) are expected to increase the encroachment of woody plant species into grasslands (Morgan et al. 2007). These conditions may also exacerbate human-related disruptions to grasslands (Hansen et al. 2001, Jetz et al. 2007).

Insect pest outbreaks are strongly influenced by environmental conditions. Drought-stressed forests and woodlands are more susceptible to insect outbreaks (Dale et al. 2001). Within New Mexico, large outbreaks of bark beetle infestations caused extensive dieback in forests during two extreme drought events in the 1950s and 2000s (Allen and Breshears 1998, Breshears et al. 2005, Ryan et al. 2008). Warmer temperatures and longer growing seasons can boost insect populations by increasing overwinter survival, increasing developmental rates, and facilitating range expansions (Logan et al. 2003, Williams et al. 2008). At the same time, increasing temperatures and drought stress plants and increase their susceptibility to infestation. Increased tree mortality due to insect outbreaks may exacerbate fire risk from heavier fuel loads and can lead to increased erosion and sedimentation.

There are many plant diseases, which are also strongly influenced by environmental conditions (Sturrock et al. 2011). Several diseases of trees, including root pathogens (e.g., *Armillaria* sp.) and canker pathogens, are more likely to reach epidemic levels where trees are weakened by heat stress and drought (Sturrock et al. 2011). Warm midsummer temperatures have been linked to explosive growth in Cytospora cankers (*Valsa melanodiscus*) and increased mortality in thinleaf alder (*Alnus incana tenuifloia*) in southwestern Colorado. Sudden aspen decline, a disease of quaking aspen (*Populus tremuloides*), presents a good example of how climate may impact forest species. This disease is characterized by rapid synchronous branch dieback and tree mortality at a very large scale. Drought has proven to be an important initial condition leading to sudden aspen decline. Further, sudden aspen decline in Colorado is almost entirely limited to the edge of aspen's climate envelope (Rehfeldt et al. 2009, Sturrock et al. 2011). Not all diseases will benefit from warming conditions, however. White pine blister rust (*Cronartium ribicola*), present within New Mexico's Sacramento and White Mountains, may decline if there are fewer wet periods in early spring and summer when temperatures are suitably cool for the spread of the basidiospore (Sturrock et al. 2011). Additionally, increased $CO_2$ concentrations can support increased growth, water efficiency, and disease resistance (Sturrock et al. 2011).

## *Pollution*

Wildlife in New Mexico may be exposed to pollutants in three primary forms: water pollution, air pollution, and solid wastes or materials. Riparian and aquatic SGCN are most vulnerable because water is a major transport medium and reservoir for pollutants that come from these sources (Novotny 1999, Akcil and Koldas 2005, Johnson and Hallberg 2005). Water pollutants include organic, inorganic, and potentially toxic substances that are discharged (intentionally or through secondary runoff) into streams and waterways. Within New Mexico, the largest number of stream of river water quality impairments have been attributed to agriculture, hyrdromodification, and urban-related runoff (NMED 2016a). Air pollution may include particulate matter, noxious gases, or emissions that lead to atmospheric changes or depositions that can lead to accumulated in wildlife through terrestrial or aquatic food chains. Vehicle fuel combustion, industrial sources, and power plants are considered to be major sources of air pollutants in New Mexico (NMED 2016b). Hazardous solid wastes may originate from Department of Energy, Department of Defense, or private commercial facilities. The majority of toxic chemical releases in New Mexico occur onto land surfaces, and individual facilities with the state's largest releases have been documented to occur from the metal and coal mining, chemical industry, coal mining, and utility sectors (EPA 2016). Discharges of all pollutant types are regulated through federal and/or state agencies and programs responsible for maintaining safe and clean human environments. However, impacts to wildlife populations depend upon individual species sensitivities and responses to various substances, as well as their levels of exposure to these pollutants.

Sulfides, metals (iron, manganese, and aluminum), and arsenic occur naturally in mineral deposits that are mined; they become pollutants when concentrated in tailings. All of these materials can be serious causes of mortality if they drain into rivers and streams. This is particularly true for sulfides, which become sulphuric acid when exposed to oxygen and water, and then devastate aquatic invertebrate populations of waterbodies to which they drain (Akcil and Koldas 2005, Younger et al. 2005).

Petrochemicals contain an array of hydrocarbons (benzene, benzopyrene, toluene, methylcholanthrene), polychlorinated biphenyls (PCB), and heavy metals that are toxic to wildlife. If consumed, these may cause lesions, cell deformation, decreased brain size, suppression of the immune system, and genetic damage in wildlife and fish embryos (McBee et al. 1987, Bickham and Smolen 1994, Custer et al. 1994, Briggs et al. 1996, Propst et al. 1999).

Both quantity and quality of available wetland and aquatic habitats influence the susceptibility of wildlife to pollutants and related factors. Waterfowl concentrated and crowded into reduced areas of remnant wetlands are increasingly susceptible to spread of disease. Concentrated levels of pesticides, herbicides, and salts from irrigated fields that drain into wetlands have been a major contributor to mortality of fish and waterfowl (Novotny 1999, Lemly et al. 2000).

# Conservation Actions: An Overview

Conservation actions should only be considered when supported by site specific information.

Conservation actions for mitigating threats to aquatic SGCN are listed here because these habitats, though of limited area, are widely distributed across the State. The threats that affect them are present in all the ecoregions in the State. Conservation actions for terrestrial habitats and SGCN are listed within ecoregion chapters because those threats often are unique to that area of New Mexico. Threats are listed according to the order presented by the IUCN (2016) and do not reflect relative severity in New Mexico. Within each potential threat category, actions are prioritized beginning with the most important to SGCN conservation. Those actions aimed at direct conservation or management of SGCN and their habitats generally received highest priority.

As new information becomes available, some actions will be modified to ensure optimal conservation outcomes. Of particular importance will be new and better information about climate change and factors related to it (e.g., emerging diseases, spatiotemporal changes in availability of food) that may test the adaptive capabilities and resiliency of SGCN.

The Department alone does not have the authority or resources to implement all conservation actions identified in this Plan. Thus, key to the Plan’s success will be collaboration with appropriate federal, tribal, state, and local government agencies, non-governmental organizations, private landowners, and interested and affected publics. In some cases, the Department will depend on collaborators to take the lead in implementing conservation actions. Examples of specific collaborators are identified after some actions, but the lists are not exhaustive.

Likewise, limited fiscal resources and staff also will preclude direct monitoring of the effect of all conservation actions. However, the Department will utilize and expand a variety of databases to gain needed information. For example, permit holders who collect SGCN for scientific or educational purposes could be required to report catch per unit effort. A full discussion of how the Department will approach monitoring is described in Chapter 11.

Ultimately, the following list of Conservation Actions represents the Department's best effort to identify potential actions that could be implemented to help conserve SGCN and aquatic habitats in New Mexico. The Department anticipates that this list will serve as a foundation for further identification of actions that can assist New Mexico's aquatic habitats and associated SGCN.

# Conservation Actions for Aquatic Species and Habitats

## Natural System Modifications*:*

- Document, monitor, protect, enhance, and restore ephemeral aquatic ecosystems (catchments, marshes/cienegas/springs, playas) to minimize the loss of these water bodies and their surrounding wetlands in New Mexico. Develop monitoring protocols and conservation actions for ephemeral aquatic habitats as well as the species and wetlands they support. In particular, focus efforts on wetland-obligate species that use these habitats for all or part of their life cycle or during migration. Potential collaborators: BLM, NRCS, USFS, NMED, SLO, NHNM, PLJV, private landowners.
- Re-connect stream and wetland habitats that have been fragmented by roads, culverts and other man-made structures that isolate and preclude movement of aquatic and semi-aquatic SGCN. Re-establish SGCN in areas where extirpated and appropriate. Potential collaborators: BLM, USFS, NMDOT, private landowners.
- Employ and support incentive programs, including those specifically designed for wetland conservation, to protect, enhance, and restore aquatic habitats.
- Consider appropriate policies to protect the biotic and abiotic resources of ephemeral aquatic ecosystems and to support higher water quality standards for wetlands and then only when supported by site specific information.
- Investigate the ecology of threats to and environmental conditions that limit SGCN that inhabit ephemeral aquatic habitats.
- Develop survey and monitoring protocols for aquatic invertebrate SGCN that currently are not monitored.
- Locate and protect SGCN that occur in high elevation aquatic ecosystems. Potential collaborators: USFS.
- Identify at-risk populations of SGCN that utilize aquatic habitats.
- Develop and maintain a database of the location and status of aquatic habitats. Use standardized monitoring and survey methods to classify and track gains and losses of habitat. Potential collaborators: NHNM, NMED
- Assess how ephemeral aquatic ecosystems affect wildlife meta-population processes.
- Assess wetland biodiversity and the relationship between local biodiversity and wetland size, spatial distribution, and connectedness.

- Examine and quantify how geographically isolated wetlands and wetland complexes contribute hydrologically, chemically, and biologically to other waters. Includes assessing how they contribute to surface and ground water quality.
- Create public awareness of the function, values, services, and products of ephemeral aquatic ecosystems.

## *Invasive and Problematic Species:*

- Investigate the current distribution of invasive and problematic species and diseases with special emphasis on their impact to SGCN and associated habitats.
- Develop and implement protocols to detect, reduce or eradicate non-native and invasive species. Potential collaborators: BLM, DOD, NRCS, USFS, USFWS, SLO, private landowners.
- Restore SGCN reduced by the presence of non-native species.

# Conservation Opportunity Areas

Conservation Opportunity Areas (COA) are areas in the State considered to have superior potential for conserving SGCN. Like all other components of the State Wildlife Action Plan (SWAP), COAs provide a non-regulatory tool to help focus and prioritize statewide actions to locations where conservation actions may maximize opportunities to prevent future listings of species, and to promote recovery of species that have already been listed. This landscape-level view of high biodiversity areas within New Mexico is not intended as a substitute for individual project decisions, or to preclude the need for site-specific assessments that may be considered in funding decisions by the Department and other resource managers. However, COAs can serve a vital function in prioritizing wildlife and habitat restoration efforts to the most critical wildlife needs within a state, as directed by the congressional language for the State Wildlife Grants (SWG) Program and its companion SWAPs.

The analysis of potential COAs utilized ArcGIS 10.2.2 (Environmental Systems Research Institute, Redlands, CA) to assess the capability and suitability of lands in New Mexico to be COAs. A GIS layer of Priority Habitats 1 and 2 (2.56 $km^2$ (1 $mi^2$) hexagonal mapping units) from the New Mexico Crucial Habitat Assessment Tool (CHAT) (http://www.nmchat.org/) was the foundation for COA selection. These priority habitats are considered vital for conservation of wildlife in New Mexico. Each hexagon was designated Priority Habitat 1 or 2 if it contained at least one species that was:

- important for recreation or economic value,
- recognized by The Nature Conservancy as imperiled globally or within the state (http://www.natureserve.org/conservation-tools/conservation-status-assessment),
- a candidate to be federally-listed as Threatened or Endangered, or
- state or federally-listed as Threatened or Endangered.

Hexagons not occupied by such species were designated as Priority Habitat 1 or 2 if they were part of a site identified as having high conservation value by the New Mexico Environment Department or Natural Heritage New Mexico (NHNM), to include additional aquatic features such as playas that were not represented as priority habitats through other mapped layers.

The Priority Habitat layer was intersected with five other GIS layers:

- points where SGCN were observed;
- polygons representing potential presence of SGCN (i.e., species distribution models based on environmental characteristics);
- polygons of large (≥1000 ha (2470 ac)) contiguous natural areas (“large intact blocks”; http://www.nmchat.org/);
- rasters (pixels) of terrestrial habitat; and
- vectors (lines) of streams and lakes.

For each hexagon, modeled or observed occurrences of potential SGCN and habitat types found within the hexagon were each grouped; then the number of records was multiplied by a weighted value. Species observations within hexagons were assigned weighted values based upon conservation attributes of those species. Numerical weighting scores were derived by evaluating population status (degree of imperilment worldwide as defined by NatureServe Conservation Status Assessment ranks (http://www.natureserve.org/conservation-tools/conservation-status-assessment), population trend, listing status, and availability of funding other than through SWG. Habitat weighting of each hexagon was based on the value to wildlife for each macrogroup present, following the tiering of habitats listed in Table 7. An extra point was added to the habitat score if the hexagon was within a large natural area. Scores for observations, potential presence, and habitats were recorded separately, normalized to a scale of 1-10 using the highest value[7] for all analyzed hexagons (n = 122,000), weighted (50% for the observation score, 20% for the potential presence score, 30% for the habitat score), and then summed.

The Getis-Ord Gi* Cluster Analysis algorithm (Getis and Ord 1992, Ord and Getis 1995) was used to group contiguous (i.e., shared edges or corners) hexagons that had scores statistically more similar to each other than other hexagons. Clusters comprised of hexagons with scores in the highest 10% across the State were selected as potential COAs. Some were small but in close proximity to other ecologically similar potential COAs. In these cases, those connected by contiguous hexagons whose scores were in the highest 50% across the State were combined into a single COA. In other cases, potential COAs too large for effective conservation were divided at physiographic boundaries (e.g., mountain ranges) into smaller COAs.

Lastly, the resulting COAs were intersected with polygons representing high priority areas for conservation: (1) The Audubon Society's Important Bird Areas (IBA), lands with diverse avifauna or rare bird species (http://nm.audubon.org/conservation/priority-ibas-new-mexico); (2) The Nature Conservancy's (TNC) Priority Conservation Area, lands where conservation efforts would be focused (www.nmconservation.org/projects/ecoregions); and (3) USGS Protected Areas database, to determine the proportion of areas managed for conservation of "biological diversity and other natural, recreation and cultural uses, managed for these purposes through legal or other effective means" (http://gapanalysis.usgs.gov/padus/data/).

Sixteen COAs were selected. The Arizona-New Mexico Mountains ecoregion contain the most (8) and the Southern Rocky Mountains ecoregion the least (1). In total, COAs cover only 4.9% (15,485 km$^2$ (5,977 mi$^2$)) of New Mexico (Figure 11), yet support 52% (122) of all SGCN (see Appendix G for more details). They also contain 31 of 33 habitats and four of six limited value habitat landcovers. Land stewards include federal (10,869 km$^2$ (4,195 mi$^2$); 70%), State (862 km$^2$ (332 mi$^2$); 5.5%), private (3510 km$^2$ (1,355 mi$^2$); 22.7%), and tribal (241 km$^2$ (93 mi$^2$); 1.6%) entities. Ninety percent of federal lands are administered by USFS. Twelve COAs encompass Important Bird Areas (IBAs), all contain TNC conservation areas, and on average, 33% (range: 0-81%) of each COA is protected for conservation of biodiversity.

[7] Ranges of values: SGCN observations (1-28); potential SGCN presence (1-31); habitat (1-17).

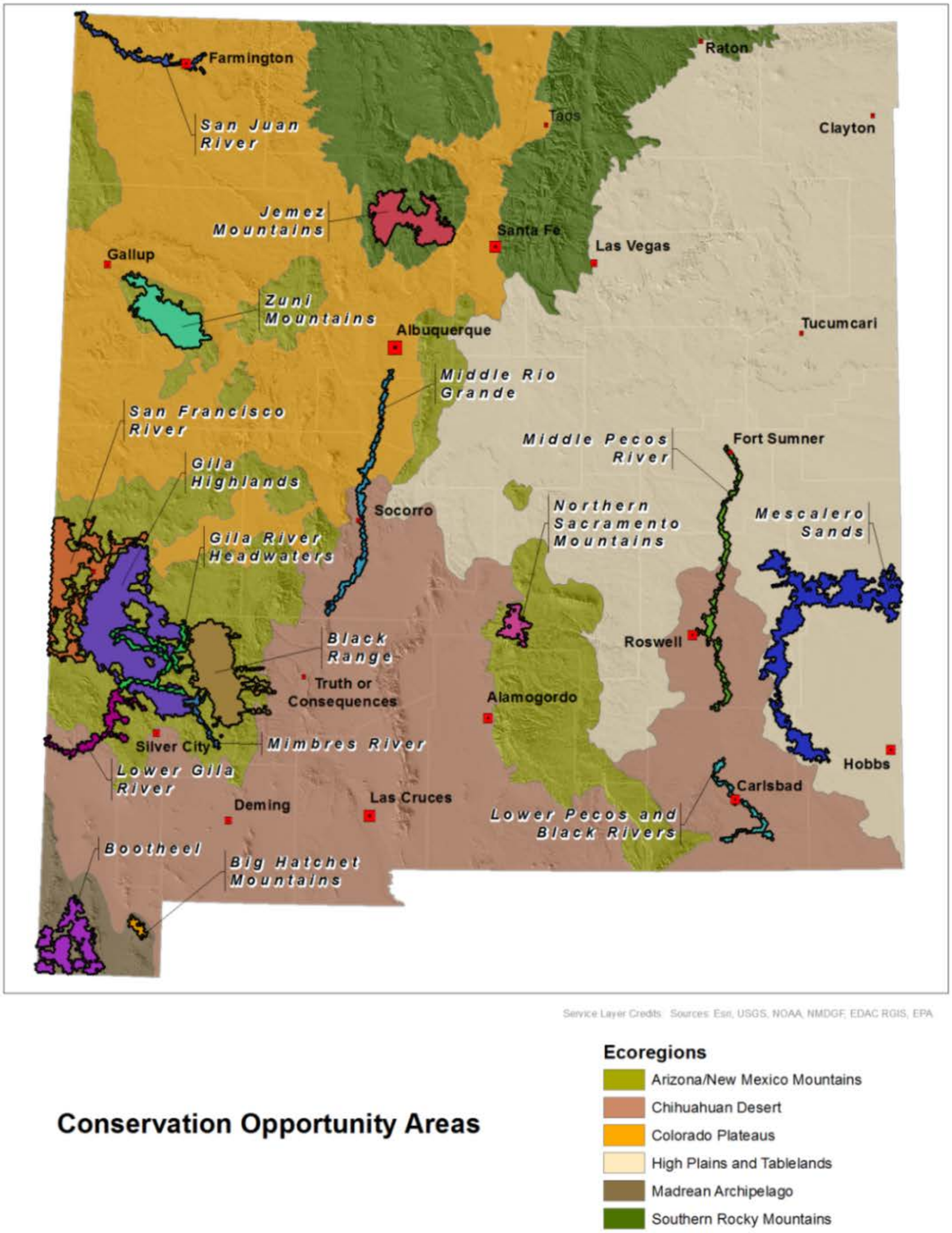



Figure 11. Conservation Opportunity Areas.

These are areas that have superior potential for conservation based on number and urgency for conservation of Species of Greatest Conservation Need and habitats they encompass.

# Chapter 4: Climate Change

Climate change is a pervasive factor that has the potential to affect nearly every wildlife species and habitat. Because its causes and effects often function on a global scale, wildlife managers may have little ability to influence a changing climate system that creates stressors or benefits for local wildlife populations. This document, while it recognizes the importance of efforts to address and mitigate the drivers of climate change, does not in any way create or direct policy with respect to these efforts. Rather, this Plan focuses on reviewing the current state of knowledge with respect to New Mexico's climate and potential climate-related changes in the state's habitats, and on outlining the types of resource management practices that can improve the resistance and resilience of wildlife populations and habitats to climate change.

This chapter discusses projected changes in New Mexico's climate and associated changes in New Mexico's wildlife habitats and impacts on New Mexico's wildlife. Climate change is considered in greater detail in this Plan than other stressors due to its broad geographic effects, ability to interact with other factors including wildfire and insect outbreaks, and because the 2006 Comprehensive Wildlife Conservation Strategy for New Mexico lacks any in-depth assessment of climate change effects to wildlife that can be used as a reference. The following information is modified from a report prepared by Megan Friggens of the US Forest Service Rocky Mountain Research Station, in collaboration with Karen Bagne and Jack Triepke. Full text of the report is at http://www.bison-m.org/documents/48358_Friggens2015SWAPccFnl.pdf.

## Historic Climate Change

Historic temperature records show temperatures have been increasing. The average global temperature for 2015 was the hottest on record (http://www.ncdc.noaa.gov/sotc/global/201513). Over the last century, temperatures within the western United States have increased by approximately 1.2 °C (Spears et al. 2013), with a corresponding decrease in record breaking cold months (Wuebbles et al. 2014). In New Mexico, mean surface air temperature increased by 1 °C from 1985 to 2005, though most of this warming occurred between 1995 and 2005 (Rangwala and Miller 2010). Temperatures within the Rio Grande Basin during the period spanning 1995 to 2004 were more than 1.1 °C higher than those observed during the 1961 to 1990 period (D'Antonio and Watkins 2006). Seasonally, mean temperatures have increased more during winter than spring or summer months. The greatest increases in temperature have been observed in the southwestern, central, and northwestern regions of New Mexico, particularly within the Jemez Mountains in the northwest (Enquist and Gori 2008). Most other mountain ranges in the state have experienced increases in temperature with the exception of parts of the Gila River headwaters, the Zuni Mountains, and the Sangre de Cristo Mountains.

Changes in snowpack, and associated changes in streamflow, have been documented. In recent decades, there has been a marked increase in the percentage of precipitation falling as rain rather than snow across the western mountain region of the United States. Since the 1950s, 74 percent of weather stations across the region recorded an increase in the percentage of precipitation falling as rain instead of snow, along with a 15-30 percent decline in snow water equivalents (the amount of water contained within the snowpack) (Fields et al. 2007). Across the west, peak stream flows from snow melt are arriving earlier than they did historically (McCabe and Wolock 2007, Lundquist et al. 2009). The snowpack in the majority of New Mexico's mountain ranges has declined over the last two decades and peak flows from snowmelt now occur an average of one week earlier than they did 50 years ago (Enquist and Gori 2008). Importantly, these changes appear to be the result of warmer temperatures rather than changes in the amount of precipitation received (Fields et al. 2007). Decreased snowpack in the mountains and earlier onset of snowmelt reduce the likelihood of sufficient water availability during the summer months when both natural and anthropogenic demand is greatest.

# Future Climate Change

Climate projections indicate that the southwest will dry over the 21st century, and that this transition to a more arid climate is already underway (Seager et al. 2007). Increased temperatures will be accompanied by increased severity and duration of heat waves and droughts, greater variability in precipitation, increased rates of evapotranspiration (loss of water to the atmosphere from the ground surface and leaves of plants), and increased frequency and intensity of wildfires and insect outbreaks (Easterling et al. 2000, Fields et al. 2007, Garfin and Lenart 2007). Maximum temperatures are projected to increase slightly more than average minimum temperatures (Figure 12). Decreased precipitation will exacerbate many of the effects of increasing temperatures, including increased evapotranspiration rates and reduced snowpack and water flow during the spring and summer.

While the number of precipitation events in New Mexico is expected to decline (Spears et al. 2013), individual precipitation events likely will become more intense, especially during the winter (Dominguez et al. 2010, Collins et al. 2013). The amount of precipitation falling during these intense events is projected to increase by 50 to 90 percent, with an increase in the likelihood of rain events over snow events.

Climate extremes will likely be intensified under global warming with an increased likelihood of more extreme dry and wet seasons (Wuebbles et al. 2014, Swain and Hayhoe 2015). Many areas are likely to experience novel climate regimes with mean climate conditions projected to be hotter and drier than previously recorded (Notaro et al. 2012). Extreme climatic conditions may be more important for predicting habitat and species response to climate change because these may be more limiting than average conditions.

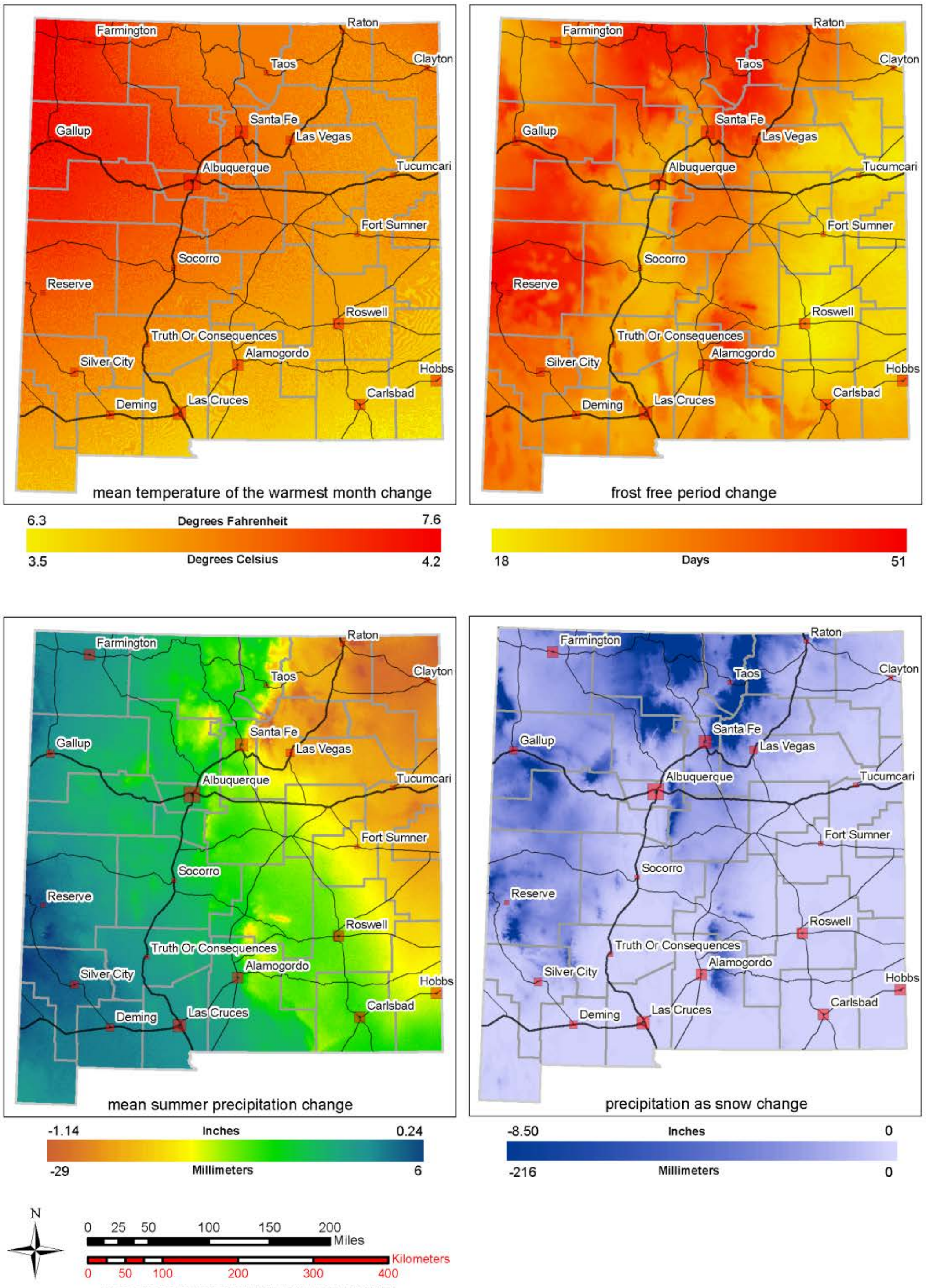



Figure 12. Projected changes in climate from 1961-1990 to 2050.

The upper left map shows changes in mean temperature of the warmest month, the upper right map shows changes in the length of the frost free period, the lower left map shows changes in mean summer (May to September) precipitation, and the lower right map shows changes in precipitation as snow. Data were obtained from the AdaptWest Project (2015).

# Climate Change Interactions with Other Threats

Climate change effects may intensify other stressors, including insects and disease. A prominent example of current climate change effects within western North America is the widespread die-off of conifer species driven by the interaction of drought, insects, and fire (Breshears et al. 2005). Climate change influences some processes directly and others indirectly, thus, few interactions between climate change and other stressors have a clear direction. For example, increased fire activity is likely to favor fire-adapted species causing shifts in plant communities (McKenzie et al. 2004). Temperature and moisture conditions affect tree host susceptibility to pathogens, pathogen transmission among trees, and the ranges of both hosts and pathogens. Drier conditions are likely to reduce plant productivity but increased carbon dioxide ($CO_2$) concentrations may support increased growth, water efficiency, and resistance to disease (Sturrock et al. 2011).

Climate change is expected to exacerbate the effects of land use change and habitat fragmentation on wildlife populations. For example, in southwest riparian ecosystems, future increases in periods of drought and intense heat are expected to increase rates of habitat loss and fragmentation, processes that limit the capacity of wildlife populations to adapt to changing conditions. These processes are further compounded by water extraction and invasive species. The Rio Grande is already suffering from the effects of water extraction and is considered at risk of more extreme flood events due to the urbanization of its watersheds (Palmer et al. 2009). The interactive effects of land use and land use change, water withdrawal, species invasions, and climate change pose a real threat to the persistence of functional aquatic systems in the southwest and the wildlife communities that depend upon them (Meyer et al. 1999). Further descriptions of interactions between climate change and other threats to Species of Greatest Conservation Need (SGCN) and their habitats are provided in later sections.

# Future Changes to Terrestrial Ecosystems

Temperature and precipitation define the environmental and hydrological conditions that determine vegetation composition and distribution at large scales. At smaller scales, vegetation responds to topography, competition, and animal influences. The sensitivity of vegetation to climate change relates to the degree to which smaller scale factors ameliorate or exacerbate climate impacts. Direct impacts of climate change on vegetation result from conditions that limit plant establishment, growth, productivity, and life history events (e.g., reproduction). Indirect effects include impacts from changing disturbance regimes (e.g., increased fire frequency and intensity). Changes in the timing of critical events, such as peak stream flows, and increases in the frequency of climate extremes, including heat waves and drought, will cause shifts in vegetation communities by disrupting ecological processes, and impacting plant recruitment and survival. Water availability is the primary factor limiting plant growth within the southwestern US In areas where there is adequate water supply, (e.g., high elevation forests), temperature is the more important limiting factor (e.g., length of growing season).

Still, many studies indicate that temperature alone drives changes in a variety of variables including tree growth (Williams et al. 2010), biodiversity (Currie 2001, Hansen et al. 2001), and plant species distributions (Notaro et al. 2012). This is likely due to the influence of temperature on evapotranspiration, which can amplify water stress during drought (Williams et al. 2013). For most of New Mexico, future rising temperatures will increase evapotranspiration rates and the likelihood of water deficits, which will limit plant growth and favor drought-tolerant species (Raymond et al. 2014).

Vegetation distributions across landscapes depend on climate and related factors (e.g., fire regimes). Shifts in vegetation distributions due to climate change are expected to be most dramatic at ecotones (the boundaries between ecosystems), particularly those in semi-arid landscapes (Allen and Breshears 1998, Kupfer et al. 2005, Joyce et al. 2008). For example, in Northern New Mexico in the 1950s, the ecotone between ponderosa pine (*Pinus ponderosa*) forest and piñon-juniper woodland shifted rapidly (<5 years) and extensively ($\geq$2 km) following mortality of ponderosa pine forest in response to severe drought (Allen and Breshears 1998). Within the shift zone, forest patches became more fragmented and soil erosion became more severe. This shift has persisted for over 40 years, indicating that the conditions resulting from these sudden changes may be comparatively long-lasting. Because regional droughts of greater magnitude and longer duration than the 1950s drought are expected under future climate change scenarios, the ecological effects of droughts, especially those at ecotones, are likely to be even greater than those described here.

Importantly, our understanding of climate impacts on New Mexico's wildlife habitats is still growing and subject to change and refinement. Climate projections can fall outside of known historical climatic ranges, thus preventing a perfect view of future conditions (Currie 2001, McKenney et al. 2007, Williams et al. 2013). In addition, changes to atmospheric carbon dioxide concentrations, which not only drive changes in climate but also influence plant water use efficiency and growth, may modulate vegetation response to hotter and drier conditions (Notaro et al. 2012).

## *Grasslands*

Grasslands are likely to be highly vulnerable to invasive species under a changing climate (Chambers and Pellant 2008, Morgan et al. 2008). Of particular concern for grasslands is that climate change may increase invasion by woody species (Morgan et al. 2007, Enquist and Gori 2008). In recent decades, creosote (*Larrea tridentata,* a shrub) has been spreading into grama grass (*Bouteloua* spp.) dominated grasslands in central New Mexico (Gill and Burke 1999) and honey mesquite (*Prosopis glandulosa*) and creosote have been spreading into black grama (*Bouteloua eriopoda*) grasslands in southern New Mexico (Buffington and Herbel 1965, Gibbens et al. 2005). Drought and shifts towards increased winter precipitation seem to be the most important climate drivers of woody plant encroachment into grassland environments (Brown et al. 1997, Pennington and Collins 2007, Báez et al. 2013, Munson et al. 2013). Warming winter temperatures can also favor shrubs, although temperature extremes during summer may actually increase mortality of shrub species (Backlund et al. 2008, Ryan et al. 2008).

Studies simulating potential range changes of grasslands under future climate scenarios agree that grassland habitats are likely to decline. Notaro et al. (2012) projected widespread loss of grassland vegetation, particularly across central New Mexico. Grass die-off over the next 70 years was most strongly correlated with changes in precipitation. Model-projected changes include large spring-summer drying trends.

## *Shrublands*

Temperature appears to be the most important climate variable for predicting shrub species distributions across the southwest. Shrublands will likely respond positively to increased mean annual temperature and increased minimum and mean winter temperatures (Notaro et al. 2012). Projected increases in winter precipitation are also likely to lead to shrubland expansion. Increased precipitation during warm months could have positive effects on shrublands, but may cause a transition to non-shrub habitat at grass-shrub transition zones (Crist et al. 2014). Increases in maximum temperatures induce stress on plants and may have a negative impact on shrublands when drought conditions limit water availability. Fire frequency is projected to increase within several shrubland types (Moritz et al. 2012), which is likely to favor grasslands.

## *Forests*

Projections indicate that climate change will have profound impacts on forest ecosystems across western North America. Most woody species are expected to shift northward to track suitable climate conditions. Many higher elevation species are projected to experience range contractions as suitable climates disappear. Alpine (above tree line) and subalpine (below tree line) habitats may experience dramatic changes, including movement of trees into alpine areas and an increase in tree density in subalpine areas. Lower elevation forest species are likely to move upslope. However, the complexity introduced by terrain and differences in dispersal abilities of different species makes it unlikely that species and communities will be able to exactly track suitable climate conditions. Further, actual shifts in communities are likely to differ from predicted responses because individual species will respond uniquely to climate change (e.g., Rehfeldt et al. 2006) and community composition may change. Alpine habitats (above tree line) are likely to all but disappear (Hansen et al. 2001). Mid- and lower elevation forests and woodlands may expand upslope, and will be more susceptible to increased fire and drought conditions at lower elevations.

Rising temperatures will increase evapotranspiration rates and amplify water limitations, leading to increased tree stress and mortality, particularly during drought periods (Williams et al. 2013). Drought-stressed forests are particularly sensitive to insect outbreaks, disease, and wildfire, all of which are expected to increase in frequency, intensity, and geographic extent with a warming climate. In recent decades, intense droughts, insect outbreaks, and wildfires have resulted in widespread tree mortality across the southwest (Breshears et al. 2005, Williams et al. 2010). Williams et al. (2010) found that between 1984 and 2008, 18 percent of forests in New Mexico and Arizona experienced mortality related to these factors. These calculations were made prior to several major fires in both New Mexico and Arizona, including the Las Conchas, Wallow, and Whitewater-Baldy fires. If modeled predictions hold true, about half of the needle-leaved evergreen forest cover in this region will be converted to shrub and grass cover by the end of the 21$^{st}$ century (Jiang et al. 2013). Given that forest mortality events are expected to continue to happen rapidly and over large areas, there is an urgent need to develop adaptive strategies that will address climate-related threats to these ecosystems in New Mexico.

## *Piñon-juniper Woodlands*

Piñon-juniper woodlands (*Pinus edulis* and *Juniperus monosperma*) have recently spread into ponderosa pine woodlands in north central New Mexico (Allen and Breshears 1998). Juniper species (*Juniperus* spp.) have also expanded into grasslands in southwestern New Mexico (Romme et al. 2009). However, woodland species, especially piñon pine trees, are highly susceptible to attack by bark beetles (*Ips confusus*) and twig beetle (*Pityophthorus opaculus*). Warmer temperatures increase bark beetle survival and developmental rates leading to more severe outbreaks (Bentz et al. 2010). Drought conditions and delayed onset of monsoons have increased mortality in infested piñon pine (Gustafson et al. 2015). Although juniper is somewhat more drought-tolerant, it also experiences increased mortality rates during persistent droughts (Breshears et al. 2005, Gaylord et al. 2013). It is likely that these widespread mortality events will become more frequent as the climate changes. Wildfires are expected to increase in woodland habitats (Moritz et al. 2012) and may lead to a shift to grassland or shrubland habitats at woodland ecotones.

## *Riparian Habitats*

Flow dynamics have a strong influence on the composition of riparian plant communities. Climate changes that reduce stream flow are expected to reduce the abundance of cottonwoods (*Populus* spp.) and willows (*Salix* spp.), the structural dominants in the floodplains of many desert rivers (Stromberg et al. 2013). Conversely, reductions in stream flow will favor certain herbaceous species, late-successional species, and drought-tolerant woody species. Warmer and prolonged growing seasons will increase water use through increased evapotranspiration, potentially reducing water availability and lowering water tables, especially later in the growing season (Perry et al. 2012). The persistence of comparatively shallow-rooted cottonwood and willow is dependent on near-continuous availability of shallow groundwater. If water tables decline, or become more variable in response to increasing aridity or water extraction, the productivity and abundance of cottonwood-willow communities will decline. At the same time, lowering water tables encourage the establishment of deeper rooted and drought-tolerant species, such as exotic tamarisk (*Tamarix* spp.) and Russian olive (*Elaeagnus angustifolia*) (Stromberg et al. 2013). Thus, potential shifts from perennial to intermittent flows in many riverine habitats may have large consequences for riparian plant community composition. Tamarisk is tolerant of intermittent flows, produces seed throughout the summer, and prefers disturbed sites (Perry et al. 2012), so it has the potential to be more competitive than native vegetation in these altered conditions. However, the tamarisk beetle has been expanding its range in New Mexico and will inhibit or kill tamarisk in these changed environments (Bloodworth et al. 2016).

Climate change is likely to disrupt phenology (timing of biological and ecological events, such as seed dispersal) within riparian plant communities, potentially increasing mortality of established communities and decreasing reproduction of native species. Early spring budburst and warmer autumns may increase productivity and growing season length for many plants, but could also increase frost injuries to young plants when late spring frosts occur. Increased autumn temperatures could affect seed dispersal of autumn fruiting riparian trees, like netleaf hackberry (*Celtis reticulata*), and slow the development of cold-hardiness in some species, like cottonwoods. Warmer spring temperatures may lead to early seed dispersal in species such as Freemont cottonwood (*Populus fremontii*) and Goodding's willow (*Salix gooddingii*). Spring floods are necessary for seedling establishment in these species, thus earlier seed dispersal or earlier flooding, associated with earlier snowmelt, may reduce cottonwood-willow seedling recruitment if seed release and peak flows lose synchrony. Changes in the timing of either seed dispersal or spring runoff events could therefore limit successful recruitment and persistence of the cottonwood-willow community, impacting the many species that depend upon riparian ecosystems for all or part of their life cycle (Perry et al. 2012).

# Future Changes to Aquatic Ecosystems

River flow and reservoir and lake levels in New Mexico are strongly tied to rainfall during the monsoon season (July-September) and winter (November-March) snowpack (Enquist et al. 2008). Approximately 40 percent of annual precipitation falls during the monsoonal storms in July and August. Another 20 percent falls during spring and fall months. Winter precipitation accounts for the remaining 40 percent (~75 percent of which falls as snow in mountainous areas; Enquist and Gori 2008) and is driven by frontal activity over the Pacific Ocean, which varies from year to year depending on the El Niño Southern Oscillation (ENSO). The Pacific Decadal Oscillation and Atlantic Multi-decadal Oscillation also influence winter precipitation, though they fluctuate over longer, multi-decadal scales and act to enhance or dampen ENSO driven trends.

Climate change alters many factors that influence hydrological cycles, including the timing, amount, and intensity of precipitation events and rain-snow ratios (Collins et al. 2013). These factors have a number of cascading effects on water volume, quality, and erosion within watersheds in New Mexico. Despite variations among climate models, all support predictions for less snow, earlier snowmelt, and increased variability in the timing and intensity of storms. Within New Mexico, most flowing streams depend upon winter snow accumulations for spring and summer flows. Reduced snowpack and earlier, more rapid snowmelt will result in earlier peak flows. Years with poor snowpack levels are likely to result in very low flows by the time monsoon storms begin (mid- to late summer).

Warm season runoff is projected to decline substantially over the southwestern US and Southern Rockies (Spears et al. 2013). Hoerling et al. (2009) estimate a 2-9 percent reduction in runoff for each degree Celsius increase in temperature in the Upper Colorado region. Hurd and Coonrod (2008) predict a 3.5-13.7 percent decrease in the mean annual flow of the Rio Grande in 2030 compared to the period spanning 1970-2000. These impacts have consequences not only for flowing stream bodies, but also for seeps and springs. Ephemeral water bodies will experience increased water temperatures and evaporation rates, thus reducing their value and availability as habitat.

Rain-snow transition zones are projected to undergo dramatic shifts to higher elevations within New Mexico and nearly all of the mountain ranges are considered at-risk with snowpack likely to decline substantially over the next century. By 2035-2065, mountain ranges within the Southern Rocky Mountains, Arizona/New Mexico Mountains, and the Colorado Plateaus ecoregions will have a much shorter period of snowfall and a greater amount of winter precipitation falling as rain. Only the northernmost mountains within the Colorado Plateaus ecoregion will continue to receive snow-dominated precipitation, although most months are projected to have a rain-snow mix even in this region. At the watershed level, predicted changes to the amount of area dominated by snowfall, rain-snow mixes, and rainfall are dramatic. For example, the snow-dominated extent of the upper Pecos River watershed is expected to disappear, while its rain-dominated extent is expected to increase by 23 percent. Likewise, the rain-dominated extent of the Rio Grande–Elephant Butte watershed is estimated to increase by 51 percent, while the Gila River watershed will become entirely rain-dominated. The snow-dominated extent of the Rio Grande headwaters will decline by 29 percent. Although future temperatures in New Mexico are predicted to mostly exceed those necessary for snowfall, the steep elevational gradients in some parts of the State may delay or reduce this loss at the local scale (Klos et al. 2014).

## *Perennial Cold Water Streams*

Climate change will decrease the availability of cold water stream habitat suitable for cold-adapted species. Many reaches within lower elevation and southern sites may no longer be suitable for cold water species. The type of precipitation received (i.e., rain or snow) can influence spring snowpack, the risk of flooding associated with rain-on-snow events, and the timing of snowmelt-driven stream flows in mountain catchments (Klos et al. 2014). The reduction in freezing temperatures within New Mexico has implications for the timing of spring snowmelt as well as the persistence of cold water streams. Loss of snowpack is predicted for most of New Mexico’s mountain ranges, which will result in reduced frequency and magnitude of spring flood events and summer flows. Lower stream flow amounts are likely to warm more quickly in response to increasing air temperatures (Spears et al. 2013). Warming water will result in a reduction in the availability of habitat for species dependent upon cold water habitats (Fang et al. 2004a, Fang et al. 2004b). For native species adapted to cold water, increased temperatures can increase thermal stress, create migration barriers, fragment habitat, and reduce reproductive success (Meyer et al. 1999, Perry et al. 2012). At the same time, increases in water temperature will likely favor the expansion of invasive aquatic and riparian species (Rood et al. 2008, Theobald et al. 2010). Decreased precipitation and increased temperatures are also expected to decrease riparian vegetation cover and increase erosion, leading to increased sedimentation in many stream and river systems (Theobald et al. 2010). Extreme weather events and post-fire erosion and debris flows can also impair water quality and impact nutrient cycling. Feedbacks between runoff volume, erosion, water quality, and evapotranspiration commonly lead to degradation of aquatic habitats (Lettenmaier 2008).

## *Perennial Warm Water Streams*

River corridors support a disproportionate amount of biodiversity in the southwest (Pase and Layser 1977). Climate change will likely reduce the availability and quality of perennial warm water systems, particularly in the southern part of New Mexico. In southwest riparian systems, drought and intense heat will likely reduce and fragment riparian habitat, issues compounded by water extraction and spread of invasive species (Palmer et al. 2009). Milly et al. (2007) projected a substantial decrease in annual runoff in the southwest under warmer conditions. Several preexisting conditions increase the vulnerability of New Mexico’s river systems to climate change. First, perennial river systems are largely supplied by snowpack, making them less buffered against the drying trends associated with a warming climate. Second, many of these systems are dammed or within logged or urbanized watersheds, reducing their resilience to increasing climate variability. In addition, dammed rivers tend to experience more drawdown of water, leaving little water available to sustain environmental flows (Palmer et al. 2009). Higher water temperatures have multiple effects for temperature-dependent species (Eaton and Scheller 1996, Johnson et al. 2005) including the likely expansion of invasive species in both aquatic and riparian habitats (Rood et al. 2008, Theobald et al. 2010). Increased salinity as a result of increased evaporation rates may also become a problem. In the western Great Plains, increased salinity is predicted to lead to a loss of endemic fish species (species that are found in a particular locality and nowhere else), many of which are already near their thermal tolerance limit (Meyer et al. 1999).

## *Perennial Lakes, Cirques, and Ponds*

The responses of lakes to climate change are influenced by their thermal stratification and depth (Spears et al. 2013). Warmer waters may facilitate the establishment of aquatic invasive species while reducing the effectiveness of biological and chemical control agents (Hellmann et al. 2008). Increases in salinity due to increased evaporation and reduced precipitation may exacerbate the rate of species invasions and lead to widespread changes in food webs (Meyer et al. 1999). Warmer water can encourage algae growth, leading to low oxygen conditions in lakes (Lettenmaier 2008). Higher water temperatures have multiple effects for temperature-dependent species (Eaton and Scheller 1996, Johnson et al. 2005). Systems that become isolated are at potentially increased risk of endemic species extinction due to climate change.

## *Perennial Marshes, Cienegas, Springs, and Seeps*

Wetland habitats (including marshes and cienegas) in New Mexico are currently threatened by drought and land disturbance. Although there are no known models that predict future conditions for wet meadows, it is likely that these systems will continue to decline under climate change. In the semi-arid environment of New Mexico, the overall abundance of wetlands tends to be greater at higher elevations, though local physiographic characteristics can also impact wetland abundance. Temperature and precipitation strongly influence marsh formation, persistence, and function. As a result, marshes are very sensitive to climate fluctuations (Perry et al. 2012, Gage and Cooper 2013).

Changes in precipitation and elevated evaporation rates due to increased temperatures can change the seasonality, depth, and duration of marsh or wetland hydroperiods (periods of available surface water), with subsequent consequences for marsh function and vegetation dynamics. In particular, hydrological variability is recognized as a predictor of vegetation patterns in marshes (Gage and Cooper 2013). Lowering of water tables as a result of hotter and drier conditions will increase decomposition in wetland soils and reduce carbon storage potential. Elevated atmospheric $CO_2$ may increase growth rates and biomass of wetland plants. Wetland hydrology may change considerably with changes to the timing of snowmelt, reduced snow pack, and increased winter flows resulting from increased rain versus snowfall. Increased frequency of summer drought periods will cause many wetlands to transition from permanent to more ephemeral (temporary) habitats (Poff et al. 2011). Wetlands are often widely dispersed across the landscape, limiting the capacity of wetland-dependent species to migrate to new locations as temperatures and water levels change and increasing the chance of extinction for endemic species. Alpine wetlands will likely be highly susceptible to negative impacts of climate changes because they are likely to lose species that cannot disperse to new sites.

## *Perennial Cold Water Reservoirs*

Cold water reservoirs may be more susceptible to changes in inflow resulting from climate change. Reservoirs within the Colorado River Basin are likely to be very sensitive to changes in inflow, with substantial drops in reservoir levels from small reductions in runoff (Christensen et al. 2004, Christensen and Lettenmaier 2007). Reservoirs on upper tributaries to the Colorado River are considered more vulnerable to changes in flow timing and snowmelt than those along lower elevation systems (Spears et al. 2013). Increased water temperatures could promote productivity and expand habitat for warm water species (Perry et al. 2012) at the expense of cold-adapted species (Raymond et al. 2014). For cold-adapted species, warmer temperatures can increase thermal stress, create migration barriers, and reduce reproductive success (Perry et al. 2012). Cold water refugia may decrease substantially within reservoirs. Collectively these impacts can change reservoir food web dynamics.

### Assessments of Climate Change for New Mexico’s Watersheds

Two climate change vulnerability assessments have considered watersheds within New Mexico. Enquist et al. (2008) ranked vulnerability of watersheds in New Mexico according to their magnitude of exposure to climate change and biological diversity. In general, lower elevation watersheds have experienced greater drying than higher elevation watersheds, although about 93 percent of all watersheds showed some decrease in moisture availability over the 1970-2006 study period. Some lower elevation watersheds, primarily in the southeast quadrant of the state, experienced less drying during the summer and fall. The Jemez, Cloverdale, and Playas Lake watersheds were identified as the most vulnerable due to the magnitude of observed moisture stress and the high numbers of SGCN. The Pecos Headwaters, Upper Rio Grande, Upper Gila, and San Francisco watersheds exhibited relatively less moisture stress.

Theobald et al. (2010) reviewed and analyzed threats to riparian ecosystems in the western United States using a risk assessment approach that considered human modification, climate change, and hydrological systems. The lower Colorado River and Great Basin regions contained the greatest number of modified watersheds. The effect of modification was more pronounced in steeper and more arid parts of the west, including within the Southern Rocky Mountains. Overall, the highest combined threat score was found for western Washington, the Great Basin, southern Idaho, northern Utah, and southern Arizona and New Mexico. Southern Arizona and New Mexico received very high riparian threat scores. Interruption of flows due to drying or other factors was among the worst for watersheds in Arizona and New Mexico, although these same watersheds were not among those with the highest degree of modified riparian area.

## *Perennial Warm Water Reservoirs*

Reservoirs and other open water habitats may be relatively buffered from climate change impacts because they are relatively stable over time compared to flowing water and ephemeral systems (Matthews 2008). Increases in water temperatures will be less severe in larger water bodies compared to catchments and ponds. Still, reservoir impacts from climate change are influenced by their thermal stratification and depth (Spears et al. 2013). There is a risk in these systems that water column turnover periods, important for nutrient cycles within lake systems, would be disrupted by climate-related changes to water temperature and volume (Matthews 2008).

Warmer waters may facilitate the establishment of aquatic invasive species, such as the zebra mussel (*Dreissena polymorpha*) and quagga mussel (*Dreissena bugensis*), and simultaneously reduce the effectiveness of biological and chemical control agents (Hellmann et al. 2008). Warmer water can also encourage algae growth and decomposition leading to low oxygen conditions (Lettenmaier 2008). Higher water temperatures have multiple effects for temperature-dependent species (Eaton and Scheller 1996, Johnson et al. 2005) and could expand habitat and promote productivity of warm water species (Perry et al. 2012).

Demand for water is expected to increase under warming conditions (Perry et al. 2012), leading to increased water shortages. Efforts to maintain reservoir storage and supply under drier and hotter climates will decrease downstream flow variability and flow magnitude, exacerbating direct effects of climate change on river and riparian systems.

## *Ephemeral Marshes, Cienegas, and Springs*

Marshes/cienegas/springs are at high risk from the synergistic effects of human-related habitat disturbance and climate change (NMDGF 2006). Currently, these habitats are limited due to declining water tables, land use changes, and water extraction. Increased temperatures will increase evapotranspiration, leading to greater rates of water loss and decreased availability of surface water. Increased variability in annual precipitation, delayed onset of monsoon precipitation, and potentially drier spring conditions will also reduce the availability of these habitats. Water quality also is likely to decrease where post-fire flooding and erosion cause increased water turbidity and sediment load.

## *Ephemeral Catchments (playas, pools, tinajas, kettles)*

The exclusive reliance of playas on direct precipitation and runoff (Gage and Cooper 2013) means that these systems are highly vulnerable to potential changes in precipitation. In eastern New Mexico, playas may be especially vulnerable to climate impacts under future, drier conditions (Matthews 2008). Where they persist, increased variation in precipitation events and increased frequency of droughts will reduce the hydroperiod (period of available surface water) of many catchments. Increases in salinity due to increased rates of evaporation along with decreased precipitation may exacerbate the rates of species invasions (Meyer et al. 1999). Many of these systems are isolated, which increases the risk of species extinction as a result of catchment loss or degradation.

# Vulnerability of SGCN to Climate Change

Climate change is already altering ecosystems and presents a substantial threat to the conservation of biodiversity (Hughes 2000, Peñuelas and Filella 2001, Root et al. 2003). Climate-related change in extinction risk will vary by species, taxonomic group, region, and time elapsed leading to questions about where to focus conservation efforts (Peterson et al. 2002, Thomas et al. 2004, MacLean and Wilson 2011). In the southwest, climate change analyses have primarily focused on rare or special status species, but fish and invertebrate species have rarely been assessed (Friggens et al. 2013). Grasslands have also been underrepresented in recent assessments (Friggens et al. 2013).

Response of species to climate change is particularly important in the context of SGCN, because ongoing conservation efforts could be overwhelmed by additional climate-related impacts or new stressors may be overlooked, leading to missed opportunities for intervention. Below we outline how climate change affects species and illustrate how information on vulnerability to climate change can be used to improve management actions by presenting two case studies.

## *Defining Vulnerability*

Although there is some controversy over the precise use and meaning of *vulnerability* in the context of climate change, most think of it as the susceptibility of a species, community, or ecosystem to negative impacts (Füssel 2007, Hinkel 2011). The term “vulnerability” as used in this chapter has a more narrow definition than the “vulnerable” criterion used in the SGCN selection process. Low vulnerability can be taken to mean low susceptibility or higher resilience to negative impacts. Some species may even experience increasing or expanding populations and distributions due to climate change. Climate change vulnerability is sometimes defined by the effects of exposure, sensitivity, and adaptive capacity (Glick et al. 2011). Exposure is based on projected changes in climate and climate-related phenomena (e.g., fire, floods) while sensitivity (i.e., how exposure is experienced) and adaptive capacity (i.e., ability to reduce negative impacts of exposure or species sensitivity) are properties of the species that can help predict how they will respond to climate change. Difficulty in predicting the response of species arises, in part, because projections of exposure tend to be large in scale (i.e., several $km^2$ or $mi^2$) while individual plants and animals often interact with their environment at much smaller scales.

When species conservation is the goal, vulnerability is measured by change in extinction risk and is generally deduced from projected geographic shifts in suitable range, by identifying species traits that predict climate change response (i.e., changes in survival or reproduction), or through a combination of these approaches (Preston et al. 2008, Notaro et al. 2012, Bagne et al. 2014).

## *Species Vulnerability to Climate Change*

Many species are expected to incur negative impacts from climate change (Foden et al. 2009, Gardali et al. 2012, Bagne et al. 2014). Species already at risk of extinction may be particularly vulnerable to these impacts. A review of special status species in the Middle Rio Grande region revealed that at risk terrestrial species were more vulnerable or likely to experience population declines, indicating that additional conservation efforts will be needed (NABCI 2010, Bagne et al. 2014). Similarly, a review of freshwater fish in California found that climate change vulnerability was positively correlated with current extinction risk (Moyle et al. 2013).

Mountainous regions and associated taxa are particularly vulnerable to change because precipitation and temperature vary rapidly across a relatively small area (Lawler et al. 2009). Importantly, mountains can create isolated islands of habitat, particularly where surrounding flatlands have very different environments, as is the case in the southwest. Wetland, riparian, and aquatic habitats, and thus associated species, also are particularly vulnerable in the southwest because their distribution is highly localized and these habitats have already been heavily modified and degraded (Patten 1998).

For all taxonomic groups, specialist and sedentary species are considered more vulnerable than generalist and highly mobile species (Foden et al. 2009, Gilman et al. 2010). Specialists are species that survive under a narrow range of environmental conditions and are thus more likely to be vulnerable to population declines than generalists, which are able to thrive under a wide variety of environmental conditions.

While species in every taxonomic group are likely to be impacted by climate change, and this is not limited to SGCN identified in this Plan, vulnerability to climate change will vary by population, species, and taxonomic group due to differences in exposure, sensitivity, and adaptive capacity to environmental change (Glick et al. 2011). Warmer water temperatures, earlier peak flows, increased rainfall variability, and lower summer base flows are expected to affect many fish and riparian species in New Mexico (Furniss et al. 2013). Although most birds are highly mobile and can readily shift among habitats, migratory species are particularly vulnerable to mismatches between key life history events and resource availability. Birds also are vulnerable to different habitat changes on wintering grounds, breeding sites, and stopover sites (Visser et al. 2004, Visser 2008). Reptiles may be particularly vulnerable to increased temperatures, including reduction in hours where thermal conditions allow lizards to forage without exceeding their critical thermal maximum body temperature, and are typically poorly represented on species conservation priority lists (Sinervo et al. 2010, Bagne et al. 2014). Mammals, though generally mobile, may be vulnerable to habitat change if they are geographically isolated (e.g., high elevation, riparian) or migratory.

## Examples of Climate Change Vulnerability

A report recently released by the US Geological Survey by Hatten et al. (2016) analyzed potential climate change effects on 31 birds and reptiles found in the southwestern United States. This analysis included developing a distribution model for each species that incorporated a variety of variables, including monthly and seasonal precipitation and temperature and the distribution of any plant identified as being ecologically important for a given focal species. The analysis identified which species were likely to experience range expansions or contractions under future climatic conditions. It also identified which variables had the strongest impact on the focal species' distributions; climate variables were identified as strong drivers of species geographic distributions.

The report examined nine SGCN birds (black-throated gray warbler (*Setophaga nigrescens*), flammulated owl (*Psiloscops flammeolus*), gray vireo (*Vireo vicinior*), juniper titmouse (*Baeolophus ridgwayi*), pinyon jay (*Gymnorhinus cyanocephalus*), pygmy nuthatch (*Sitta pygmaea*), sagebrush sparrow (*Artemisiospiza nevadensis*), Virginia's warbler (*Oreothlypis virginiae*), and Williamson's sapsucker (*Sphyrapicus thyroideus*)) and three SGCN reptiles (Arizona black rattlesnake (*Crotalus cerberus*), rock rattlesnake (*Crotalus lepidus*), and Gila monster (*Heloderma suspectum*)). At least six of the bird SGCN and all three reptile SGCN are projected to experience declines in their geographic distributions by the year 2099, with some species experiencing dramatic range declines of up to 80% (pygmy nuthatch). The ranges of two SGCN birds were projected to increase by 2099 (gray vireo and sagebrush sparrow).


Species shown above, from left to right, are: pinyon jay, black-throated gray warbler, gray vireo.


Species shown above, from left to right, are: pygmy nuthatch, juniper titmouse, Virginia's warbler.

Invertebrates are not well represented in climate change assessments, but like most vertebrates, are expected to move northward and to higher elevations (Brantley and Ford 2012). Mollusc (e.g., snails) and crustacean (e.g., crayfish) species are also vulnerable to climate change as they tend to be narrowly restricted within freshwater habitats, which are already some of the most threatened habitats worldwide (Dudgeon et al. 2006).

Physiological requirements and limitations related to temperature and moisture determine critical components of energetics, survival, and reproduction (Helmuth et al. 2005, Bernardo and Spotila 2006, Sinervo et al. 2010). A species may be intolerant to new environmental conditions, become more restricted in activity, or become more sensitive to increasingly extreme climate-related events such as fires or storms (Walsberg 2000, Bernardo and Spotila 2006, Sinervo et al. 2010). Higher metabolic costs for ectotherms ("cold-blooded" organisms that rely mainly on external sources of energy for regulating body temperature, including fish, reptiles, amphibians, and invertebrates) during warmer winters when food resources are limited could decrease survival within these populations (Kaspari et al. 2000, Brantley and Ford 2012). Species phenology (timing of key life history events) and interactions can also be impacted by climate change (Bagne et al. 2011). For many species, the timing of biological events (e.g., reproduction, migration) is triggered by temperature or moisture cues and is thus affected by a changing climate. When this timing is altered so that it no longer matches the timing and availability of critical resources or favorable conditions, then species survival and reproduction often decline (Dunn and Winkler 1999, Both et al. 2006). Finally, the response of one species to climate change may trigger a population change in another via predator-prey relationships, disease, pollination, parasitism, or mutualism (interactions between individuals of different species that benefit both species). These changes in interactions between species can further alter species vulnerability if they are tied to survival or reproduction (Freed et al. 2005, Memmott et al. 2007, Gilman et al. 2010).

## *Species Resilience in the Face of Climate Change*

Climate change may create more favorable conditions for a given species in a given location. As some habitat types contract, others will expand, disproportionately benefiting species associated with expanding habitats. Elevated atmospheric $CO_2$ levels and warmer temperatures can enhance plant growth and lengthen growing seasons, providing more forage or longer breeding periods (Morgan et al. 2001). More variable and extreme weather can have positive effects on the availability of ephemeral waters, maintenance of spawning habitats, and prevention of woody plant encroachment. Species with distributions outside of New Mexico that experience more favorable conditions may expand or shift their range into New Mexico, although these are unlikely to be current SGCN.

Several species traits are associated with resilience to climate change. Generalist species can switch to different prey or host species and thus are not as sensitive to changing conditions as species with more restricted resource requirements (Chessman 2013, Moyle et al. 2013). Similarly, wide-ranging species typically tolerate a larger array of environmental conditions. Any species can benefit when conditions that limit population growth (i.e., cold winters) are improved. Warm-water fishes, for example, may be more tolerant of warming conditions than cold-water species and may invade newly suitable locations further up cool water streams

(Moyle et al. 2013). Species that periodically experience inactive life stages and low metabolic rates have greater capacity to adapt to fluctuating resources (Humphries et al. 2002, Bronson 2009). For example, although warmer waters increase metabolic demands, aquatic insects that experience periodic dormancy can reduce energetic demands (Sweeney et al. 1992). Species with longer, more flexible, and more productive reproductive periods likely will be more resilient to increasingly variable and unpredictable conditions, although species with shorter reproductive periods may be favored during drought periods (Jiguet et al. 2007, Chessman 2013, Moyle et al. 2013).

### *Combining Climate-related Effects with Other Stressors*

As demonstrated by the process for selecting SGCN, there are many stressors on species populations and negative effects of climate change are just one subset to be considered when prioritizing species or actions. Climate change is an important consideration because additional stress on species already prone to extinction could overwhelm conservation efforts. Unfortunately, the very nature of populations of SGCN makes them prone to the exacerbating effects of climate change. Many SGCN have very restricted ranges and are sometimes comprised of only a single population. Thus, these species are particularly vulnerable to shifting climate and habitats because small isolated ranges offer little habitat variability and little opportunity for dispersal (Opdam and Wascher 2004).

By adding to or altering impacts already affecting species, climate change modifies extinction risk and creates a complex challenge for conservation practitioners (McCarty 2001, MacNally et al. 2009). Climate-driven threats, such as exceedance of temperature thresholds, have often been overlooked in selecting special status species and need to be considered, especially in anticipation of future population trends (Bagne et al. 2014). Climate change effects can also exacerbate other stressors such as fire, invasive species, or landscape fragmentation that may already be implicated in species decline.

Aquatic and riparian habitats are particularly vulnerable to stressors exacerbated by climate change. Higher temperatures and more variable rainfall will reduce already limited surface water supplies (Serrat-Capdevila et al. 2007, Theobald et al. 2010). Hotter, drier, and more variable conditions encourage fires that remove vegetation, favor invasive plant species such as tamarisk, and increase rates of sediment deposition in aquatic habitats (Swetnam and Betancourt 1990, Westerling et al. 2006). Excessive forage removal and trampling from cattle grazing is exacerbated during periods of higher temperatures when cattle preferentially graze near water (DelCurto et al. 2005). Greater water withdrawal for both agricultural and residential uses is expected as temperatures increase (Foti et al. 2012). Shifting availability of suitable conditions exacerbates issues related to fragmentation and land conversion, restricting movement of even highly mobile species and limiting the ability of species to respond to environmental change.

## Managing Climate Change Vulnerability

Climate change is an important consideration for the success of species conservation programs because it can aggravate current threats and produce new impacts. Exacerbation of current threats may require intensified conservation efforts, while threats unique to climate change will require innovative strategies (Bagne et al. 2014). Consideration of climate change effects complements traditional conservation approaches, which have focused on threats that are ongoing or were historically responsible for species declines. The key to finding effective management actions is to identify factors responsible for vulnerability or resilience for a given species.

## Summarizing Approaches to Managing for Climate Change Vulnerability

This section can be summarized to the following general recommendations for coping with climate change:

1. Implement management actions that enhance populations of SGCN (e.g., improve water supply and quality, implement prescribed fire programs) and reduce existing pressures on SGCN from sources other than climate change (e.g., control exotic species, prevent habitat loss and fragmentation).
2. Use short-term strategies that enhance the ability of natural systems to resist the effects of climate change and maintain ecosystem services (e.g., control woody plant encroachment into grassland ecosystems). Use longer-term strategies that enhance species and ecosystem resilience to climate-related stressors (e.g., conserve genetic diversity to enhance a species ability to adapt to changing conditions).
3. Accommodate future species range shifts by: (1) maintaining connectivity between protected areas and suitable habitats for native species; and (2) planning invasive species monitoring and control efforts in areas where they are expected to expand.
4. Apply management actions when conditions are most favorable to native species and SGCN, and take advantage of climate-related stressors to invasive species.
5. Expect long-term conservation of vulnerable SGCN to require intensified effort, innovative approaches, and flexibility.
6. Implement monitoring programs to detect population trends and evaluate success of climate-related management actions.

Management actions designed to cope with climate change effects encompass four main strategies: *resistance*, *resilience*, *response*, and *realignment* (Millar et al. 2007, Peterson et al. 2011). *Resistance* strategies include actions that enhance the ability of species, ecosystems, or environments to resist forces of climate change and maintain values and ecosystem services in their present or desired states and conditions (e.g., use early detection rapid response to control exotic species). Resistance strategies, including intensive and localized management of rare and isolated species, may only defer the effects of climate change over the short-term (Heller and Zavaleta 2009). *Resilience* strategies enhance the capacity of ecosystems to withstand or absorb increasing effects without irreversible changes in important processes and functionality (e.g., reduce existing pressures on species from sources other than climate change, facilitate maintenance of or increases in genetic diversity). *Response* strategies work directly with climate-induced changes to assist transitions to future states by mitigating and minimizing undesired and disruptive outcomes (e.g., assist with species migrations to areas projected to have suitable climatic conditions in future). The *realignment* strategy refers to an adjustment in management or planning goals to account for substantially altered reference conditions and new ecosystem dynamics (i.e., historical baselines may be inappropriate in the face of a changing climate) (Millar et al. 2007, Joyce et al. 2008, Peterson et al. 2011).

The predicted response of species to various climate-related factors can help identify the targets of such management actions. Habitats need to be managed under the expectation that they will change and shift over time. Specific components of habitat (e.g., snags, breeding ponds) also can be targeted for management if they are expected to decline. A species vulnerable due to its low dispersal ability may benefit from translocation or creation of habitat corridors. If a species is sensitive to extreme events, such as prolonged drought, high severity wildfires, and intense flooding, then action plans can be developed to anticipate and take necessary emergency actions (Bagne and Finch 2013). Heat sensitivity of certain species may be mitigated by providing buffered habitat elements, such as shade or deep pools. Management may need to target the responses of interacting species. Similarly, some traits generating resilience may be enhanced through management, including creation of reserves where habitats are expanding or protection of vegetation that buffers temperatures. Conservation of genetic diversity also may enhance species resilience to physiologically limiting conditions (e.g., increased temperatures) (Heller and Zavaleta 2009).

Any landscape or reserve planning needs to account for how habitats shift over time (Hodgson et al. 2009). Greater connectivity between suitable habitats and protected areas can facilitate movement of species as habitats shift. Establishment of migration corridors, management of areas surrounding corridors and protected areas, and expansion of protected areas can all improve habitat connectivity (McLachlan et al. 2007, Hodgson et al. 2009). In the absence of connectivity or dispersal potential, assisted migration (i.e., movement of species and populations to areas likely to have suitable climatic conditions in future) is a potential strategy for preventing species extinction, but also is controversial. Research is needed to address knowledge gaps before assisted migration efforts can be initiated. These gaps include information on relationships among species, dispersal distance, and detailed habitat requirements (McLachlan et al. 2007). Translocation, or movement of individuals to historically occupied locations, is less controversial and may help species cope with short-term habitat change, dispersal barriers, or increasing population fluctuations. Programs to move populations, however, tend to be costly and are often unsuccessful (Fischer and Lindenmayer 2000).

Climate change can make some types of management more difficult. Individual threats may be harder to manipulate under changing climate conditions. One example is water supply, which will decline in response to warmer temperatures (and increased evapotranspiration), more variable rainfall, reduced snowpack, and greater demand. Fire management will also become more difficult as warmer weather and more frequent drought limit the window for applying prescribed fire and make suppression more challenging. However, identification of factors associated with species vulnerability to climate change can lead to development of alternative conservation approaches. For example, it may be more practical to create artificial water bodies than to regulate water withdrawals. In addition to a single-species focus, a list of species and their vulnerabilities can be used to identify management issues common among multiple species, making conservation efforts more efficient and comprehensive. For example, at Fort Huachuca in Arizona, management of fire and fuels, invasive species, natural and artificial waters, and landscape planning was found relevant for multiple species (Bagne and Finch 2013).

When faced with uncertainty or few management options to target climate-related vulnerability, there are several possible approaches. “No-regrets” adaptation options are actions that increase population numbers or reduce stressors regardless of future climate change effects. Mitigation of other stressors (e.g., invasive species, habitat loss) is often recommended in lieu of addressing climate change effects. However, many impacts are interrelated and the increasing vulnerability for many species indicates that conservation efforts will need to be intensified over time. “Win-win” options confer benefits under both current and future climate conditions (Peterson et al. 2011). Fire management, invasive species control, and watershed improvement often fall within this category. Habitat quality can be improved through these types of actions, thus enhancing resilience of species to climate change and other disturbances. Population monitoring can be a useful tool when effects or management options are uncertain, or funds are limited. Furthermore, monitoring is needed to determine the success of any implemented actions.

Opportunities for improved species management can also arise with climate change and should be anticipated. Removal or control of exotic plants or animals may be more successful when they are stressed by climate extremes. For example, low water levels can create barriers and stress exotic fish and amphibian populations. This can facilitate the removal of these species, which in turn may benefit native amphibians and fish, which may be more tolerant of drying (Doubledee et al. 2003, Bagne and Finch 2013). Furthermore, invasive aquatic species may decline if they are intolerant of warmer or more saline waters (Higgins and Wilde 2005, Rahel and Olden 2008). Exploitation of the vulnerabilities of undesirable species can be summarized as a “kick them when they’re down” strategy and fits well with “no-regrets” and “win-win” strategies of climate change adaptation (Peterson et al. 2011, Bagne and Finch 2013). Preventative and early intervention programs to control invasive species can be applied where range expansion is predicted. These programs tend to be cheaper and more effective (Davies and Johnson 2011). Climatic variation will also include wet or productive years and habitat restoration or translocation programs can be timed to correspond with these events.

Using information about the vulnerabilities and resilience of two SGCN (the Arizona treefrog (*Hyla wrightorum*) and the black-tailed prairie dog (*Cynomys ludovicianus*)), two case studies were developed to demonstrate the relevance of vulnerability to conservation action. For each species, vulnerable or resilient factors were connected to potential targeted actions. These case studies are only a demonstration of how to use species climate change responses in management applications and should not be taken as actual species conservation plans. More information on the vulnerability and resilience assessment can be found in the full report by Friggens et al. (2015): http://www.bison-m.org/documents/48358_Friggens2015SWAPccFnl.pdf.

## Case Study 1: Arizona Treefrog

The Arizona treefrog is vulnerable to multiple climate change effects including: reduction in terrestrial and breeding habitat, low dispersal ability, desiccation (drying), high severity wildfire, limited reproductive period, and disease. Management of the Arizona treefrog under changing climate conditions will be complicated by vulnerability of both aquatic and terrestrial habitats, as well as its currently small and isolated populations. There is considerable uncertainty in predicting response because there are very few published studies on this species. Although high severity fire is clearly detrimental to habitats and may kill adults, impacts of other variables related to fire on treefrogs and their habitats are unknown. In addition, future timing of monsoons is important for determining availability of breeding habitats, but is not well projected. This makes the associated population response unclear.

Despite uncertainty, vulnerability traits of the Arizona treefrog point towards potential management actions. Fire management could be used to increase resilience of upland woodland habitats to drought and fire mortality. Low severity prescribed fire could reduce the risk of stand-replacing fires detrimental to treefrog populations while preserving a mosaic of unburned patches. Fire risk could also be reduced by creation of firebreaks or application of mechanical treatments. Resilience of adult treefrogs to desiccation might be increased by management actions that promote accumulation of leaf litter and other debris if it can be assumed that these can buffer adults from extreme conditions. Upland habitats may also shift upwards in elevation, thus corridors to facilitate movement should be maintained or, in the absence of potential dispersal, the plausibility of assisted migration should be investigated.

Regulation of water withdrawals as well as wetland and stream restoration could help maintain breeding habitats. Occupied waters that are more resilient to water flow declines (e.g., deeper ponds, habitats with greater canopy cover) should be identified and prioritized for conservation. The potential to increase water availability in habitats more vulnerable to drying should be evaluated and rescue measures should be considered. Artificial waters could, in some cases, be managed to maintain water levels during critical periods such as during breeding or prolonged droughts. Shift of permanent streams to intermittent cycles may increase potential breeding habitats, but only if they are within dispersal distance of current populations, adjacent upland habitats are suitable, and populations of predators are small. Attention to changing flow will be critical, as management actions (e.g., control of predators, connection of habitat) may be needed to make these newly intermittent waters suitable. Reduced and more variable stream flow also is an opportunity for more effective control of non-native fish and amphibians as many are less resilient to decreased water flow and newly isolated populations may be controlled more easily (Doubledee et al. 2003).

Chytridiomycosis (a disease of amphibians caused by the fungus *Batrachochytrium dendrobatidis*) has not been identified in wild populations of Arizona treefrogs, but snails that host the trematode *Ribeiroia ondatrae* have been implicated in observed limb deformities (Johnson and Sutherland 2003). Snail hosts are often present in stock ponds and tanks, which may be more heavily used by treefrogs under drying conditions (Bagne and Finch 2013). Management that targets the reduction of snail hosts and trematode infection may be appropriate. Monitoring should include measures of disease, hosts, or parasites so early intervention can be implemented.

## Case Study 2: Black-tailed Prairie Dog

Black-tailed prairie dogs have a few climate change vulnerabilities along with some indicators of resilience. Human impacts (e.g., shooting, poisoning) on this species can be high and thus are a source of non-climate stress that can be reduced to increase resilience. In general, prairie dogs can use a variety of grassland habitat types and have also been reported to occur in open woodlands. However, black-tailed prairie dogs are only associated with shortgrass prairie and desert grassland habitat types. The shortgrass prairie habitat in particular appears likely to decrease (see section on grasslands above), and conversion of grasslands to scrublands is expected in several areas, leading to a reduction in prairie dog habitat. Prairie dogs modify their habitat and have some capacity to engineer their own resilience to climate change by maintaining preferred habitat features (e.g., slow woody species encroachment). Management actions that favor open habitats, including prescribed fire, mechanical removal of woody vegetation, and sustainable livestock grazing, can be used to enhance prairie dog habitats. Expansion of open vegetation types is expected in some areas. These predicted areas of grassland expansion can be evaluated to gauge potential for future suitability and to prioritize locations for conservation. For example, grasslands are likely to replace woodlands in some areas of eastern New Mexico that are allowed to burn. However, transition to suitable prairie dog habitat will take time, as various elements of the ecosystem are not expected to change at the same rate and different species respond in different ways with unknown effects on habitat suitability.

Prairie dogs are vulnerable to plague (an introduced pathogen), which can kill entire colonies. The interaction of plague with a changing climate is likely to be important, but is not well known, especially for southwest climates. The distribution of plague is projected to expand north and east, thus, conditions in New Mexico may become less favorable (Nakazawa et al. 2007). Prediction of plague response is complicated by the interaction of the disease-causing bacteria (*Yersinia pestis*), the vector (e.g., flea), the susceptibility of prairie dogs, and other flea hosts (Gage and Kosoy 2005, Lorange 2005). High summer temperatures tend to reduce plague outbreaks, while periods of higher rainfall, which are expected irregularly, tend to increase vectors (e.g., fleas), transmission, and plague outbreaks. Thus, prediction of future plague effects is complex and uncertain (Parmenter et al. 1999, Stapp et al. 2004). Flea infestation increases with anthropogenic disturbance. Thus, management focused on minimizing disturbance or prioritizing conservation in remote areas may increase resilience (Friggens 2010). Roads and streams create barriers to disease transmission and are associated with lower occurrence of plague (Collinge et al. 2005). Lower population densities, which may occur following periods of low rainfall, wildfire, or drought, may also decrease transmission and aid in disease management. Colony isolation during plague outbreaks may be effected by creation of temporary barriers, particularly during late spring when most intercolony dispersal occurs (Garrett and Franklin 1988). Vaccination and application of insecticides at burrows are potential management tools to increase resilience to plague (Seery et al. 2003, Rocke et al. 2010).

High genetic variation in prairie dogs has been noted with several subspecies proposed. Thus, different populations are expected to vary in their response to climate change. This may incur some resilience to the species as a whole. Maintenance of genetic diversity and associated resilience will require landscape level planning. Dispersal to new habitats may be encouraged by removal of barriers during late spring. Low reproductive rates mean that proactive management is important to avoiding low populations, which recover slowly. Food subsidies, translocation, and predator control are all options for increasing populations (Truett et al. 2001). Management plans should establish protocols for initiating these types of interventions.

# Chapter 5: Colorado Plateaus Conservation Profile

## Species of Greatest Conservation Need (SGCN) and their Habitats

The Colorado Plateaus ecoregion encompasses 64,454 km$^2$ (24,886 mi$^2$) of the northwestern quarter of New Mexico and is at the southeastern corner of 922,570 km$^2$ (356,206 mi$^2$) of contiguous cold desert that extends west across northern Arizona, Utah, and Nevada, as well as north into southern Idaho. In New Mexico, elevations range from 1,000-2,200 m (3,200-7,200 ft) and terrain consists of large plains dissected by plateaus, mesas, arroyos, and canyons. The climate is dry (average annual precipitation: 30 cm (11.8 in)) and characterized by cold winters and hot summers, with frost-free periods ranging from approximately 50-220 days.

Sixty-four SGCN occur in the Colorado Plateaus ecoregion; over half are birds (Table 9, Table 11). Twenty-eight percent of the SGCN within the Colorado Plateaus fall within category I (Immediate Priority), and 30% are in the Susceptible category. Fifty-five percent of SGCN occurrences are based upon direct observations of species within the Colorado Plateaus ecoregion.

Table 9. Number of Species of Greatest Conservation Need in the Colorado Plateaus ecoregion.

| Category[8] / Taxon | I | H | S | D | F | Total |
|---|---|---|---|---|---|---|
| Amphibians | 0 | 0 | 2 | 0 | 1 | 3 |
| Birds | 12 | 5 | 15 | 3 | 4 | 39 |
| Crustaceans | 0 | 0 | 0 | 5 | 0 | 5 |
| Fish | 3 | 0 | 0 | 0 | 4 | 7 |
| Mammals | 3 | 0 | 2 | 0 | 2 | 7 |
| Molluscs | 0 | 1 | 0 | 0 | 0 | 1 |
| Reptiles | 0 | 1 | 0 | 1 | 0 | 2 |
| Total | 18 | 7 | 19 | 9 | 11 | 64 |

[8]Category abbreviations are: I = Immediate Priority, H = Limited Habitat, S = Susceptible, D = Data Needed, F = Federally-listed.

The Colorado Plateaus ecoregion supports 28 naturally vegetated terrestrial habitats, five limited-value habitat land covers, and 76,200 ha (188,000 ac) of cultivated lands (Figure 13, Table 10). Most habitat is either Intermountain Dry Shrubland and Grassland (i.e., sagebrush steppe, 41%) or Intermountain Juniper Woodland (26%). At low elevations, vegetation is comprised of a grass-shrub mix that includes four-wing saltbush (*Atriplex canescens*), greasewood (*Sarcobatus vermiculatus*), blue grama (*Bouteloua gracilis*), and black grama (*B. eriopoda*). At higher elevations, vegetation is dominated by piñon-juniper woodlands comprised of two-needle piñon (*Pinus edulis*), Utah juniper (*Juniperus osteosperma*), big sagebrush (*Artemisia tridentata*), blue grama, and western wheatgrass (*Pascopyrum smithii*).

Only 12 lakes and reservoirs occur in this ecoregion: three are warm water (total area: 550 ha (1,160 ac)), two are cold water (total area: 4.5 ha (11 ac)), and seven support cold water species in winter and warm water species in summer (total area: 8,101 ha (20,010 ac)) (Figure 14). Navajo Lake represents most (87%) of the total water surface area (6,334 ha (15,645 ac)). Most streams are ephemeral and only flow after summer thundershowers. However, 75 perennial streams flow through the ecoregion. Of these, 1,739 km (1,086 mi) are cold water and 2,261 km (1,413 mi) are warm water.

Table 10. Terrestrial habitat types of the Colorado Plateaus ecoregion.

| Habitat Category | USNVC Code | Habitat Name[9] | Tier[10] | Climate Vulnerability[11] | Area (km²) | (mi²) |
|---|---|---|---|---|---|---|
| Alpine and Montane Vegetation | M168 | Rocky Mountain Subalpine-High Montane Meadow | 2 | Moderate→High | 88 | 34 |
| | M049 | Rocky Mountain Montane Shrubland | 3 | Moderate→High | 32 | 12 |
| | M011 | Madrean Montane Forest & Woodland | 3 | Moderate | 4 | 2 |
| | M026 | Intermountain Juniper Woodland | 4 | Low→Very High | 16,718 | 6,455 |
| | M027 | Rocky Mountain Piñon-Juniper Woodland | 4 | Very High | 3,747 | 1,447 |
| | M022 | Rocky Mountain Lower Montane Forest | 4 | Low→Moderate | 256 | 99 |
| | M010 | Madrean Lowland Evergreen Woodland | 4 | High | 177 | 68 |
| | M091 | Warm Interior Chaparral | 4 | _ _ | 8 | 3 |
| | M020 | Rocky Mountain Subalpine-High Montane Conifer Forest | 4 | Moderate→High | 2 | 0.82 |
| Plains-Mesa Grassland | M051 | Great Plains Mixedgrass Prairie | 2 | _ _ | 147 | 57 |
| | M053 | Great Plains Shortgrass Prairie | 3 | Very High | 2 | 0.76 |
| Desert Grassland and Scrub | M171 | Intermountain Dry Shrubland & Grassland | 2 | Low→Very High | 26,265 | 10,141 |
| | M087 | Chihuahuan Semi-Desert Grassland | 2 | High | 721 | 278 |
| | M169 | Intermountain Tall Sagebrush Shrubland | 3 | Low→Very High | 3,081 | 1,190 |
| | M093 | Intermountain Saltbush Shrubland | 4 | Very High | 3,402 | 1,314 |
| | M086 | Chihuahuan Desert Scrub | 4 | High→Very High | 274 | 106 |

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9 Habitats were macrogroups identified in the US National Vegetation Classification System (USNVC), except Other Land Covers which were derived from Southwestern Regional Gap Analysis land cover classes.

10 Tiers reflect the urgency for conservation and were based on the degree of imperilment within the United States according to the NatureServe Conservation Status Assessment (http://www.natureserve.org/conservation-tools/conservation-status-assessment and the spatial pattern of the habitat.

11 Climate vulnerability levels were based on a vulnerability analysis performed for Ecological Response Units (ERU) across New Mexico and Arizona (Triepke et al. (2014). The ERU classification system represents major ecosystem types of the Southwest. Vulnerability for each ERU was calculated as the relative probability of type conversion. The ERUs were then crosswalked to the habitats shown here.

| Habitat Category | USNVC Code | Habitat Name[9] | Tier[10] | Climate Vulnerability[11] | Area (km$^2$) | (mi$^2$) |
|---|---|---|---|---|---|---|
| | M170 | Intermountain Dwarf Sagebrush Shrubland | 4 | Low→Very High | 204 | 79 |
| Cliff, Scree & Rock Vegetation | M887 | Cliff, Scree & Rock Vegetation | 4 | Moderate→Very High | 4,065 | 1,569 |
| Arroyo Riparian | M092 | Warm-Desert Arroyo Riparian Scrub | 2 | _ _ | 13 | 5 |
| | M095 | Intermountain Arroyo Riparian Scrub | 2 | _ _ | 3 | 1 |
| Riparian Woodland and Wetland | M082 | Desert Alkali-Saline Wetland | 1 | Very High | 2,111 | 815 |
| | M034 | Rocky Mountain Montane Riparian Forest | 1 | _ _ | 407 | 157 |
| | M028 | Great Plains Floodplain Forest | 1 | _ _ | 378 | 146 |
| | M075 | Montane-Subalpine Wet Shrubland & Wet Meadow | 1 | _ _ | 52 | 20 |
| | M888 | Arid West Interior Freshwater Emergent Marsh | 1 | _ _ | 8 | 3 |
| Introduced and Semi-Natural Vegetation | M499 | Annual Grassland | 5 | _ _ | 47 | 18 |
| | M298/ M302 | Introduced Riparian Vegetation | 5 | _ _ | 27 | 11 |
| | M512 | Perennial Grassland | 5 | _ _ | 2 | 0.58 |
| Other Land Cover | N/A | Developed & Urban | 5 | _ _ | 1,067 | 412 |
| | N/A | Herbaceous Agricultural Vegetation | 5 | _ _ | 762 | 294 |
| | N/A | Barren | 5 | _ _ | 53 | 21 |
| | N/A | Quarries, Mines, Gravel Pits and Oil Wells | 5 | _ _ | 98 | 38 |
| | N/A | Recently Disturbed or Modified | 5 | _ _ | 0.94 | 0.36 |

Table 11. Species of Greatest Conservation Need (SGCN) in the Colorado Plateaus ecoregion.

| Common Name | Scientific Name | Taxon | Category | Reason to Include[12] | Habitats[13] |
|---|---|---|---|---|---|
| Boreal Chorus Frog | *Pseudacris maculata* | Amphibians | S | V | M051, M053, M087, M171 |
| Northern Leopard Frog | *Lithobates pipiens* | Amphibians | S | De, V | M011, M022, M026, M027, M034, M049, M171, M887 |
| Chiricahua Leopard Frog | *Lithobates chiricahuensis* | Amphibians | F | De, V, Di | M010, M011, M020, M022, M026, M027, M034, M049, M075, M086, M091, M171, M887 |
| Flammulated Owl | *Psiloscops flammeolus* | Birds | I | V | M010, M011, M020, M022, M026, M027, M028, M034, M049, M075, M091 |
| Mexican Whip-poor-will | *Antrostomus arizonae* | Birds | I | De, V | M010, M026, M027, M091 |
| Gray Vireo | *Vireo vicinior* | Birds | I | V | M051, M053, M086, M087, M170, M171 |
| Pinyon Jay | *Gymnorhinus cyanocephalus* | Birds | I | De, V | M888, EC, PCWR, PLCP, PMCSS, PWWR, PWWS |
| Juniper Titmouse | *Baeolophus ridgwayi* | Birds | I | De, V | M010, M011, M020, M022, M026, M027, M028, M034, M049, M051, M053, M082, M086, M087, M091, M093, M168, M169, M170, M171, M887 |
| Bendire's Thrasher | *Toxostoma bendirei* | Birds | I | De, V | M010, M022, M026, M082, M086, M087, M887 |

[12] Reason to include indicates which of five criteria for inclusion on the SGCN list a particular species met. Abbreviations are as follows: De = Declining; Di= Disjunct; E = Endemic; K = Keystone; V = Vulnerable.

[13] Aquatic habitat abbreviations are as follows: PCWS = Perennial Cold Water Streams; PWWS = Perennial Warm Water Streams; PLCP = Perennial Lakes, Cirques, Ponds; PMCSS = Perennial Marshes/Cienegas/Springs/Seeps; PCWR = Perennial Cold Water Reservoirs; PWWR = Perennial Warm Water Reservoirs; EMCS = Ephemeral Marshes/Cienegas/Springs; EC = Ephemeral Catchments. Habitat codes refer to National Vegetation Classification designations, which are identified in Table 10 above.

| Common Name | Scientific Name | Taxon | Category | Reason to Include[12] | Habitats[13] |
|---|---|---|---|---|---|
| Sprague's Pipit | *Anthus spragueii* | Birds | I | De, V | M026, M051, M053, M082, M086, M087, M092, M093, M169, M170, M171, M887 |
| Grace's Warbler | *Setophaga graciae* | Birds | I | De, V | M028, M034, M092, M888 |
| Black-throated Gray Warbler | *Setophaga nigrescens* | Birds | I | De, V | M010, M026, M027, M051, M053, M082, M086, M087, M093, M168, M169, M171, M499 |
| Virginia's Warbler | *Oreothlypis virginiae* | Birds | I | De, V | M010, M026, M027, M049, M051, M053, M086, M087, M168, M169, M170, M171, M887 |
| Black-chinned Sparrow | *Spizella atrogularis* | Birds | I | De, V | M011, M020, M022, M034, M887 |
| Chestnut-collared Longspur | *Calcarius ornatus* | Birds | I | De, V | M028, M053 |
| Eared Grebe | *Podiceps nigricollis* | Birds | H | De, V, Di | M010, M011, M020, M022, M026, M027, M034, M887 |
| Bald Eagle | *Haliaeetus leucocephalus* | Birds | H | V, K | M010, M011, M026, M027, M028, M034, M049, M051, M053, M082, M086, M087, M091, M092, M093, M095, M168, M169, M170, M171, M298, M887 |
| Peregrine Falcon | *Falco peregrinus* | Birds | H | V, K | M010, M011, M020, M022, M026, M027, M034 |
| Burrowing Owl | *Athene cunicularia* | Birds | H | De, V, Di | M010, M011, M020, M022, M026, M027, M028, M034, M049, M887 |
| Bank Swallow | *Riparia riparia* | Birds | H | De, V, Di | M010, M011, M020, M022, M026, M027, M034, M049, M051, M053, M086, M087, M091, M168, M887 |
| Mountain Plover | *Charadrius montanus* | Birds | S | De, V | M010, M011, M020, M022, M026, M027, M028, M034, M049, M051, M075, M086, M087, M168, M171, M887 |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[12] | Habitats[13] |
|---|---|---|---|---|---|
| Common Nighthawk | *Chordeiles minor* | Birds | S | De, V | M010, M011, M049, M051, M053, M082, M086, M087, M091, M092, M095, M169, M170, M171 |
| Williamson's Sapsucker | *Sphyrapicus thyroideus* | Birds | S | V | M010, M026, M027, M034, M049, M051, M053, M082, M086, M087, M091, M093, M169, M170, M171, M887 |
| Red-headed Woodpecker | *Melanerpes erythrocephalus* | Birds | S | De, V | M010, M026, M027, M049, M051, M087, M168, M169, M170, M171, M499, M512 |
| Olive-sided Flycatcher | *Contopus cooperi* | Birds | S | De, V | M010, M011, M020, M022, M026, M027, M034, M169, M887 |
| Loggerhead Shrike | *Lanius ludovicianus* | Birds | S | De, V | M010, M011, M020, M022, M026, M027, M034, M887 |
| Clark's Nutcracker | *Nucifraga columbiana* | Birds | S | De | M888, EC, PLCP, PMCSS, PWWR, PWWS |
| Pygmy Nuthatch | *Sitta pygmaea* | Birds | S | De, V | M010, M011, M022, M028, M034, M086, M087, M091, M092, M887 |
| Mountain Bluebird | *Sialia currucoides* | Birds | S | De, V | M010, M011, M086, M087 |
| Western Bluebird | *Sialia mexicana* | Birds | S | De, V | M053, M086, M087, M171 |
| Cassin's Sparrow | *Peucaea cassinii* | Birds | S | De, V | M010, M011, M022, M027, M028, M034, M049, M053, M082, M086, M087, M091, M092, M093, M169, M170, M171, M298, M499, M887, M888 |
| Sagebrush Sparrow | *Artemisiospiza nevadensis* | Birds | S | De, V | M010, M011, M020, M022, M026, M027, M034, M049, M075, M091, M168, M887, M888 |
| Vesper Sparrow | *Pooecetes gramineus* | Birds | S | De, V | M028, M034, M082, M168, M298, M888 |
| Cassin's Finch | *Haemorhous cassinii* | Birds | S | De, V | EC |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[12] | Habitats[13] |
|---|---|---|---|---|---|
| Evening Grosbeak | *Coccothraustes vespertinus* | Birds | S | De, V | EC |
| Clark’s Grebe | *Aechmophorus clarkii* | Birds | D | V | EC |
| Common Black Hawk | *Buteogallus anthracinus* | Birds | D | V | EC |
| Elf Owl | *Micrathene whitneyi* | Birds | D | V | EC |
| Aplomado Falcon | *Falco femoralis* | Birds | F | De, V | PCWR, PCWS, PWWR, PWWS |
| Yellow-billed Cuckoo | *Coccyzus americanus* | Birds | F | De, V, Di | PWWS |
| Mexican Spotted Owl | *Strix occidentalis lucida* | Birds | F | V | PCWS, PWWS |
| Southwestern Willow Flycatcher | *Empidonax traillii extimus* | Birds | F | V | PWWS |
| Colorado Fairy Shrimp | *Branchinecta coloradensis* | Crustaceans | D | V, Di | PWWS |
| Packard’s Fairy Shrimp | *Branchinecta packardi* | Crustaceans | D | V, Di | PWWS |
| Bowman’s Fairy Shrimp | *Streptocephalus thomasbowmani* | Crustaceans | D | V, Di | PWWS |
| Fuzzy Cyst Clam Shrimp | *Eulimnadia antlei* | Crustaceans | D | V, Di | M011, M034, M075, PCWS, PWWS |
| Clam Shrimp | *Eulimnadia follismilis* | Crustaceans | D | V, Di | PCWS, PWWS |
| Rio Grande Chub | *Gila pandora* | Fish | I | V | PCWR, PCWS, PWWR, PWWS |
| Roundtail Chub | *Gila robusta* | Fish | I | De, V, Di | PWWS |
| Rio Grande Sucker | *Catostomus plebeius* | Fish | I | De, V | PCWS, PWWS |
| Rio Grande Silvery Minnow | *Hybognathus amarus* | Fish | F | De, V, Di | PWWS |
| Colorado Pikeminnow | *Ptychocheilus lucius* | Fish | F | De, V, Di, K | PWWS |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[12] | Habitats[13] |
|---|---|---|---|---|---|
| Zuni Bluehead Sucker | *Catostomus discobolus yarrowi* | Fish | F | De, V, Di | PWWS |
| Razorback Sucker | *Xyrauchen texanus* | Fish | F | De, V, Di | PWWS |
| American Mink | *Vison vison* | Mammals | I | V | M051, M053, M086, M087, M093 |
| North American River Otter | *Lontra canadensis* | Mammals | I | V | M051, M053, M087, M171 |
| Gunnison's Prairie Dog | *Cynomys gunnisoni* | Mammals | I | De, V, K | M011, M022, M026, M027, M034, M049, M171, M887 |
| Pale Townsend's Big-eared Bat | *Corynorhinus townsendii* | Mammals | S | V | M010, M011, M020, M022, M026, M027, M034, M049, M075, M086, M091, M171, M887 |
| Spotted Bat | *Euderma maculatum* | Mammals | S | V | M010, M011, M020, M022, M026, M027, M028, M034, M049, M075, M091 |
| Mexican Gray Wolf | *Canis lupus baileyi* | Mammals | F | De, V, K | M010, M026, M027, M091 |
| New Mexico Meadow Jumping Mouse | *Zapus hudsonius luteus* | Mammals | F | De, V, E | M051, M053, M086, M087, M170, M171 |
| Sangre de Cristo Woodlandsnail | *Ashmunella thomsoniana* | Molluscs | H | Di | M888, EC, PCWR, PLCP, PMCSS, PWWR, PWWS |
| California Kingsnake | *Lampropeltis californiae* | Reptiles | H | Di | M010, M011, M020, M022, M026, M027, M028, M034, M049, M051, M053, M082, M086, M087, M091, M093, M168, M169, M170, M171, M887 |
| Desert Massasauga | *Sistrurus catenatus* | Reptiles | D | De, V | M010, M022, M026, M082, M086, M087, M887 |

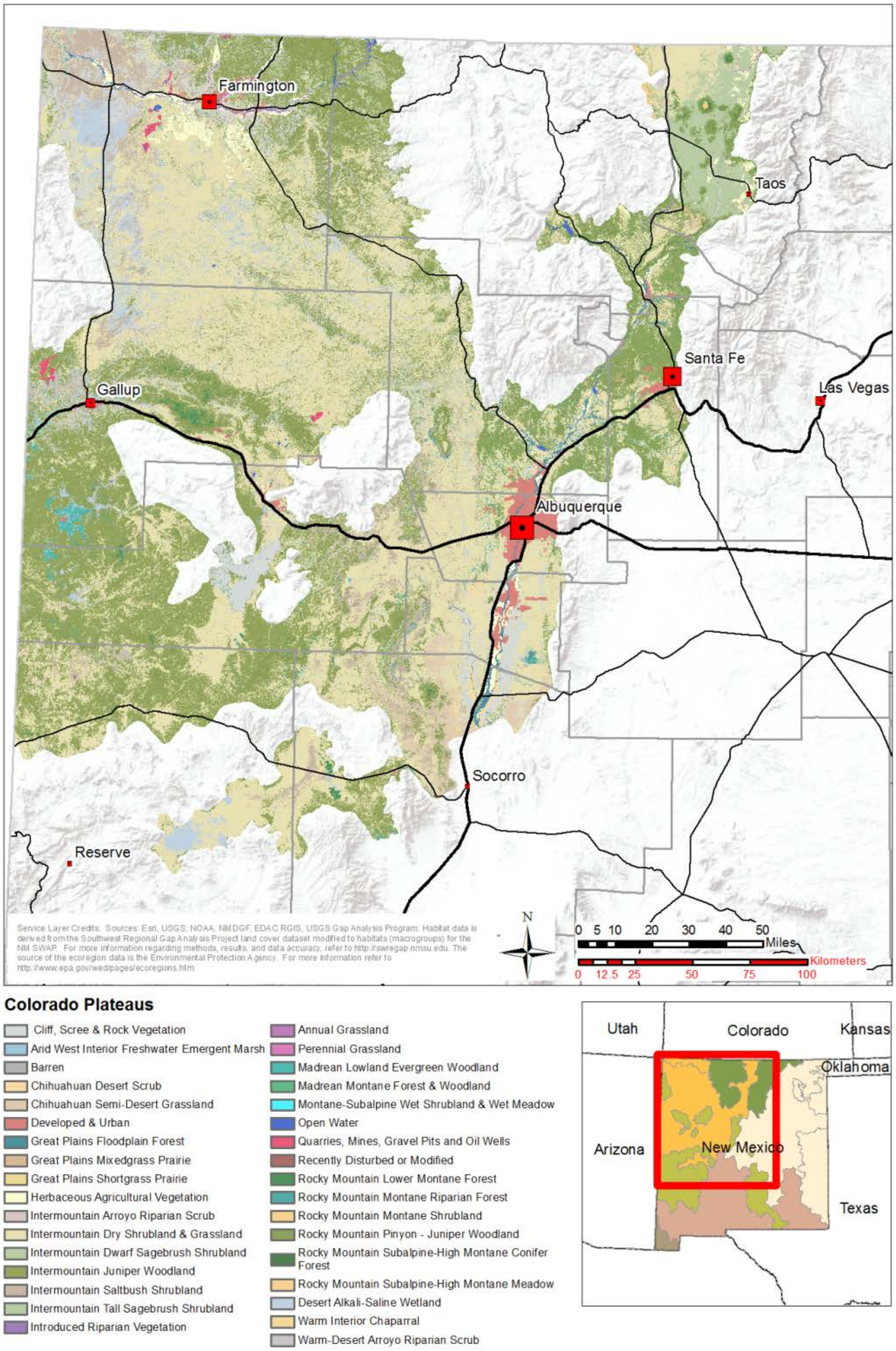



Figure 13. Terrestrial habitats in the Colorado Plateaus ecoregion.

Delineations from US National Vegetation Classification macrogroups and SWReGAP landcover classes.

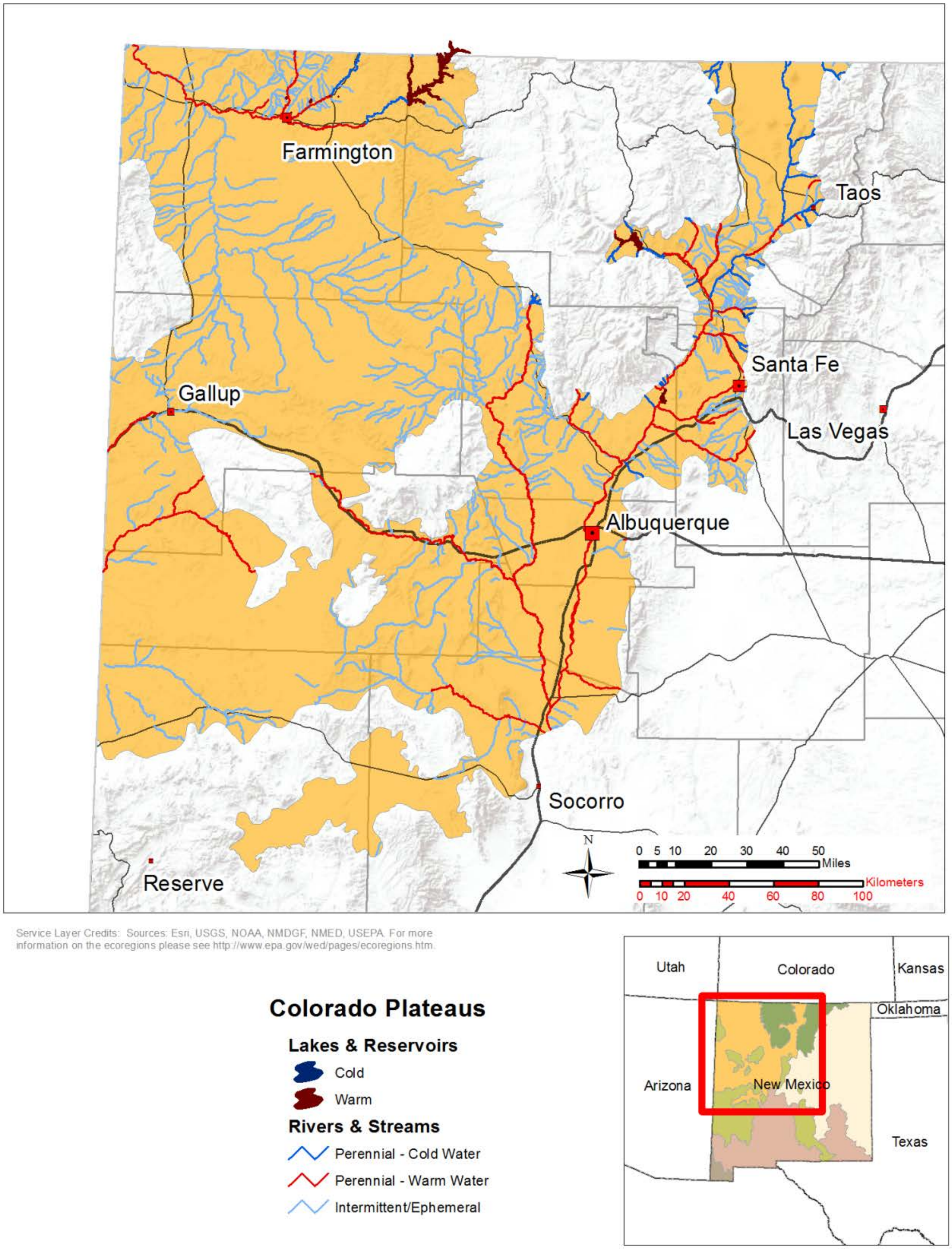



Figure 14. Aquatic habitats in the Colorado Plateaus ecoregion.

# Habitat Descriptions

## *Intermountain Juniper Woodland*

The Intermountain Juniper Woodland **[M026]** [14] occurs as a savanna to woodland on warm, dry, lower mountain slopes and plateaus at 1,800-2,600 m (5,910-8,530 ft) elevation in the Colorado Plateaus and Arizona/New Mexico Mountains ecoregions, and, to a lesser extent, in the Southern Rocky Mountains and mountains of the Chihuahuan Desert ecoregion. The tree canopy ranges from open to closed and is dominated by Utah juniper (*Juniperus osteosperma*) along with two-needle piñon (*Pinus edulis*). Shrub layers frequently are dominated by big sagebrush (*Artemisia tridentata*), which can form a moderately dense shrub canopy. Other common associated shrubs include yellow rabbitbrush (*Chrysothamnus viscidiflorus*), rubber rabbitbrush (*Ericameria nauseosa*), and Sonoran scrub oak (*Quercus turbinella*). The herbaceous layer ranges from sparse to dense and includes blue grama (*Bouteloua gracilis*), needle and thread (*Hesperostipa comata*), James' galleta (*Pleuraphis jamesii*), Idaho fescue (*Festuca idahoensis*), and muttongrass (*Poa fendleriana*).

Substrates are variable, but are generally shallow, cobbly, gravelly, or sandy to clay loam. Old-growth stands are largely restricted to rocky outcrops, upper slopes and ridges, and rims of mesas and canyons that are fire resistant. Younger seral stands have invaded adjacent shrublands and grasslands in recent times and now occur on lower slopes, valleys, and plains. In open savannas, periodic fire (at a 10 to 30 year interval) is important to maintaining the structure. Juniper trees less than 1.2 m (4 ft) tall are readily killed by fires.

## *Intermountain Dry Shrubland and Grassland*

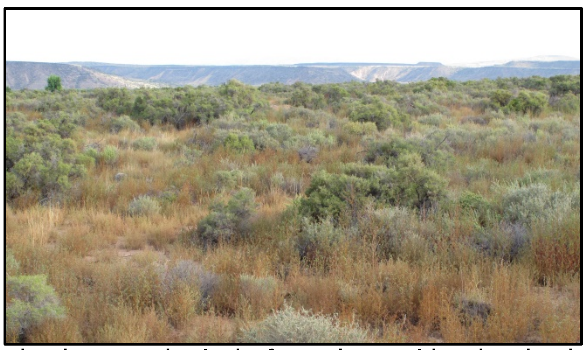
The Intermountain Dry Shrubland and Grassland **[M171]**, which occurs at 1,450-2,320 m (4,750-7,610 ft) elevation mostly in the Colorado Plateaus and Arizona/New Mexico Mountains ecoregions, is dominated by grasses with scattered shrubs (shrub-steppe). Cool-season grasses are often dominant, including Indian ricegrass (*Achnatherum hymenoides*), Letterman's needlegrass (*A. lettermannii*), needle and thread, muttongrass, and Sandberg bluegrass (*P. secunda*), but warm-season

[14] Complete descriptions of habitats are available by clicking on hyperlinked USNVC codes.

grasses can also be prevalent such as blue grama (*Bouteloua gracilis*), James' galleta, alkali sacaton (*Sporobolus airoides*), and sand dropseed (*S. cryptandrus*). While shrubs are usually subordinate to grasses, they can be diverse and include big sagebrush, yellow rabbitbrush, Torrey's jointfir (*Ephedra torreyana*), Mormon tea (*E. viridis*), rubber rabbitbrush (*Ericameria nauseosa*), winterfat (*Krascheninnikovia lanata*), sand sagebrush (*Artemisia filifolia*), and fourwing saltbush (*Atriplex canescens*). Forb cover is sparse but can be diverse; representative species are fineleaf hymenopappus (*Hymenopappus filifolius*), hoary tansyaster (*Machaeranthera canescens* var. *ambigua*), and scarlet globemallow (*Sphaeralcea coccinea).*

This habitat is commonly found in swales, playas, mesa tops, plateau parks, canyon bottoms and slopes, foothills, alluvial terraces, and plains. Soils vary from deep to shallow, and from sandy to finer textured. The substrate is typically derived from sandstone or shale. Some occurrences on sandy soils have a high cover of cryptogams on the soil surface.

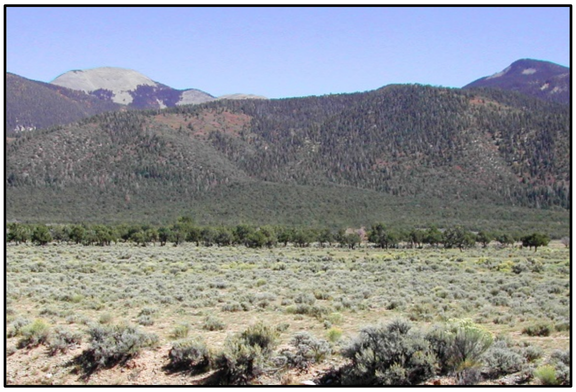
## *Intermountain Saltbrush Shrubland*



The Intermountain Saltbrush Shrubland **[M093]** occurs at 1,520-2,200 m (4,985-7,220 ft) elevation in the Colorado Plateaus ecoregion, but extends southward into the Arizona/New Mexico Mountains and High Plains and Tablelands ecoregions. This shrubland is characterized by an open to moderately dense cover of shrubs (<2 m (7 ft) tall) with a sparse herbaceous layer composed of perennial bunchgrasses. Dominant shrubs may include fourwing saltbush, shadscale saltbush (*Atriplex confertifolia*), cattle saltbush (*A. polycarpa*), and greasewood (*Sarcobatus vermiculatus*). Sometimes stands are co-dominated by big sagebrush, winterfat, or species of jointfir (*Ephedra* spp.) and wolfberries (*Lycium* spp.). Medium-tall and short perennial grasses include Indian ricegrass, blue grama, saltgrass (*Distichlis spicata*), needle and thread, western wheatgrass (*Pascopyrum smithii*), and alkali sacaton (*Sporobolus airoides*). Forb cover is generally sparse.

Sites can be found on all aspects of valley bottoms, alluvial and alkaline flats, mesas and plateaus, playas, drainage terraces, washes and interdune basins, bluffs, and gentle to moderately steep sandy or rocky slopes. Substrates are typically saline, alkaline, fine-textured soils developed from shale or alluvium. Infiltration rate is typically low. Soils are shallow to moderately deep, poorly developed, and the product of a semi-arid climate. Their surface often is very barren, and interspaces between the characteristic plant clusters are commonly covered by a microphytic crust.

## *Intermountain Tall Sagebrush Shrubland*



The Intermountain Tall Sagebrush Shrubland **[M169]** found in the Colorado Plateaus and Arizona-New Mexico Mountains ecoregions, has an open to dense (10-80% cover) shrub canopy (<2 m (7 ft) tall) dominated by big sagebrush. Some stands of this shrubland are codominated by fourwing saltbush, shadscale saltbush, rubber rabbitbrush, spiny hopsage (*Grayia spinosa*), greasewood, or spineless horsebrush (*Tetradymia canescens*). The herbaceous understory is variable and characterized by a sparse to dense (5-50%) cover of grasses such as Indian ricegrass and needle and thread.

Stands occur from 900 to 2,500 m (2,950-8,200 ft) in elevation on a variety of terrains that include flat to steeply sloping upland slopes on alluvial fans and terraces, toeslopes, lower and middle slopes, draws, badlands, foothills, and rocky slopes. Soils vary from deep and well-developed to shallow, rocky, and poorly developed.

## *Desert Alkali-Saline Wetland*

Desert Alkali-Saline Wetland **[M082]**, primarily of the Chihuahuan Desert and Colorado Plateaus ecoregions**,** is dominated by salt-tolerant shrubs such as iodinebush (*Allenrolfea occidentalis),* big sagebrush, and saltbush (*Atriplex* spp.). The understory and intershrub spaces can be sparse or dominated by graminoids such as saltgrass (*Distichlis spicata*)*,* spikerush (*Eleocharis* spp.)*,* rushes (*Juncus* spp.)*,* pickleweeds (*Salicornia* spp.)*,* greasewood, and alkali sacaton*.*

This wetland type occurs near drainages or on stream terraces or flats and may form rings around drying ponds or playas. Soils are alkaline to saline (depending upon soil moisture), which greatly affects species composition. Sites also experience intermittent, seasonal, or semi-permanent flooding, resulting in surface water retained into the growing season or throughout the year (except drought years). Sites that seasonally dry develop exposed mudflats, which are colonized by annual wetland vegetation.

## *Rocky Mountain Montane Riparian Forest*

Rocky Mountain Montane Riparian Forest **[M034]**, mostly of the Southern Rocky Mountains, Arizona/New Mexico Mountains, and Colorado Plateaus ecoregions, consists of riparian and permanently saturated forests and woodlands dominated by either broadleaf deciduous trees, montane conifers, or a mix of the two. The typical broadleaf dominants are narrowleaf cottonwood (*Populus angustifolia*), lanceleaf cottonwood (*P. acuminata*), Arizona alder (*Alnus oblongifolia*), and boxelder (*Acer negundo*). Conifers are represented by upland species that have extended their distribution into the riparian zone and may include subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*), blue spruce (*P. pungens*), and ponderosa pine (*Pinus ponderosa*). The understories are typically shrubby and may include gray alder (*Alnus incana*), redosier dogwood (*Cornus sericea*), peachleaf willow (*Salix amygdaloides*), and Bebb willow (*S. bebbiana*). Herbaceous layers can be dominated by forbs or graminoids or be sparsely vegetated, depending on the amount of shading, soil moisture, and disturbance history. Representative herbaceous species include bluejoint (*Calamagrostis canadensis*), horsetails (*Equisetum* spp.), and arrowleaf ragwort (*Senecio triangularis*). Introduced forage species, such as creeping bentgrass (*Agrostis stolonifera*), Kentucky bluegrass (*Poa pratensis*), timothy (*Phleum pratense*), and smooth brome (*Bromus inermis*), can be abundant.

This forest type is mostly comprised of montane to subalpine riparian communities occurring as narrow bands lining streambanks and alluvial terraces in narrow to wide, low gradient valley bottoms and on floodplains with sinuous stream channels. Beavers cut younger cottonwoods (*Populus* spp.) and willows (*Salix* spp.) and frequently dam side channels; hence, they are thought to be important to maintaining the hydrological regime for these communities in unconfined floodplains. Elevations range between 1,600 and 3,475 m (5,250-11,400 ft) and the habitat is commonly associated with Montane-Subalpine Wet Shrubland and Wet Meadow **[M075].**

## *Intermountain Dwarf Sagebrush Shrubland*

Intermountain Dwarf Sagebrush Shrubland **[M170]** occurs from 1,500-2,450 m (4,920-8,035 ft) elevation in the Colorado Plateaus and Southern Rocky Mountains ecoregions and is characterized by an open to moderately dense shrub or dwarf-shrub layer with a sparse to moderately dense herbaceous layer. In New Mexico, black sagebrush (*Artemisia nova*) is the characteristic sage along with other shrub associates such as Torrey's jointfir, Mormon tea, and antelope bitterbrush (*Purshia tridentata*). The herbaceous layer is often sparse but, on occasion, a moderate to dense cover of perennial grasses can be present that may include Indian ricegrass, blue grama, Idaho fescue, needle and thread, western wheatgrass, James' galleta, and muttongrass.

Some sites have significant biological crust formation on the soil surface. Sites generally are xeric and may be wind-blown ridges and benches, gravelly alluvial fans, hilltops, canyons, gravelly draws, and dry flats. Substrates are variable, but are typically alluvium derived from limestone, shale, basalt, rhyolite, or volcanics.

## *Intermountain Arroyo Riparian Scrub*

Intermountain Arroyo Riparian Scrub **[M095]** occurs at 1,600-2,475 m (5,250-8,120 ft) elevation in the Colorado Plateaus ecoregion and is primarily an open shrubland habitat with patches of vegetation occurring within and along the edges of ephemeral cold-desert washes. Dominant species may be common in the surrounding uplands including sand sagebrush (*Artemisia filifolia*), big sagebrush, fourwing saltbush, shadscale saltbush, skunkbush sumac (*Rhus trilobata*), longleaf brickellbush (*Brickellia longifolia*), and rubber rabbitbrush. Herbaceous cover is sparse, although non-native annuals such as cheatgrass (*Bromus tectorum*) and prickly Russian thistle (*Salsola tragus*) are sometimes abundant.

This habitat is associated with flash flooding and rapid sheet and gully flows that scour channel bottoms. The vegetation is sparse from both the high impact of flooding and the lack of moisture for the rest of the year.

# Threats and Conservation Actions

Ten threats could potentially impact SGCN in 15 habitats within the Colorado Plateaus ecoregion (Table 12). These threats are summarized below and listed in the order presented by the IUCN (2016). The list does not reflect the order of threat severity.

- Development: Water withdrawals for use by Farmington and Albuquerque.
- Agriculture and Aquaculture: Grazing practices that impact SGCN habitat and groundwater withdrawal for crops.
- Energy and Mining: Habitat loss and fragmentation from oil and gas development.
- Transportation and Utilities: Collisions with transmission lines, roads acting as barriers to movement.
- Biological Resource Use: Wood harvesting in piñon-juniper woodlands.
- Human Intrusion and Disturbance: Disturbance by off-highway vehicles (OHVs).
- Natural System Modifications: Degradation of riparian and aquatic ecosystems.
- Invasive and Problematic Species: Cheatgrass invasion in sagebrush steppe, introduction of zebra (*Dreissena polymorpha*) and/or quagga (*Dreissena bugensis*) mussels in aquatic habitats, and invasion of riparian habitats by tamarisk (*Tamarix* spp.) or other non-native plants.
- Pollution: Air, soil, and water contamination from industrial activities.
- Climate Change: Reduction in crucial habitats (e.g., riparian) from prolonged drought.

Conservation concerns include invasion of cheatgrass in the sagebrush steppe, modification of riverine ecosystems because of water withdrawals, and habitat fragmentation and pollution from industrial activities, including oil and gas extraction.

Oil and natural gas development has resulted in a high density network of roads and wellpads over large areas of the northwestern part of this ecoregion that have reduced large patches of Intermountain Tall Sagebrush Shrubland and Intermountain Juniper Woodland habitats to small fragments. Traffic contributes to direct mortality of wildlife and traffic-related disturbance may disrupt normal behavior patterns of SGCN. As patches of habitat shrink, vulnerability of SGCN to predators increases. Conservation actions to address these threats include making efforts early in the planning of energy developments to minimize habitat fragmentation, removing unused roads, and restoring habitat to pre-development conditions.

Cheatgrass germinates earlier than native grasses, and out-competes them for space and resources. More importantly, it serves as a fine fuel that increases the likelihood of unnaturally intense fires. Following wildfire, cheatgrass readily colonizes burned areas, thereby accelerating degradation of the sagebrush steppe to a state that is markedly less useful for livestock and wildlife (Knapp 1996, Ford et al. 2012). Conservation actions include determining and implementing strategies to eradicate cheatgrass.

Withdrawal of water from the San Juan River and Rio Grande for crops and municipalities reduces flows upon which several imperiled fish (Colorado pikeminnow (*Ptychocheilus lucius)*, razorback sucker (*Xyrauchen texanus)*, and Rio Grande silvery minnow (*Hybognathus amarus*)) and invertebrates depend. It also decreases the extent and functionality of riparian habitat.

These threats could be reduced by water conservation measures and adjustment of reservoir water releases to mimic natural flow patterns.

Depending on location, the Colorado Plateaus ecoregion was warmer and wetter or warmer and drier than normal from 1991 to 2005, and was consistently warmer and drier than normal from 2000 to 2005. With continued climate change, the ranges of big sagebrush and narrowleaf cottonwood are expected to contract substantially, and tree species, including two-needle piñon (*Pinus edulis*), Engelmann spruce (*Picea engelmannii*), and Utah juniper (*Juniperus osteosperma*), may also sharply decline (Rehfeldt et al. 2006, Notaro et al. 2012). Additionally, distribution of two-needle piñon, ponderosa pine, Engelmann spruce and Utah juniper may shift upslope by 100-500 m (328-1,640ft) (Rehfeldt et al. 2006). The habitats with very high vulnerability to climate change are Great Plains Shortgrass Prairie, Intermountain Saltbush Shrubland, and Desert Alkali-Saline Wetland (Table 10; Triepke et al. 2014).

Table 12. Potential threats to habitat and associated SGCN in the Colorado Plateaus ecoregion.

Threat categories were derived from IUCN (2016). Habitats listed are those that are dominant in the amount of area they encompass or are particularly important to conserve (Tier 1 or 2) in this ecoregion.

| Habitat \ Threat | Development | Agriculture & Aquaculture | Energy & Mining | Transportation & Utilities | Biological Resource Use | Human Intrusions & Disturbance | Natural System Modifications | Invasive & Problematic Species | Pollution | Climate Change |
|---|---|---|---|---|---|---|---|---|---|---|
| Cliff, Scree & Rock Vegetation | | | X | X | | X | | | | |
| Desert Alkali-Saline Wetland | | X | X | | | | | X | | X |
| Great Plains Floodplain Forest | X | X | | | | X | X | X | | X |
| Intermountain Arroyo Riparian Scrub | | X | X | | | X | | X | X | X |
| Intermountain Dry Shrubland & Grassland | | X | | X | | X | | X | X | X |
| Intermountain Dwarf Sagebrush Shrubland | | X | | | | X | | X | X | X |
| Intermountain Juniper Woodland | | | X | X | | X | X | | X | X |
| Intermountain Saltbush Shrubland | | X | | | | X | | X | X | X |
| Intermountain Tall Sagebrush Shrubland | | X | X | | | X | | X | X | X |
| Rocky Mountain Montane Riparian Forest | | X | X | | X | | X | | | X |
| Rocky Mountain Piñon-Juniper Woodland | | X | X | X | X | X | X | X | X | X |
| Perennial Cold Water Streams | X | X | X | | | | X | X | X | X |
| Perennial Cold and Warm Water Reservoirs | | | | | | | | | | X |
| Perennial Marshes/Cienegas/Springs/Seeps | | X | X | | | | X | X | | X |
| Perennial Warm Water Streams | | X | | | | | X | X | X | X |

The following are proposed conservation actions for the Colorado Plateaus ecoregion, listed in order of priority within each IUCN threat category. Threat categories are listed according to the order presented by IUCN (2016).

## *Development:*

- Determine distribution and habitat needs of SGCN that reside near urban areas.
- Investigate the potential impacts of current and future development on SGCN. Potential collaborators: universities.
- Maintain contact with municipal staff in charge of planning and zoning to stay informed about new developments. Potential collaborators: municipalities.
- Inform municipal staff of nearby SGCN and how to minimize development-related impacts to SGCN. Potential collaborators: municipalities.
- Work with municipalities to initiate policies that will minimize negative impacts of future developments on SGCN. Potential collaborators: municipalities.
- Participate in public involvement opportunities when proposed developments might threaten the persistence of SGCN.

## *Agriculture and Aquaculture:*

- Determine where habitat restoration would benefit SGCN and work with federal, state, and private land managers to restore degraded rangelands to good or excellent condition. Monitor restoration results to develop and initiate any identified improvements to restoration practices. Potential collaborators: BLM, USFS, SLO, private land managers.
- Establish baseline composition, condition, and function of major range habitats to inform habitat restoration actions, particularly for juniper and sagebrush habitats. Potential collaborators: BLM, USFS, universities.
- Determine how timing, intensity, and duration of livestock grazing affect SGCN and their habitats, including the interaction between grazing, fire, and the spread of invasive and problematic species. Potential collaborators: BLM, NRCS, USFS, NMDA, SLO, universities, private land managers.
- Promote expanded use of appropriate, cost effective, grazing practices that ensure long-term ecological sustainability for SGCN and their habitats (especially riparian habitats). These include actions that contribute to recovery of rangelands impacted by drought and allow restoration activities to be completed (Gripne 2005). Potential collaborators: BLM, USFS, SLO, private land managers.
- Promote grazing systems that address both livestock and SGCN habitat needs based on site-specific conditions. When particular habitat components need improvement, coordinate with ranchers and resource managers to identify and implement modifications that would provide the desired habitat outcomes. Potential collaborators: BLM, USFS, SLO, private landowners.
- Gather and assess current information on grazing practices and determine how the Department can support landowners that provide habitat for wildlife. Potential collaborators: BLM, NRCS, USFS, NMDA, SLO, private organizations.

- Promote use of devices and models that improve water conservation and irrigation efficiency (Schaible and Aillery 2012), to help conserve the structure and function of aquatic and riparian habitats. Potential collaborators: NRCS, NMOSE.
- Promote rest-rotation and/or deferred-rotation grazing systems that incorporate rested pastures and help improve overall range condition and enhanced wildlife habitat. When drought or other conditions that limits grazing occur, these rested pastures can provide forage reserves and relieve pressure on grazed pastures or allotments and provide time for owners to make contingency plans for excess livestock. Potential collaborators: BLM, NRCS, USFS, USFWS, SLO, private landowners.

## *Energy and Mining:*

- Determine where energy development and mineral extraction currently, and in the future, may affect SGCN. Potential collaborators: BLM, USFS, EMNRD, NM Bureau of Geology and Mineral Resources, SLO, energy and mining companies.
- Work to minimize negative impacts (especially habitat fragmentation) on SGCN from new energy development and mining. Potential collaborators: BLM, EMNRD, SLO, energy and mining companies.
- Restore SGCN populations and habitats negatively impacted by resource extraction. This includes augmenting or reintroducing affected populations, closing unused roads, removing well pads, reclaiming disturbed habitats as close as possible to their original topography, and restoring native vegetation. Potential collaborators: BLM, USFS, EMNRD, SLO, energy and mining companies.
- Maintain and foster open communication with mining and energy companies and land management agencies to minimize adverse impacts of development to SGCN. Potential collaborators: BLM, USFS, EMNRD, SLO, energy and mining companies.

## *Transportation and Utilities:*

- Determine where roads, vehicle traffic, and utility lines are inhibiting or preventing movement of SGCN within and between seasonal ranges. Potential collaborators: utility companies.
- Work with utility companies and NMDOT to complete mitigation measures that will increase the probability of safe passage for affected SGCN. These include modifying barrier fences along roadways, constructing road crossings, placing warning signs for motorists, marking utility lines so they can be readily seen by birds, and placing safeguards that will reduce the probability of electrocution. Potential collaborators: NMDOT, utility companies.
- Monitor the efficacy of mitigation measures and initiate any identified improvements.

## *Biological Resource Use:*

- Determine the distribution (historic and current), composition, and function of piñon-juniper woodlands and savannas needed by SGCN, as well as SGCN prevalence in these habitats. Potential collaborators: BLM, USFS, universities, private entities.
- Work with landowners and land management agencies to maintain healthy, and return degraded, woodlands and savannas to an improved composition and function for wildlife. Potential collaborators: BLM, USFS, SLO, private landowners.

- Inform natural resource law enforcement staff of distribution and habitat needs of SGCN and partner with them to enforce laws to protect SGCN populations and habitats. Potential collaborators: BLM, NPS, USFS, USFWS.

## *Human Intrusions and Disturbance:*

- Identify and characterize areas and routes frequented by OHVs, and use that information to assess the potential impacts to SGCN and other wildlife. Potential collaborators: BLM, USFS, SLO.
- Identify, designate, and promote areas for OHV use that avoid disturbance to, or modification of, SGCN habitats. Potential collaborators: BLM, USFS, SLO.
- Initiate a public information campaign to inform and educate OHV users of permitted and prohibited activities that can impact SGCN and other wildlife. This may include public service announcements, print advertising, public meetings, and signs in areas frequented by OHV users. Potential collaborators: BLM, USFS, SLO.
- Work with public land management agencies to regularly review and update OHV travel routes and trails open to the public and appropriate restrictions necessary to protect SGCN and other wildlife. Potential collaborators: BLM, USFS, SLO.
- Work with land management agencies to improve OHV law enforcement with passive measures such as strategically located barricades and active measures including monitoring and enforcement patrols to reduce negative impacts of OHVs on SGCN and other wildlife. Potential collaborators: BLM, USFS, SLO.
- Work with the public to educate residents and recreationists about restrictions on and potential negative impacts of free ranging domestic pets on SGCN and other wildlife. Potential collaborators: municipalities, universities, non-profit organizations.

## *Natural System Modifications:*

- Restore stands of trees in forests and woodlands to natural or historic densities that reduce the probability of insect and disease outbreaks and stand-replacing wildfires. Avoid unnecessary removal of large old-growth trees and snags, which serve as important wildlife habitat (Kalies and Rosenstock 2013). Potential collaborators: BLM, USFS, SFD, SLO, non-profit organizations.
- Design and implement riparian and aquatic habitat restoration projects to benefit SGCN. This may include establishing priorities for habitat restoration and developing reach-specific plans. Monitor restoration projects to determine effectiveness (Block et al. 2001) and adaptability to management. May also include specific actions such as reintroducing keystone species including beavers (*Castor canadensis*; Baker and Cade 1995, McKinstry et al. 2001), restoration and monitoring of self-sustaining populations of river otters (*Lontra canadensis*) and native fishes. Potential collaborators: ACOE, BLM, BOR, NPS, USFS, USFWS, NHNM, SFD, SLO, universities, private land managers.
- Assess the magnitude, frequency, timing, duration, and rate of change of flow and the effects of hydrologic alterations on different types of riparian systems. Determine flows needed to sustain SGCN and their habitats, and the effects of flow stabilization by upstream dams. Work with agencies that manage dams and reservoirs to ensure amounts and

patterns of flows needed for persistence of SGCN. Potential collaborators: ACOE, BOR, USFWS, USGS, NMOSE, universities, private industry.

- Determine beneficial fire frequencies and intensities and work with land management agencies and private landowners to develop fire management plans and implement prescribed burns that avoid disturbing SGCN during sensitive periods (e.g., nesting), maintain condition of sensitive habitats (e.g., riparian habitat) and protect people and property. Potential collaborators: BLM, NPS, USFS, SLO, SFD, private landowners..
- Determine responses of upland habitats and associated riparian/aquatic communities that include SGCN to prescribed burns and wildfires. Integrate fire and fuels management into riparian ecosystem conservation. Design and implement projects that reduce unnaturally high fire risk associated with increased fuel loads or lack of moist soils in riparian areas. Methods may include flooding or mechanical removal of vegetation (Ellis 2001). Potential collaborators: ACOE, BLM, BOR, NPS, USFS, USFWS, NHNM, SLO, private land managers.
- Promote post-fire management activities that are beneficial to SGCN. Includes minimizing ash flow into streams. Potential collaborators: NRCS, NPS, USFS, SFD, SLO, non-profit organizations, private landowners.
- Implement a standardized method to inventory, assess, and monitor riparian and aquatic habitats and efforts to conserve them. Determine amount, status, and trend of habitat, levels of fragmentation and how SGCN might be affected. Potential collaborators: ACOE, BLM, BOR, NPS, USFS, USFWS, NHNM, NMED, SFD, SLO, universities.
- Restore and protect aquatic, riparian, wetland, and wet meadow habitats and the surface and ground water that supports them. Minimize activities that lead to gully formation and soil erosion. Potential collaborators: ACOE, BLM, BOR, NRCS, USFS, USFWS, private landowners.
- Survey and monitor perennial marshes/cienegas/springs/seeps habitats and the SGCN that inhabit them to determine changes in quantity and quality of habitat, as well as status and trend of SGCN. Potential collaborators: BLM, USFS, USFWS, NHNM, NMED, SLO, universities.
- Promote land management practices, standards, and guidelines to conserve and/or restore structure and function of corridors that provide important habitat for SGCN. This should include xeric riparian communities that serve as important migratory corridors for birds and other wildlife while providing ecosystem services, and wildlife corridors that link isolated mountain ranges (Powledge 2003) and coniferous forest patches. Potential collaborators: BLM, NPS, USFS, USFWS, NHNM, universities.
- Encourage sustainable groundwater use to protect aquatic and riparian habitats. Promote water conservation, such as use of devices and models that facilitate optimal irrigation (Schaible and Aillery 2012), to conserve the structure and function of aquatic and riparian habitats. Potential collaborators: NRCS, NMDA, SLO, municipalities, water management districts.
- Promote citizen participation in restoration and conservation of watersheds. Potential collaborators: ACOE, BOR, USFS, USFWS, NMED, universities, private land managers, non-profit organizations.

- Inform interested and affected members of the public about the value of riparian systems and maintaining in-stream flows in order to build support for conservation of riparian species and habitat restoration efforts. Potential collaborators: NRCS, USFS, universities, non-profit organization, private land managers.
- Examine the structural characteristics of habitat fragmentation and how it influences patch size, edge effect, dispersal behavior, and daily and seasonal movements/migrations by wildlife including SGCN. Focus on riparian and aquatic habitats. Potential collaborators: BLM, USFS, USFWS, NHNM, NMED, SLO, universities.

## *Invasive and Problematic Species:*

- Promote land management strategies that will inhibit the spread of cheatgrass. Potential collaborators: BLM, USFS, SLO.
- Determine historic and current SGCN habitats infested with cheatgrass. Work with landowners and land management agencies to restore these areas to native species. Potential collaborators: BLM, USFS, SLO, private landowners.
- Continue current campaign to prevent infestation of aquatic habitats by zebra and quagga mussels. Potential collaborators: BOR, NMSP, universities.
- Determine the distribution of salt cedar and other exotic plant species in riparian habitats. Determine the impact of their removal and reduction on SGCN. Create and initiate a plan that, if these species are reduced or removed, will re-create historic structure and composition of riparian habitats and have minimal negative impacts on SGCN. Potential collaborators: BLM, USFS, ACOE, BOR, NRCS, SLO, private landowners.
- Determine the distribution of all invasive and problematic species found in this ecoregion, and assess related threats to SGCN. Potential collaborators: BLM, USFS, universities.
- Develop strategies to prevent emerging diseases from getting into the Colorado Plateaus ecoregion, as well as strategies that will inhibit the spread of ones already there. Potential collaborators: universities.

## *Pollution:*

- Work with appropriate agencies that enforce mining and energy development regulations, Best Management Practices, and safeguards that protect water quality and minimize mortality of SGCN. Potential collaborators: EMNRD, NMED, private industry.
- Evaluate and mitigate the effects of air pollution from coal burning power plants on SGCN and their habitats. Potential collaborators: EMNRD, NMED, private industry.
- Assess impacts to habitat and SGCN from industrial activities, including mining and energy development. These impacts may include direct mortality, pollution from produced wastewater (including brine and hydraulic injection fluids), and sediment runoff from roads. Potential collaborators: USFS, BLM, SLO, EMNRD, NMED, private industry, local governments.
- Determine effects of agro- and petrochemicals, and urban runoff, on SGCN fish. Potential collaborators: NMED, universities.

## *Climate Change:*

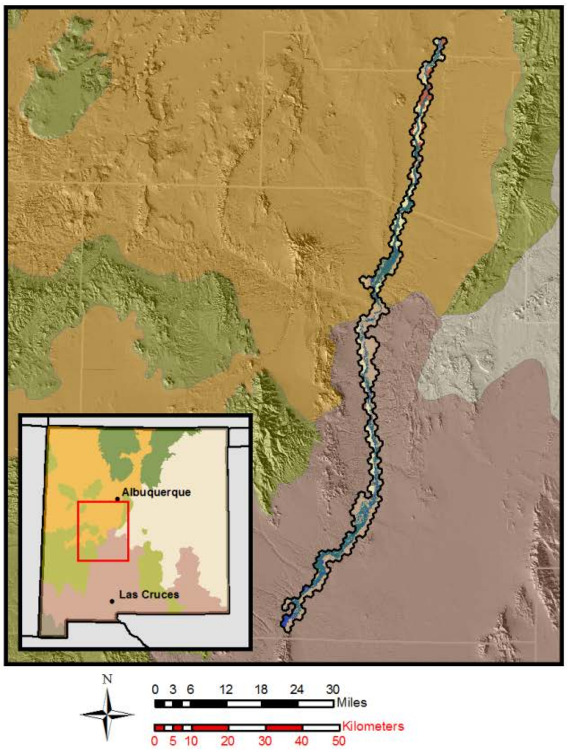
- Determine how regional and global climate change will affect SGCN, vegetation patterns, and community and ecosystem processes and dynamics. Of particular importance is identifying habitats and SGCN that are most likely to be negatively affected by climate change, including impacts on travel corridors and connectivity. Plan and complete projects that help maintain the distribution and natural functioning of these impacted species and habitats. Potential collaborators: BLM, USFWS, USGS, universities.
- Determine ecology, distribution, status, and trends of, and threats to SGCN (especially invertebrates that are not currently monitored, riparian-obligate species, and rare native fishes) and their habitats. Use this information to develop and implement effective monitoring protocols and conservation actions. Potential collaborators: BLM, USFWS, universities, non-profit organizations, private industry.
- Assess the synergistic effects between climate change and other threats to SGCN and their habitats. Potential collaborators: USFWS, USGS, universities.
- Develop new species recovery plans that consider the current status of and limiting factors for species, as well as projected future conditions for both species and their habitats.
- Inform the public about the potential adverse effects of continued climate change on SGCN and their habitats. Potential collaborators: USFWS, USGS, universities, non-profit organizations.
- Monitor SGCN to determine long-term trends that correlate to ecosystem dynamics and habitat changes. Potential collaborators: BLM, NPS, USFWS, tribal resource management entities, universities.

## *Actions that Address Multiple Threats:*

- Identify or develop an accessible common database of information to document the status and condition of, threats to, and conservation actions implemented in Colorado Plateaus ecoregion habitats. Identify data gaps and varying data collection methodologies that provide a framework for identifying and promoting robust standard monitoring approaches. Potential collaborators: universities.

# Conservation Opportunity Areas

## *Middle Rio Grande*




| Habitat | Tier | Area (ha) |
|---|---|---|
| Arid West Interior Freshwater Emergent Marsh | 1 | 124.6 |
| Chihuahuan Desert Scrub | 4 | 12,820.8 |
| Chihuahuan Semi-Desert Grassland | 2 | 5,878.4 |
| Cliff, Scree & Rock Vegetation | 4 | 1,471.5 |
| Desert Alkali-Saline Wetland | 1 | 164.3 |
| Developed & Urban | 5 | 3,007.3 |
| Great Plains Floodplain Forest | 1 | 15,896.9 |
| Herbaceous Agricultural Vegetation | 5 | 8,884.4 |
| Intermountain Dry Shrubland & Grassland | 2 | 638.6 |
| Intermountain Saltbush Shrubland | 4 | 18.4 |
| Intermountain Tall Sagebrush Shrubland | 3 | 0.6 |
| Open Water | 5 | 3,322.5 |
| Rocky Mountain Montane Riparian Forest | 1 | 1.4 |
| Rocky Mountain Montane Shrubland | 3 | 1.7 |
| Southwest Riparian Forest | 1 | 3.1 |
| Warm-Desert Arroyo Riparian Scrub | 2 | 393.7 |

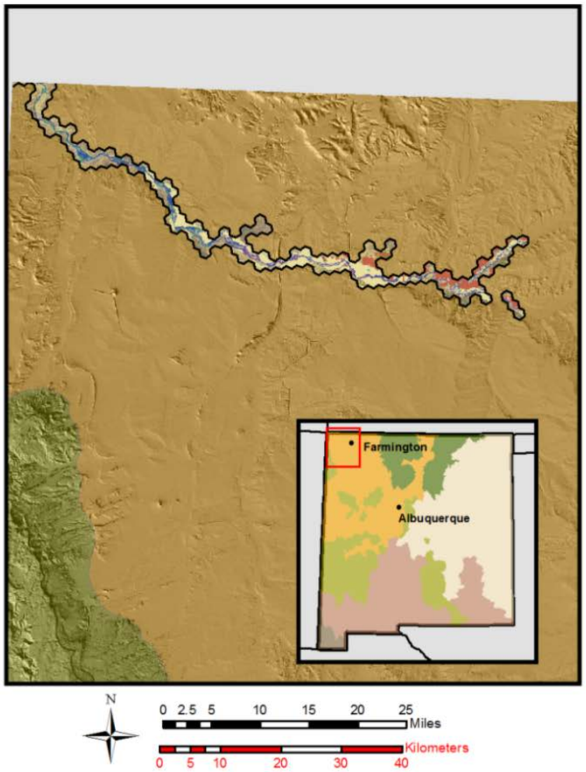
Figure 15. Middle Rio Grande Conservation Opportunity Area.

The Middle Rio Grande Conservation Opportunity Area (COA) (Figure 15) encompasses 52,570 ha (129,903 ac) from the south end of Albuquerque to the north end of Elephant Butte Reservoir. Most of its land (55%) is privately-owned, but 21% is managed by USFWS, 8% by NMSP, and 6% is tribal. It contains three Important Bird Areas (Bosque del Apache, Elephant Butte, Ladd S. Gordon), three TNC conservation areas (Bosque Wilderness, Sedillo Spring, Sevilleta), and 26% of its lands are protected.

Landcover includes 13 native vegetation habitats plus open water, developed, and agricultural lands. Dominant habitats are Great Plains Floodplain Forest (30%) and Chihuahuan Desert Scrub (24%), but a sizable area (16.4%) is agriculture. Perennial aquatic habitats include 238 km (148 mi) of warm water streams and 2,091 ha (5,167 ac) of warm water reservoirs.

SGCN total 11, including one species categorized as an Immediate Priority SGCN (Rio Grande chub) and two species considered SGCN based on their occurrence in highly specialized or limited habitats in the state (bank swallow, Bell’s vireo).

## *San Juan River*




| Habitat | Tier | Area (ha) |
|---|---|---|
| Annual Grassland | 5 | 756.5 |
| Barren | 5 | 24.8 |
| Cliff, Scree & Rock Vegetation | 4 | 3,066.5 |
| Desert Alkali-Saline Wetland | 1 | 1,735.2 |
| Developed & Urban | 5 | 2,888.5 |
| Herbaceous Agricultural Vegetation | 5 | 6,151.2 |
| Intermountain Arroyo Riparian Scrub | 2 | 13.0 |
| Intermountain Dry Shrubland & Grassland | 2 | 5,248.6 |
| Intermountain Juniper Woodland | 4 | 241.0 |
| Intermountain Saltbush Shrubland | 4 | 4,437.1 |
| Intermountain Tall Sagebrush Shrubland | 3 | 0.6 |
| Introduced Riparian Vegetation | 5 | 1,449.1 |
| Open Water | 5 | 2,102.5 |
| Quarries, Mines, Gravel Pits and Oil Wells | 5 | 56.7 |
| Rocky Mountain Montane Riparian Forest | 1 | 1,364.1 |

Figure 16. San Juan River Conservation Opportunity Area.

The San Juan River Conservation Opportunity Area (COA) (Figure 16) encompasses 29,572 ha (73,074 ac) from Navajo Dam west to where the river crosses into Colorado near the Four Corners. Most (61.3%) of the COA is on tribal lands; 31.2% is privately-owned. It contains one Important Bird Area (B-Square Ranch) and two TNC conservation areas (Canyon of the Ancients, San Juan River). Only 1% is protected.

Landcover includes eight native vegetation habitats plus open water, developed, and agricultural areas. Agricultural lands are the most abundant. Intermountain Dry Shrubland and Grassland (18%), Intermountain Saltbush Shrubland (15%), and Cliff, Scree, and Rock (10%) are the dominant native habitats. Perennial aquatic habitats include 185 km (115 mi) of warm water streams, 27 km (17 mi) of cold water streams, and 1.8 ha (4.4 ac) of warm water reservoirs.

SGCN total nine, including one species categorized as an Immediate Priority SGCN (roundtail chub) and two species considered SGCN based on their occurrence in highly specialized or limited habitats in the state (bank swallow, California kingsnake).

# Chapter 6: Southern Rocky Mountains Conservation Profile

## Species of Greatest Conservation Need (SGCN) and their Habitats

The Southern Rocky Mountains ecoregion encompasses 26,450 km$^2$ (10,212 mi$^2$) and includes the Sangre de Cristo, Jemez, and San Juan Mountains in New Mexico. These ranges are at the southern end of a 144,350 km$^2$ (55,734 mi$^2$) contiguous segment that extends to southern Wyoming. In New Mexico, elevations range from 1,980-4,012 m (6,496-13,163 ft); terrain is characterized by steep rugged mountains, complex masses of peaks, and some intermontane valleys. The climate is mostly characterized as mid-latitude continental, but is subarctic at high elevations. Summers are cool to warm; winters are severely cold (occasionally <-20 $^{o}$C (-4 $^{o}$F)). Precipitation averages 60 cm (24 in) (range: 25-175 cm (10-69 in)) and occurs as snow in winter and thundershowers in summer.

Sixty-three SGCN occur in the Southern Rocky Mountains ecoregion; over half are birds (Table 13, Table 15). Most SGCN with the ecoregion fall within the Susceptible (32%), Immediate Priority (25%), or Limited Habitat (24%) categories. Occurrence of most SGCN (70%) in the ecoregion is based on observations.

Table 13. Number of Species of Greatest Conservation Need in the Southern Rocky Mountains ecoregion.

| Category[15] / Taxon | I | H | S | D | F | Total |
|---|---|---|---|---|---|---|
| Amphibians | 1 | 0 | 2 | 0 | 1 | 4 |
| Birds | 9 | 7 | 14 | 1 | 3 | 34 |
| Crustaceans | 0 | 0 | 0 | 3 | 0 | 3 |
| Fish | 3 | 0 | 1 | 0 | 0 | 4 |
| Mammals | 3 | 1 | 3 | 0 | 2 | 9 |
| Molluscs | 0 | 7 | 0 | 2 | 0 | 9 |
| Total | 16 | 15 | 20 | 6 | 6 | 63 |

[15]Category abbreviations are: I = Immediate Priority, H = Limited Habitat, S = Susceptible, D = Data Needed, F = Federally-listed.

Terrestrial habitats include 26 naturally vegetated types, three unvegetated land covers, and 10,800 ha (26,676 ac) of cultivated land (Table 14, Figure 17). Dominant habitats are stratified by elevation. Below 2,400 m (7,800 ft), characteristic habitats are piñon-juniper woodlands or a grass-shrub mix comprised of big sagebrush (*Artemisia tridentata*), mountain mahogany (*Cercocarpus montanus*), Gambel's oak (*Quercus gambellii*) and western wheatgrass (*Pascopyrum smithii*). Forests of ponderosa pine (*Pinus ponderosa*) and Douglas fir (*Pseudotsuga menziesii*) are dominant from 2,400-3,000 m (7,800-9,800 ft), whereas forests of Engelmann spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*), and quaking aspen (*Populus tremuloides*) are found from approximately 3,000-3,500 m (9,800-11,500 ft). Above 3,500 m (11,500 ft) is alpine vegetation characterized by low shrubs, sedges, and krummholz (conifer trees shaped by heavy persistent winds) vegetation.

This ecoregion contains 83% of cold water habitats and almost half of all lakes and reservoirs in New Mexico (Figure 18). The 54 waterbodies are all cold water and cover 4,768 ha (11,778 ac); 22 are natural lakes that cover 50 ha (123 ac). Three reservoirs (Heron, El Vado, Eagle Nest) account for 96% of the total water surface area. The Southern Rocky Mountains also contain 9,850 km (6,121 mi) of streams (51% of the total length for New Mexico), 84% of which are cold water habitats (75% of the statewide total).

Table 14. Terrestrial habitat types of the Southern Rocky Mountains ecoregion.

| Habitat Category | USNVC Code | Habitat name[16] | Tier[17] | Climate Vulnerability[18] | Area (km$^2$) | Area (mi$^2$) |
|---|---|---|---|---|---|---|
| Alpine and Montane Vegetation | M168 | Rocky Mountain Subalpine-High Montane Meadow | 2 | Low→Moderate | 1,501 | 580 |
| | M049 | Rocky Mountain Montane Shrubland | 3 | Moderate | 1,260 | 487 |
| | M099 | Rocky Mountain Alpine Vegetation | 3 | -- | 26 | 10 |
| | M011 | Madrean Montane Forest & Woodland | 3 | Moderate→High | 2 | 0.81 |
| | M022 | Rocky Mountain Lower Montane Forest | 4 | Low→Moderate | 12,075 | 4,662 |
| | M027 | Rocky Mountain Piñon-Juniper Woodland | 4 | Moderate | 3,640 | 1,405 |
| | M020 | Rocky Mountain Subalpine-High Montane Conifer Forest | 4 | Moderate | 2,870 | 1,108 |
| | M026 | Intermountain Juniper Woodland | 4 | Low→Moderate | 1,610 | 621 |
| | M010 | Madrean Lowland Evergreen Woodland | 4 | Moderate→High | 10 | 4 |
| Plains-Mesa Grasslands | M051 | Great Plains Mixedgrass Prairie | 2 | -- | 312 | 120 |
| | M053 | Great Plains Shortgrass Prairie | 3 | Moderate | 395 | 153 |
| | M052 | Great Plains Sand Grassland & Shrubland | 3 | Moderate | 0.20 | 0.08 |
| Desert Grassland and Scrub | M171 | Intermountain Dry Shrubland & Grassland | 2 | Low→High | 693 | 267 |
| | M087 | Chihuahuan Semi-Desert Grassland | 2 | Moderate→High | 0.13 | 0.05 |
| | M169 | Intermountain Tall Sagebrush Shrubland | 3 | Low→Moderate | 1,027 | 397 |
| | M170 | Intermountain Dwarf Sagebrush Shrubland | 4 | Low→Moderate | 15 | 6 |

[16] Habitats were macrogroups identified in the US National Vegetation Classification System (USNVC), except Other Land Covers which were derived from Southwestern Regional Gap Analysis land cover classes.
[17] Tiers reflect the urgency for conservation and were based on the degree of imperilment within the United States according to the NatureServe Conservation Status Assessment (http://www.natureserve.org/conservation-tools/conservation-status-assessment) and the spatial pattern of the habitat.
[18] Climate vulnerability levels were based on a vulnerability analysis performed for Ecological Response Units (ERU) across New Mexico and Arizona (Triepke et al. (2014). The ERU classification system represents major ecosystem types of the Southwest. Vulnerability for each ERU was calculated as the relative probability of type conversion. The ERUs were then crosswalked to the habitats shown here.

| Habitat Category | USNVC Code | Habitat name[16] | Tier[17] | Climate Vulnerability[18] | Area (km²) | (mi²) |
|---|---|---|---|---|---|---|
| | M093 | Intermountain Saltbush Shrubland | 4 | -- | 3 | 1 |
| Cliff, Scree & Rock Veg. | M887 | Cliff, Scree & Rock Vegetation | 4 | Moderate→High | 232 | 90 |
| Riparian Woodlands and Wetlands | M034 | Rocky Mountain Montane Riparian Forest | 1 | -- | 166 | 64 |
| | M075 | Montane-Subalpine Wet Shrubland & Wet Meadow | 1 | -- | 151 | 58 |
| | M028 | Great Plains Floodplain Forest | 1 | -- | 35 | 14 |
| | M082 | Desert Alkali-Saline Wetland | 1 | -- | 11 | 4 |
| | M888 | Arid West Interior Freshwater Emergent Marsh | 1 | -- | 2 | 0.68 |
| Introduced and Semi-Natural Vegetation | M512/ M498 | Perennial Grassland | 5 | -- | 3 | 1 |
| | M499 | Annual Grassland | 5 | -- | 1 | 0.41 |
| Other Land Cover | N/A | Developed & Urban | 5 | -- | 54 | 21 |
| | N/A | Herbaceous Agricultural Vegetation | 5 | -- | 108 | 42 |
| | N/A | Recently Disturbed or Modified | 5 | -- | 215 | 83 |

Table 15. Species of Greatest Conservation Need (SGCN) in the Southern Rocky Mountains ecoregion.

| Common Name | Scientific Name | Taxon | Category | Reason to Include[19] | Habitats[20] |
|---|---|---|---|---|---|
| Boreal Toad | *Anaxyrus boreas* | Amphibians | I | De, V, Di | M020, M022, M034, M075, M168, PLCP, PMCSS |
| Northern Leopard Frog | *Lithobates pipiens* | Amphibians | S | De, V | M020, M022, M028, M034, M049, M051, M053, M075, M082, M888 |
| Boreal Chorus Frog | *Pseudacris maculata* | Amphibians | S | V | M020, M022, M028, M034, M051, M075, M168, EC, EMCS, PCWS, PLCP, PMCSS, PWWS |
| Jemez Mountains Salamander | *Plethodon neomexicanus* | Amphibians | F | De, V, E | M020, M022, M099, M887, M034, M168 |
| Juniper Titmouse | *Baeolophus ridgwayi* | Birds | I | De, V | M010, M011, M026, M027, M034, M049, M887 |
| Pinyon Jay | *Gymnorhinus cyanocephalus* | Birds | I | De, V | M010, M011, M022, M026, M027, M028, M034, M049, M053, M095, M169, M171, M887, M888 |
| Lewis's Woodpecker | *Melanerpes lewis* | Birds | I | De, V | M011, M020, M022, M028, M034, M075, M076 |
| Virginia's Warbler | *Oreothlypis virginiae* | Birds | I | De, V | M010, M011, M020, M022, M026, M027, M028, M034, M049, M075, M076, M091 |
| Flammulated Owl | *Psiloscops flammeolus* | Birds | I | V | M010, M011, M020, M022, M026, M027, M034, M049, M051, M075, M168, M169, M171, M887 |
| Grace's Warbler | *Setophaga graciae* | Birds | I | De, V | M011, M022, M026, M027, M034, M036, M049, M171, M887 |

[19] Reason to include indicates which of five criteria for inclusion on the SGCN list a particular species met. Abbreviations are as follows: De = Declining; Di= Disjunct; E = Endemic; K = Keystone; V = Vulnerable.

[20] Aquatic habitat abbreviations are as follows: PCWS = Perennial Cold Water Streams; PWWS = Perennial Warm Water Streams; PLCP = Perennial Lakes, Cirques, Ponds; PMCSS = Perennial Marshes/Cienegas/Springs/Seeps; PCWR = Perennial Cold Water Reservoirs; PWWR = Perennial Warm Water Reservoirs; EMCS = Ephemeral Marshes/Cienegas/Springs; EC = Ephemeral Catchments. Habitat codes refer to National Vegetation Classification designations, which are identified in Table 14 above.

| Common Name | Scientific Name | Taxon | Category | Reason to Include[19] | Habitats[20] |
|---|---|---|---|---|---|
| Black-throated Gray Warbler | *Setophaga nigrescens* | Birds | I | De, V | M010, M011, M020, M022, M026, M027, M034, M049, M075, M076, M086, M091, M171, M887 |
| Gray Vireo | *Vireo vicinior* | Birds | I | V | M010, M011, M022, M026, M027, M028, M034, M049, M051, M082, M086, M087, M091, M092, M093, M169, M171, M887, |
| White-tailed Ptarmigan | *Lagopus leucura* | Birds | I | De, V, Di | M020, M075, M099, M168 |
| Boreal Owl | *Aegolius funereus* | Birds | H | De, V, Di | M020, M022, M075, M168 |
| Burrowing Owl | *Athene cunicularia* | Birds | H | De, V, Di | M026, M051, M052, M053, M071, M082, M086, M087, M092, M093, M169, M170, M171, M887 |
| Black Swift | *Cypseloides niger* | Birds | H | V, Di | M011, M020, M022, M034, M887 |
| Peregrine Falcon | *Falco peregrinus* | Birds | H | V, K | M010, M022, M026, M082, M086, M087, M887 |
| Bald Eagle | *Haliaeetus leucocephalus* | Birds | H | V, K | M010, M011, M020, M022, M026, M027, M028, M034, M049, M051, M052, M053, M082, M086, M087, M091, M093, M099, M168, M169, M170, M171, M887 |
| Eared Grebe | *Podiceps nigricollis* | Birds | H | De, V, Di | M888, EC, PCWR, PLCP, PMCSS, PWWR, PWWS |
| Bank Swallow | *Riparia riparia* | Birds | H | De, V, Di | M028, M034, M076, M092, M888 |
| Sagebrush Sparrow | *Artemisiospiza nevadensis* | Birds | S | De, V | M010, M026, M027, M034, M049, M051, M052, M053, M082, M086, M087, M091, M093, M169, M170, M171, M887 |
| Mountain Plover | *Charadrius montanus* | Birds | S | De, V | M010, M026, M027, M051, M052, M053, M071, M082, M086, M087, M093, M168, M169, M171, M499 |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[19] | Habitats[20] |
|---|---|---|---|---|---|
| Common Nighthawk | *Chordeiles minor* | Birds | S | De, V | M010, M026, M027, M049, M051, M052, M053, M086, M087, M168, M169, M170, M171, M887 |
| Evening Grosbeak | *Coccothraustes vespertinus* | Birds | S | De, V | M010, M011, M020, M022, M026, M027, M034, M887 |
| Olive-sided Flycatcher | *Contopus cooperi* | Birds | S | De, V | M010, M011, M020, M022, M026, M027, M034, M887 |
| Cassin's Finch | *Haemorhous cassinii* | Birds | S | De, V | M010, M011, M020, M022, M026, M027, M034, M169, M887 |
| Loggerhead Shrike | *Lanius ludovicianus* | Birds | S | De, V | M010, M011, M026, M027, M028, M034, M049, M051, M052, M053, M076, M082, M086, M087, M091, M092, M093, M095, M168, M169, M170, M171, M887 |
| Red-headed Woodpecker | *Melanerpes erythrocephalus* | Birds | S | De, V | M028, M036, M053, M076 |
| Williamson's Sapsucker | *Sphyrapicus thyroideus* | Birds | S | V | M011, M020, M022, M034, M887 |
| Clark's Nutcracker | *Nucifraga columbiana* | Birds | S | De, | M010, M011, M020, M022, M026, M027, M034 |
| Vesper Sparrow | *Pooecetes gramineus* | Birds | S | De, V | M010, M026, M027, M049, M051, M052, M087, M168, M169, M170, M171, M499, M512 |
| Mountain Bluebird | *Sialia currucoides* | Birds | S | De | M010, M011, M020, M022, M026, M027, M034, M049, M051, M053, M086, M087, M091, M168, M887 |
| Western Bluebird | *Sialia mexicana* | Birds | S | De, V | M010, M011, M020, M022, M026, M027, M028, M034, M049, M051, M075, M076, M086, M087, M168, M171, M887 |
| Pygmy Nuthatch | *Sitta pygmaea* | Birds | S | De, V | M010, M011, M020, M022, M026, M027, M028, M034, M049, M887 |
| Brown-capped Rosy-Finch | *Leucosticte australis* | Birds | D | V | M027, M099, M168, M887 |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[19] | Habitats[20] |
|---|---|---|---|---|---|
| Southwestern Willow Flycatcher | *Empidonax traillii extimus* | Birds | F | V | M028, M034, M082, M168, M888 |
| Yellow-billed Cuckoo | *Coccyzus americanus* | Birds | F | De, V, Di | M010, M011, M022, M027, M028, M034, M049, M052, M053, M076, M082, M086, M087, M091, M092, M093, M169, M170, M171, M499, M887, M888 |
| Mexican Spotted Owl | *Strix occidentalis lucida* | Birds | F | V | M010, M011, M020, M022, M026, M027, M034, M049, M075, M091, M168, M887, M888 |
| Colorado Fairy Shrimp | *Branchinecta coloradensis* | Crustaceans | D | V, Di | EC |
| Versatile Fairy Shrimp | *Branchinecta lindahli* | Crustaceans | D | V, Di | EC |
| Knobblip Fairy Shrimp | *Eubranchipus bundyi* | Crustaceans | D | V, Di | EC |
| Rio Grande Sucker | *Catostomus plebeius* | Fish | I | De, V | PCWS, PWWS |
| Rio Grande Chub | *Gila pandora* | Fish | I | V | PCWR, PCWS, PWWR, PWWS |
| Roundtail Chub | *Gila robusta* | Fish | I | De, V, Di | PWWS |
| Southern Redbelly Dace | *Phoxinus erythrogaster* | Fish | S | V, Di | PCWS |
| Gunnison's Prairie Dog | *Cynomys gunnisoni* | Mammals | I | De, V, K | M022, M026, M027, M051, M053, M086, M087, M093, M095, M168, M169, M170, M171, M499 |
| North American River Otter | *Lontra canadensis* | Mammals | I | V | PCWS, PWWS |
| American Mink | *Vison vison* | Mammals | I | V | M011, M034, M075, PCWS, PWWS |
| American Pika | *Ochotona princeps* | Mammals | H | V, Di | M020, M168, M887 |
| Pale Townsend's Big-eared Bat | *Corynorhinus townsendii* | Mammals | S | V | M010, M011, M020, M022, M026, M027, M034, M049, M086, M087, M091, M171, M887 |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[19] | Habitats[20] |
|---|---|---|---|---|---|
| Spotted Bat | *Euderma maculatum* | Mammals | S | V | M010, M022, M026, M027, M034, M075, M076, M086, M092, M095, M168, M171, M887, M888 |
| Pacific Marten | *Martes caurina* | Mammals | S | V | M020, M022, M034, M099 |
| Black-footed Ferret | *Mustela nigripes* | Mammals | F | De, V | M052, M053, M087, M171, M499, M512 |
| New Mexico Meadow Jumping Mouse | *Zapus hudsonius luteus* | Mammals | F | De, V, E | M011, M022, M028, M034, M036, EMCS, PCWS, PWWS |
| Jemez Woodlandsnail | *Ashmunella ashmuni* | Molluscs | H | E, Di | M020, M022, M027, M034 |
| Sangre de Cristo Woodlandsnail | *Ashmunella thomsoniana* | Molluscs | H | Di | M022, M027, M034 |
| Ruidoso Snaggletooth Snail | *Gastrocopta ruidosensis* | Molluscs | H | V, Di | M022 |
| Star Gyro | *Gyraulus crista* | Molluscs | H | V, Di | PCWS |
| Lake Fingernailclam | *Musculium lacustre* | Molluscs | H | Di | PCWS |
| Long Fingernailclam | *Musculium transversum* | Molluscs | H | Di | PWWS |
| Lilljeborg's Peaclam | *Pisidium lilljeborgi* | Molluscs | H | V, Di | PLCP |
| Sangre De Cristo Peaclam | *Pisidium sanguinichristi* | Molluscs | D | De, V, E, Di | PLCP |
| Wrinkled Marshsnail | *Stagnicola caperata* | Molluscs | D | V, Di | PMCSS |

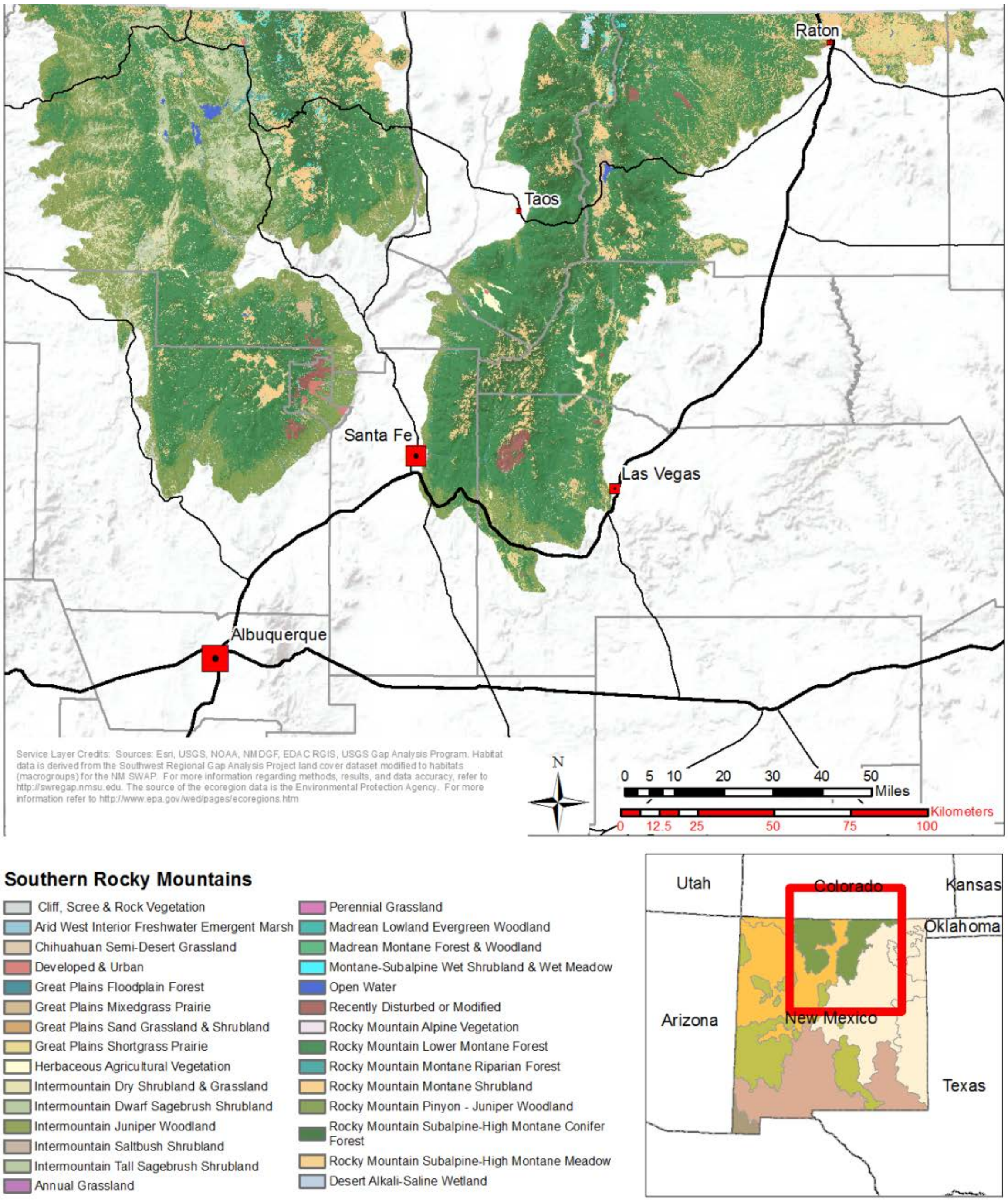



Figure 17. Terrestrial habitats in the Southern Rocky Mountains ecoregion.

Delineations from US National Vegetation Classification macrogroups and SWReGAP landcover classes.

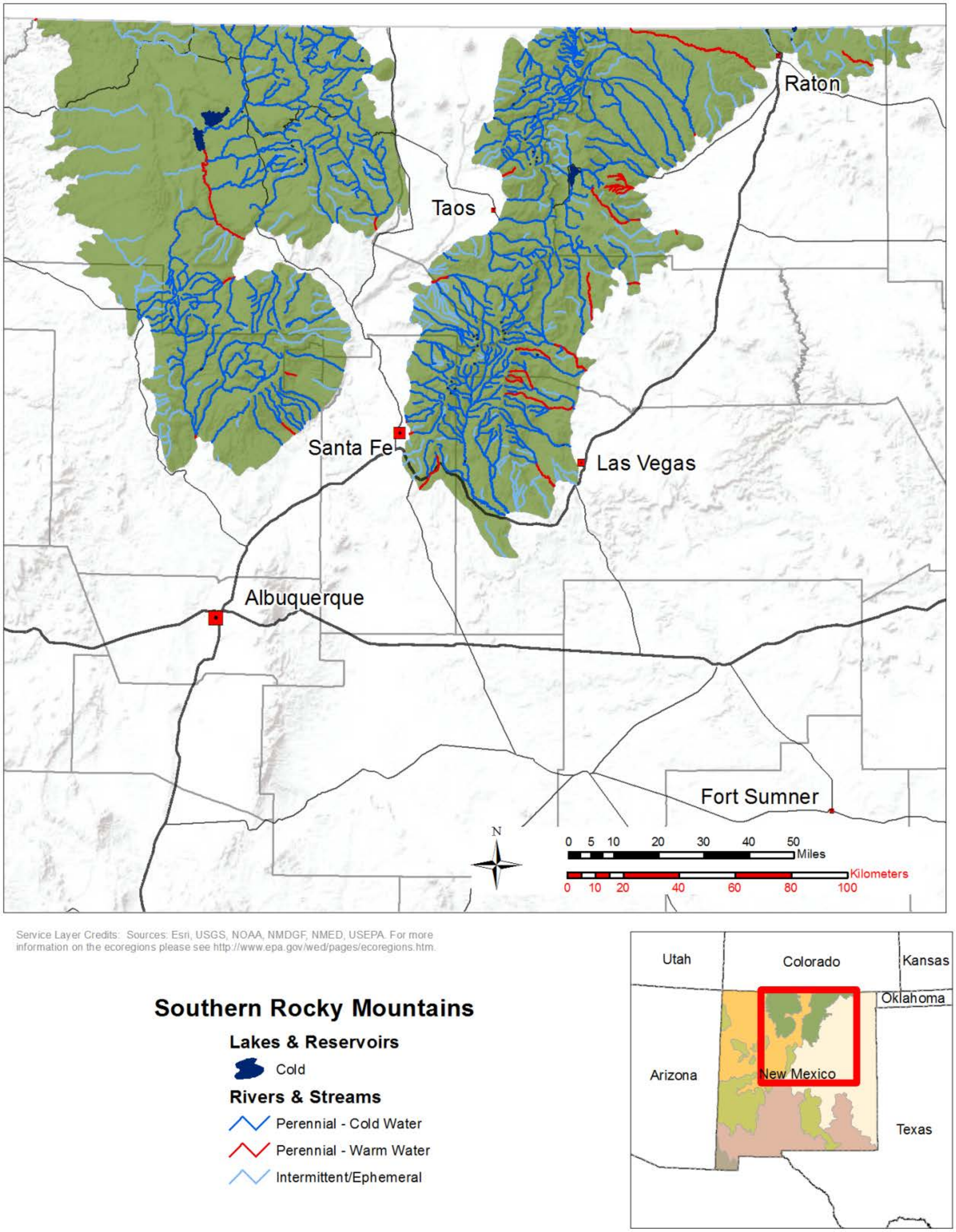



Figure 18. Aquatic habitats in the Southern Rocky Mountains ecoregion.

# Habitat Descriptions

## *Rocky Mountain Lower Montane Forest*

The Rocky Mountain Lower Montane Forest **[M022]**[21] is a mid-elevation (2,350-3300 m (7,700-10800 ft)) forest, woodland, and savanna habitat that occurs in the Southern Rocky and Arizona/New Mexico Mountains ecoregions, as well as isolated locations in the Colorado Plateaus and High Plains and Tablelands ecoregions. Characteristic trees are predominantly conifers and include white fir (A*bies concolor*), Douglas-fir, ponderosa pine*,* limber pine (*Pinus flexilis*), southwestern white pine (*P. strobiformis*), and Rocky Mountain juniper (*Juniperus scopulorum*). Cold-deciduous trees occasionally mix in the canopy or are dominant in some locations, e.g., quaking aspen and big-tooth maple (*Acer grandidentatum*). At the lower-elevation margins, Mexican piñon (*Pinus cembroides*), two-needle piñon (*P. edulis*), and alligator juniper (*Juniperus deppeana*) may be present in the subcanopy. Cold-deciduous, broad-leaved shrubs can be common in the undergrowth, e.g., Rocky Mountain maple (*Acer glabrum),* Gambel's oak*,* and New Mexico locust *(Robinia neomexicana).* In closed-canopy conditions, grasses or forbs may be sparse. Under more open canopies, grasses in particular may be abundant, leading to the formation of savanna-like woodland. Representative graminoids include mountain muhly (*Muhlenbergia montana)*, Arizona fescue (*Festuca arizonica),* fringed brome *(Bromus ciliates),* and Ross' sedge (*Carex rossii*).

This forest type occurs across a broad range of soils, geology, and topographical conditions. Fire regimes vary from mixed severity (surface and canopy fires) to low severity (mostly frequent surface fires, e.g., savannas). In general, fire suppression has led to encroachment of more shade-tolerant, less fire-tolerant species, resulting in an attendant increase in fire hazard.

[21] Complete descriptions of habitats available by clicking on hyperlinked USNVC codes.

## *Rocky Mountain Piñon-Juniper Woodland*

The Rocky Mountain Piñon-Juniper Woodland **[M027]** occurs at 1,980-2,600 m (6,500-8,500 ft) as a savanna to woodland in dry mountains and foothills of the Southern Rocky Mountains, Arizona/New Mexico Mountains, Colorado Plateaus, and High Plains and Tablelands ecoregions, and isolated locations of the Chihuahuan Desert ecoregion. It is characterized by shorter (3-20 m tall) conifer trees that include oneseed juniper (*Juniperus monosperma*) and/or two-needle piñon. Rocky Mountain juniper (*J. scopulorum*) may replace oneseed juniper at higher elevations. Savannas have widely spaced, mature trees with lush perennial grasses and scattered shrubs. Woodlands are typically open-canopied (10-30% cover), but closed-canopy stands with a sparse understory are not uncommon. Understory shrub species may include Bigelow sage (*Artemisia bigelovii*), alderleaf mountain mahogany (*Cercocarpus montanus*), rubber rabbitbrush (*Ericameria nauseosa*), wavyleaf oak (*Quercus pauciloba*), and skunkbush sumac (*Rhus trilobata*). Succulents include tree cholla (*Cylindropuntia imbricata*), tulip pricklypear (*Opuntia phaeacantha*), and plains pricklypear (*O. polyacantha*). The herbaceous layer varies from sparse to grassy. Representative grass dominants are Scribner's needlegrass (*Achnatherum scribneri*), sideoats grama (*Bouteloua curtipendula*), blue grama (*B. gracilis*), needle and thread (*Hesperostipa comata*), and James' galleta (*Pleuraphis jamesii*). Forbs may be diverse but generally have low abundance; representative species include wholeleaf Indian paintbrush (*Castilleja integra),* James' buckwheat *(Eriogonum jamesii),* fineleaf hymenopappus *(Hymenopappus filifolius),* and many-flowered ipomopsis *(Ipomopsis multiflora)*.

Substrates range from deep loams to shallow, skeletal soils on rocky sites. Fire regimes vary from stand-replacing, high severity but infrequent fires (or no fires) to low severity, surface fires of savannas.

## *Rocky Mountain Subalpine-High Montane Conifer Forest*

Rocky Mountain Subalpine-High Montane Conifer Forest **[M020]** (also known as Spruce-Fir Forest) occurs at the highest elevations (3,250-3,670 m (10,660-12,040 ft)) of any forest in the Southern Rocky Mountains and Arizona/New Mexico Mountains ecoregions, as well as isolated locations of the Madrean Archipelago ecoregion. It is mostly comprised of evergreen conifers with some broad-leaved, cold-deciduous trees. Canopies range from nearly closed-canopy forests to very open or patchy short-statured woodlands found in clumps or ribbons with intervening grasslands or shrublands. Characteristic trees include subalpine fir, Engelmann spruce, and quaking aspen. The shrub layer, when present, may be represented by tall or short cold-deciduous or evergreen shrubs such as fivepetal cliffbush (*Jamesia americana)*, kinnikinnik *(Arctostaphylos uva-ursi),* and whortleberry *(Vaccinium myrtillus)*. Herbaceous cover can range from nearly absent under closed-canopy conditions to luxuriant and diverse on more open and moist sites. Representative species include dryspike sedge (*Carex siccata),* sprucefir fleabane (*Erigeron eximius*), starry false lily of the valley (*Maianthemum stellatum*)*,* sickletop lousewort (*Pedicularis racemosa*)*,* and Fendler's meadow-rue (*Thalictrum fendleri*).

Locations of this habitat may be driven by interactions among several factors including snow deposition, desiccating winds, soil and substrate characteristics, precipitation, temperature, latitude, elevation, and aspect. This habitat can be found on gentle to very steep mountain slopes, high elevation ridgetops and upper slopes, shoulder slopes, cirque headwalls, plateau-like surfaces, basins, toeslopes, and alluvial stream terraces. At the highest elevations, trees can be weakened or damaged from blowing snow and ice-crystals as well as severe cold. This habitat is subject to stand-replacing disturbances such as avalanche, crown fire, insect outbreaks, disease, and occasional windthrow. Fire regimes are generally mixed severity or stand-replacing with long return intervals (150 to 500 years). Insect outbreaks are more frequent, every 30-50 years in some types, and can alter both the structure and composition of stands.

## *Rocky Mountain Subalpine-High Montane Meadow*

Rocky Mountain Subalpine-High Montane Meadow **[M168]** is comprised of graminoid- or forb-dominated mesic meadows and subalpine grasslands at 2,200-3,000 m (7,200-9,800 ft) (3,350 m (11,000 ft) on warm aspects) elevation mostly in the Southern Rocky Mountains and Arizona/New Mexico Mountains ecoregions.

Characteristic grass species in montane and subalpine grasslands include Parry's oatgrass (*Danthonia parryi*), Arizona fescue*,* Idaho fescue (*Festuca idahoensis),* Thurber's fescue (*F. thurberi)*, and mountain muhly along with a sometimes diverse set of relatively dry forbs such as Indian paintbrush species (*Castilleja* spp.), pingue rubberweed (*Hymenoxys richardsonii),* sidebells penstemon *(Penstemon secundiflorus),* wooly cinquefoil *(Potentilla hippiana)*, and Rocky Mountain goldenrod *(Solidago multiradiata)*. Mesic meadows tend to be forb-dominated and include common yarrow *(Achillea millefolium),* bluebell bellflower *(Campanula rotundifolia),* fireweed *(Chamerion angustifolium),* aspen fleabane *(Erigeron speciosus),* largeleaf avens *(Geum macrophyllum),* common cowparsnip *(Heracleum maximum),* and arrowleaf ragwort *(Senecio triangularis),* among others*.* Graminoids form a minor component and are usually mesic taxa with relatively broad and soft blades such as California brome (*Bromus carinatus),* smallwing sedge *(Carex microptera),* and tufted hairgrass *(Deschampsia caespitosa).* Broadleaf deciduous shrubs, such as shrubby cinquefoil *(Dasiphora fruticosa* ssp. *floribunda)* and snowberry (*Symphoricarpos* spp.), are often present, but do not dominate.

This habitat occurs in a wide variety of environments where finely-textured soils, snow deposition, rocky substrates, or windswept, dry conditions limit tree establishment. Grasslands occur on flat to rolling plains, in intermontane parks, and on dry sideslopes, especially with south and west aspects. Mesic meadows occur in swales that lose their snow cover relatively late in the season.

## *Rocky Mountain Montane Shrubland*

Rocky Mountain Montane Shrubland **[M049]** is found from 1,800-2,700 m (5,900-8,860 ft) in the foothills and canyon slopes of Southern Rocky Mountains and Arizona-New Mexico Mountains ecoregions with isolated occurrences in the High Plains and Tablelands and Chihuahuan Desert ecoregions. Vegetation is characterized by an open to dense, broad-leaved deciduous shrub canopy dominated by alderleaf mountain mahogany and/or Gambel's oak. Other shrubs may be codominant such as big sagebrush, Fendler's ceanothus (*Ceanothus fendleri*), chokecherry (*Prunus virginiana*), skunkbush sumac, wax currant (*Ribes cereum*), New Mexico locust, wild roses (*Rosa* spp.), mountain snowberry (*Symphoricarpos oreophilus*), and roundleaf snowberry (*S. rotundifolius*). The herbaceous layer is sparse to moderately dense and dominated by perennial graminoids and a mix of scattered forbs. Annual grasses and forbs are seasonally present. Graminoids are characterized by species that are also common in adjacent woodlands and forests, e.g. Scribner needlegrass *(Achnatherum scribneri),* big bluestem *(Andropogon gerardii),* threeawns *(Aristida* spp.), sideoats grama, blue grama, long-stolon sedge *(Carex inops),* Geyer's sedge *(Carex geyeri),* Arizona wheatgrass *(Elymus arizonicus),* fescue (*Festuca* spp.), needle and thread, New Mexico feathergrass *(Hesperostipa neomexicana),* prairie junegrass *(Koeleria macrantha),* and mountain muhly. Representative forbs include common yarrow, sagebrush *(Artemisia* spp.), geraniums (*Geranium* spp.), starry false lily of the valley, Fendler's meadow-rue, and American vetch (*Vicia americana)*.

Soils are typically poorly developed, rocky to very rocky, and well-drained. Fire typically plays an important role in determining vegetative composition.

## *Great Plains Mixed-Grass Prairie*

The Great Plains Mixed-Grass Prairie **[M051]** is relatively uncommon and is primarily found in the High Plains and Tablelands ecoregion with some occurrences in the Southern Rocky Mountains, Arizona/New Mexico Mountains, and Colorado Plateaus ecoregions. It is comprised of a mixture of short and tall grass species. In New Mexico, the common grasses can form dense stands and include sideoats grama, little bluestem

(*Schizachyrium scoparium*), sand dropseed (*Sporobolus cryptandrus*), needle and thread*,* New Mexico feathergrass (*Hesperostipa neomexicana*), western wheatgrass (*Pascopyrum smithii*), and blue grama (*B. gracilis*). Shrubs tend to be a minor element. Forbs can be prevalent. Common yarrow (*Achillea millefolium*), white sagebrush (*Artemisia ludoviciana*), purple prairie clover (*Dalea purpurea*), and white prairie aster (*Symphyotrichum falcatum*) are typical representatives.

Soils are typically mollisols rich in organic matter and range from silt loams to silty clay loams with sandy loams possible on the western edge of the range. Fire and poorly managed grazing constitute the primary disturbances affecting this habitat.

## *Montane-Subalpine Wet Shrubland and Wet Meadow*

Montane-Subalpine Wet Shrubland and Wet Meadow [**M075**] occurs in the Colorado Plateaus, Southern Rocky Mountains, and Arizona/New Mexico Mountains ecoregions and occasionally the High Plains and Tablelands and Chihuahuan Desert ecoregions. This habitat type is generally wet all season long but may dry out by the end of summer. Herbaceous wetlands are typically graminoid-dominated, but forbs may be prevalent. Dominant graminoids include bluejoint (*Calamagrostis canadensis*), water sedge (*Carex aquatilis*), Northwest Territory sedge (*C. utriculata*), smallwing sedge (*C. microptera*), and tufted hairgrass (*Deschampsia caespitosa*). Dominant forb species are represented by white marsh marigold (*Caltha leptosepala*)*,* heartleaf bittercress (*Cardamine cordifolia*), arrowleaf ragwort (*Senecio triangularis*)*,* and creeping sibbaldia (*Sibbaldia procumbens*). Shrublands form open to closed canopies dominated by wetland-obligate shrubs and subshrubs such as gray alder (*Alnus incana*)*,* water birch (*Betula occidentalis*)*,* redosier dogwood (*Cornus sericea*)*,* Bebb willow (*Salix bebbiana*)*,* Booth's willow (*S. boothii*)*,* Drummond's willow (*S. drummondiana*)*,* and park willow (*S.monticola*).

This habitat type is mostly comprised of montane to subalpine riparian communities and occurs as narrow bands lining streambanks and alluvial terraces in narrow to wide, low gradient valley bottoms and floodplains with sinuous stream channels. Herbaceous wetlands can also be found around seeps, fens, and isolated springs on hill slopes away from valley bottoms. Montane marshes that are created as a function of beaver dams and along shorelines can be quite common. This habitat is commonly associated with Rocky Mountain Montane Riparian Forest **[M034]**.

## *Rocky Mountain Alpine Vegetation*

Rocky Mountain Alpine Vegetation **[M099]** occurs at and above timberline in the Southern Rocky Mountains ecoregion. Vegetation ranges from sparse cushion plants to dense turf or dwarf-shrublands. Most fell-field plants are cushioned or matted, succulent, flat to the ground in rosettes, densely haired, and thickly cutinized. Plant cover in fell-fields is 15-50%; exposed rocks with crustose lichens make up the rest. Fell-fields usually are found within or adjacent to alpine dry turf. Common dry turf species include Ross' avens (*Geum rossii*), bog sedges (*Kobresia* spp.), alpine clover (*Trifolium dasyphyllum*), curly sedge (*Carex rupestris*), and Drummond's rush (*Juncus drummondii*). Dwarf-shrublands are characterized by a semi-continuous layer of ericaceous dwarf-shrubs or dwarf willows less than 0.5 m (1.6 ft) in height with dense tufts of graminoids and scattered forbs.

Wind and its movement of snow has a strong local effect, producing wind-scoured fell-fields, dry turf, snow accumulation heath communities, and short growing season snowbed sites. Fell-fields are typically free of snow during the winter as they are found on ridgetops, upper slopes, and exposed saddles, whereas dry turf is found on gentle to moderate slopes, flat ridges, valleys, and basins where the soil has become relatively stabilized and the water supply is more-or-less constant. Dwarf-shrubland sites tend to be in level or concave areas; water needs are met with late-melting snow and subirrigation from surrounding slopes.

# Threats and Conservation Actions

Ten threats could potentially impact SGCN in 14 habitats within the Southern Rocky Mountains ecoregion (Table 16). These threats are summarized below and listed in the order presented by the IUCN (2016). The list does not reflect the order of threat severity.

- Development: Vacation home developments in forest and riparian habitats.
- Agriculture and Aquaculture: Cattle and elk grazing in sensitive meadow and riparian habitats.
- Energy and Mining: Wind energy development and hardrock mining.
- Transportation and Utilities: Fragmentation of forest habitat from utility corridors, and forest roads in sensitive habitats.
- Biological Resource Use: Firewood and timber harvest that reduces cover and forage for SGCN.
- Human Intrusion and Disturbance: Off-highway vehicles (OHVs) used off of designated roads.
- Natural System Modifications: Unnaturally dense forests and woodlands and catastrophic wildfire due to fire suppression.
- Invasive and Problematic Species: Insect and disease outbreaks in forest stands and/or invasion of riparian habitats by tamarisk (*Tamarix* spp.) or other non-native plants.
- Pollution: Toxic runoff from mines.
- Climate Change: Drought and higher temperatures increase the probability of disease outbreaks and catastrophic wildfires in forests.

Conservation concerns include development, tree diseases, fire, and poorly managed grazing.

Urban development is comparatively light in this ecoregion, with most development consisting of small villages and towns that are relatively far apart. The continued expansion of vacation home developments is of concern as these homes are generally located in forested areas, often near riparian habitat.

The need for low intensity fires in maintaining healthy forests in the Southwest has been well documented. However, fire suppression and removal of fine fuels by large herbivore grazing has contributed to the growth of dense forests prone to insect mortality and destructive, high intensity fires. Warmer temperatures tied to climate change have exacerbated the spread of insect infestation in forests and may be contributing to the intensity of fires. Allowing wildfires to burn, or setting prescribed fires where they pose no danger to humans or their property, reduces fuel loads. This is a necessary step in restoring a low intensity fire regime. Forests characterized by fewer, larger trees with a healthy herbaceous understory will be key to healthy SGCN populations.

The Southern Rocky Mountains ecoregion was warmer and wetter than normal from 1991-2005 but warmer and drier when only considering 2000-2005 data. Minimum and maximum temperatures were higher than normal from 1970-2006. This ecoregion supports the highest number of drought-sensitive species that will be vulnerable to decline under continued climate change. Habitats with medium to high vulnerability to climate change are Madrean Lowland Evergreen Woodland and Cliff, Scree and Rock communities (Table 14; Triepke et al 2014).

Table 16. Potential threats to habitat and associated SGCN in the Southern Rocky Mountains ecoregion.

Threat categories were derived from IUCN (2016). Habitats listed are those that are dominant in the amount of area they encompass or are particularly important to conserve (Tier 1 or 2) in this ecoregion.

| Habitat \ Threat | Development | Agriculture & Aquaculture | Energy & Mining | Transportation & Utilities | Biological Resource Use | Human Intrusions & Disturbance | Natural System Modifications | Invasive & Problematic Species | Pollution | Climate Change |
|---|---|---|---|---|---|---|---|---|---|---|
| Great Plains Mixedgrass Prairie | | X | X | X | | | | | | X |
| Intermountain Juniper Woodland | X | X | | | | | X | | | X |
| Montane-Subalpine Wet Shrubland & Wet Meadow | | X | | | | X | X | | | X |
| Rocky Mountain Alpine Vegetation | | X | | | | | | X | | X |
| Rocky Mountain Lower Montane Forest | X | X | X | X | X | X | X | | | X |
| Rocky Mountain Montane Riparian Forest | X | X | | | | | X | | X | X |
| Rocky Mountain Montane Shrubland | X | X | X | | | X | X | | | X |
| Rocky Mountain Piñon-Juniper Woodland | X | | | | | | X | | | X |
| Rocky Mountain Subalpine-High Montane Conifer Forest | X | | | X | X | X | X | | | X |
| Rocky Mountain Subalpine-High Montane Meadow | | X | | | | X | | X | | X |
| Perennial Cold Water Streams | | X | | | X | X | X | X | X | X |
| Perennial Cold Water Reservoirs | X | | | | | | X | X | | X |
| Perennial Marshes/Cienegas/Springs/Seeps | | X | | | X | X | X | X | | X |
| Perennial Warm Water Streams | | X | | | | | X | X | | X |

The following are proposed conservation actions for the Southern Rocky Mountains ecoregion, listed in order of priority within each IUCN threat category. Threat categories are listed according to the order presented by IUCN (2016).

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## *Development:*

- Reduce impacts of housing developments by establishing development standards that ensure habitat integrity and functionality while minimizing wildfire threats to private residences. Potential collaborators: Counties, municipalities.
- Identify habitat crucial to SGCN that might be threatened by development.

## *Agriculture and Aquaculture:*

- Determine where habitat restoration would benefit SGCN and work with federal, state, and private land managers to restore degraded rangelands to good or excellent condition. Monitor the results of restoration and initiate any identified improvements to restoration practices. Potential collaborators: BLM, USFS, SLO, private land managers.
- Determine historic composition, condition, and function of major range habitats, to guide habitat restoration activities, including tree invasion into grassland meadows. Potential collaborators: universities, BLM, USFS.
- Determine how timing, intensity, and duration of livestock grazing affect SGCN and their habitats, including the interaction between grazing, fire, and the spread of invasive and problematic species. Potential collaborators: BLM, NRCS, USFS, NMDA, SLO, universities, private land managers.
- Promote expanded use of appropriate, cost effective, grazing practices that ensure long-term ecological sustainability for SGCN and their habitats (especially riparian habitats). These include actions that contribute to recovery of rangelands impacted by drought and allow restoration activities to be completed (Gripne 2005). Potential collaborators: BLM, USFS, SLO, private land managers.
- Promote grazing systems that address both livestock and SGCN habitat needs based on site-specific conditions. When particular habitat components need improvement, coordinate with ranchers and resource managers to identify and implement modifications that would provide the desired habitat outcomes. Potential collaborators: BLM, USFS, SLO, private landowners.
- Gather and assess current information on grazing practices and determine how the Department can support landowners that provide habitat for wildlife.
- Promote use of devices and models that improve water conservation and irrigation efficiency (Schaible and Aillery 2012), to help conserve the structure and function of aquatic and riparian habitats. Potential collaborators: NRCS, NMOSE.
- Promote rest-rotation and/or deferred-rotation grazing systems that incorporate rested pastures and help improve overall range condition and enhanced wildlife habitat. When drought or other conditions that limits grazing occur, these rested pastures can provide forage reserves and relieve pressure on grazed pastures or allotments and provide time for

owners to make contingency plans for excess livestock. Potential collaborators: BLM, NRCS, USFS, USFWS, SLO, private landowners.

## *Energy and Mining:*

- Promote best management practices that minimize the impact (especially habitat fragmentation) of energy development (including renewables (Lovich and Ennen 2011)) and mining in both aquatic and terrestrial habitats crucial to SGCN. Potential collaborators: BLM, EMNRD, SLO, energy and mining companies.
- Reclaim disturbed habitats impacted by resource extraction as close as possible to pre-development conditions. Rehabilitate abandoned well pads, mining sites, and associated access roads. Remove unneeded roads and transmission lines. Restore native vegetation. Where feasible, maintain abandoned mines as habitat for bats and snakes by constructing appropriate bat gates on mine shafts and adits (Spanjer and Fenton 2005). Potential collaborators: BLM, USFS, USFWS, EMNRD, NM Bureau of Mining and Geology, mining and energy companies, and private landowners.
- Determine where energy and mineral extraction is, and in the future may be, affecting SGCN. Potential collaborators: BLM, USFS, EMNRD, NM Bureau of Geology and Mineral Resources, SLO, energy and mining companies.
- Maintain and foster open communication with mining and energy companies and land management agencies to minimize adverse impacts of development to SGCN. Potential collaborators: BLM, USFS, EMNRD, SLO, energy and mining companies.

## *Transportation and Utilities:*

- Consolidate and establish utility corridors such that adverse effects to SGCN and their habitats are minimized. Potential collaborators: BLM, USFS, utility companies, interested and affected members of the public.
- Complete safe passages across roads for SGCN. Measures include modifying barrier fences along roadways and constructing road crossings that are permeable to SGCN. Monitor the efficacy of mitigation and initiate any identified maintenance and improvements. Potential collaborators: BLM, USFS, NMDOT, SLO.
- Work with appropriate agencies to develop and enforce road management plans (Crist et al. 2005). Potential collaborators: BLM, USFS.
- Identify and conserve natural habitat corridors, reduce fragmentation, and provide necessary habitat for SGCN. Potential approaches include conservation easements and safe passage corridors across highways. Potential collaborators: BLM, USFS, NHNM, TNC.

## *Biological Resource Use:*

- Develop and implement strategies to sustainably harvest wood products to retain old-growth trees, large diameter snags, and coarse woody debris at densities needed by SGCN. Potential collaborators: BLM, USFS, SFD, SLO.
- Work with landowners and land management agencies to maintain healthy, and return degraded, forests and woodlands to an improved composition and function for wildlife. Potential collaborators: BLM, USFS, SLO, private landowners.

- Inform natural resource law enforcement officers of the distribution and life history of SGCN. Partner with them to enforce laws to protect SGCN populations and habitats. Potential collaborators: BLM, USFS, NPS, USFWS.

## *Human Intrusions and Disturbance:*

- Identify and characterize areas and routes frequented by OHVs, and use that information to assess the potential impacts to SGCN and other wildlife. Potential collaborators: BLM, USFS, SLO.
- Identify, designate, and promote areas for OHV use that avoid disturbance to, or modification of, SGCN habitats. Potential collaborators: BLM, USFS, SLO.
- Initiate a public information campaign to inform and educate OHV users of permitted and prohibited activities that can impact SGCN and other wildlife. This may include public service announcements, print advertising, public meetings, and signs in areas frequented by OHV users. Potential collaborators: BLM, USFS, SLO.
- Work with public land management agencies to regularly review and update OHV travel routes and trails open to the public and appropriate restrictions necessary to protect SGCN and other wildlife. Potential collaborators: BLM, USFS, SLO.
- Work with land management agencies to improve OHV law enforcement with passive measures such as strategically located barricades and active measures including monitoring and enforcement patrols to reduce negative impacts of OHVs on SGCN and other wildlife. Potential collaborators: BLM, USFS, SLO.
- Work with the public to educate residents and recreationists about restrictions on and potential negative impacts of free ranging domestic pets on SGCN and other wildlife. Potential collaborators: municipalities, universities, non-profit organizations.
- Discourage recreation development in aspen stands to reduce exposure of aspens to injury and fungal infections. Potential collaborators: USFS.

## *Natural System Modifications:*

- Restore stands of trees in forests and woodlands to natural or historic densities that reduce the probability of insect and disease outbreaks and stand-replacing wildfires. Avoid unnecessary removal of large old-growth trees and snags, which serve as important wildlife habitat (Kalies and Rosenstock 2013). Potential collaborators: BLM, USFS, SFD, SLO, non-profit organizations.
- Design and implement riparian and aquatic habitat restoration projects to benefit SGCN. This may include establishing priorities for habitat restoration and developing reach-specific plans. Monitor restoration projects to determine effectiveness (Block et al. 2001) and adaptability to management. May also include specific actions such as reintroducing keystone species including beavers (*Castor canadensis*; Baker and Cade 1995, McKinstry et al. 2001), restoration and monitoring of self-sustaining populations of river otters (*Lontra canadensis*) and native fishes. Potential collaborators: ACOE, BLM, BOR, NPS, USFS, USFWS, NHNM, SFD, SLO, universities, private land managers.
- Restore and protect aquatic, riparian, wetland, and wet meadow habitats and the surface and ground water that supports them. Minimize activities that lead to gully formation and soil

erosion. Potential collaborators: ACOE, BLM, BOR, NRCS, USFS, USFWS, private landowners.

- Promote land management practices, standards, and guidelines to conserve and/or restore structure and function of corridors that provide important habitat for SGCN. This should include xeric riparian communities that serve as important migratory corridors for birds and other wildlife while providing ecosystem services, and wildlife corridors that link isolated mountain ranges (Powledge 2003) and coniferous forest patches. Potential collaborators: BLM, NPS, USFS, USFWS, NHNM, universities.
- Determine beneficial fire frequencies and intensities and work with land management agencies and private landowners to develop fire management plans and implement prescribed burns that avoid disturbing SGCN during sensitive periods (e.g., nesting), maintain condition of sensitive habitats (e.g., riparian habitat) and protect people and property. Potential collaborators: BLM, NPS, USFS, SLO, SFD, private landowners.
- Determine responses of upland habitats and associated riparian/aquatic communities that include SGCN to prescribed burns and wildfires. Integrate fire and fuels management into riparian ecosystem conservation. Design and implement projects that reduce unnaturally high fire risk associated with increased fuel loads or lack of moist soils in riparian areas. Methods may include flooding or mechanical removal of vegetation (Ellis 2001). Potential collaborators: ACOE, BLM, BOR, NPS, USFS, USFWS, NHNM, SLO, private land managers.
- Promote post-fire management activities that are beneficial to SGCN. Includes minimizing ash flow into streams. Potential collaborators: NRCS, NPS, USFS, SFD, SLO, non-profit organizations, private landowners.
- Assess the magnitude, frequency, timing, duration, and rate of change of flow and the effects of hydrologic alterations on different types of riparian systems. Determine flows needed to sustain SGCN and their habitats, and the effects of flow stabilization by upstream dams. Work with agencies that manage dams and reservoirs to ensure amounts and patterns of flows needed for persistence of SGCN. Potential collaborators: ACOE, BOR, USFWS, USGS, NMOSE, universities, private industry.
- Survey and monitor perennial marshes/cienegas/springs/seeps habitats and the SGCN that inhabit them to determine changes in quantity and quality of habitat, as well as status and trend of SGCN. Potential collaborators: BLM, USFS, USFWS, NHNM, NMED, SLO, universities.
- Implement a standardized method to inventory, assess, and monitor riparian and aquatic habitats and efforts to conserve them. Determine amount, status, and trend of habitat, levels of fragmentation and how SGCN might be affected. Potential collaborators: ACOE, BLM, BOR, NPS, USFS, USFWS, NHNM, NMED, SFD, SLO, universities.
- Encourage sustainable groundwater use to protect aquatic and riparian habitats. Promote water conservation, such as use of devices and models that facilitate optimal irrigation (Schaible and Aillery 2012), to conserve the structure and function of aquatic and riparian habitats. Potential collaborators: NRCS, NMDA, SLO, municipalities, water management districts.

- Promote citizen participation in restoration and conservation of watersheds. Potential collaborators: ACOE, BOR, USFS, USFWS, NMED, universities, private land managers, non-profit organizations.
- Inform interested and affected members of the public about the value of riparian systems and maintaining in-stream flows in order to build support for conservation of riparian species and habitat restoration efforts. Potential collaborators: NRCS, USFS, universities, non-profit organization, private land managers.
- Examine the structural characteristics of habitat fragmentation and how it influences patch size, edge effect, dispersal behavior, and daily and seasonal movements/migrations by wildlife including SGCN. Focus on riparian and aquatic habitats. Potential collaborators: BLM, USFS, USFWS, NHNM, NMED, SLO, universities.

## *Invasive and Problematic Species:*

- Determine the current distribution of invasive and problematic species and diseases and their impact on SGCN and associated habitats. Potential collaborators: BLM, USFS, BOR, ACOE, SLO, NMED, universities.
- Inform anglers on the importance of not introducing invasive and problematic species. Potential collaborators: BLM, USFS, BOR, ACOE, NMED, non-profit organizations.
- Determine how alien plant species affect physical processes of riparian ecosystems, including how they compete with native riparian plant species. Potential collaborators: BLM, BOR, ACOE, USFS, SLO, NMED, universities.
- Develop strategies to prevent emerging diseases from getting into the Southern Rocky Mountains ecoregion, as well as strategies that will inhibit the spread of ones already in the ecoregion. Potential collaborators: BLM, USFS, universities.
- Design and implement protocols for early detection of invasive and problematic species and diseases. Quickly respond to detection. Potential collaborators: BLM, USFS, SLO, NMED, universities.
- Eradicate or control existing non-native and invasive species before they become established. Potential collaborators: BLM, USFS, SLO, universities.
- Restore native riparian plants (e.g., cottonwood and willow) and natural riparian ecosystem processes and functions following tamarisk removal or biocontrol, and ensure maintenance of adequate water supply for native plants. At sites with low water availability, restoration of native xeric plants may be more appropriate than wetland plants. Potential collaborators: BLM, BOR, ACOE, USFS, SLO, NMED, universities, private land managers, non-profit organizations.
- Stage and balance tamarisk removal and native habitat restoration over time, to avoid rapid loss of exotic woody riparian habitats for wildlife until native habitats can be developed (Sogge et al. 2013). Potential collaborators: BLM, BOR, ACOE, SLO, NMED, universities, private land managers, non-profit organizations.
- Proactively restore native riparian vegetation in areas likely to be most altered by the tamarisk beetle (i.e., large tamarisk monocultures in the most hydrologically altered river systems). Potential collaborators: BLM, BOR, ACOE, SLO, NMED, universities, private land managers, non-profit organizations.

- Protect and sustain existing stands of native riparian vegetation that may serve as important refugia in areas currently or likely to be affected by the tamarisk beetle (Paxton et al. 2011, Sogge et al. 2013). Potential collaborators: BLM, SLO, NMED, universities, private land managers, non-profit organizations.
- Develop explicit, measurable goals and objectives, site-specific plans, and post-implementation monitoring and maintenance for all riparian restoration projects. Document and report restoration approaches used, including successes and failures (Shafroth et al. 2008, Sogge et al. 2013). Potential collaborators: ACOE, BLM, BOR, NRCS, NMDA, Soil and Water Conservation Districts, SFD, SLO, USFS, USFWS, private landowners.

## *Pollution:*

- Work with appropriate agencies to enforce mining and energy development regulations, Best Management Practices, and safeguards that protect water quality and minimize mortality of SGCN. Assess impacts to habitat and SGCN from industrial activities, including mining and energy development. These impacts may include direct mortality, acid mine drainage, and sediment runoff from roads. Potential collaborators: BLM, USFS, SLO, EMNRD, NMED, local governments, energy and mining companies.
- Determine the impacts of agro- and petrochemicals on SGCN fish. Potential collaborators: NMED, universities.

## *Climate Change:*

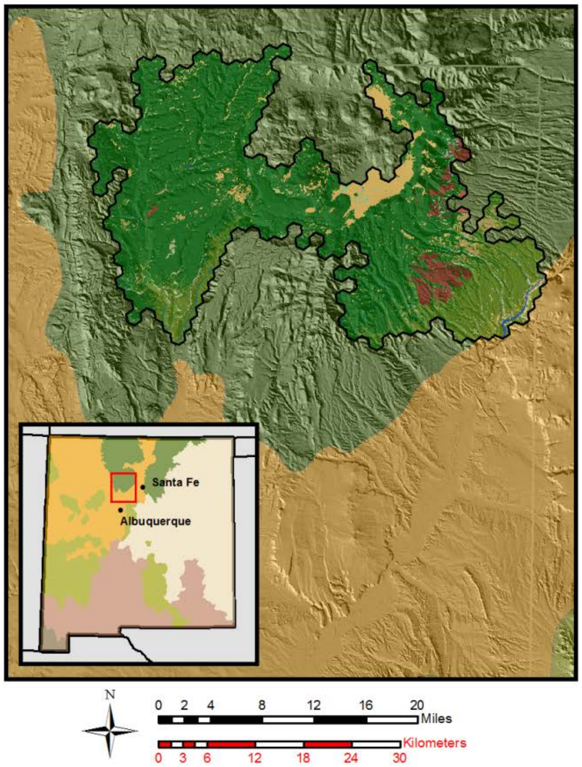
- Determine how regional and global climate change will affect SGCN, vegetation patterns, and community and ecosystem processes and dynamics. Of particular importance is identifying habitats and SGCN that are most likely to be negatively affected by climate change, including impacts on travel corridors and connectivity. Plan and complete projects that help maintain the distribution and natural functioning of these impacted species and habitats. Potential collaborators: USFS, USFWS, USGS, universities.
- Assess the synergistic effects between climate change and other threats to SGCN and their habitats. Potential collaborators: USFS, USFWS, USGS, universities.
- Determine ecology, distribution, status, and trends of, and threats to, SGCN (especially invertebrates that are not currently monitored and riparian-obligate species) and their habitats. Use this information to develop and implement effective monitoring protocols and conservation actions. Potential collaborators: USFS, USFWS, SLO, universities, non-profit organizations, private industry.
- Develop new species recovery plans that consider the current status of and limiting factors for species, as well as projected future conditions for both species and their habitats.
- Inform the public about potential adverse effects of climate change on SGCN and their habitats. Potential collaborators: USFS, USFWS, USGS, universities, non-profit organizations.
- Monitor SGCN to determine long-term trends that correlate to ecosystem dynamics and habitat changes. Potential collaborators: DOD, NPS, USFS, USFWS, SLO, universities.

## *Actions that Address Multiple Threats:*

- Identify or develop an accessible common database of information to document the status and condition of, threats to, and conservation actions implemented in Southern Rocky Mountains ecoregion habitats. Identify data gaps and varying data collection methodologies that provide a framework for identifying and promoting robust standard monitoring approaches. Potential collaborators: NHNM.

# Conservation Opportunity Areas

## *Jemez Mountains*




| Habitat | Tier | Area (ha) |
|---|---|---|
| Chihuahuan Desert Scrub | 4 | 3.4 |
| Cliff, Scree & Rock Vegetation | 4 | 1,194.1 |
| Developed & Urban | 5 | 140.8 |
| Great Plains Floodplain Forest | 1 | 545.9 |
| Great Plains Mixedgrass Prairie | 2 | 1,049.4 |
| Intermountain Dry Shrubland & Grassland | 2 | 378.8 |
| Intermountain Juniper Woodland | 4 | 0.7 |
| Intermountain Saltbush Shrubland | 4 | 1.4 |
| Intermountain Tall Sagebrush Shrubland | 3 | 430.0 |
| Madrean Montane Forest & Woodland | 3 | 0.7 |
| Montane-Subalpine Wet Shrubland & Wet Meadow | 1 | 90.1 |
| Open Water | 5 | 134.7 |
| Recently Disturbed or Modified | 5 | 3,582.0 |
| Rocky Mountain Lower Montane Forest | 4 | 74,862.2 |
| Rocky Mountain Montane Riparian Forest | 1 | 503.9 |
| Rocky Mountain Montane Shrubland | 3 | 2,297.6 |
| Rocky Mountain Pinyon - Juniper Woodland | 4 | 16,625.1 |
| Rocky Mountain Subalpine-High Montane Conifer Forest | 4 | 4,411.5 |
| Rocky Mountain Subalpine-High Montane Meadow | 2 | 5,909.5 |

Figure 19. Jemez Mountains Conservation Opportunity Area.

The Jemez Mountains Conservation Opportunity Area (COA) (Figure 19) encompasses 112,113 ha (277,037 ac) in the southern half of the Jemez Mountains, 40 km (25 mi) west of Santa Fe. Most is under federal management (66% USFS, 25.8% NPS). It contains two Important Bird Areas (Bandelier, Valles Caldera), one TNC conservation area (Jemez Mountains), and 26% is protected.

Sixteen terrestrial habitats, open water, and developed or disturbed landcovers (3,582 ha recently burned) occur within its boundaries. Two-thirds of the COA is Rocky Mountain Lower Montane Forest. Perennial aquatic habitats include 243 km (151 mi) of warm water streams, 613 km (381 mi) of cold water streams, and 13.5 ha (33.4 ac) of cold water reservoirs.

SGCN total 18, including six species categorized as Immediate Priority SGCN (flammulated owl, gray vireo, Gunnison’s prairie dog, pinyon jay, Rio Grande chub, Rio Grande sucker).

# Chapter 7: High Plains and Tablelands Conservation Profile

## Species of Greatest Conservation Need (SGCN) and their Habitats

The High Plains and Tablelands ecoregion encompasses 102,890 km$^2$ (39,726 mi$^2$) of eastern New Mexico and is part of a contiguous 989,557 km$^2$ (382,070 mi$^2$) semi-arid prairie that extends across most of Kansas and Oklahoma, eastern Colorado, north and west Texas, southeastern Wyoming, and southern Nebraska. In New Mexico, elevations range from 750-2,000 m (2,500-6,600 ft), and terrain is smooth to slightly irregular with intermittent mesas and plateaus. The climate is marked by hot summers and cold winters. Precipitation averages 40 cm (16 in) (range 30-50 cm (12-20 in)) with over half occurring as thundershowers during July-September.

Seventy SGCN occur in the High Plains and Tablelands ecoregion. Over half are birds (Table 17, Table 19). Most SGCN within the ecoregion fall within the Susceptible (30%), Immediate Priority (26%), or Limited Habitat (23%) categories. Occurrence of 66% of SGCN in the ecoregion is based on observations.

Table 17. Number of Species of Greatest Conservation Need in the High Plains and Tablelands ecoregion.

| Category[22] / Taxon | I | H | S | D | F | Total |
|---|---|---|---|---|---|---|
| Amphibians | 0 | 1 | 2 | 0 | 0 | 3 |
| Birds | 11 | 6 | 14 | 2 | 3 | 36 |
| Crustaceans | 0 | 1 | 0 | 3 | 0 | 4 |
| Fish | 4 | 2 | 3 | 0 | 4 | 13 |
| Mammals | 3 | 1 | 1 | 0 | 1 | 6 |
| Molluscs | 0 | 4 | 0 | 1 | 0 | 5 |
| Reptiles | 0 | 1 | 1 | 1 | 0 | 3 |
| Total | 18 | 16 | 21 | 7 | 8 | 70 |

[22]Category abbreviations are: I = Immediate Priority, H = Limited Habitat, S = Susceptible, D = Data Needed, F = Federally-listed.

Terrestrial habitats include 26 naturally vegetated types, three unvegetated land covers, and 387,000 ha (955,890 ac) of cultivated lands (Table 18, Figure 20). Great Plains Shortgrass Prairie encompasses 66% of the ecoregion; Rocky Mountain Piñon-Juniper Woodland is the second most widespread habitat (10%). Other major habitats include Great Plains Sand Grassland and Shrubland, Chihuahuan Semi-Desert Grassland, and Chihuahuan Desert Scrub. Characteristic species of the shortgrass prairie include blue grama (*Bouteloua gracilis*), buffalograss (*Buchloe dactyloides*), and fringed sage (*Artemisia frigida*). Mixed grass prairie species include sideoats grama (*Bouteloua curtipendia*), western wheatgrass (*Pascopyrum smithii*), and little bluestem (*Schizachyrium scoparium*).

Perennial water is limited (Figure 21). Most surface area of the 32 reservoirs and ponds are warm water (12 bodies; 10,154 ha (25,081 ac)). Four reservoirs (Conchas, Santa Rosa, Sumner, and Ute Lakes) account for 88% of the warm water habitat and 81% of all aquatic habitat in the ecoregion. Reservoirs and ponds that are cold water year round encompass 554 ha (1,370 ac); those that are cold water during winter only encompass 308 ha (761 ac)). Warm water, perennial streams extend 3,257 km (2,024 mi); cold water streams extend 992 km (616 mi).

Table 18. Terrestrial habitat types of the High Plains and Tablelands ecoregion.

| Habitat Category | USNVC Code | Habitat Name[23] | Tier[24] | Climate Vulnerability[25] | Area ($km^2$) | Area ($mi^2$) |
|---|---|---|---|---|---|---|
| Alpine and Montane Vegetation | M168 | Rocky Mountain Subalpine-High Montane Meadow | 2 | Moderate | 0.86 | 0.33 |
| | M049 | Rocky Mountain Montane Shrubland | 3 | Moderate | 528 | 204 |
| | M011 | Madrean Montane Forest & Woodland | 3 | -- | 4 | 1 |
| | M027 | Rocky Mountain Piñon-Juniper Woodland | 4 | Moderate→High | 10,351 | 3,997 |
| | M010 | Madrean Lowland Evergreen Woodland | 4 | Moderate→High | 880 | 340 |
| | M022 | Rocky Mountain Lower Montane Forest | 4 | Moderate | 435 | 168 |
| | M091 | Warm Interior Chaparral | 4 | High | 16 | 6 |
| | M026 | Intermountain Juniper Woodland | 4 | Moderate | 0.12 | 0.05 |
| Plains-Mesa Grasslands | M051 | Great Plains Mixedgrass Prairie | 2 | High | 208 | 80 |
| | M053 | Great Plains Shortgrass Prairie | 3 | High | 67,534 | 26,075 |
| | M052 | Great Plains Sand Grassland & Shrubland | 3 | High | 4,043 | 1,561 |
| Desert Grassland and Scrub | M087 | Chihuahuan Semi-Desert Grassland | 2 | Moderate→High | 4,668 | 1,802 |
| | M171 | Intermountain Dry Shrubland & Grassland | 2 | Moderate→High | 1,446 | 558 |
| | M169 | Intermountain Tall Sagebrush Shrubland | 3 | -- | 9 | 3 |
| | M086 | Chihuahuan Desert Scrub | 4 | Moderate→High | 6,609 | 2,552 |
| | M093 | Intermountain Saltbush Shrubland | 4 | -- | 238 | 92 |
| | M170 | Intermountain Dwarf Sagebrush Shrubland | 4 | -- | 108 | 42 |

[23] Habitats were macrogroups identified in the US National Vegetation Classification System (USNVC), except Other Land Covers which were derived from Southwestern Regional Gap Analysis land cover classes.
[24] Tiers reflect the urgency for conservation and were based on the degree of imperilment within the United States according to the NatureServe Conservation Status Assessment (http://www.natureserve.org/conservation-tools/conservation-status-assessment) and the spatial pattern of the habitat.
[25] Climate vulnerability levels were based on a vulnerability analysis performed for Ecological Response Units (ERU) across New Mexico and Arizona (Triepke et al. (2014). The ERU classification system represents major ecosystem types of the Southwest. Vulnerability for each ERU was calculated as the relative probability of type conversion. The ERUs were then crosswalked to the habitats shown here.

| Habitat Category | USNVC Code | Habitat Name[23] | Tier[24] | Climate Vulnerability[25] | Area (km$^2$) | Area (mi$^2$) |
|---|---|---|---|---|---|---|
| Arroyo Riparian | M092 | Warm-Desert Arroyo Riparian Scrub | 2 | -- | 49 | 19 |
| Cliff, Scree & Rock Vegetation | M887 | Cliff, Scree & Rock Vegetation | 4 | Moderate | 334 | 129 |
| Riparian Woodlands and Wetlands | M028 | Great Plains Floodplain Forest | 1 | -- | 305 | 118 |
| | M082 | Desert Alkali-Saline Wetland | 1 | -- | 170 | 66 |
| | M888 | Arid West Interior Freshwater Emergent Marsh | 1 | -- | 28 | 11 |
| | M034 | Rocky Mountain Montane Riparian Forest | 1 | -- | 26 | 10 |
| | M036 | Southwest Riparian Forest | 1 | -- | 8 | 3 |
| | M075 | Montane-Subalpine Wet Shrubland & Wet Meadow | 1 | -- | 4 | 2 |
| | M071 | Great Plains Wet Meadow, Marsh & Playa | 1 | -- | 1 | 0.45 |
| Other Land Cover | N/A | Herbaceous Agricultural Vegetation | 5 | -- | 3,870 | 1,494 |
| | N/A | Developed & Urban | 5 | -- | 331 | 128 |
| | N/A | Recently Disturbed or Modified | 5 | -- | 504 | 195 |

Table 19. Species of Greatest Conservation Need (SGCN) in the High Plains and Tablelands ecoregion.

| Common Name[26] | Scientific Name | Taxon | Category | Reason to Include[27] | Habitats[28] |
|---|---|---|---|---|---|
| Western Narrow-mouthed Toad | *Gastrophryne olivacea* | Amphibians | H | V, Di | M051, M052, M053, M071, M076, M082, M086, M087, M092, M888 |
| Northern Leopard Frog | *Lithobates pipiens* | Amphibians | S | De, V | M022, M028, M034, M049, M051, M053, M075, M082, M888 |
| Boreal Chorus Frog | *Pseudacris maculata* | Amphibians | S | V | M022, M028, M034, M051, M071, M075, M095, M168, EC, EMCS, PCWS, PLCP, PMCSS, PWWS |
| Bendire's Thrasher | *Toxostoma bendirei* | Birds | I | De, V | M026, M027, M028, M051, M082, M086, M087, M092, M093, M169, M170, M171, M887 |
| Sprague's Pipit | *Anthus spragueii* | Birds | I | De, V | M051, M053, M087, M171 |
| Juniper Titmouse | *Baeolophus ridgwayi* | Birds | I | De, V | M010, M011, M026, M027, M034, M036, M049, M887 |
| Chestnut-collared Longspur | *Calcarius ornatus* | Birds | I | De, V | M051, M052, M053, M086, M087, M170, M171 |
| Pinyon Jay | *Gymnorhinus cyanocephalus* | Birds | I | De, V | M010, M011, M022, M026, M027, M028, M034, M049, M053, M169, M171, M887, M888 |
| Lewis's Woodpecker | *Melanerpes lewis* | Birds | I | De, V | M011, M022, M028, M034, M036, M075, |

[26] Species marked with an * may not currently be found in this ecoregion but were present historically.
[27] Reason to include indicates which of five criteria for inclusion on the SGCN list a particular species met. Abbreviations are as follows: De = Declining; Di = Disjunct; E = Endemic; K = Keystone; V = Vulnerable.
[28] Aquatic habitat abbreviations are as follows: PCWS = Perennial Cold Water Streams; PWWS = Perennial Warm Water Streams; PLCP = Perennial Lakes, Cirques, Ponds; PMCSS = Perennial Marshes/Cienegas/Springs/Seeps; PCWR = Perennial Cold Water Reservoirs; PWWR = Perennial Warm Water Reservoirs; EMCS = Ephemeral Marshes/Cienegas/Springs; EC = Ephemeral Catchments. Habitat codes refer to National Vegetation Classification designations, which are identified in Table 18 above.

| Common Name[26] | Scientific Name | Taxon | Category | Reason to Include[27] | Habitats[28] |
|---|---|---|---|---|---|
| Flammulated Owl | *Psiloscops flammeolus* | Birds | I | V | M010, M011, M022, M026, M027, M034, M036, M049, M051, M075, M168, M169, M171, M887 |
| McCown's Longspur | *Rhynchophanes mccownii* | Birds | I | De, V | M053, M087, M171 |
| Grace's Warbler | *Setophaga graciae* | Birds | I | De, V | M011, M022, M026, M027, M034, M036, M049, M171, M887 |
| Black-throated Gray Warbler | *Setophaga nigrescens* | Birds | I | De, V | M010, M011, M022, M026, M027, M034, M036, M049, M075, M086, M091, M171, M887, |
| Gray Vireo | *Vireo vicinior* | Birds | I | V | M010, M011, M022, M026, M027, M028, M034, M036, M049, M051, M082, M086, M087, M091, M092, M093, M169, M171, M887 |
| Burrowing Owl | *Athene cunicularia* | Birds | H | V, Di | M026, M036, M051, M052, M053, M071, M082, M086, M087, M092, M093, M169, M170, M171, M887 |
| American Bittern | *Botaurus lentiginosus* | Birds | H | V, Di | M028, M075, M888 |
| Peregrine Falcon | *Falco peregrinus* | Birds | H | V, K | M010, M022, M026, M036, M082, M086, M087, M887 |
| Bald Eagle | *Haliaeetus leucocephalus* | Birds | H | V, K | M010, M011, M022, M026, M027, M028, M034, M036, M049, M051, M052, M053, M082, M086, M087, M091, M093, M168, M169, M170, M171, M887 |
| Bank Swallow | *Riparia riparia* | Birds | H | De, V, Di | M028, M034, M036, M092, M888 |
| Bell's Vireo | *Vireo bellii* | Birds | H | V, Di | M010, M011, M027, M028, M034, M036, M053, M086, M087 |
| Baird's Sparrow | *Ammodramus bairdii* | Birds | S | De, V | M053, M086, M087, M171 |
| Mountain Plover | *Charadrius montanus* | Birds | S | De, V | M010, M026, M027, M051, M052, M053, M082, M086, M087, M093, M168, M169, M171 |

| Common Name[26] | Scientific Name | Taxon | Category | Reason to Include[27] | Habitats[28] |
|---|---|---|---|---|---|
| Common Nighthawk | *Chordeiles minor* | Birds | S | De, V | M010, M026, M027, M049, M051, M052, M053, M086, M087, M168, M169, M170, M171, M887 |
| Olive-sided Flycatcher | *Contopus cooperi* | Birds | S | De, V | M010, M011, M022, M026, M027, M034, M887 |
| Loggerhead Shrike | *Lanius ludovicianus* | Birds | S | De, V | M010, M011, M026, M027, M028, M034, M036, , M049, M051, M052, M053, M082, M086, M087, M091, M092, M093, M168, M169, M170, M171, M887 |
| Red-headed Woodpecker | *Melanerpes erythrocephalus* | Birds | S | De, V | M028, M036, M053 |
| Long-billed Curlew | *Numenius americanus* | Birds | S | De, V | M034, M052, M053, M071, M075, M082, M086, M171, M888 |
| Varied Bunting | *Passerina versicolor* | Birds | S | De, V | M010, M036, M086, M087, M091, M092, M887 |
| Lesser Prairie-Chicken | *Tympanuchus pallidicinctus* | Birds | S | De, V, Di | M051, M052, M053, M087, M171 |
| Williamson’s Sapsucker | *Sphyrapicus thyroideus* | Birds | S | V | M011, M022, M034, M887 |
| Cassin’s Sparrow | *Peucaea cassinii* | Birds | S | De, V | M010, M011, M049, M051, M052, M053, M082, M086, M087, M091, M092, M169, M170, M171 |
| Vesper Sparrow | *Pooecetes gramineus* | Birds | S | De, V | M010, M026, M027, M036, M049, M051, M052, M087, M168, M169, M170, M171 |
| Mountain Bluebird | *Sialia currucoides* | Birds | S | De, V | M010, M011, M022, M026, M027, M034, M049, M051, M053, M086, M087, M091, M168, M887 |
| Western Bluebird | *Sialia mexicana* | Birds | S | De, V | M010, M011, M022, M026, M027, M028, M034, M036, M049, M051, M075, M086, M087, M168, M171, M887 |

| Common Name[26] | Scientific Name | Taxon | Category | Reason to Include[27] | Habitats[28] |
|---|---|---|---|---|---|
| Common Black Hawk | *Buteogallus anthracinus* | Birds | D | V | M010, M011, M022, M028, M034, M036, M086, M087, M092, M887 |
| Clark's Grebe | *Aechmophorus clarkii* | Birds | D | V | M888, EC, PLCP, PMCSS, PWWR, PWWS |
| Southwestern Willow Flycatcher | *Empidonax traillii extimus* | Birds | F | V | M028, M034, M036, M082, M168, M888 |
| Yellow-billed Cuckoo | *Coccyzus americanus* | Birds | F | De, V, Di | M010, M011, M022, M027, M028, M034, M036, M049, M052, M053, M082, M086, M087, M091, M092, M093, M169, M170, M171, M887, M888 |
| Aplomado Falcon | *Falco femoralis* | Birds | F | De, V | M053, M086, M087, M171 |
| Conchas Crayfish | *Orconectes deanae* | Crustaceans | H | V, Di | PWWR, PWWS |
| Diversity Clam Shrimp | *Eulimnadia diversa* | Crustaceans | D | V, Di | EC |
| Western Plains Crayfish | *Orconectes causeyi* | Crustaceans | D | V, Di | PWWR, PWWS |
| Southern Plains Crayfish | *Procambarus simulans* | Crustaceans | D | V, Di | PWWS |
| Peppered Chub | *Macrhybopsis tetranema* | Fish | I | De, V, Di | PWWS |
| Rio Grande Sucker | *Catostomus plebeius* | Fish | I | De, V | PCWS, PWWS |
| Rio Grande Chub | *Gila pandora* | Fish | I | V | PCWR, PCWS, PWWR, PWWS |
| Gray Redhorse* | *Moxostoma congestum* | Fish | I | De, V, Di | PWWR, PWWS |
| Greenthroat Darter* | *Etheostoma lepidum* | Fish | H | De, V, Di | PMCSS, PWWS |
| Bigscale Logperch (native pop.) | *Percina macrolepida* | Fish | H | De, V, Di | PWWS |
| Mexican Tetra* | *Astyanax mexicanus* | Fish | S | V, Di | PMCSS, PWWS |
| Suckermouth Minnow | *Phenacobius mirabilis* | Fish | S | De, V | PWWS |

| Common Name[26] | Scientific Name | Taxon | Category | Reason to Include[27] | Habitats[28] |
|---|---|---|---|---|---|
| Southern Redbelly Dace | *Phoxinus erythrogaster* | Fish | S | V, Di | PCWS |
| Pecos Gambusia* | *Gambusia nobilis* | Fish | F | De, V, E | PMCSS |
| Rio Grande Silvery Minnow* | *Hybognathus amarus* | Fish | F | De, V, Di | PWWS |
| Arkansas River Shiner (native pop.) | *Notropis girardi* | Fish | F | De, V, Di | PWWS |
| Pecos Bluntnose Shiner | *Notropis simus pecosensis* | Fish | F | De, V, E, Di | PWWS |
| Gunnison's Prairie Dog | *Cynomys gunnisoni* | Mammals | I | De, V, K | M022, M026, M027, M051, M053, M086, M087, M093, M168, M169, M170, M171 |
| Black-tailed Prairie Dog | *Cynomys ludovicianus* | Mammals | I | De, V, K | M028, M051, M052, M053, M086, M087, M170 |
| American Mink | *Vison vison* | Mammals | I | V | M011, M034, M036, M075, PCWS, PWWS |
| Least Shrew | *Cryptotis parva* | Mammals | H | V, Di | M028, M051, M071, M082, M888, EMCS |
| Pale Townsend's Big-eared Bat | *Corynorhinus townsendii* | Mammals | S | V | M010, M011, M022, M026, M027, M034, M049, M086, M087, M091, M171, M887 |
| Black-footed Ferret | *Mustela nigripes* | Mammals | F | De, V | M052, M053, M087, M171 |
| Sangre de Cristo Woodlandsnail | *Ashmunella thomsoniana* | Molluscs | H | Di | M022, M027, M034 |
| Swamp Fingernailclam | *Musculium partumeium* | Molluscs | H | Di | PWWS |
| New Mexico Ramshorn Snail | *Pecosorbis kansasensis* | Molluscs | H | V, Di | M086, M087, PCWS, PMCSS, PWWS |
| Paper Pondshell | *Utterbackia imbecillis* | Molluscs | H | V, Di | PWWR, PWWS |
| Creeping Ancylid Snail | *Ferrissia rivularis* | Molluscs | D | V, Di | PWWR |
| Dunes Sagebrush Lizard | *Sceloporus arenicolus* | Reptiles | H | De, V, Di | M052, M053, M086, M087 |

| **Common Name**[26] | **Scientific Name** | **Taxon** | **Category** | **Reason to Include**[27] | **Habitats**[28] |
|---|---|---|---|---|---|
| Arid Land Ribbonsnake | *Thamnophis proximus* | Reptiles | S | V | M028, M036, M051, M052, M053, M086, M087, M091, M888, EC |
| Desert Massasauga | *Sistrurus catenatus* | Reptiles | D | De, V | M051, M052, M053, M086, M087, M093 |

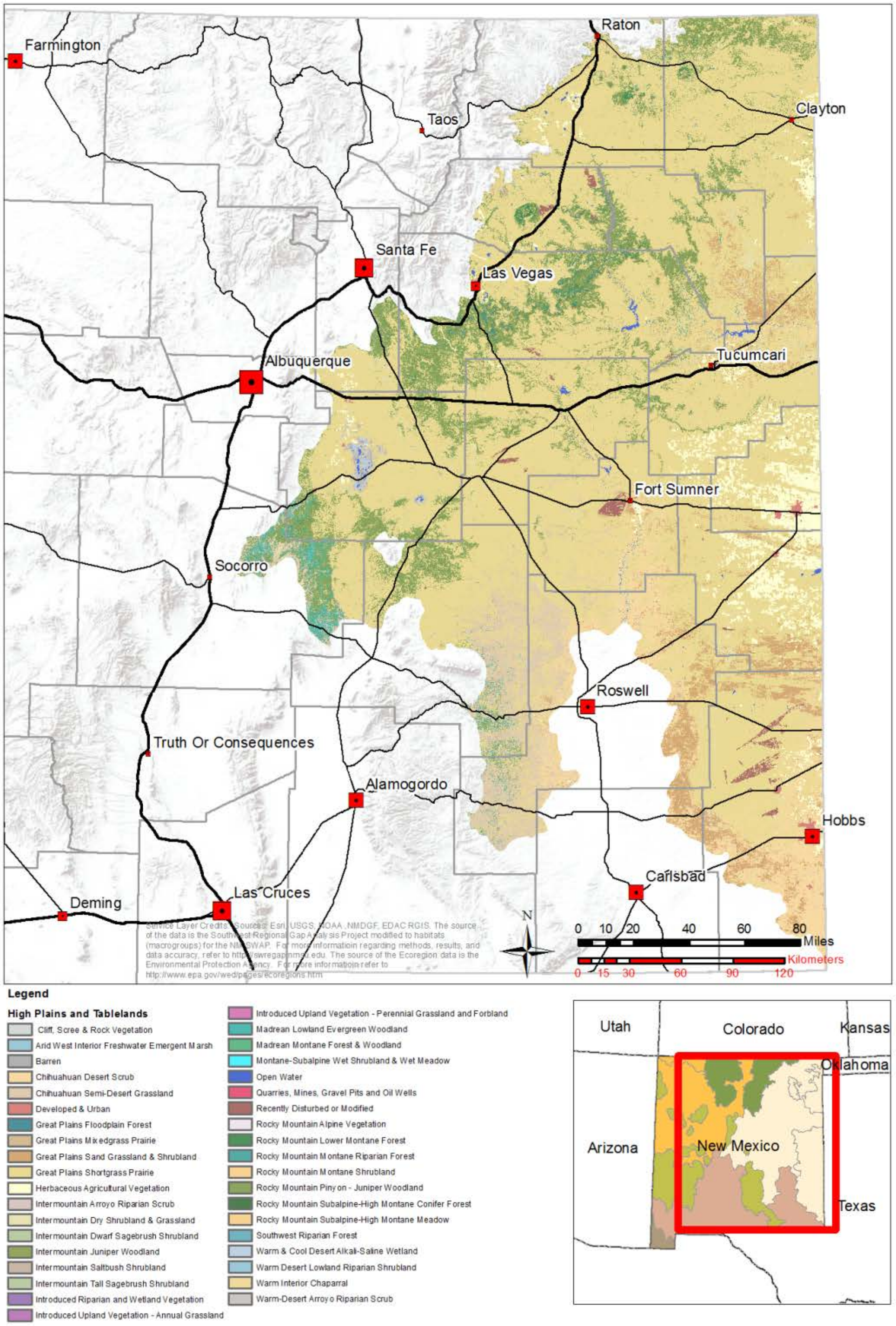



Figure 20. Terrestrial habitats in the High Plains and Tablelands ecoregion.

Delineations from US National Vegetation Classification macrogroups and SWReGAP landcover classes.

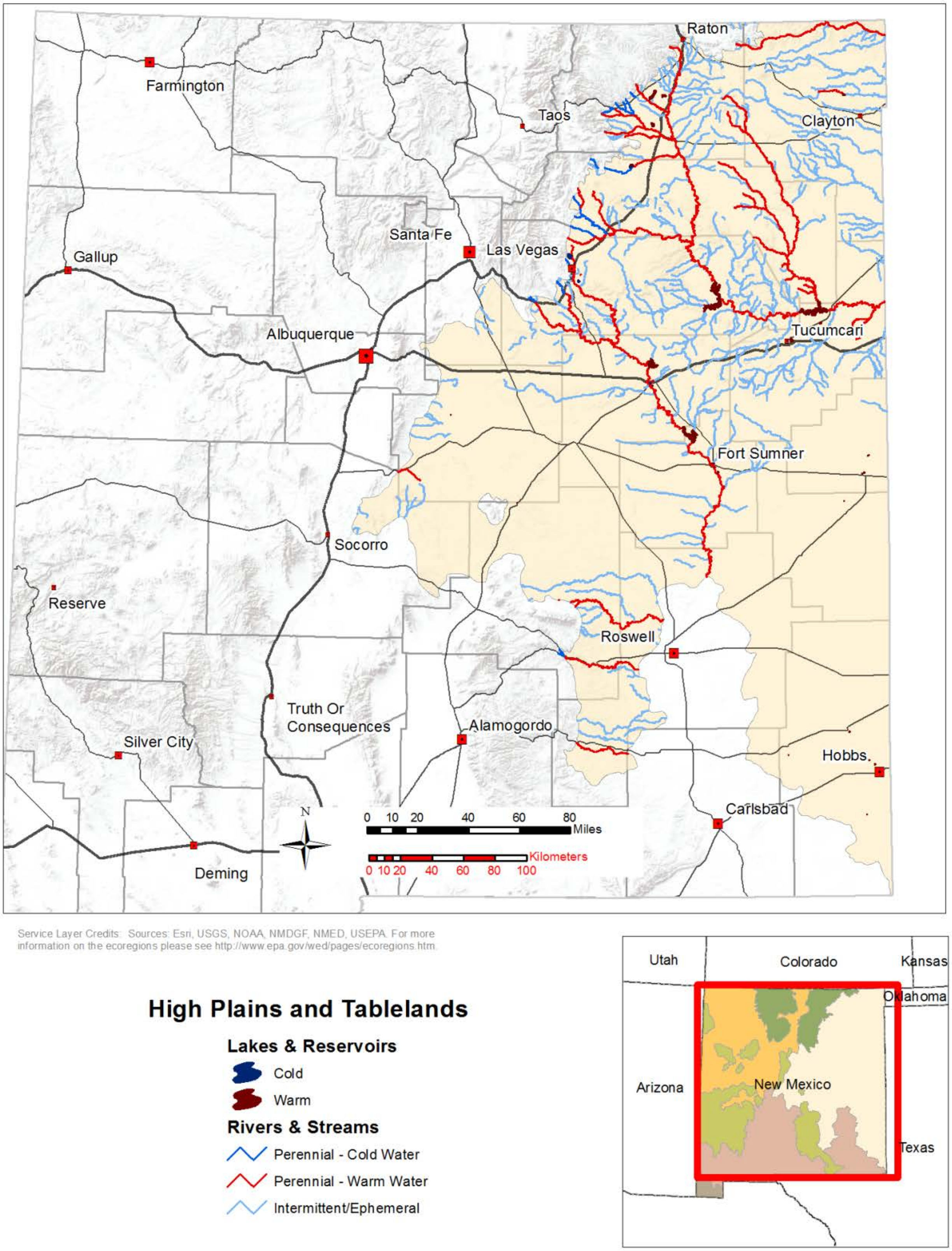



Figure 21. Aquatic habitats in the High Plains and Tablelands ecoregion.

# Habitat Descriptions

## *Great Plains Shortgrass Prairie*

The Great Plains Shortgrass Prairie **[M053]**[29] is prevalent in the High Plains and Tablelands ecoregion but can also occur in isolated locations throughout New Mexico. Dominant grasses are blue grama, buffalograss, and western wheatgrass with purple threeawn (*Aristida purpurea*), sideoats grama (*Bouteloua curtipendula*), hairy grama (*B. hirsuta*), plains lovegrass (*Eragrostis intermedia*), New Mexico feathergrass (*Hesperostipa neomexicana)*, needle and thread (*Hesperostipa comata*), James' galleta (*Pleuraphis jamesii*), and sand dropseed (*Sporobolus cryptandrus*) as common associates. In the southern portion of this community, honey mesquite (*Prosopis glandulosa*) may form a sparse to moderately dense short tree or shrub canopy.

Stands of this habitat occur on primarily flat to rolling uplands. Soils typically are loamy but may range from sandy to clayey. Historically, expansive fires occurred after a series of years with above-average precipitation, during which litter/fine fuels built up. Currently, fire suppression and more extensive grazing in the region may have likely decreased the fire frequency.

## *Great Plains Sand Grassland and Shrubland*

The Great Plains Sand Grassland and Shrubland **[M052]**, found in the High Plains and Tablelands ecoregion, and to lesser extent in the Southern Rocky Mountains and Chihuahuan Desert ecoregions, may occur as open grasslands to closed shrublands or a mix of the two. The most common dominant grasses are sand bluestem (*Andropogon hallii*), little bluestem, and sand dropseed. Shrublands are sparse to moderately dense and typically dominated or co-dominated by sand sagebrush (*Artemisia filifolia*) and sand shinnery oak (*Quercus havardii*). Invasive honey mesquite can be common, particularly in the southern portion of the range.

Stands of this habitat occur on well-drained, often deep, sandy to loamy sand soils on nearly flat terrain to vegetated dunelands. This habitat is particularly susceptible to wind erosion. Blowouts

[29] Complete descriptions of habitats are available by clicking on hyperlinked USNVC codes.

and sand draws are some of the unique, wind-driven disturbances in the sand prairies creating a complex matrix of microhabitats across the landscape.

## *Great Plains Floodplain Forest*

Great Plains Floodplain Forest **[M028]** is found mostly in the High Plains and Tablelands, Colorado Plateaus, and Chihuahuan Desert ecoregions along small to relatively large rivers with low gradients and wide floodplains. Eastern cottonwood (*Populus deltoides*) is the most common tree and may form pure stands with peachleaf willow (*Salix amygdaloides*), Gooding's willow (*S. gooddingii*), and coyote willow (*S. exigua*) in the understory. Herbaceous cover is generally sparse in drier sites but, under more mesic conditions, native wetland species can be present such as bulrushes (*Schoenoplectus americanus*), common spikerush (*Eleocharis palustris*), rushes (*Juncus balticus*, *J. longistylis,* and *J. tenuis*), fowl mannagrass (*Glyceria striata*), sedges (e.g., *Carex aquatilis*), and horsetails (*Equisetum arvense* and *E. laevigatum*). Invasive exotic species can also be prevalent such as redtop (*Agrostis gigantea*), creeping bentgrass (*A. stolonifera*), Kentucky bluegrass (*Poa pratensis*), and sweetclover (*Melilotus officinalis*).

Stream gradients are generally low (<1%), and riverbeds tend to be mostly sandy. Gravels and cobbles are more common as the gradient increases. This type of forest is found on elevated sidebars and low terraces that are situated above the active channel. Flooding frequency ranges from every two years on lower bars to once in more than 50 years on elevated terraces. Soils of young fluvial landforms are poorly-developed entisols. Soils may be coarse loamy throughout or overlain by a sandy layer. Gravels and cobbles are generally scattered throughout the profile. Soils are dry within one meter of the ground surface but become moist upon approaching the groundwater table, particularly during seasonal flooding events.

## *Great Plains Wet Meadow, Marsh and Playa*

The Great Plains Wet Meadow, Marsh and Playa **[M071]** habitat is primarily associated with playa lakes of the High Plains and Tablelands ecoregion. Playas are small, closed basins typified by the presence of an impermeable clay layer (Randall clay) that leads to creation of ephemeral lakes following rainfall events. They are rarely linked to outside groundwater sources and do not have an extensive watershed. Vegetation is typically herbaceous-dominated with a mix of annual and perennial graminoids and forbs but is highly variable depending on rainfall. Representative graminoids include spike rushes (*Eleocharis* spp.), foxtail barley (*Hordeum jubatum*), western wheatgrass, vine-mesquite grass (*Panicum obtusum*), and buffalograss.

# Threats and Conservation Actions

Nine threats could adversely affect SGCN in nine habitats within the High Plains and Tablelands of New Mexico (Table 20). These threats are summarized below and listed in the order presented by the IUCN (2016). The list does not reflect the order of threat severity.

- Agriculture and Aquaculture: Grazing practices that impact SGCN habitat and withdrawal of groundwater for crops.
- Energy and Mining: Wind energy and oil and gas extraction.
- Transportation and Utilities: Transmission lines and roads.
- Biological Resource Use: Wood harvesting and removal in piñon-juniper woodlands.
- Human Intrusion and Disturbance: Military activities and off-highway vehicles (OHVs).
- Natural System Modifications: Degradation of playas and sand shinnery oak/grass communities.
- Invasive and Problematic Species: Introduction of zebra and quagga mussels (*Dreissena polymorpha*) in aquatic habitat and invasion of riparian habitats by tamarisk (*Tamarix* spp.) or other non-native plants.
- Pollution: Air, soil, and water contamination from industrial activities.
- Climate Change: Habitat alteration (particularly aquatic and riparian) from prolonged drought.

Conservation concerns include managing grasslands to provide cost-effective livestock grazing and adequate habitat for SGCN, and restoring aquatic and riparian habitats, particularly playas.

Grassland ecosystems in much of this ecoregion evolved with short-term, intensive grazing by large herbivores. These nomadic grazers left a mosaic of grazed and ungrazed patches that provided for the needs of grassland-dependent species. Conserving SGCN in this ecoregion requires the implementation or continuation of grazing practices that produce the same result: a healthy mix of grass and shrub species that provide enough resources for SGCN to thrive.

The High Plains and Tablelands ecoregion supports crucial habitat for several imperiled aquatic and riparian SGCN. Withdrawal of both surface and groundwater has decreased the availability of these habitats. An increase in invasive species, such as tamarisk, has decreased the quality of riparian habitats. Of particular concern are playas, seasonal wetlands that provide important habitat for wintering and migrating waterfowl and shorebirds. Many playas have been destroyed or degraded to the extent that they no longer function properly. This results in higher densities of birds in remaining playas, and in turn, increased potential for disease transmission. Conservation actions include monitoring changes in quality and quantity of riparian habitats, restoring native riparian flora where possible, and working with landowners to conserve playas.

Habitats predicted to have high vulnerability to climate change are Warm Interior Chaparral, Great Plains Mixedgrass Prairie, Great Plains Shortgrass Prairie, and Great Plains Sand Grassland and Shrubland (Table 18; Triepke et al. 2014).

Table 20. Potential threats to habitat and associated SGCN in the High Plains and Tablelands ecoregion.

Threat categories were derived from IUCN (2016). Habitats listed are those that are dominant in the amount of area they encompass or are particularly important to conserve (Tier 1 or 2) in this ecoregion.

| Habitat / Threat | Development | Agriculture & Aquaculture | Energy & Mining | Transportation & Utilities | Biological Resource Use | Human Intrusions & Disturbance | Natural System Modifications | Invasive & Problematic Species | Pollution | Climate Change |
|---|---|---|---|---|---|---|---|---|---|---|
| Great Plains Floodplain Forest | | X | | | | | X | X | | X |
| Great Plains Sand Grassland & Shrubland | | X | X | X | | X | | X | | X |
| Great Plains Shortgrass Prairie | | X | X | X | | X | X | X | | X |
| Great Plains Wet Meadow, Marsh & Playa | | X | X | X | | | X | X | X | X |
| Rocky Mountain Piñon-Juniper Woodland | | | | X | X | | X | | | |
| Perennial Cold Water Streams | | X | | | | | X | | | X |
| Perennial Cold and Warm Water Reservoirs | | X | | | | X | X | | X | X |
| Perennial Marshes/Cienegas/ Springs/Seeps | | X | | | | | X | X | X | X |
| Perennial Warm Water Streams | | X | | | | | X | X | X | X |

The following are proposed conservation actions for the High Plains and Tablelands ecoregion, listed in order of priority within each IUCN threat category. Threat categories are listed according to the order presented by IUCN (2016).

## *Agriculture and Aquaculture:*

- Determine where habitat restoration would benefit SGCN and work with federal, state, and private land managers to restore degraded rangelands to good or excellent condition. Monitor restoration results to develop and initiate any identified improvements to restoration practices. Potential collaborators: BLM, USFS, SLO, private land managers.
- Establish baseline composition, condition, and function of major range habitats to inform habitat restoration actions, particularly for mesquite invasion into historic grasslands. Potential collaborators: BLM, USFS, universities.
- Determine how timing, intensity, and duration of livestock grazing affect SGCN and their habitats, including the interaction between grazing, fire, and the spread of invasive and problematic species. Potential collaborators: BLM, NRCS, USFS, NMDA, SLO, universities, private land managers.
- Promote use of appropriate, cost effective, grazing practices that ensure long-term ecological sustainability for SGCN and their habitats (especially riparian habitats). These include actions that contribute to recovery of rangelands impacted by drought and allow restoration activities to be completed (Gripne 2005). Potential collaborators: BLM, USFS, SLO, private land managers.
- Promote grazing systems that address both livestock and SGCN habitat needs based on site-specific conditions. When particular habitat components need improvement, coordinate with ranchers and resource managers to identify and implement modifications that would provide the desired habitat outcomes. Potential collaborators: BLM, USFS, SLO, private landowners.
- Employ existing incentive programs to promote persistence of productive wildlife habitat on private lands as well as conservation of SGCN. Support maintenance and growth of incentive programs. Potential collaborators: NRCS, NMDA, SLO, BLM
- Gather and assess current information on grazing practices and determine how the Department can support landowners that provide habitat for wildlife. Potential collaborators: BLM, NRCS, USFS, NMDA, SLO, private organizations.
- Balance irrigation and groundwater demands with the needs of aquatic communities, particularly those supporting native fish, amphibian, and springsnail populations. Potential collaborators: BOR, ACOE, NMISC/OSE, water users
- Promote use of devices and models that improve water conservation and irrigation efficiency (Schaible and Aillery 2012), to help conserve the structure and function of aquatic and riparian habitats. Potential collaborators: NRCS, NMOSE.
- Promote rest-rotation and/or deferred-rotation grazing systems that incorporate rested pastures and help improve overall range condition and enhanced wildlife habitat. When drought or other conditions that limits grazing occur, these rested pastures can provide forage reserves and relieve pressure on grazed pastures or allotments and provide time for

owners to make contingency plans for excess livestock. Potential collaborators: BLM, NRCS, USFS, USFWS, SLO, private landowners.

- Implement practices that would increase populations and nesting success of birds, such as maintaining a network of grassland reserves that can serve as refugia for species dependent on high quality natural grassland habitats. This may include promoting aggregation of fields in the Conservation Reserve Program and minimizing haying activities during the nesting and brood-rearing seasons. Potential collaborators: NRCS, private landowners.

## *Energy and Mining:*

- Promote best management practices that minimize the impacts of energy development and mining to both aquatic and terrestrial habitats critical to SGCN. This includes participating in the planning, development, and environmental assessment of wind and solar energy facilities to reduce the potential for adverse effects on SGCN, especially birds and bats.
- Restore habitats impacted by resource extraction as close as possible to pre-development conditions. Rehabilitate abandoned well pads and associated access roads. Decommission and remove unneeded and/or abandoned infrastructure and equipment such as roads, pits, pipelines, transmission lines, and unused machinery. Restore native vegetation . Potential collaborators: BLM, USFS, USFWS, EMNRD, NM Bureau of Mining and Geology, private landowners, energy companies.
- Maintain and foster open communication with mining and energy companies and land management agencies to minimize adverse impacts of development to SGCN. Potential collaborators: BLM, USFS, EMNRD, SLO, energy and mining companies.

## *Transportation and Utilities:*

- Site and consolidate utility corridors to minimize adverse effects to SGCN and their habitats. Potential collaborators: BLM, USFS, SLO, utility companies.
- Identify, initiate, and complete mitigation measures to facilitate safe passage of SGCN across roads and utility rights of way. Measures may include modifying barrier fences along roadways, and constructing road crossings that are permeable to SGCN. Monitor the efficacy of mitigation measures, ensure that maintenance sustains effectiveness, and make identified improvements. Potential collaborators: BLM, USFS, NMDOT, SLO.

## *Biological Resource Use:*

- Work with landowners and land management agencies to balance the use of piñon-juniper woodlands in a manner that maintains healthy, and returns degraded, stands to an improved composition and function for wildlife, while protecting the surrounding grassland communities from woody plant invasion. Potential collaborators: BLM, USFS, SLO, private landowners.

## *Human Intrusions and Disturbance:*

- Identify and characterize areas and routes frequented by OHVs, and use that information to assess the potential impacts to SGCN and other wildlife. Potential collaborators: BLM, USFS, SLO.
- Identify, designate, and promote areas for OHV use that avoid disturbance to, or modification of, SGCN habitats. Potential collaborators: BLM, USFS, SLO.
- Initiate a public information campaign to inform and educate OHV users of permitted and prohibited activities that can impact SGCN and other wildlife. This may include public service announcements, print advertising, public meetings, and signs in areas frequented by OHV users. Potential collaborators: BLM, USFS, SLO.
- Work with public land management agencies to regularly review and update OHV travel routes and trails open to the public and appropriate restrictions necessary to protect SGCN and other wildlife. Potential collaborators: BLM, USFS, SLO.
- Work with land management agencies to improve OHV law enforcement with passive measures such as strategically located barricades and active measures including monitoring and enforcement patrols to reduce negative impacts of OHVs on SGCN and other wildlife. Potential collaborators: BLM, USFS, SLO.
- Work with the public to educate residents and recreationists about restrictions on and potential negative impacts of free ranging domestic pets on SGCN and other wildlife. Potential collaborators: universities, municipalities, non-profit organizations.
- Work with the Department of Defense to minimize impacts of military training exercises on SGCN in areas on or adjacent to military reservations. Potential collaborators: DOD.

## *Natural System Modifications:*

- Design and implement riparian and aquatic habitat restoration projects to benefit SGCN. This may include establishing priorities for habitat restoration and developing reach-specific plans. Monitor restoration projects to determine effectiveness (Block et al. 2001) and adaptability to management. May also include specific actions such as reintroducing keystone species including beavers (*Castor canadensis*; Baker and Cade 1995, McKinstry et al. 2001) and native fishes. Potential collaborators: ACOE, BLM, BOR, NPS, USFS, USFWS, NHNM, SFD, SLO, universities, private land managers.
- Restore and protect aquatic, riparian, wetland, and wet meadow habitats and the surface and ground water that supports them. Minimize activities that lead to gully formation and soil erosion. Potential collaborators: ACOE, BLM, BOR, NRCS, USFS, USFWS, private landowners.
- Assess the magnitude, frequency, timing, duration, and rate of change of flow and the effects of hydrologic alterations on different types of riparian systems. Determine flows needed to sustain SGCN and their habitats, and the effects of flow stabilization by upstream dams. Work with agencies that manage dams and reservoirs to ensure amounts and patterns of flows needed for persistence of SGCN. Potential collaborators: ACOE, BOR, USFWS, USGS, NMOSE, universities, private industry.

- Encourage sustainable groundwater use to protect aquatic and riparian habitats. Promote water conservation, such as use of devices and models that facilitate optimal irrigation (Schaible and Aillery 2012), to conserve the structure and function of aquatic and riparian habitats. Potential collaborators: NRCS, NMDA, SLO, municipalities, water management districts.
- Reduce shrub encroachment in grassland habitats important to SGCN. This may be achieved through reduction of processes that promote shrub encroachment, implementation of a natural fire regime (Ravi et al. 2009), reseeding with native grasses, and shrub removal (Bestelmeyer et al. 2003). Potential collaborators: ACOE, BLM, BOR, DOD, NPS, USFWS, SLO, private landowners.
- Determine responses of upland habitats and associated riparian/aquatic communities that include SGCN to prescribed burns and wildfires. Integrate fire and fuels management into riparian ecosystem conservation. Design and implement projects that reduce unnaturally high fire risk associated with increased fuel loads or lack of moist soils in riparian areas. Methods may include flooding or mechanical removal of vegetation (Ellis 2001). Potential collaborators: ACOE, BLM, BOR, NPS, USFS, USFWS, NHNM, SLO, private land managers.
- Restore, protect and monitor important disjunct wildlife habitats, such as caves, playas, and saline lakes. Potential collaborators: BLM, DOD, NPS, NRCS, USFWS, EMNRD, private interests.
- Ensure the ecological sustainability and integrity of the Great Plains Shortgrass Prairie and associated SGCN by establishing conservation agreements, memoranda of understanding, or acquiring lands from willing sellers. Potential collaborators: ACOE, BOR, USFWS, NHNM, SFD, SLO, NHNM, private landowners.
- Survey and monitor perennial marshes/cienegas/springs/seeps habitats and the SGCN that inhabit them to determine changes in quantity and quality of habitat, as well as status and trend of SGCN. Potential collaborators: BLM, USFS, USFWS, NHNM, NMED, SLO, universities.
- Determine beneficial fire frequencies and intensities and work with land management agencies and private landowners to develop fire management plans and implement prescribed burns that avoid disturbing SGCN during sensitive periods (e.g., nesting), maintain condition of sensitive habitats (e.g., riparian habitat) and protect people and property. Potential collaborators: BLM, NPS, USFS, SLO, SFD, private landowners.
- Restore stands of trees in woodlands to natural or historic densities that reduce the probability of insect and disease outbreaks and stand-replacing wildfires. Avoid unnecessary removal of large old-growth trees and snags, which serve as important wildlife habitat (Kalies and Rosenstock 2013). Potential collaborators: BLM, USFS, SFD, SLO, non-profit organizations.
- Promote land management practices, standards, and guidelines to conserve and/or restore structure and function of corridors that provide important habitat for SGCN. This should include xeric riparian communities that serve as important migratory corridors for birds and other wildlife while providing ecosystem services, and wildlife corridors that link isolated mountain ranges (Powledge 2003) and coniferous forest patches. Potential collaborators: BLM, NPS, USFS, USFWS, NHNM, universities.

- Implement protections to conserve aquatic habitats within closed basins or hydrologic units not currently designated as Waters of the United States. Potential collaborators: BLM, NMED, NMOSE, water users.
- Implement a standardized method to inventory, assess, and monitor riparian and aquatic habitats and efforts to conserve them. Determine amount, status, and trend of habitat, levels of fragmentation and how SGCN might be affected. Potential collaborators: ACOE, BLM, BOR, NPS, USFS, USFWS, NHNM, NMED, SFD, SLO, universities.
- Promote citizen participation in restoration and conservation of watersheds. Potential collaborators: ACOE, BOR, USFS, USFWS, NMED, universities, private land managers, non-profit organizations.
- Inform interested and affected members of the public about the value of riparian systems and maintaining in-stream flows in order to build support for conservation of riparian species and habitat restoration efforts. Potential collaborators: NRCS, USFS, universities, non-profit organization, private land managers.
- Examine the structural characteristics of habitat fragmentation and how it influences patch size, edge effect, dispersal behavior, and daily and seasonal movements/migrations by wildlife including SGCN. Focus on riparian and aquatic habitats. Potential collaborators: BLM, USFS, USFWS, NHNM, NMED, SLO, universities.

## *Invasive and Problematic Species:*

- Design and implement protocols for early detection of invasive and problematic species and diseases. Quickly respond to detection. Potential collaborators: BLM, USFS, SLO, NMED, universities.
- Eradicate or control existing non-native and invasive species before they become established. Potential collaborators: BLM, USFS, SLO, universities.
- Where feasible, reestablish native aquatic communities in perennial streams and restored aquatic habitats. Potential collaborators: BLM, BOR, USFWS, USFS, SLO, private land managers, non-profit organizations.
- Determine the current distribution of invasive and problematic species and diseases and their impacts on SGCN. Potential collaborators: BLM, BOR, ACOE, SLO, NMED, universities.
- Investigate and monitor black-tailed prairie dog population distribution, density, and abundance (Facka et al. 2008). Evaluate factors influencing the spread of plague (George et al. 2013), the ecological consequences of control efforts (Miller et al. 2007), and the potential for emerging plague vaccine application. Potential collaborators: BLM, DOD, USFWS, SLO, private land managers, non-profit organizations.
- Develop strategies to prevent emerging diseases from getting into the High Plains and Tablelands ecoregion, as well as strategies that will inhibit the spread of ones already in the ecoregion. Potential collaborators: BLM, SLO, private land managers.
- Restore native riparian plants (e.g., cottonwood and willow) and natural riparian ecosystem processes and functions following tamarisk removal or biocontrol, and ensure maintenance of adequate water supply for native plants. At sites with low water availability, restoration of

native xeric plants may be more appropriate than wetland plants. Potential collaborators: BLM, BOR, ACOE, USFWS, USFS, SLO, private land managers, non-profit organizations.
- Stage and balance tamarisk removal and native habitat restoration over time, to avoid rapid loss of exotic woody riparian habitats for wildlife until native habitats can be developed (Sogge et al. 2013). Potential collaborators: BLM, BOR, ACOE, SLO, NMED, private land managers, non-profit organizations.
- Protect sustain, and proactively restore existing stands of native riparian vegetation that may serve as important refugia in areas currently or likely to be affected by the tamarisk beetle, such as large tamarisk monocultures in the most hydrologically altered river systems) (Paxton et al. 2011, Sogge et al. 2013). Potential collaborators: BLM, BOR, SLO, private land managers, non-profit organizations.
- Develop explicit, measurable goals and objectives, site-specific plans, and post-implementation monitoring and maintenance for all riparian restoration projects. Document and report restoration approaches used, including successes and failures (Shafroth et al. 2008, Sogge et al. 2013). Potential collaborators: ACOE, BLM, BOR, NRCS, NMDA, Soil and Water Conservation Districts, SFD, SLO, USFS, USFWS, private landowners.

## *Pollution:*

- Work with appropriate agencies to enforce mining and energy development regulations, Best Management Practices, and safeguards that protect water quality and minimize mortality of SGCN. Potential collaborators: BLM, EMNRD, NMED, SLO.
- Evaluate and mitigate the effects of pollutants in runoff from housing and urban areas, industrial areas, and agricultural areas (e.g., sewage, nutrients, toxic chemicals, sediment) on SGCN and their habitats. This includes solid waste that may entangle wildlife. Potential collaborators: EPA, NMED, municipalities.
- Evaluate and mitigate the effects of excess generation of heat, light, and/or sound from sources such as power plants, urban areas, and highways on SGCN and their habitats. Potential collaborators: utility companies, private industry, NMDOT.
- Assess impacts to habitat and SGCN from industrial activities, including mining and energy development. These impacts may include direct mortality, pollution from produced wastewater (including brine and hydraulic injection fluids), and sediment runoff from roads. Potential collaborators: BLM, USFS, SLO, EMNRD, NMED, local governments, energy and mining companies.
- Determine the impacts of agro- and petrochemicals on SGCN fish. Potential collaborators: EPA, NMED, private industry.

## *Climate Change:*

- Determine how regional and global climate change will affect SGCN, vegetation patterns, and community and ecosystem processes and dynamics. Of particular importance are environmental conditions or thresholds that could limit SGCN, especially species that inhabit aquatic and riparian habitats, and evaluations of grassland/prairie or riparian area connectivity. Plan and complete projects that help maintain the distribution and natural functioning of climate-impacted species and habitats. Potential collaborators: USFS, USFWS, USGS, universities.

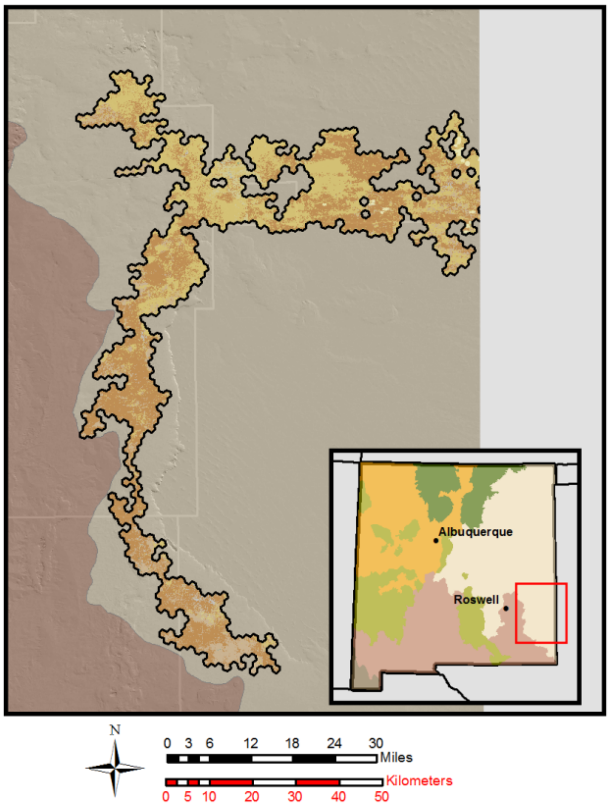
- Determine life history needs, ecology, distribution, status and trends of, and threats to, SGCN (especially invertebrates that are not currently monitored, riparian-obligate species, and rare native fish) and their habitats. Use this information to develop and implement effective monitoring protocols and conservation actions. Potential collaborators: BLM, USFS, USFWS, SLO, universities, non-profit organizations, private industry.
- Develop new species recovery plans that consider the current status of and limiting factors for species, as well as projected future conditions for both species and their habitats.
- Assess the synergistic effects between climate change and other threats to SGCN and their habitats. Potential collaborators: USFS, USFWS, USGS, universities.
- Inform the public about potential adverse effects of climate change on SGCN and their habitats. Potential collaborators: USFS, USFWS, USGS, universities, non-profit organizations.
- Monitor SGCN to determine long-term trends that correlate to ecosystem dynamics and habitat changes. Potential collaborators: BLM, DOD, USFS, USFWS, SLO, universities, TNC.

## *Actions that Address Multiple Threats:*

- Identify or develop an accessible common database of information to document the status and condition of, threats to, and conservation actions implemented in High Plains and Tablelands ecoregion habitats. Identify data gaps and varying data collection methodologies that provide a framework for identifying and promoting robust standard monitoring approaches. Potential collaborators: universities, NHNM.

# Conservation Opportunity Areas

## *Mescalero Sands*




| Habitat | Tier | Area (ha) |
|---|---|---|
| Arid West Interior Freshwater Emergent Marsh | 1 | 12.2 |
| Chihuahuan Desert Scrub | 4 | 27,867.7 |
| Chihuahuan Semi-Desert Grassland | 2 | 2,328.3 |
| Cliff, Scree & Rock Vegetation | 4 | 1,816.0 |
| Desert Alkali-Saline Wetland | 1 | 35.6 |
| Great Plains Floodplain Forest | 1 | 1.0 |
| Great Plains Mixedgrass Prairie | 2 | 3.7 |
| Great Plains Sand Grassland & Shrubland | 3 | 110,929.5 |
| Great Plains Shortgrass Prairie | 3 | 92,038.5 |
| Herbaceous Agricultural Vegetation | 5 | 1,787.1 |
| Intermountain Dry Shrubland & Grassland | 2 | 4,442.1 |
| Intermountain Dwarf Sagebrush Shrubland | 4 | 0.5 |
| Madrean Lowland Evergreen Woodland | 4 | 25.3 |
| Montane-Subalpine Wet Shrubland & Wet Meadow | 1 | 0.4 |
| Open Water | 5 | 2.0 |
| Rocky Mountain Montane Shrubland | 3 | 58.5 |
| Rocky Mountain Pinyon - Juniper Woodland | 4 | 1.1 |
| Southwest Riparian Forest | 1 | 21.2 |
| Warm-Desert Arroyo Riparian Scrub | 2 | 4.0 |

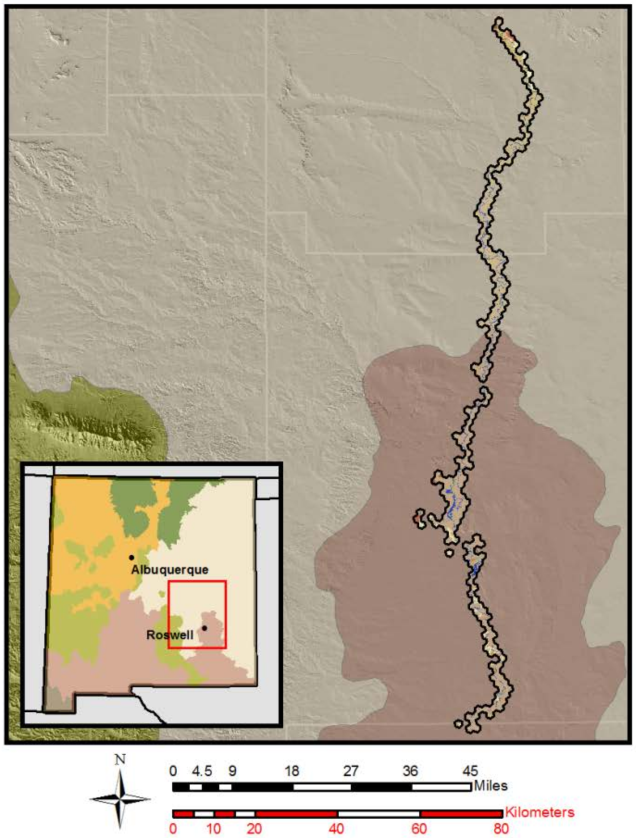
Figure 22. Mescalero Sands Conservation Opportunity Area.

The Mescalero Sands Conservation Opportunity Area (COA) (Figure 22) encompasses 241,311 ha (596,292 ac) beginning approximately 40 km (25 mi) west of Hobbs and extending north and then east to the Texas state line south of Portales. Land stewardship is divided among four entities: 40% privately-owned, 39% BLM, 17% SLO, and 4% by the Department. It contains >20 Important Bird Areas (Department Prairie-Chicken Areas), four TNC conservation areas (Milnesand, Lone Wolf, Querecho Plains, and Mescalero Sands), but only 7% is protected.

Landcover includes 17 native vegetation habitats, open water, and agricultural lands. Most is Great Plains Sand Grassland and Shrubland (46%) or Great Plains Shortgrass Prairie (38%). This COA contains no perennial aquatic habitat.

SGCN total nine and include one species categorized as an Immediate Priority SGCN (black-tailed prairie dog) and two species considered SGCN based on their occurrence within specialized or limited habitats in the state (burrowing owl, dunes sagebrush lizard).

## *Middle Pecos River*




| Habitat | Tier | Area (ha) |
|---|---|---|
| Arid West Interior Freshwater Emergent Marsh | 1 | 741.4 |
| Chihuahuan Desert Scrub | 4 | 32,922.5 |
| Chihuahuan Semi-Desert Grassland | 2 | 3,484.9 |
| Cliff, Scree & Rock Vegetation | 4 | 175.9 |
| Desert Alkali-Saline Wetland | 1 | 114.0 |
| Developed & Urban | 5 | 432.2 |
| Great Plains Floodplain Forest | 1 | 1,134.4 |
| Great Plains Sand Grassland & Shrubland | 3 | 993.9 |
| Great Plains Shortgrass Prairie | 3 | 5,039.9 |
| Herbaceous Agricultural Vegetation | 5 | 3,720.7 |
| Intermountain Dry Shrubland & Grassland | 2 | 417.8 |
| Madrean Lowland Evergreen Woodland | 4 | 2.5 |
| Open Water | 5 | 3,013.3 |
| Recently Disturbed or Modified | 5 | 479.3 |
| Rocky Mountain Montane Shrubland | 3 | 11.4 |
| Rocky Mountain Pinyon - Juniper Woodland | 4 | 32.0 |
| Southwest Riparian Forest | 1 | 376.4 |
| Warm-Desert Arroyo Riparian Scrub | 2 | 1,816.6 |

Figure 23. Middle Pecos River Conservation Opportunity Area.

The Middle Pecos River Conservation Opportunity Area (COA) (Figure 23) encompasses 54,870 ha (135,587 ac) that extends along the Pecos River from Fort Sumner to Lake Arthur, south of Roswell. Most of the COA is privately-owned (62%), but sizable portions are managed by the BLM (16.25%) and USFWS (12%). It contains two Important Bird Areas (Bitter Lake NWR and Bosque Redondo) and one TNC conservation area (Crawford Ranch). Only 14% of the COA is protected.

Landcover includes 14 native vegetation habitats, open water, and agricultural, disturbed, and developed lands. Chihuahuan Desert Scrub is the dominant (60%) terrestrial habitat. Perennial aquatic habitats include 417 km (259 mi) of warm water streams and 22 ha (54 ac) of warm water reservoirs.

SGCN total 24 and include four species categorized as Immediate Priority SGCN (black-tailed prairie dog, gray redhorse, Pecos pupfish, Texas hornshell).

# Chapter 8: Chihuahuan Deserts Conservation Profile

## Species of Greatest Conservation Need (SGCN) and their Habitats

The Chihuahuan Desert ecoregion encompasses 69,900 $km^2$ (26,989 $mi^2$) of the southern third of New Mexico and represents the northern boundary of 510,159 $km^2$ (196,973 $mi^2$) of contiguous warm desert that extends southward into central Mexico. In New Mexico, elevations range from 850-2,600 m (2,800-8,550 ft). Terrain consists of broad basins bordered by isolated, rugged mountains. The ecoregion is arid, marked by hot summers and mild winters. Mean annual temperatures are 17-20 $^{o}$C (63-68 $^{o}$F) and annual precipitation averages 34 cm (10.4 in) (range: 20-64 cm (6-20 in)), most of which falls in summer.

This ecoregion supports the highest number of SGCN (136) (Table 21, Table 23). Birds are the dominant taxa, making up 41% of the taxa in the ecoregion. The categories Susceptible (27%) and Data Needed (22%) were the most numerous within the ecoregion. Seventy-seven percent of occurrences of SGCN in the ecoregion were based on observations.

Table 21. Number of Species of Greatest Conservation Need in the Chihuahuan Desert ecoregion.

| Taxon \ Category[30] | I | H | S | D | F | Total |
|---|---|---|---|---|---|---|
| Amphibians | 0 | 3 | 1 | 2 | 1 | 7 |
| Birds | 13 | 5 | 25 | 8 | 5 | 56 |
| Crustaceans | 0 | 0 | 0 | 13 | 2 | 15 |
| Fish | 7 | 2 | 3 | 0 | 8 | 20 |
| Mammals | 4 | 1 | 2 | 1 | 5 | 13 |
| Molluscs | 1 | 5 | 1 | 3 | 5 | 15 |
| Reptiles | 1 | 1 | 5 | 3 | 0 | 10 |
| Total | 26 | 17 | 37 | 30 | 26 | 136 |

[30]Category abbreviations are: I = Immediate Priority, H = Limited Habitat, S = Susceptible, D = Data Needed, F = Federally-listed.

Terrestrial habitats include 27 naturally vegetated types, three unvegetated land covers, and 125,000 ha (309,000 ac) of agricultural land (Table 22, Figure 24). However, almost all the ecoregion is encompassed by two habitats: Chihuahuan Semi-Desert Grassland (34%) and Chihuahuan Desert Scrub (51%). Thus, except in small patches of high elevation woodlands of oak (*Quercus* spp.) and piñon-juniper above 2,150 m (7,050 ft) in the mountains, dominant species are blue grama (*Bouteloua gracilis*) and black grama (*B. eriopoda*), creosote (*Larrea tridentata*), American tarwort (*Flourensia cernua*), mesquite (*Prosopis* spp.), and yuccas (*Yucca* spp.).

Perennial water sources are limited to six warm water reservoirs (7,503 ha (18,532 ac)) and 21 warm water, perennial streams (1,130 km (700 mi)) (Figure 25). Eighty percent of the surface area of reservoirs is encompassed by Elephant Butte and Caballo Lakes.

Table 22. Terrestrial habitat types of the Chihuahuan Desert ecoregion.

| Habitat Category | USNVC Code | Habitat Name[31] | Tier[32] | Climate Vulnerability[33] | Area (km²) | (mi²) |
|---|---|---|---|---|---|---|
| Alpine and Montane Vegetation | M168 | Rocky Mountain Subalpine-High Montane Meadow | 2 | High | 1 | 0.44 |
| | M011 | Madrean Montane Forest & Woodland | 3 | Moderate→Very High | 29 | 11 |
| | M049 | Rocky Mountain Montane Shrubland | 3 | High | 8 | 3 |
| | M010 | Madrean Lowland Evergreen Woodland | 4 | Moderate→Very High | 1,485 | 573 |
| | M020 | Rocky Mountain Subalpine-High Montane Conifer Forest | 4 | -- | 7 | 3 |
| | M022 | Rocky Mountain Lower Montane Forest | 4 | High | 13 | 5 |
| | M026 | Intermountain Juniper Woodland | 4 | Moderate→Very High | 38 | 15 |
| | M027 | Rocky Mountain Piñon-Juniper Woodland | 4 | Moderate→Very High | 155 | 60 |
| | M091 | Warm Interior Chaparral | 4 | Moderate→Very High | 213 | 82 |
| Plains-Mesa Grassland | M051 | Great Plains Mixedgrass Prairie | 2 | -- | 0.61 | 0.24 |
| | M052 | Great Plains Sand Grassland & Shrubland | 3 | Very High | 1,167 | 450 |
| | M053 | Great Plains Shortgrass Prairie | 3 | Very High | 799 | 308 |
| Desert Grassland and Scrub | M087 | Chihuahuan Semi-Desert Grassland | 2 | Moderate→Very High | 24,253 | 9,364 |
| | M171 | Intermountain Dry Shrubland & Grassland | 2 | Moderate→Very High | 411 | 159 |
| | M169 | Intermountain Tall Sagebrush Shrubland | 3 | -- | 2 | 0.70 |
| | M086 | Chihuahuan Desert Scrub | 4 | High | 35,261 | 13,614 |

[31] Habitats were macrogroups identified in the US National Vegetation Classification System (USNVC), except Other Land Covers which were derived from Southwestern Regional Gap Analysis land cover classes.
[32] Tiers reflect the urgency for conservation and were based on the degree of imperilment within the United States according to the NatureServe Conservation Status Assessment (http://www.natureserve.org/conservation-tools/conservation-status-assessment) and the spatial pattern of the habitat.
[33] Climate vulnerability levels were based on a vulnerability analysis performed for Ecological Response Units (ERU) across New Mexico and Arizona (Triepke et al. (2014). The ERU classification system represents major ecosystem types of the Southwest. Vulnerability for each ERU was calculated as the relative probability of type conversion. The ERUs were then crosswalked to the habitats shown here.

| Habitat Category | USNVC Code | Habitat Name[31] | Tier[32] | Climate Vulnerability[33] | Area (km$^2$) | (mi$^2$) |
|---|---|---|---|---|---|---|
| | M093 | Intermountain Saltbush Shrubland | 4 | -- | 14 | 5 |
| | M170 | Intermountain Dwarf Sagebrush Shrubland | 4 | -- | 0.41 | 0.16 |
| Arroyo Riparian | M092 | Warm-Desert Arroyo Riparian Scrub | 2 | -- | 130 | 50 |
| Riparian Woodland and Wetland | M028 | Great Plains Floodplain Forest | 1 | -- | 131 | 51 |
| | M034 | Rocky Mountain Montane Riparian Forest | 1 | -- | 23 | 9 |
| | M036 | Southwest Riparian Forest | 1 | -- | 218 | 84 |
| | M075 | Montane-Subalpine Wet Shrubland & Wet Meadow | 1 | -- | 0.03 | 0.01 |
| | M076 | Warm Desert Lowland Riparian Shrubland | 1 | -- | 0.93 | 0.36 |
| | M082 | Desert Alkali-Saline Wetland | 1 | -- | 511 | 197 |
| | M888 | Arid West Interior Freshwater Emergent Marsh | 1 | -- | 41 | 16 |
| Cliff, Scree & Rock | M887 | Cliff, Scree & Rock Vegetation | 4 | High | 2,841 | 1,097 |
| Other Land Cover | N/A | Developed & Urban | 5 | -- | 574 | 222 |
| | N/A | Herbaceous Agricultural Vegetation | 5 | -- | 1,251 | 483 |
| | N/A | Quarries, Mines, Gravel Pits and Oil Wells | 5 | -- | 24 | 9 |
| | N/A | Recently Disturbed or Modified | 5 | -- | 8 | 3 |

Table 23. Species of Greatest Conservation Need (SGCN) in the Chihuahuan Desert ecoregion.

| Common Name | Scientific Name | Taxon | Category | Reason to Include[34] | Habitats[35] |
|---|---|---|---|---|---|
| Western Narrow-mouthed Toad | *Gastrophryne olivacea* | Amphibians | H | V, Di | M051, M052, M053, M076, M082, M086, M087, M092, M888 |
| Sonoran Desert Toad | *Incilius alvarius* | Amphibians | H | Di | M036, M076, M082, M087, M092, EC, EMCS, PMCSS |
| Lowland Leopard Frog | *Lithobates yavapaiensis* | Amphibians | H | V, Di | M010, M011, M026, M036, M076, EC, EMCS, PMCSS |
| Rio Grande Leopard Frog | *Lithobates berlandieri* | Amphibians | S | V | M028, M036, M076, M092, M888, PMCSS, PWWS |
| Arizona Toad | *Anaxyrus microscaphus* | Amphibians | D | V | M010, M011, M022, M026, M034, M036, M076, M086, M087 |
| Eastern Barking Frog | *Craugastor augusti latrans* | Amphibians | D | V | M086 |
| Chiricahua Leopard Frog | *Lithobates chiricahuensis* | Amphibians | F | De, V, Di | M010, M011, M020, M022, M034, M036, M075, M076, EC, PMCSS, |
| Bendire’s Thrasher | *Toxostoma bendirei* | Birds | I | De, V | M026, M027, M028, M051, M076, M082, M086, M087, M092, M093, M169, M170, M171, M887 |
| Sprague’s Pipit | *Anthus spragueii* | Birds | I | De, V | M051, M053, M087, M171 |
| Juniper Titmouse | *Baeolophus ridgwayi* | Birds | I | De, V | M010, M011, M026, M027, M034, M036, M049, M887 |
| Chestnut-collared Longspur | *Calcarius ornatus* | Birds | I | De, V | M051, M052, M053, M086, M087, M170, M171 |

[34] Reason to include indicates which of five criteria for inclusion on the SGCN list a particular species met. Abbreviations are as follows: De = Declining; Di = Disjunct; E = Endemic; K = Keystone; V = Vulnerable.
[35] Aquatic habitat abbreviations are as follows: PCWS = Perennial Cold Water Streams; PWWS = Perennial Warm Water Streams; PLCP = Perennial Lakes, Cirques, Ponds; PMCSS = Perennial Marshes/Cienegas/Springs/Seeps; PCWR = Perennial Cold Water Reservoirs; PWWR = Perennial Warm Water Reservoirs; EMCS = Ephemeral Marshes/Cienegas/Springs; EC = Ephemeral Catchments. Habitat codes refer to National Vegetation Classification designations, which are identified in Table 22 above.

| Common Name | Scientific Name | Taxon | Category | Reason to Include[34] | Habitats[35] |
|---|---|---|---|---|---|
| Pinyon Jay | *Gymnorhinus cyanocephalus* | Birds | I | De, V | M010, M011, M022, M027, M026, M028, M034, M049, M053, M169, M171, M887, M888 |
| Flammulated Owl | *Psiloscops flammeolus* | Birds | I | V | M010, M011, M020, M022, M026, M027, M034, M036, M049, M051, M075, M168, M169, M171, M887 |
| McCown's Longspur | *Rhynchophanes mccownii* | Birds | I | De, V | M053, M087, M171 |
| Grace's Warbler | *Setophaga graciae* | Birds | I | De, V | M011, M022, M026, M027, M034, M036, M049, M171, M887 |
| Black-throated Gray Warbler | *Setophaga nigrescens* | Birds | I | De, V | M010, M011, M020, M022, M026, M027, M034, M036, M049, M075, M076, M086, M091, M171, M887 |
| Black-chinned Sparrow | *Spizella atrogularis* | Birds | I | De, V | M010, M026, M027, M091 |
| Gray Vireo | *Vireo vicinior* | Birds | I | V | M010, M011, M022, M026, M027, M028, M034, M036, M049, M051, M082, M086, M087, M091, M092, M093, M169, M171, M887 |
| Red-faced Warbler | *Cardellina rubrifrons* | Birds | I | V | M010, M011, M022, M034, M036, M887 |
| Painted Redstart | *Myioborus pictus* | Birds | I | V | M010, M011, M022, M034, M036 |
| Burrowing Owl | *Athene cunicularia* | Birds | H | De, V, Di | M026, M036, M051, M052, M053, M082, M086, M087, M092, M093, M169, M170, M171, M887 |
| Peregrine Falcon | *Falco peregrinus* | Birds | H | V, K | M010, M022, M026, M036, M082, M086, M087, M887 |
| Bald Eagle | *Haliaeetus leucocephalus* | Birds | H | V, K | M010, M011, M020, M022, M026, M027, M028, M034, M036, M049, M051, M052, M053, M082, M086, M087, M091, M093, M168, M169, M170, M171, M887 |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[34] | Habitats[35] |
|---|---|---|---|---|---|
| Bank Swallow | *Riparia riparia* | Birds | H | De, V, Di | M028, M034, M036, M076, M092, M888 |
| Bell's Vireo | *Vireo bellii* | Birds | H | V, Di | M010, M011, M027, M028, M034, M036, M053, M076, M086, M087 |
| Baird's Sparrow | *Ammodramus bairdii* | Birds | S | De, V | M053, M086, M087, M171 |
| Violet-crowned Hummingbird | *Amazilia violiceps* | Birds | S | De, V | M010, M011, M036, M086, M087 |
| Sagebrush Sparrow | *Artemisiospiza nevadensis* | Birds | S | De, V | M010, M026, M027, M034, M049, M051, M052, M053, M082, M086, M087, M091, M093, M169, M170, M171, M887 |
| Costa's Hummingbird | *Calypte costae* | Birds | S | De, V | M010, M011, M020, M022, M034, M036, M076, M086, M087, M092 |
| Mountain Plover | *Charadrius montanus* | Birds | S | De, V | M010, M026, M027, M051, M052, M053, M082, M086, M087, M093, M168, M169, M171 |
| Snowy Plover | *Charadrius nivosus* | Birds | S | De, V | M036, M082, M086, M087, M092, M887, M888 |
| Common Nighthawk | *Chordeiles minor* | Birds | S | De, V | M010, M026, M027, M049, M051, M052, M053, M086, M087, M168, M169, M170, M171, M887 |
| Common Ground-dove | *Columbina passerina* | Birds | S | De, V | M010, M034, M036, M076, M082, M086, M087, M171, M887 |
| Olive-sided Flycatcher | *Contopus cooperi* | Birds | S | De, V | M010, M011, M020, M022, M027, M026, M034, M887 |
| Cassin's Finch | *Haemorhous cassinii* | Birds | S | De, V | M010, M011, M020, M022, M026, M027, M034, M169, M887 |
| Loggerhead Shrike | *Lanius ludovicianus* | Birds | S | De, V | M010, M011, M026, M027, M028, M034, M036, M049, M051, M052, M053, M076, M082, M086, M087, M091, M092, M093, M168, M169, M170, M171, M887 |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[34] | Habitats[35] |
|---|---|---|---|---|---|
| Whiskered Screech-Owl | *Megascops trichopsis* | Birds | S | De, V | M010, M011, M022, M036 |
| Red-headed Woodpecker | *Melanerpes erythrocephalus* | Birds | S | De, V | M028, M036, M053, M076 |
| Gila Woodpecker | *Melanerpes uropygialis* | Birds | S | De, V | M010, M034, M036, M076, M086, M087 |
| Long-billed Curlew | *Numenius americanus* | Birds | S | De, V | M034, M052, M053, M075, M082, M086, M171, M888 |
| Varied Bunting | *Passerina versicolor* | Birds | S | De, V | M010, M036, M076, M086, M087, M091, M092, M887 |
| Neotropic Cormorant | *Phalacrocorax brasilianus* | Birds | S | De, V | M036, M888, PLCP, PMCSS, PWWR, PWWS |
| Lesser Prairie-Chicken | *Tympanuchus pallidicinctus* | Birds | S | De, V, Di | M051, M052, M053, M087, M171 |
| Thick-billed Kingbird | *Tyrannus crassirostris* | Birds | S | De, V | M010, M011, M036, M091 |
| Lucy’s Warbler | *Oreothlypis luciae* | Birds | S | V | M010, M011, M022, M034, M036, M076, M086, M087, M092 |
| Clark’s Nutcracker | *Nucifraga columbiana* | Birds | S | De | M010, M011, M020, M022, M026, M027, M034 |
| Cassin’s Sparrow | *Peucaea cassinii* | Birds | S | De, V | M010, M011, M049, M051, M052, M053, M076, M082, M086, M087, M091, M092, M169, M170, M171 |
| Vesper Sparrow | *Pooecetes gramineus* | Birds | S | De, V | M010, M026, M027, M036, M049, M051, M052, M087, M168, M169, M170, M171 |
| Mountain Bluebird | *Sialia currucoides* | Birds | S | De, V | M010, M011, M020, M022, M026, M027, M034, M049, M051, M053, M086, M087, M091, M168, M887 |
| Western Bluebird | *Sialia mexicana* | Birds | S | De, V | M010, M011, M020, M022, M026, M027, M028, M034, M036, M049, M051, M075, M076, M086, M087, M168, M171, M887 |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[34] | Habitats[35] |
|---|---|---|---|---|---|
| Common Black Hawk | *Buteogallus anthracinus* | Birds | D | V | M010, M011, M022, M028, M034, M036, M086, M087, M091, M092, M887 |
| Lucifer Hummingbird | *Calothorax lucifer* | Birds | D | V | M010, M011, M036, M076, M086, M087, M091, M887 |
| Broad-billed Hummingbird | *Cynanthus latirostris* | Birds | D | V | M034, M036, M087 |
| Abert's Towhee | *Melozone aberti* | Birds | D | V | M036, M076, M086, M087, M091, M092, M093 |
| Botteri's Sparrow | *Peucaea botterii* | Birds | D | V | M010, M082, M086, M087, M092, M093, M171, M887 |
| Elegant Trogon | *Trogon elegans* | Birds | D | V | M010, M011, M036 |
| Clark's Grebe | *Aechmophorus clarkii* | Birds | D | V | M888, EC, PLCP, PMCSS, PWWR, PWWS |
| Elf Owl | *Micrathene whitneyi* | Birds | D | V | M010, M011, M036, M086, M087 |
| Southwestern Willow Flycatcher | *Empidonax traillii extimus* | Birds | F | V | M028, M034, M036, M082, M168, M888 |
| Yellow-billed Cuckoo | *Coccyzus americanus* | Birds | F | De, V, Di | M010, M011, M022, M027, M028, M034, M036, M049, M052, M053, M076, M082, M086, M087, M091, M092, M093, M169, M170, M171, M887, M888 |
| Aplomado Falcon | *Falco femoralis* | Birds | F | De, V | M053, M076, M086, M087, M171 |
| Least Tern | *Sternula antillarum* | Birds | F | V | M028, M036, M082, M086, M087, M888 |
| Mexican Spotted Owl | *Strix occidentalis lucida* | Birds | F | V | M010, M011, M020, M022, M026, M027, M034, M036, M049, M075, M091, M168, M887, M888 |
| Alkali Fairy Shrimp | *Branchinecta mackini* | Crustaceans | D | V, Di | EC |
| Swaybacked Clam Shrimp | *Eocyzicus concavus* | Crustaceans | D | V, Di | EC |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[34] | Habitats[35] |
|---|---|---|---|---|---|
| Straightbacked Clam Shrimp | *Eocyzicus digueti* | Crustaceans | D | V, Di | EC |
| Sitting Bull Spring cryptic species Amphipod | *Gammarus* sp. (unnamed) | Crustaceans | D | V, Di | PMCSS |
| BLNWR cryptic species Amphipod | *Gammarus* sp. (unnamed) | Crustaceans | D | V, Di | PMCSS |
| Lynch Tadpole Shrimp | *Lepidurus lemmoni* | Crustaceans | D | V, Di | EC |
| Sublette's Fairy Shrimp | *Phallocryptis subletti* | Crustaceans | D | V, Di | EC |
| Moore's Fairy Shrimp | *Streptocephalus moorei* | Crustaceans | D | V, E, Di | EC |
| Mexican Beavertail Fairy Shrimp | *Thamnocephalus mexicanus* | Crustaceans | D | V, Di | EC |
| Brine Shrimp | *Artemia franciscana* | Crustaceans | D | V, Di | EC |
| Mexican Clam Shrimp | *Cyzicus mexicanus* | Crustaceans | D | V, Di | EC |
| Cylindrical Cyst Clam Shrimp | *Eulimnadia cylindrova* | Crustaceans | D | V, Di | EC |
| Texan Clam Shrimp | *Eulimnadia texana* | Crustaceans | D | V, Di | EC |
| Noel's Amphipod | *Gammarus desperatus* | Crustaceans | F | De, V, E, Di | M888, PLCP, PMCSS |
| Socorro Isopod | *Thermosphaeroma thermophilum* | Crustaceans | F | V, E, Di | PMCSS |
| Blue Sucker | *Cycleptus elongatus* | Fish | I | De, V, Di | PWWR, PWWS |
| Pecos Pupfish | *Cyprinodon pecosensis* | Fish | I | De, V, Di | PMCSS, PWWS |
| White Sands Pupfish | *Cyprinodon tularosa* | Fish | I | De, V, E, Di | PWWS |
| Rio Grande Sucker | *Catostomus plebeius* | Fish | I | De, V | PCWS, PWWS |
| Rio Grande Chub | *Gila pandora* | Fish | I | V | PCWR, PCWS, PWWR, PWWS |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[34] | Habitats[35] |
|---|---|---|---|---|---|
| Roundtail Chub | *Gila robusta* | Fish | I | De, V, Di | PWWS |
| Gray Redhorse | *Moxostoma congestum* | Fish | I | De, V, Di | PWWR, PWWS |
| Greenthroat Darter | *Etheostoma lepidum* | Fish | H | De, V, Di | PMCSS, PWWS |
| Bigscale Logperch (native pop.) | *Percina macrolepida* | Fish | H | De, V, Di | PWWS |
| Mexican Tetra | *Astyanax mexicanus* | Fish | S | V, Di | PMCSS, PWWS |
| Desert Sucker | *Catostomus clarkii* | Fish | S | De, V | PWWS |
| Sonora Sucker | *Catostomus insignis* | Fish | S | De, V | PWWS |
| Pecos Gambusia | *Gambusia nobilis* | Fish | F | De, V, E | PMCSS |
| Gila Chub | *Gila intermedia* | Fish | F | De, V, Di | PWWS |
| Chihuahua Chub | *Gila nigrescens* | Fish | F | De, V, Di | PWWS |
| Rio Grande Silvery Minnow | *Hybognathus amarus* | Fish | F | De, V, Di | PWWS |
| Spikedace | *Meda fulgida* | Fish | F | De, V, Di | PWWS |
| Pecos Bluntnose Shiner | *Notropis simus pecosensis* | Fish | F | De, V, E, Di | PWWS |
| Gila Topminnow | *Poeciliopsis occidentalis occidentalis* | Fish | F | De, V, Di | PMCSS |
| Loach Minnow | *Rhinichthys (Tiaroga) cobitis* | Fish | F | De, V, Di | PWWS |
| Organ Mountains Colorado Chipmunk | *Tamias quadrivittatus australis* | Mammals | I | V, Di | M010, M011, M022, M027, M049, M091, M092, M887 |
| Oscura Mountains Colorado Chipmunk | *Tamias quadrivittatus oscuraensis* | Mammals | I | V, Di | M010, M011, M022, M091 |
| Gunnison's Prairie Dog | *Cynomys gunnisoni* | Mammals | I | De, V, K | M022, M026, M027, M051, M053, M086, M087, M093, M168, M169, M170, M171 |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[34] | Habitats[35] |
|---|---|---|---|---|---|
| Black-tailed Prairie Dog | *Cynomys ludovicianus* | Mammals | I | De, V, K | M028, M051, M052, M053, M086, M087, M170 |
| Least Shrew | *Cryptotis parva* | Mammals | H | V, Di | M028, M051, M071, M082, M888, EMCS |
| Pale Townsend's Big-eared Bat | *Corynorhinus townsendii* | Mammals | S | V | M010, M011, M020, M022, M026, M027, M034, M049, M086, M087, M091, M171, M887 |
| Spotted Bat | *Euderma maculatum* | Mammals | S | V | M010, M022, M026, M027, M034, M036, M075, M076, M086, M092, M168, M171, M887, M888 |
| Mexican Long-tongued Bat | *Choeronycteris mexicana* | Mammals | D | V | M010, M011, M086, M087 |
| Mexican Gray Wolf | *Canis lupus baileyi* | Mammals | F | De, V, K | M010, M011, M087 |
| Mexican Long-nosed Bat | *Leptonycteris nivalis* | Mammals | F | V | M010, M011, M034, M036, M086, M087, M091, M092, M887 |
| New Mexico Meadow Jumping Mouse | *Zapus hudsonius luteus* | Mammals | F | De, V, E | M011, M022, M028, M034, M036, EMCS , PCWS, PWWS |
| Lesser Long-nosed Bat | *Leptonycteris yerbabuenae* | Mammals | F | V | M010, M011, M086, M087, M887 |
| Jaguar | *Panthera onca* | Mammals | F | De, V, K | M010, M011, M036, M087, M887 |
| Texas Hornshell | *Popenaias popeii* | Molluscs | I | De, V, Di | PWWS |
| Pecos Springsnail | *Pyrgulopsis pecosensis* | Molluscs | H | De, V, E, Di | PMCSS |
| Doña Ana Talussnail | *Sonorella todseni* | Molluscs | H | V, E, Di | M036, M087, M091 |
| Tularosa  Springsnail | *Juturnia tularosae* | Molluscs | H | V, Di | PMCSS |
| New Mexico Ramshorn Snail | *Pecosorbis kansasensis* | Molluscs | H | V, Di | M086, M087, PCWS, PMCSS, PWWS |
| Ovate Vertigo Snail | *Vertigo ovata* | Molluscs | H | De, V, Di | M086, M888 |
| Texas Liptooth Snail | *Linisa texasiana* | Molluscs | S | V, Di | M086 |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[34] | Habitats[35] |
|---|---|---|---|---|---|
| Woodlandsnail | *Ashmunella amblya cornudasensis* | Molluscs | D | V, E, Di | M087 |
| Metcalf Holospira Snail | *Holospira metcalfi* | Molluscs | D | V, E, Di | M010, M087 |
| Wrinkled Marshsnail | *Stagnicola caperata* | Molluscs | D | V, Di | PMCSS |
| Pecos Assiminea | *Assiminea pecos* | Molluscs | F | De, V, Di | M028, M086, M087, M888 |
| Koster's Springsnail | *Juturnia kosteri* | Molluscs | F | De, V, E, Di | PMCSS |
| Chupadera Springsnail | *Pyrgulopsis chupaderae* | Molluscs | F | De, V, E, Di | PMCSS |
| Socorro Springsnail | *Pyrgulopsis neomexicana* | Molluscs | F | De, V, E, Di | PMCSS |
| Roswell Springsnail | *Pyrgulopsis roswellensis* | Molluscs | F | De, V, E, Di | PMCSS |
| Western River Cooter | *Pseudemys gorzugi* | Reptiles | I | De, V, Di | M036, M086, M888, PCWS, PLCP |
| Dunes Sagebrush Lizard | *Sceloporus arenicolus* | Reptiles | H | De, V, Di | M052, M053, M086, M087 |
| Reticulate Gila Monster | *Heloderma suspectum suspectum* | Reptiles | S | V | M010, M036, M076, M086, M087, M091 |
| Green Rat Snake | *Senticolis triaspis* | Reptiles | S | V | M010, M036, M076, M086 |
| Arid Land Ribbonsnake | *Thamnophis proximus* | Reptiles | S | V | M028, M036, M051, M052, M053, M076, M086, M087, M091, M888, EC |
| Rock Rattlesnake | *Crotalus lepidus* | Reptiles | S | V | M010, M011, M049, M087, M887 |
| Gray-banded Kingsnake | *Lampropeltis alterna* | Reptiles | S | V | M076, M086, M087, M092, M887 |
| Plain-bellied Water Snake | *Nerodia erythrogaster* | Reptiles | D | V, Di | M036, M086, M888, PWWS |
| Desert Massasauga | *Sistrurus catenatus* | Reptiles | D | De, V | M051, M052, M053, M086, M087, M093 |
| Big Bend Slider | *Trachemys gaigeae* | Reptiles | D | V, Di | M028, M036, M086, M087, M888 |

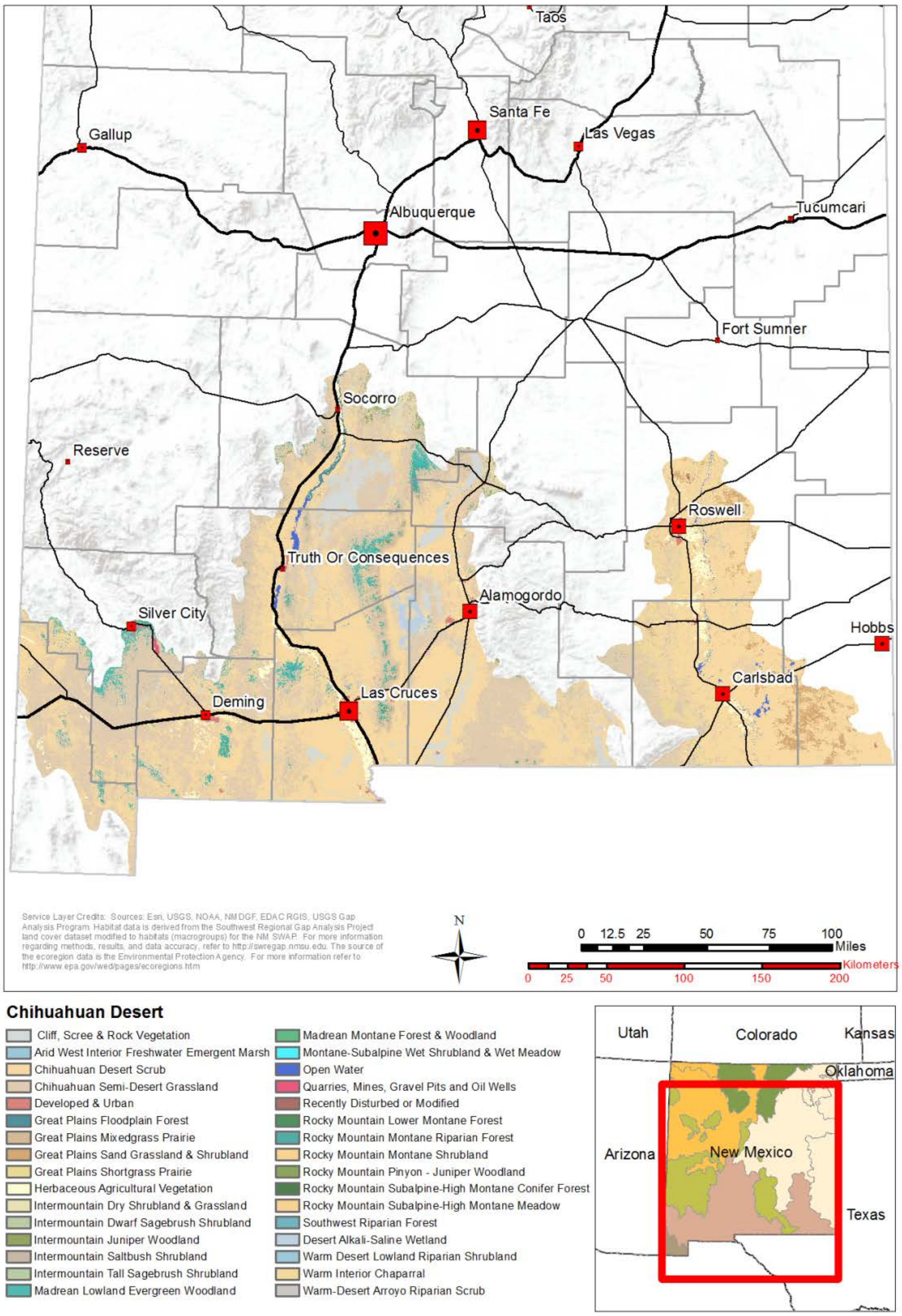



Figure 24. Terrestrial habitats in the Chihuahuan Desert ecoregion.

Delineations from US National Vegetation Classification macrogroups and SWReGAP landcover classes.

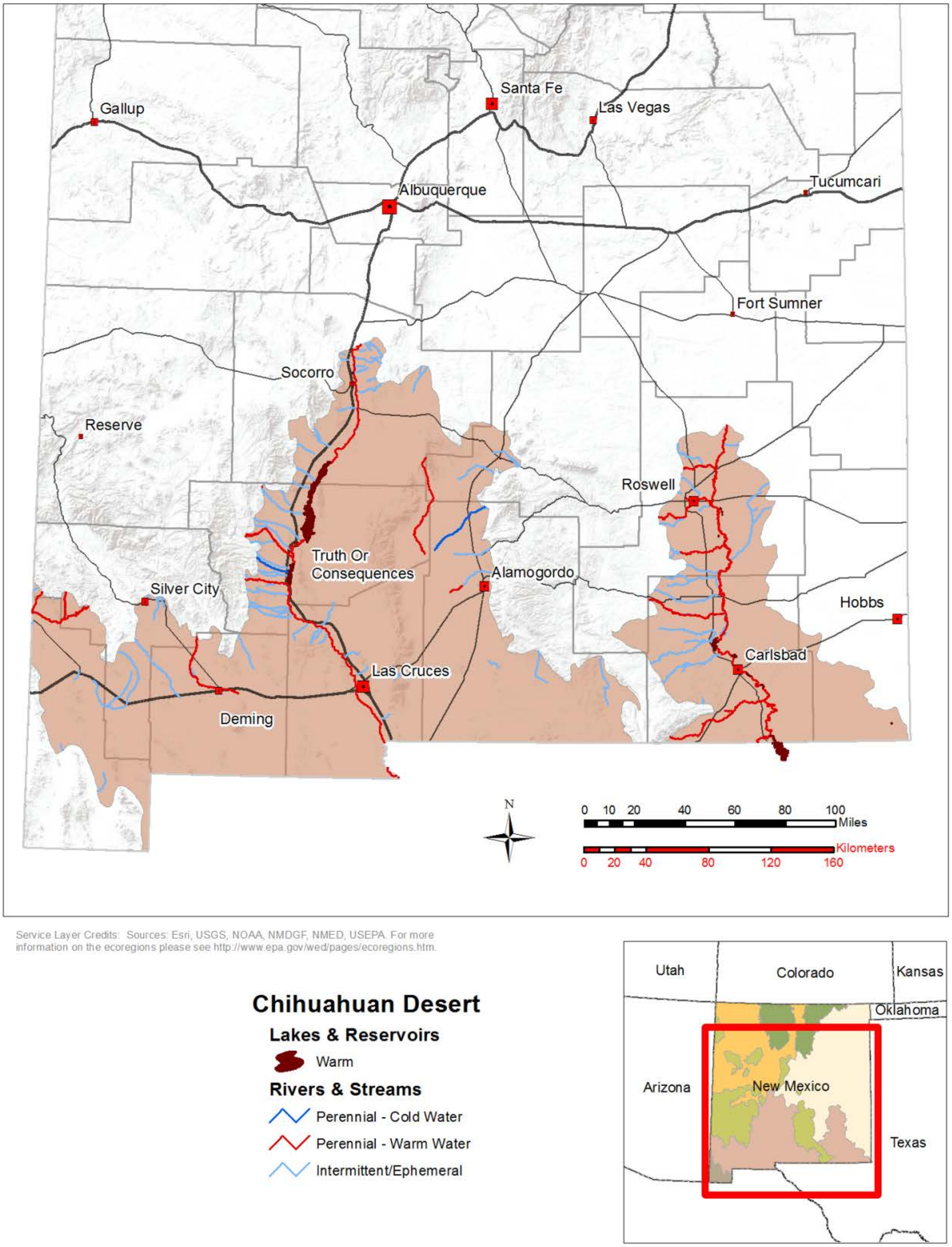



Figure 25. Aquatic habitats in the Chihuahuan Desert ecoregion.

# Habitat Descriptions

## *Chihuahuan Desert Scrub*

Chihuahuan Desert Scrub **[M086]**[36] occurs mostly at 1,000-2,000 m (3,280-6,560 ft) elevation in the Chihuahuan Desert ecoregion. It may also be found in all other ecoregions except the Southern Rocky Mountains ecoregion. It is a moderate to sparse xeromorphic shrub community characterized by a sparse to dense tall shrub layer dominated or co-dominated by whitethorn acacia (*Acacia constricta*), viscid acacia (*A. neovernicosa*), tarbush, and creosote. Other species may include catclaw acacia (*A. greggii*), sand sagebrush (*Artemisia filifolia*), fourwing saltbush (*Atriplex canescens*), Torrey's jointfir (*Ephedra torreyana*), longleaf jointfir (*E. trifurca*), ocotillo (*Fouquieria splendens*), cactus apple (*Opuntia engelmannii*), mariola (*Parthenium incanum*), soaptree yucca (*Yucca elata*), Torrey's yucca (*Y. torreyi*), skeleton-leaf goldeneye (*Viguiera stenoloba*), and lechuguilla (*Agave lechuguilla*). Many stands of this habitat type lack an herbaceous understory layer and develop a pebbly desert pavement on the soil surface, sometimes with scattered grasses and forbs. If present, the understory is a sparse to moderately dense herbaceous layer dominated by grasses including black grama, bush muhly (*Muhlenbergia porteri*), curlyleaf muhly (*M. setifolia*), tobosagrass (*Pleuraphis mutica*), burrograss (*Scleropogon brevifolius*), and mesa dropseed (*Sporobolus flexuosus*). Forb species often are present, but have low cover.

Stands of this habitat occur in broad desert basins and plains and extend up onto dissected gravelly alluvial fans, piedmonts (bajadas), and foothills. Substrates include coarse-textured loams on well-drained, gravelly plains, slopes with soils that are typically non-saline and calcareous, sandy plains, coppice dunes, and sandsheets. Soils are fine-textured (silts, clay loams, and clays), often saline, on alluvial flats and around playas, as well as in river floodplains. Stands can extend upslope on to colluvial slopes with cobbly skeletal soils. Drought is a relatively common occurrence in this desert scrub, generally occurring every 10 to 15 years and lasting two to three years, with occasional long-term drought periods (10 to 15 years duration).

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[36] Complete descriptions of habitats available by clicking on hyperlinked USNVC codes.

## *Warm-Desert Arroyo Riparian Scrub*

Warm-Desert Arroyo Riparian Scrub **[M092]** occurs primarily in the Chihuahuan Desert ecoregion, but extends northward into the Colorado Plateaus and High Plains and Tablelands ecoregions and westward into the Madrean Archipelago and Arizona/New Mexico Mountains ecoregions. It is primarily an open shrubland habitat with patches of vegetation occurring within and along the edges of ephemeral desert washes, dissected piedmonts, mesas, plains, and basin floors. Desert willow (*Chilopsis linearis*), Apache plume (*Fallugia paradoxa*), and littleleaf sumac (*Rhus microphylla*) are the typical dominants, with singlewhorl burrobrush (*Hymenoclea monogyra)*, catclaw acacia, little walnut (*Juglans microcarpa*), and splitleaf brickellbush (*Brickellia laciniata*) as common associates. The herbaceous layer is usually sparse with widely scattered grasses and forbs. This habitat is associated with flash flooding and rapid sheet and gully flows that scour channel bottoms. The vegetation is sparse from both the high impact of flooding and the lack of moisture for the rest of the year.

## *Southwest Riparian Forest*

Southwest Riparian Forest **[M036]** is a lowland riverine riparian habitat found along larger, lower gradient streams and rivers and occasionally in spring-fed depressions along canyon waterways. It is found mostly in the Chihuahuan Desert and Arizona/New Mexico Mountains ecoregions. Broad-leaved deciduous trees dominate. Fremont cottonwood (*Populus fremontii)* and Rio Grande cottonwood (*P. deltoides* var. *wislizenii)* are diagnostic, along with Arizona sycamore (*Platanus wrightii*), netleaf hackberry (*Celtis laevigata*), velvet ash (*Fraxinus velutina*), Arizona walnut (*Juglans major*), and Gooding's willow (*Salix gooddingii*). Coyote willows (*Salix exigua*) and seepwillows (*Baccharis* spp.) can be common in the understory, but grasses and forbs tend to be scattered and can include Torrey rush (*Juncus torreyi*), knotgrass (*Paspalum distichum*), alkali muhly (*Muhlenbergia asperifolia*), western water hemlock (*Cicuta douglasii*), and smooth horsetail (*Equisetum laevigatum*). Graminoid exotics can dominate including creeping bentgrass (*Agrostis stolonifera*), barnyard grass (*Echinochloa crus-galli*), and annual rabbitsfoot grass (*Polypogon monspeliensis*).

Most of the dominant woody species are phreatophytes and require the presence of a seasonally shallow water table. The stream gradients are low to moderate (0.3% on average), and channel substrates tend to be sands and gravels. Typically, it occurs on bars and terraces along channels that are flooded every 1 to 25 years. Soils are moist and well-drained but weakly-developed entisols that are either sandy throughout or sandy underlain by a gravelly matrix. They tend to be dry on the surface most of the year, but are moist within the rooting zone of most species, particularly during spring runoff.

## *Arid West Interior Freshwater Emergent Marsh*

Arid West Interior Freshwater Emergent Marsh **[M888]** occurs in the Chihuahuan Desert ecoregion and, to a lesser extent, in the surrounding ecoregions. Encompassed within this habitat is wetland vegetation of shallow freshwater to brackish waterbodies found below seeps and in bottomlands along drainages, river floodplain depressions, cienegas, oxbow lakes, frequently flooded gravel bars, low-lying sidebars, in-fill side channels, small ponds, stock ponds, ditches, and slow-moving perennial streams in valleys and mountain foothills. This type of marsh is characterized by a typically lush herbaceous layer than can be diverse or approach a single-species monoculture. Structure varies from emergent forbs, which barely reach the water surface, to tall graminoids that reach as tall as 4 m (13 ft). Dominant species typically include wetland-obligate species such as threesquare (*Schoenoplectus pungens*), chair maker's bulrush (*S. americanus*), broadleaf cattail (*Typha latifolia*), southern cattail (*T. domingensis*), common spikerush (*Eleocharis palustris*), mountain rush (*Juncus balticus*), knotgrass (*Paspalum distichum*), clustered field sedge (*Carex praegracilis*), wooly sedge (*Carex pellita*), flatsedges (*Cyperus* spp.), beggarticks (*Bidens* spp.), water hemlocks (*Cicuta* spp.), monkey flowers (*Mimulus* spp.), and canarygrasses (*Phalaris* spp.).

This type of wetland is mostly confined to small areas in suitable floodplain or basin topography with a consistent source of freshwater. Marshes may be semipermanently flooded, but some marshes only receive seasonal flooding. They are also found along the borders of ponds, lakes, or reservoirs that have more open water. Some occurrences are interdunal wetlands in wind deflation areas where sands are scoured down to the water table. Soils typically show indications of high water tables and anoxic conditions (gleying).

# Threats and Conservation Actions

Nine threats could potentially impact SGCN in 12 habitats within the Chihuahuan Desert ecoregion.

(Table 24). These threats are summarized below and listed in the order presented by the IUCN (2016). The list does not reflect the order of threat severity.

- Agriculture and Aquaculture: Grazing practices that impact SGCN habitat and groundwater withdrawal for crops.
- Energy and Mining: Wind energy development and oil and gas extraction.
- Transportation and Utilities: Transmission lines and roads.
- Biological Resource Use: Collection of reptiles and amphibians.
- Human Intrusion and Disturbance: Military activities and off-highway vehicles (OHVs).
- Natural System Modifications: Degradation of riparian and aquatic habitats.
- Invasive and Problematic Species: Introduction of quagga (*Dreissena bugensis*) and zebra mussels (*Dreissena polymorpha*) in aquatic habitat and tamarisk intrusion in riparian habitat.
- Pollution: Air, soil, and water contamination from industrial activities.
- Climate Change: Habitat alteration due to prolonged drought.

Conservation concerns include poorly managed grazing, unregulated energy development, and degradation of riparian habitats, particularly from intrusion by tamarisk. Unlike grasslands in the High Plains and Tablelands ecoregion, Chihuahuan Desert grasslands did not evolve with periodic grazing by large herbivores. Additionally, forage availability is not predictable or particularly abundant because of variable and limited precipitation. Thus, cost-effective grazing is difficult to achieve. Withdrawal of groundwater for crop production is another challenge in balancing agriculture and conservation. Sharp drops in groundwater levels will deplete aquatic and riparian habitats. Conservation actions for these challenges include working with ranchers and farmers to determine and either continue the use of or implement practices that will meet their needs and achieve SGCN conservation.

Energy extraction and development in this ecoregion includes oil and gas, and increasingly, solar and wind. Over time, the habitats have become highly fragmented where energy development has occurred. In recent years, best management practices and new technologies have provided opportunities to reduce the amount of surface disturbance associated with oil and gas well development. Solar and wind development is increasing, and its potential impacts on wildlife are not fully recognized nor understood. Nevertheless, they could have a substantial adverse impact if placed in habitats crucial to SGCN. All energy-related threats require knowledge of SGCN distribution and habitat requirements. They also warrant early and continued participation in planning and development of energy resources.

Riparian and aquatic habitats, and the SGCN that depend on them, maintain a precarious existence in this ecoregion given demands for water, unpredictable and limited precipitation, and the potential for increasing drought from climate change. Invasive species make SGCN conservation more complex and difficult. This is particularly true when SGCN have adapted to their presence (e.g., southwestern willow flycatcher nesting in tamarisk). Conservation actions include early detection and eradication of invasive species, and determining and implementing strategies to rapidly restore native species to densities suitable for riparian-obligate SGCN.

Most areas within the Chihuahuan Desert ecoregion experienced warmer temperatures and either wetter or drier conditions (depending on location) than normal during 1991-2005 (Enquist and Gori 2008). Average maximum and minimum temperatures recorded by weather stations at the following sites increased significantly from 1970-2005: Bottomless Lakes, Lost River, Pecos River, Bitter Lake, Rio Felix, and Lower Hondo (Enquist and Gori 2008).

Under continued climate change, Chihuahuan Desert Scrub habitat is expected to expand and Chihuahuan Semi-Desert Grasslands are expected to decrease in area. Woodlands may disappear completely by mid-century (Rehfeldt et al. 2006). Habitats with very high vulnerability to climate change are Great Plains Sand Grassland and Shrubland and Great Plains Shortgrass Prairie (Table 22; Triepke et al. 2014).

Table 24. Potential threats to habitat and associated SGCN in the Chihuahuan Desert ecoregion.

Threat categories were derived from IUCN (2016). Habitats listed are those that are dominant in the amount of area they encompass or are particularly important to conserve (Tier 1 or 2) in this ecoregion.

| Habitat / Threat | Development | Agriculture & Aquaculture | Energy & Mining | Transportation & Utilities | Biological Resource Use | Human Intrusions & Disturbance | Natural System Modifications | Invasive & Problematic Species | Pollution | Climate Change |
|---|---|---|---|---|---|---|---|---|---|---|
| Arid West Interior Freshwater Emergent Marsh | | X | | | | | X | X | X | X |
| Chihuahuan Desert Scrub | | X | X | X | X | X | | | | |
| Chihuahuan Semi-Desert Grassland | | X | X | X | X | | | | | X |
| Cliff, Scree & Rock Vegetation | | | | X | | X | | | | |
| Great Plains Floodplain Forest | | X | X | X | | X | X | X | | X |
| Southwest Riparian Forest | | X | X | X | X | X | X | X | | X |
| Warm-Desert Arroyo Riparian Scrub | | X | X | X | X | | X | X | X | X |
| Warm Desert Lowland Riparian Shrubland | | X | | | X | | X | X | X | X |
| Perennial Cold Water Streams | | X | | X | | | X | X | X | X |
| Perennial Warm Water Reservoirs | | X | | | | | X | X | X | X |
| Perennial Marshes/Cienegas/Springs/Seeps | | X | | X | | | X | X | X | X |
| Perennial Warm Water Streams | | X | X | X | | | X | X | X | X |

The following are proposed conservation actions for the Chihuahuan Desert ecoregion, listed in order of priority within each threat category. Threat categories are listed according to the order presented by IUCN (2016).

## *Agriculture and Aquaculture:*

- Determine where habitat restoration would benefit SGCN and work with federal, state, and private land managers to restore degraded rangelands to good or excellent condition. Monitor restoration results to develop and initiate any identified improvements to restoration practices. Potential collaborators: BLM, USFS, SLO, private land managers.
- Establish baseline composition, condition, and function of major range habitats to inform habitat restoration actions, with an emphasis on shrub invasion into historic grasslands. Potential collaborators: BLM, USFS, universities.
- Determine how timing, intensity, and duration of livestock grazing affect SGCN and their habitats, including the interaction between grazing, fire, and the spread of invasive and problematic species. Potential collaborators: BLM, NRCS, USFS, NMDA, SLO, universities, private land managers.
- Balance irrigation and groundwater demands with the needs of aquatic communities, particularly those supporting native fish, amphibian, and springsnail populations. Potential collaborators: BOR, ACOE, NMISC/OSE, water users.
- Promote expanded use of appropriate, cost effective, grazing practices that ensure long-term ecological sustainability for SGCN and their habitats (especially riparian habitats). These include actions that contribute to recovery of rangelands impacted by drought and allow restoration activities to be completed (Gripne 2005). Potential collaborators: BLM, USFS, SLO, private land managers.
- Promote grazing systems that address both livestock and SGCN habitat needs based on site-specific conditions. When particular habitat components need improvement, coordinate with ranchers and resource managers to identify and implement modifications that would provide the desired habitat outcomes. Potential collaborators: BLM, USFS, SLO, private landowners.
- Promote use of devices and models that improve water conservation and irrigation efficiency (Schaible and Aillery 2012), to help conserve the structure and function of aquatic and riparian habitats. Potential collaborators: NRCS, NMOSE.
- Promote financial incentives to maintain tracts of native vegetation. Potential collaborators: BLM, NRCS, USFWS, NMDA, SLO, private land managers.
- Gather and assess current information on grazing practices and determine how the Department can support landowners that provide habitat for wildlife. Potential collaborators: BLM, NRCS, USFS, NMDA, SLO, private organizations.
- Promote rest-rotation and/or deferred-rotation grazing systems that incorporate rested pastures and help improve overall range condition and enhanced wildlife habitat. When drought or other conditions that limits grazing occur, these rested pastures can provide forage reserves and relieve pressure on grazed pastures or allotments and provide time for

owners to make contingency plans for excess livestock. Potential collaborators: BLM, NRCS, USFS, USFWS, SLO, private landowners.

## *Energy and Mining:*

- Promote best management practices that minimize the impacts (especially habitat fragmentation) of energy development (including of renewable energy sources (Lovich and Ennen 2011)) and mining to both aquatic and terrestrial habitats crucial to SGCN. Potential collaborators: BLM, EMNRD, SLO, universities, private industry.
- Inform, train, and support resource managers in the implementation of measures to prevent direct take of SGCN associated with energy extraction and mining. These include constructing appropriate bat gates on mine shafts (e.g., Spanjer and Fenton 2005) and the use of appropriate exclusionary fencing to keep wildlife out of potentially toxic sites. Potential collaborators: BLM, EMNRD, universities, private industry.
- Restore habitats impacted by resource extraction as close as possible to pre-development conditions. Rehabilitate abandoned well pads, mining sites, and associated access roads. Remove unneeded roads and transmission lines. Restore native vegetation . Where feasible, maintain abandoned mines as habitat for bats and snakes by constructing appropriate bat gates on mine shafts and adits (Spanjer and Fenton 2005). Potential collaborators: BLM, USFWS, EMNRD, NM Bureau of Mining and Geology, private landowners, mining and energy companies.
- Maintain open communication with mining and energy companies and land management agencies to minimize adverse impacts of development to SGCN.

## *Transportation and Utilities:*

- Site and consolidate utility corridors to minimize adverse effects to SGCN and their habitats. Potential collaborators: BLM, DOD, SLO, local governments, utility companies.
- Complete mitigation to facilitate aquatic and terrestrial (including xeric riparian) habitat linkages across roads or other linear development features for SGCN. These include modifying barrier fences along roadways, and constructing road crossings that are permeable to SGCN. Monitor the efficacy of mitigation and initiate any identified maintenance and improvements. Potential collaborators: BLM, DOD, SLO, local governments, private industry.

## *Biological Resource Use*

- Enforce laws that protect SGCN populations, especially reptiles and amphibians. Longer-lived species, such as turtles, may be especially threatened by over-collection (Fitzgerald et al. 2004). Potential collaborators: BLM, NPS, USFWS, other land managers.

## *Human Intrusions and Disturbance:*

- Identify and characterize areas and routes frequented by OHVs, and use that information to assess the potential impacts to SGCN and other wildlife. Potential collaborators: BLM, USFS, SLO.

- Identify, designate, and promote areas for OHV use that avoid disturbance to, or modification of, SGCN habitats. Potential collaborators: BLM, USFS, SLO.
- Initiate a public information campaign to inform and educate OHV users of permitted and prohibited activities that can impact SGCN and other wildlife. This may include public service announcements, print advertising, public meetings, and signs in areas frequented by OHV users. Potential collaborators: BLM, USFS, SLO, local governments.
- Work with public land management agencies to regularly review and update OHV travel routes and trails open to the public and appropriate restrictions necessary to protect SGCN and other wildlife. Potential collaborators: BLM, USFS, recreational users, SLO.
- Work with land management agencies to improve OHV law enforcement with passive measures such as strategically located barricades and active measures including monitoring and enforcement patrols to reduce negative impacts of OHVs on SGCN and other wildlife. Potential collaborators: BLM, USFS, SLO.
- Work with the public to educate residents and recreationists about restrictions on and potential negative impacts of free ranging domestic pets on SGCN and other wildlife. Potential collaborators: universities, municipalities, non-profit organizations.
- Reduce adverse effects of border enforcement activities on SGCN and sensitive habitats. Potential collaborators: BLM, US Customs and Border Protection.

## *Natural System Modifications:*

- Design and implement riparian and aquatic habitat restoration projects to benefit SGCN. This may include establishing priorities for habitat restoration and developing reach-specific plans. Monitor restoration projects to determine effectiveness (Block et al. 2001) and adaptability to management. May also include specific actions such as reintroducing keystone species including beavers (*Castor canadensis*; Baker and Cade 1995, McKinstry et al. 2001) and native fishes. Potential collaborators: ACOE, BLM, BOR, NPS, USFS, USFWS, NHNM, SFD, SLO, universities, private land managers.
- Restore and protect aquatic and wetland habitats, particularly springs and cienegas, and the surface and ground water that supports them. Minimize activities that lead to gully formation and soil erosion. Protection may involve conservation easements or acquisition of lands from willing sellers. Potential collaborators: ACOE, BLM, BOR, NRCS, USFS, USFWS, private landowners.
- Encourage sustainable groundwater use to protect aquatic and riparian habitats. Promote water conservation, such as use of devices and models that facilitate optimal irrigation (Schaible and Aillery 2012), to conserve the structure and function of aquatic and riparian habitats. Potential collaborators: NRCS, NMDA, SLO, municipalities, water management districts.
- Assess the magnitude, frequency, timing, duration, and rate of change of flow and the effects of hydrologic alterations on different types of riparian systems. Determine flows needed to sustain SGCN and their habitats, and the effects of flow stabilization by upstream dams. Work with agencies that manage dams and reservoirs to ensure amounts and patterns of flows needed for persistence of SGCN. Potential collaborators: ACOE, BOR, USFWS, USGS, NMOSE, universities, private industry.

- Determine responses of upland habitats and associated riparian/aquatic communities that include SGCN to prescribed burns and wildfires. Integrate fire and fuels management into riparian ecosystem conservation. Design and implement projects that reduce unnaturally high fire risk associated with increased fuel loads or lack of moist soils in riparian areas. Methods may include flooding or mechanical removal of vegetation (Ellis 2001). Potential collaborators: ACOE, BLM, BOR, NPS, USFS, USFWS, NHNM, SLO, private land managers.
- Promote land management practices, standards, and guidelines to conserve and/or restore structure and function of corridors that provide important habitat for SGCN. This should include xeric riparian communities that serve as important migratory corridors for birds and other wildlife while providing ecosystem services, and wildlife corridors that link isolated mountain ranges (Powledge 2003) and coniferous forest patches. Potential collaborators: BLM, NPS, USFS, USFWS, NHNM, universities.
- Reduce shrub encroachment in grassland habitats important to SGCN. This may be achieved through reduction of processes that promote shrub encroachment, implementation of a natural fire regime (Ravi et al. 2009), reseeding with native grasses, and shrub removal (Bestelmeyer et al. 2003). Potential collaborators: ACOE, BLM, BOR, DOD, NPS, USFWS, SLO, private landowners.
- Restore, protect and monitor important disjunct wildlife habitats, such as playas, saline lakes, caves and talus slopes. Potential collaborators: BLM, DOD, NPS, NRCS, USFWS, EMNRD, private interests.
- Determine beneficial fire frequencies and intensities and work with land management agencies and private landowners to develop fire management plans and implement prescribed burns that avoid disturbing SGCN during sensitive periods (e.g., nesting), maintain condition of sensitive habitats (e.g., riparian habitat) and protect people and property. Potential collaborators: BLM, NPS, USFS, SLO, SFD, private landowners.
- Restore stands of trees in forests and woodlands to natural or historic densities that reduce the probability of insect and disease outbreaks and stand-replacing wildfires. Avoid unnecessary removal of large old-growth trees and snags, which serve as important wildlife habitat (Kalies and Rosenstock 2013). Potential collaborators: BLM, USFS, SFD, SLO, non-profit organizations.
- Promote post-fire management activities that are beneficial to SGCN. Includes minimizing ash flow into streams. Potential collaborators: NRCS, NPS, USFS, SFD, SLO, non-profit organizations, private landowners.
- Implement a standardized method to inventory, assess, and monitor riparian and aquatic habitats and efforts to conserve them. Determine amount, status, and trend of habitat, levels of fragmentation and how SGCN might be affected. Potential collaborators: ACOE, BLM, BOR, NPS, USFS, USFWS, NHNM, NMED, SFD, SLO, universities.
- Survey and monitor perennial marshes/cienegas/springs/seeps habitats and the SGCN that inhabit them to determine changes in quantity and quality of habitat, as well as status and trend of SGCN. Potential collaborators: BLM, USFS, USFWS, NHNM, NMED, SLO, universities.

- Implement protections to conserve aquatic habitats within closed basins or hydrologic units not currently designated as Waters of the United States. Potential collaborators: BLM, NMED, NMOSE, water users.
- Promote citizen participation in restoration and conservation of watersheds. Potential collaborators: ACOE, BOR, USFS, USFWS, NMED, universities, private land managers, non-profit organizations.
- Inform interested and affected members of the public about the value of riparian systems and maintaining in-stream flows in order to build support for conservation of riparian species and habitat restoration efforts. Potential collaborators: NRCS, USFS, universities, non-profit organization, private land managers.
- Examine the structural characteristics of habitat fragmentation and how it influences patch size, edge effect, dispersal behavior, and daily and seasonal movements/migrations by wildlife including SGCN. Focus on riparian and aquatic habitats. Potential collaborators: BLM, USFS, USFWS, NHNM, NMED, SLO, universities.

## *Invasive and Problematic Species:*

- Work with appropriate agencies to enforce regulations to prevent the introduction and spread of non-native species. Potential collaborators: USFWS, EMNRD, NMDA.
- Implement early detection protocols and treatment to prevent invasive and problematic species and emerging diseases from becoming established. Potential collaborators: BLM, USFWS, USFS, EMNRD, NMDA, resource management districts.
- Reduce or eradicate non-native species and diseases as necessary to achieve restoration of native species and communities. Potential collaborators: BLM, DOD, USFWS, USFS, EMNRD, NMDA, resource management districts.
- Design and implement protocols for early detection of invasive and problematic species and diseases. Quickly respond to detection. Potential collaborators: BLM, USFWS, EMNRD, NMDA, private interests.
- Eradicate or control existing non-native and invasive species before they become established. Potential collaborators: BLM, BOR, ACOE, USFS, SLO, NMDA, private land managers, non-profit organizations.
- Develop strategies to prevent emerging diseases from getting into the Chihuahuan Deserts ecoregion, as well as strategies that will inhibit the spread of ones already in the ecoregion. Potential collaborators: BLM, SLO, universities.
- Restore native riparian plants (e.g., cottonwood and willow) and natural riparian ecosystem processes and functions following tamarisk removal or biocontrol, and ensure maintenance of adequate water supply for native plants. At sites with low water availability, restoration of native xeric plants may be more appropriate than wetland plants. Potential collaborators: BLM, BOR, ACOE, SLO, NMED, universities, private land managers, non-profit organizations.
- Stage and balance tamarisk removal and native habitat restoration over time, to avoid rapid loss of tamarisk habitats for wildlife until native habitats can be developed (Sogge et al. 2013).

- Protect sustain, and proactively restore existing stands of native riparian vegetation that may serve as important refugia in areas currently or likely to be affected by the tamarisk beetle, such as large tamarisk monocultures in the most hydrologically altered river systems) (Paxton et al. 2011, Sogge et al. 2013). Potential collaborators: BLM, BOR, ACOE, SLO, NMED, universities, private land managers, non-profit organizations.
- Develop explicit, measurable goals and objectives, site-specific plans, and post-implementation monitoring and maintenance for all riparian restoration projects. Document and report restoration approaches used, including successes and failures (Shafroth et al. 2008, Sogge et al. 2013). Potential collaborators: BLM, BOR, ACOE, USFWS, USFS, NRCS, NMDA, Soil and Water Conservation Districts, SFD, SLO, private landowners.

## *Pollution:*

- Work with appropriate agencies to enforce mining and energy development regulations, Best Management Practices, and safeguards that protect water quality and minimize mortality of SGCN. Potential collaborators: BLM, EMRND, NMED.
- Assess impacts to habitat and SGCN from mining and energy development activities. These impacts may include direct mortality, pollution from transport of extracted or waste products, and sediment runoff from roads. Potential collaborators: BLM, USFS, SLO, EMNRD, NMED, local governments, energy and mining companies.
- Evaluate and mitigate the effects of pollutants in runoff from housing and urban areas, industrial areas, and agricultural areas (e.g., sewage, nutrients, toxic chemicals, sediment) on SGCN and their habitats. This includes solid waste that may entangle wildlife. Potential collaborators: EPA, NMED, municipalities, local governments.
- Evaluate and mitigate the effects of excess generation of heat, light, and/or sound from sources such as power plants, urban areas, and highways on SGCN and their habitats. Potential collaborators: local utilities, private industry.
- Determine effects of agro- and petrochemicals, and urban runoff, on SGCN fish. Potential collaborators: EPA, NMED, NMDA.

## *Climate Change:*

- Determine how regional and global climate change will affect SGCN, vegetation patterns, and community and ecosystem processes, dynamics, and connectivity. Of particular importance are impacts of increased heat and water stress on SGCN and their associated habitats. Plan and complete projects that help maintain the distribution and natural functioning of climate-impacted species and habitats. Potential collaborators: BLM, NPS, USFWS, USGS, universities.
- Assess the synergistic effects between climate change and other threats to SGCN and their habitats. Potential collaborators: USFWS, USGS, universities.
- Determine ecology, distribution, status and trends of, and threats to, SGCN (especially invertebrates that are not currently monitored and riparian-obligate species) and their habitats. Use this information to develop and implement effective monitoring protocols and conservation actions. Potential collaborators: BLM, USFWS, SLO, universities, non-profit organizations, private industry.

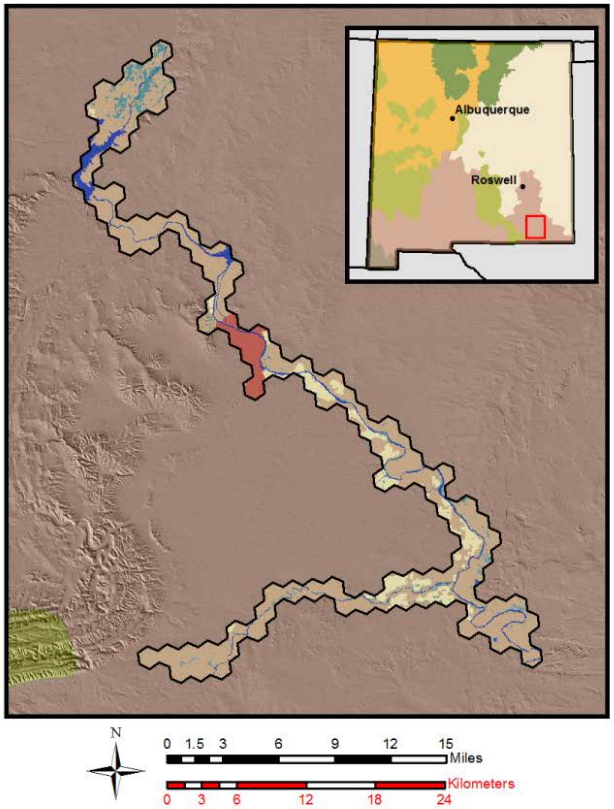
- Develop new species recovery plans that consider the current status of and limiting factors for species, as well as projected future conditions for both species and their habitats.
- Monitor SGCN to determine long-term trends that correlate to ecosystem dynamics and habitat changes. Potential collaborators: BLM, BOR, DOD, NPS, USFWS, SLO, universities.

## *Actions that Address Multiple Threats:*

- Identify or develop an accessible common database of information to document the status and condition of, threats to, and conservation actions implemented in Chihuahuan Deserts ecoregion habitats. Identify data gaps and varying data collection methodologies that provide a framework for identifying and promoting robust standard monitoring approaches. Potential collaborators: universities, NHNM.

# Conservation Opportunity Areas

## *Lower Pecos and Black Rivers*




| Habitat | Tier | Area (ha) |
|---|---|---|
| Arid West Interior Freshwater Emergent Marsh | 1 | 144.1 |
| Chihuahuan Desert Scrub | 4 | 19,057.9 |
| Chihuahuan Semi-Desert Grassland | 2 | 459.9 |
| Cliff, Scree & Rock Vegetation | 4 | 0.9 |
| Desert Alkali-Saline Wetland | 1 | 12.4 |
| Developed & Urban | 5 | 1,272.2 |
| Great Plains Sand Grassland & Shrubland | 3 | 2.3 |
| Great Plains Shortgrass Prairie | 3 | 49.7 |
| Herbaceous Agricultural Vegetation | 5 | 2,822.2 |
| Open Water | 5 | 1,733.1 |
| Southwest Riparian Forest | 1 | 1,374.3 |
| Warm-Desert Arroyo Riparian Scrub | 2 | 9.5 |

Figure 26. Lower Pecos and Black Rivers Conservation Opportunity Area.

The Lower Pecos and Black Rivers Conservation Opportunity Area (COA) (Figure 26) encompasses 26,918 ha (66,516 ac) that extends along the Pecos River from Brantley Lake to 10 km (6 mi) south of the confluence with the Black River, and along the Black River from the Guadalupe Mountains to its confluence with the Pecos River. Most of the COA is privately-owned (55%), but sizable portions are managed by the Department (16.5%) and BLM (14%). It contains three Important Bird Areas (Brantley Lake State Park, Six-Mile Dam, Laguna Grande Complex) and two TNC conservation areas (Remuda/Big Sinks, Black River Basin). Twenty percent of the COA is protected.

Landcover includes nine native vegetation habitats plus substantial amounts of open water and agricultural and developed lands. Chihuahuan Desert Scrub is the dominant habitat (71%). Perennial aquatic habitats include 236 km (147 mi) of warm water streams and 615 ha (1,520 ac) of warm water reservoirs.

SGCN total 21 and include five species categorized as Immediate Priority SGCN (blue sucker, gray redhorse, Pecos pupfish, Texas hornshell, western river cooter).

# Chapter 9: Madrean Archipelago Conservation Profile

## Species of Greatest Conservation Need (SGCN) and their Habitats

The Madrean Archipelago ecoregion encompasses 4,330 km$^2$ (1,672 mi$^2$) of the southwestern corner of New Mexico, but is at the northeastern corner of a 205,178 km$^2$ (79,220 mi$^2$) contiguous patch that extends west into southeastern Arizona and south to central Mexico along the eastern edge of the Western Sierra Madre Mountains. In New Mexico, elevations range from 1,200-2,600 m (3,900-8,500 ft). Terrain consists of broad basins bordered by isolated, rugged mountains. The climate is a dry, subtropical steppe with hot summers and mild winters. Mean annual temperatures range from 7-19 $^o$C (45-66 $^o$F) with 170-280 frost-free days, and precipitation averages 26 cm (10.2 in) (range: 42-95 cm (17-37 in)), mostly occurring from July-September.

Seventy-nine SGCN occur in the Madrean Archipelago ecoregion; over half are birds (Table 25, Table 27). The most common categories for SGCN within this ecoregion are Susceptible (32%) and Limited Habitat (23%). Sixty-seven percent of SGCN occurrences in the ecoregion are based on observations.

Table 25. Number of Species of Greatest Conservation Need in the Madrean Archipelago ecoregion.

| Category[37] / Taxon | I | H | S | D | F | Total |
|---|---|---|---|---|---|---|
| Amphibians | 0 | 2 | 0 | 0 | 1 | 3 |
| Birds | 10 | 4 | 20 | 6 | 3 | 43 |
| Crustaceans | 0 | 0 | 0 | 1 | 0 | 1 |
| Mammals | 2 | 1 | 1 | 3 | 4 | 11 |
| Molluscs | 0 | 7 | 0 | 5 | 0 | 12 |
| Reptiles | 0 | 4 | 4 | 0 | 1 | 9 |
| Total | 12 | 18 | 25 | 15 | 9 | 79 |

[37]Category abbreviations are: I = Immediate Priority, H = Limited Habitat, S = Susceptible, D = Data Needed, F = Federally-listed.

Terrestrial vegetation in the Madrean Archipelago ecoregion consists of 12 naturally vegetated types, three unvegetated land covers, and 145 ha (358 ac) of cultivated land (Table 26, Figure 27). Chihuahuan Semi-Desert Grassland is dominant (61%). Characteristic species include black grama (*Bouteloua eriopoda*), tobosagrass (*Pleuraphis mutica*), blue grama (*B. gracilis*), yuccas (*Yucca* spp.), and ocotillo (*Fouquieria splendens*). Madrean Lowland Evergreen Woodland encompasses 16% of the ecoregion and supports Emory oak (*Quercus emoryi*), silverleaf oak (*Q. hypoleucoides)*, Arizona white oak (*Q. arizonica*), Mexican piñon (*Pinus cembroides*), alligator juniper (*Juniperus deppeana*), and Utah juniper (*J. osteosperma*).

The Madrean Archipelago in New Mexico supports no perennial water sources except for scattered springs, seeps, and cienegas (Figure 28).

Table 26. Terrestrial habitat types of the Madrean Archipelago ecoregion.

| Habitat Category | USNVC Code | Habitat Name[38] | Tier[39] | Climate Vulnerability[40] | Area ($km^2$) | ($mi^2$) |
|---|---|---|---|---|---|---|
| Alpine and Montane Vegetation | M011 | Madrean Montane Forest & Woodland | 3 | High | 14 | 5 |
| | M010 | Madrean Lowland Evergreen Woodland | 4 | Moderate→Very High | 701 | 271 |
| | M091 | Warm Interior Chaparral | 4 | Moderate→Very High | 50 | 19 |
| | M027 | Rocky Mountain Piñon-Juniper Woodland | 4 | Moderate→Very High | 0.46 | 0.18 |
| | M020 | Rocky Mountain Subalpine-High Montane Conifer Forest | 4 | -- | 0.14 | 0.05 |
| Desert Grassland and Scrub | M087 | Chihuahuan Semi-Desert Grassland | 2 | Very High | 2639 | 1,019 |
| | M086 | Chihuahuan Desert Scrub | 4 | Very High | 812 | 313 |
| Arroyo Riparian | M092 | Warm-Desert Arroyo Riparian Scrub | 2 | -- | 2 | 0.77 |
| Riparian Woodlands and Wetlands | M036 | Southwest Riparian Forest | 1 | -- | 11 | 4 |
| | M076 | Warm Desert Lowland Riparian Shrubland | 1 | -- | 2 | 0.64 |
| | M888 | Arid West Interior Freshwater Emergent Marsh | 1 | -- | 0.01 | 0.004 |
| Cliff, Scree & Rock Vegetation | M887 | Cliff, Scree & Rock Vegetation | 4 | Very High | 60 | 23 |
| Other Land Cover | N/A | Developed & Urban | 5 | -- | 0.58 | 0.22 |
| | N/A | Herbaceous Agricultural Vegetation | 5 | -- | 1 | 0.56 |
| | N/A | Recently Disturbed or Modified | 5 | -- | 26 | 10 |

[38] Habitats were macrogroups identified in the US National Vegetation Classification System (USNVC), except Other Land Covers which were derived from Southwestern Regional Gap Analysis land cover classes.

[39] Tiers reflect the urgency for conservation and were based on the degree of imperilment within the United States according to the NatureServe Conservation Status Assessment (http://www.natureserve.org/conservation-tools/conservation-status-assessment) and the spatial pattern of the habitat.

[40] Climate vulnerability levels were based on a vulnerability analysis performed for Ecological Response Units (ERU) across New Mexico and Arizona (Triepke et al. (2014). The ERU classification system represents major ecosystem types of the Southwest. Vulnerability for each ERU was calculated as the relative probability of type conversion. The ERUs were then crosswalked to the habitats shown here.

Table 27. Species of Greatest Conservation Need (SGCN) in the Madrean Archipelago ecoregion.

| Common Name | Scientific Name | Taxon | Category | Reason to Include[41] | Habitats[42] |
|---|---|---|---|---|---|
| Sonoran Desert Toad | *Incilius alvarius* | Amphibians | H | Di | M036, M076, M087, M092, EC, EMCS, PMCSS |
| Lowland Leopard Frog | *Lithobates yavapaiensis* | Amphibians | H | V, Di | M010, M011, M036, M076, EC, EMCS,PMCSS |
| Chiricahua Leopard Frog | *Lithobates chiricahuensis* | Amphibians | F | De, V, Di | M010, M011, M020, M036, M076, EC, PMCSS, |
| Bendire's Thrasher | *Toxostoma bendirei* | Birds | I | De, V | M027, M076, M086, M087, M092, M887 |
| Arizona Grasshopper Sparrow | *Ammodramus savannarum ammolegus* | Birds | I | De, V, Di | M086, M087, M887 |
| Sprague's Pipit | *Anthus spragueii* | Birds | I | De, V | M087 |
| Chestnut-collared Longspur | *Calcarius ornatus* | Birds | I | De, V | M086, M087 |
| Virginia's Warbler | *Oreothlypis virginiae* | Birds | I | De, V | M010, M011, M020, M027, M036, M076, M091 |
| Flammulated Owl | *Psiloscops flammeolus* | Birds | I | V | M010, M011, M020, M027, M036, M887 |
| McCown's Longspur | *Rhynchophanes mccownii* | Birds | I | De, V | M087 |
| Black-chinned Sparrow | *Spizella atrogularis* | Birds | I | De, V | M010, M027, M091 |

[41] Reason to include indicates which of five criteria for inclusion on the SGCN list a particular species met. Abbreviations are as follows: De = Declining; Di = Disjunct; E = Endemic; K = Keystone; V = Vulnerable.
[42] Aquatic habitat abbreviations are as follows: PCWS = Perennial Cold Water Streams; PWWS = Perennial Warm Water Streams; PLCP = Perennial Lakes, Cirques, Ponds; PMCSS = Perennial Marshes/Cienegas/Springs/Seeps; PCWR = Perennial Cold Water Reservoirs; PWWR = Perennial Warm Water Reservoirs; EMCS = Ephemeral Marshes/Cienegas/Springs; EC = Ephemeral Catchments. Habitat codes refer to National Vegetation Classification designations, which are identified in Table 26 above.

| Common Name | Scientific Name | Taxon | Category | Reason to Include[41] | Habitats[42] |
|---|---|---|---|---|---|
| Gray Vireo | *Vireo vicinior* | Birds | I | V | M010, M011, M026, M027, M036, M086, M087, M091, M092, M887 |
| Mexican Whip-poor-will | *Antrostomus arizonae* | Birds | I | De, V | M020, M027 |
| Burrowing Owl | *Athene cunicularia* | Birds | H | De, V, Di | M036, M086, M087, M092, M887 |
| Peregrine Falcon | *Falco peregrinus* | Birds | H | V, K | M010, M036, M086, M087, M887 |
| Bell's Vireo | *Vireo bellii* | Birds | H | V, Di | M010, M011, M027, M036, M076, M086, M087 |
| Gould's Wild Turkey | *Meleagris gallopavo mexicana* | Birds | H | V, Di | M010, M036, M087 |
| Baird's Sparrow | *Ammodramus bairdii* | Birds | S | De, V | M086, M087 |
| Violet-crowned Hummingbird | *Amazilia violiceps* | Birds | S | De, V | M010, M011, M036, M086, M087 |
| Costa's Hummingbird | *Calypte costae* | Birds | S | De, V | M010, M011, M020, M036, M076, M086, M087, M092 |
| Northern Beardless Tyrannulet | *Camptostoma imberbe* | Birds | S | De, V | M010, M011, M036, M076, M086, M087, M092 |
| Mountain Plover | *Charadrius montanus* | Birds | S | De, V | M010, M027, M086, M087 |
| Common Nighthawk | *Chordeiles minor* | Birds | S | De, V | M010, M027, M086, M087, M887 |
| Common Ground-dove | *Columbina passerina* | Birds | S | De, V | M010, M036, M076, M086, M087, M887 |
| Cassin's Finch | *Haemorhous cassinii* | Birds | S | De, V | M010, M011, M020, M027, M887 |
| Yellow-eyed Junco | *Junco phaeonotus* | Birds | S | De, V | M010, M011, M020, M086, M087, M092 |
| Loggerhead Shrike | *Lanius ludovicianus* | Birds | S | De, V | M010, M011, M027, M036, M076, M086, M087, M091, M092, M887 |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[41] | Habitats[42] |
|---|---|---|---|---|---|
| Whiskered Screech-Owl | *Megascops trichopsis* | Birds | S | De, V | M010, M011, M036 |
| Gila Woodpecker | *Melanerpes uropygialis* | Birds | S | De, V | M010, M036, M076, M086, M087 |
| Varied Bunting | *Passerina versicolor* | Birds | S | De, V | M010, M036, M076, M086, M087, M091, M092, M887 |
| Thick-billed Kingbird | *Tyrannus crassirostris* | Birds | S | De, V | M010, M011, M036, M091 |
| Lucy's Warbler | *Oreothlypis luciae* | Birds | S | V | M010, M011, M036, M076, M086, M087, M092 |
| Cassin's Sparrow | *Peucaea cassinii* | Birds | S | De, V | M010, M011, M076, M086, M087, M091, M092 |
| Vesper Sparrow | *Pooecetes gramineus* | Birds | S | De, V | M010, M027, M036, M087 |
| Mountain Bluebird | *Sialia currucoides* | Birds | S | De, V | M010, M011, M020, M027, M086, M087, M091, M887 |
| Western Bluebird | *Sialia mexicana* | Birds | S | De, V | M010, M011, M020, M027, M036, M076, M086, M087, M887 |
| Pygmy Nuthatch | *Sitta pygmaea* | Birds | S | De, V | M010, M011, M020, M036, M027, M887 |
| Lucifer Hummingbird | *Calothorax lucifer* | Birds | D | V | M010, M011, M036, M076, M086, M087, M091, M887 |
| Broad-billed Hummingbird | *Cynanthus latirostris* | Birds | D | V | M036, M087 |
| Abert's Towhee | *Melozone aberti* | Birds | D | V | M036, M076, M086, M087, M091, M092 |
| Botteri's Sparrow | *Peucaea botterii* | Birds | D | V | M010, M086, M087, M092, M887 |
| Elegant Trogon | *Trogon elegans* | Birds | D | V | M010, M011, M036 |
| Elf Owl | *Micrathene whitneyi* | Birds | D | V | M010, M011, M036, M086, M087 |
| Yellow-billed Cuckoo | *Coccyzus americanus* | Birds | F | De, V, Di | M010, M011, M027, M036, M076, M086, M087, M091, M092, M887, M888 |
| Aplomado Falcon | *Falco femoralis* | Birds | F | De, V | M076, M086, M087 |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[41] | Habitats[42] |
|---|---|---|---|---|---|
| Mexican Spotted Owl | *Strix occidentalis lucida* | Birds | F | V | M010, M011, M020, M027, M036, M091, M887, M888 |
| Dumont's Fairy Shrimp | *Streptocephalus henridumontis* | Crustaceans | D | V, Di | EC |
| White-sided Jackrabbit | *Lepus callotis* | Mammals | I | De, V, Di | M087 |
| Black-tailed Prairie Dog | *Cynomys ludovicianus* | Mammals | I | De, V, K | M086, M087 |
| Arizona Shrew | *Sorex arizonae* | Mammals | H | V, Di | M011, EMCS |
| Pale Townsend's Big-eared Bat | *Corynorhinus townsendii* | Mammals | S | V | M010, M011, M020, M027, M086, M087, M091, M887 |
| Mexican Long-tongued Bat | *Choeronycteris mexicana* | Mammals | D | V | M010, M011, M086, M087 |
| Western Yellow Bat | *Lasiurus xanthinus* | Mammals | D | V | M010, M036, M086 |
| Southern Pocket Gopher | *Thomomys umbrinus* | Mammals | D | V, Di | M010, M011 |
| Mexican Gray Wolf | *Canis lupus baileyi* | Mammals | F | De, V, K | M010, M011, M087 |
| Mexican Long-nosed Bat | *Leptonycteris nivalis* | Mammals | F | V | M010, M011, M036, M086, M087, M091, M092, M887 |
| Lesser Long-nosed Bat | *Leptonycteris yerbabuenae* | Mammals | F | V | M010, M011, M086, M087, M887 |
| Jaguar | *Panthera onca* | Mammals | F | De, V, K | M010, M011, M036, M087, M887 |
| Hacheta Grande Woodlandsnail | *Ashmunella hebardi* | Molluscs | H | De, V, E, Di | M010, M011 |
| Shortneck Snaggletooth Snail | *Gastrocopta dalliana* | Molluscs | H | V, Di | M010 |
| New Mexico Talussnail (Big Hatchet Mountains) | *Sonorella hachitana* | Molluscs | H | De, V, E, Di | M887 |
| Animas Mountains Holospira Snail | *Holospira animasensis* | Molluscs | H | V, Di | M010, M091 |
| Cross Holospira Snail | *Holospira crossei* | Molluscs | H | V, Di | M010, M011, M091 |
| New Mexico Talussnail (Florida Mountains) | *Sonorella hachitana flora* | Molluscs | H | V, E, Di | M010 |
| Fringed Mountainsnail | *Radiocentrum ferrissi* | Molluscs | D | De, V, E, Di | M010, M011 |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[41] | Habitats[42] |
|---|---|---|---|---|---|
| Animas Peak Woodlandsnail | *Ashmunella animasensis* | Molluscs | D | V, E, Di | M010, M011, M020, M887 |
| Animas Talussnail | *Sonorella animasensis* | Molluscs | D | V, E, Di | M010, M011, M020, M887 |
| New Mexico Talussnail (Peloncillo Mountains) | *Sonorella hachitana peloncillensis* | Molluscs | D | V, E, Di | M010 |
| Vallonia Snail | *Vallonia sonorana* | Molluscs | D | V, Di | M010, M011 |
| Slevin's Bunchgrass Lizard | *Sceloporus slevini* | Reptiles | H | De, V, Di | M010, M011, M087 |
| Giant Spotted Whiptail | *Aspidoscelis stictogramma* | Reptiles | H | Di | M010, M036, M076, M087, M091 |
| Mountain Skink | *Plestiodon callicephalus* | Reptiles | H | V, Di | M010, M011, M036, M086, M087, M091 |
| Gray-checkered Whiptail | *Aspidoscelis dixoni* | Reptiles | H | Di | M086, M087 |
| Reticulate Gila Monster | *Heloderma suspectum suspectum* | Reptiles | S | V | M010, M036, M076, M086, M091, M087 |
| Sonoran Mud Turtle | *Kinosternon sonoriense* | Reptiles | S | V | M010, PMCSS |
| Green Rat Snake | *Senticolis triaspis* | Reptiles | S | V | M010, M036, M076, M086 |
| Rock Rattlesnake | *Crotalus lepidus* | Reptiles | S | V | M010, M011, M087, M887 |
| New Mexico Ridge-nosed Rattlesnake | *Crotalus willardi obscurus* | Reptiles | F | V, Di | M010, M011, M091, M887 |

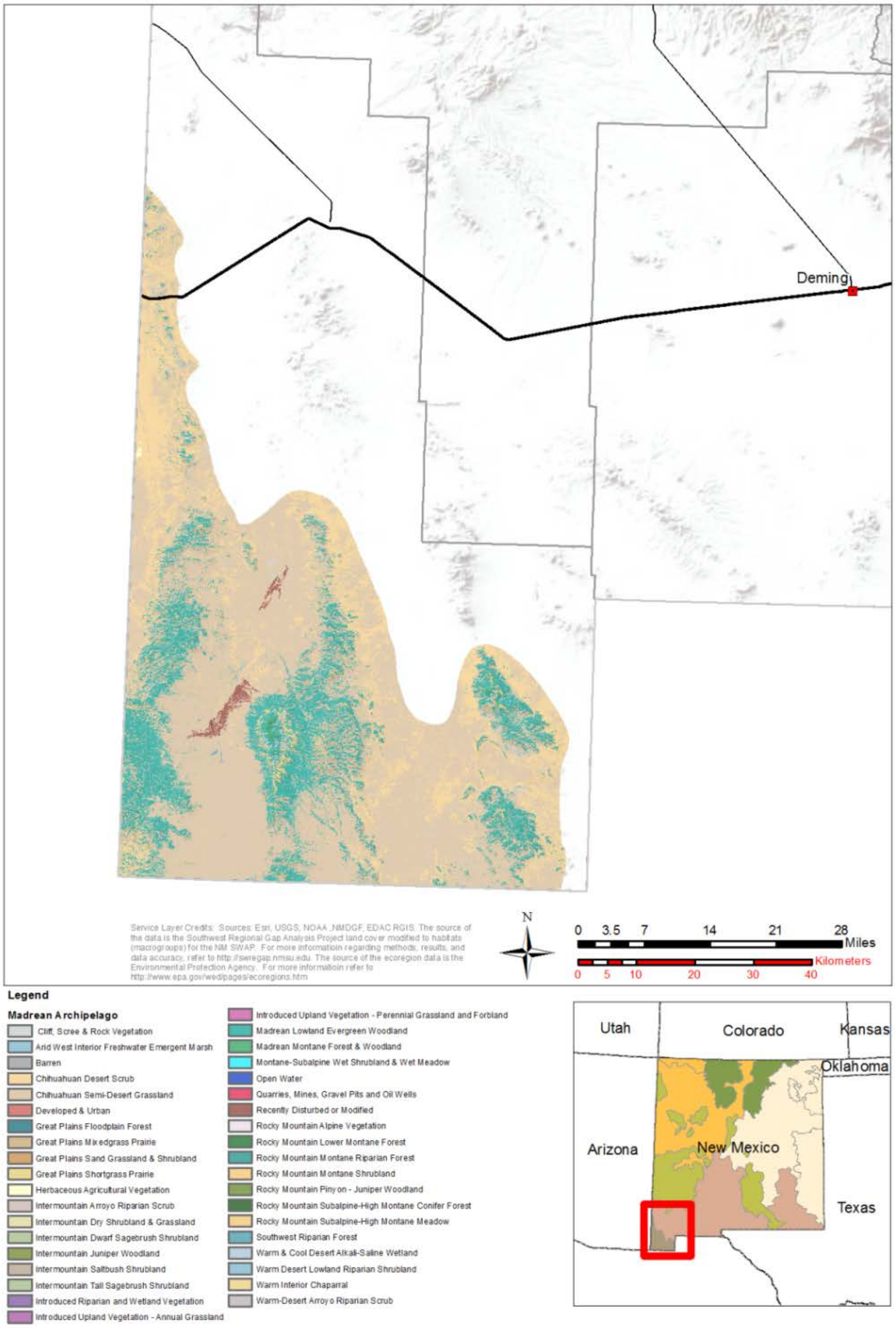



Figure 27. Terrestrial habitats in the Madrean Archipelago ecoregion.

Delineations from US National Vegetation Classification macrogroups and SWReGAP landcover classes.

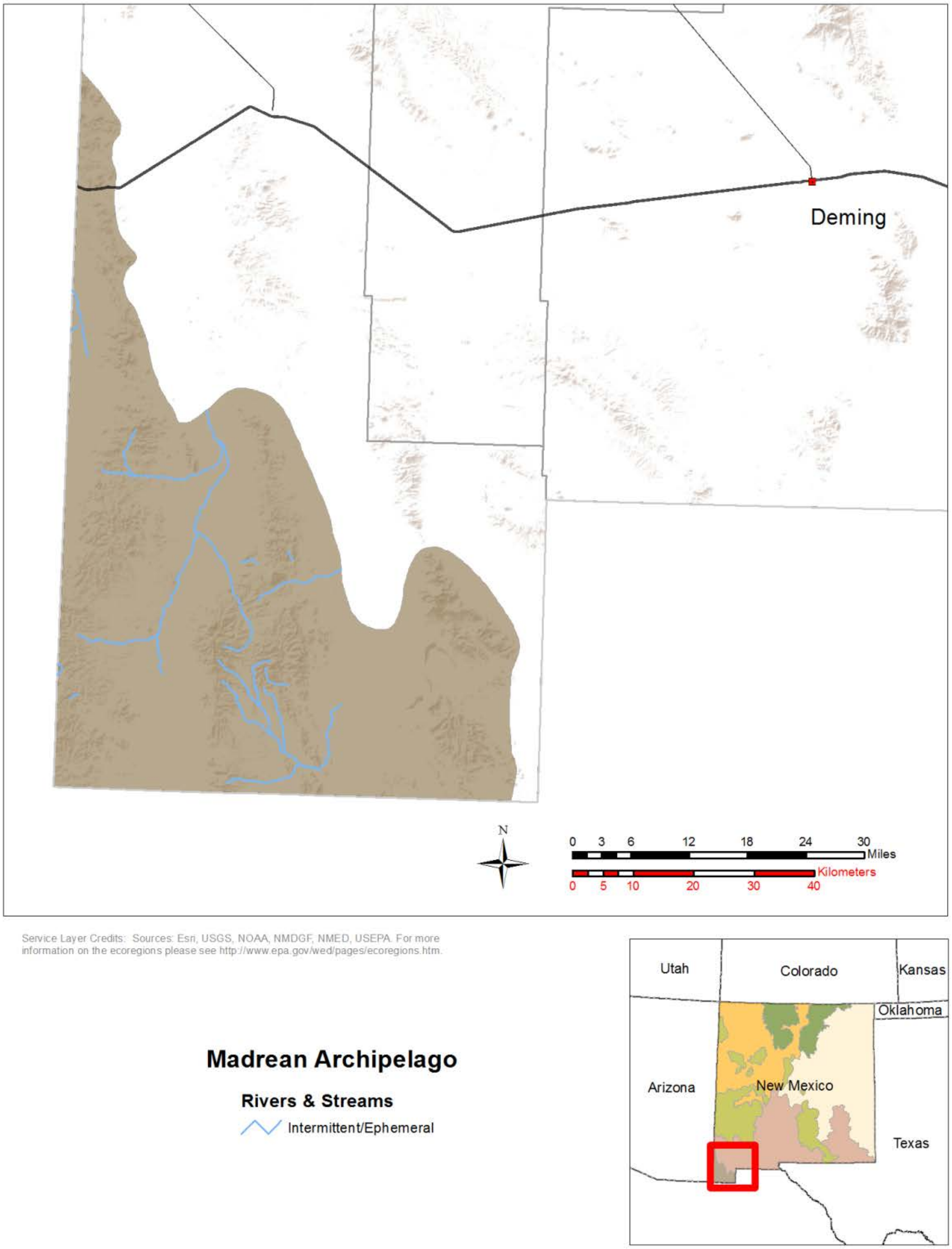



Figure 28. Aquatic habitats in the Madrean Archipelago ecoregion.

# Habitat Descriptions

## *Chihuahuan Semi-Desert Grassland*

Chihuahuan Semi-Desert Grassland **[M087]**[43] is found at 870-2,200 m (2,850-7,220 ft) elevation throughout the Chihuahuan Desert ecoregion and extends into the Madrean Archipelago and limited areas of the Colorado Plateaus and High Plains and Tablelands ecoregions. This diverse habitat is characterized by an open to dense herbaceous layer dominated by perennial grasses, but shrubs and subshrubs are typical components. In lowland settings of broad alluvial plains and flats and swales, dominant species may include tobosagrass, alkali sacaton (*Sporobolus airoides*), giant sacaton (*S. wrightii)*, or vine mesquite (*Panicum obtusum*). Grasslands of sandy sites are characterized by black grama and mesa dropseed (*Sporobolus flexuosus*), often with soaptree yucca (*Yucca elata*) and/or Torrey's jointfir (*Ephedra torreyana*) shrubs. Black grama, blue grama, hairy grama (*Bouteloua hirsuta*), curly-mesquite (*Hilaria belangeri*), bush muhly (*Muhlenbergia porteri*), and curly leaf muhly (*M. setifolia*) are representatives of upland piedmonts and foothills along with shrubs such as lechuguilla (*Agave lechuguilla*), sotols (*Dasylirion* spp.), beargrasses (*Nolina* spp.), and Torrey's yucca (*Yucca torreyi*). This habitat also includes Madrean lower montane grasslands dominated by bullgrass (*Muhlenbergia emersleyi*) and New Mexico muhly (*M. pauciflora*). Grasslands on gypsiferous soils include gypsum grama (*Bouteloua breviseta*) and gyp dropseed *(Sporobolus nealleyi*), along with herbaceous gypsophiles such as Hartweg's sundrops (*Calylophus hartwegii*) and hairy crinklemat (*Tiquilia hispidissima*).

Soils range from deep, fine-textured loams or clay loams (incipient mollisols) to sandy loams and also include rocky and shallow alluvial fans and hill slopes. Impermeable caliche and argillic horizons are common. Periodic fires are prevalent in some of these grasslands with 10 to 30 year, or longer, return intervals.

[43] Complete descriptions of habitats available by clicking on hyperlinked USNVC codes.

## *Madrean Lowland Evergreen Woodland*

The Madrean Lowland Evergreen Woodland [**M010**] (also known as oak woodland or encinal) occurs at elevations of 1,300-2,225 m (4,265-7,230 ft) in foothills, canyons, gently sloping alluvial fan piedmonts (bajadas), steeper colluvial foothill slopes, ridges, and mesa tops of the Arizona/New Mexico Mountains and Madrean Archipelago ecoregions. It also occurs in isolated locations of the Chihuahuan Desert and High Plains and Tablelands ecoregions. At the upper elevation limit, woodlands can be found as small-patch stands in a mosaic with Madrean montane forests.

This habitat is characterized by a short (3-15 m (10-49 ft)), open to closed canopy of evergreen, conifer, and broad-leaved trees. Diagnostic species may have their center of distribution southward in the Sierra Madre of Mexico and include alligator juniper, Mexican piñon, border piñon (*Pinus discolor*), Arizona white oak (*Quercus arizonica*), Emory oak (*Q. emoryi*), gray oak (*Q. grisea*), and Mexican blue oak (*Q. oblongifolia*). At the northern end of the range, communities may be dominated or codominated by northern tree species, including oneseed juniper (*Juniperus monosperma*) and two-needle piñon (*Pinus edulis*), but Madrean species will always be present. The understory may be sparse on some substrates or dominated by shrubs or grasses. Common shrubs include sacahuista *(Nolina microcarpa),* pungent oak *(Q. pungens),* Sonoran scrub oak *(Q. turbinella),* skunkbush sumac *(Rhus aromatica),* and banana yucca *(Yucca baccata).* Madrean grass species, such as bullgrass, longtongue muhly *(M. longiligula),* New Mexico muhly, piñon ricegrass *(Piptochaetium fimbriatum),* Pringle's speargrass *(P. pringlei)*, and Texas bluestem *(Schizachyrium cirratum*), can be abundant.

Fire regimes vary from stand-replacing, high severity but infrequent fires (or no fires) to low severity, surface fires of savannas.

## *Warm Desert Lowland Riparian Shrubland*

Warm Desert Lowland Riparian Shrubland **[M076]** occurs primarily in the Chihuahuan Desert, High Plains and Tablelands, and Madrean Archipelago ecoregions. This habitat type is characterized by a mix of phreatophyte species including Emory's baccharis (*Baccharis emoryi*), mule-fat (*B. salicifolia*), silver buffaloberry (*Shepherdia argentea*), and coyote willow (*Salix exigua*). On drier sites, honey mesquite (*Prosopis glandulosa*) or velvet mesquite (*P. velutina*) may dominate. As phreatophytes, the shrubs tap into groundwater below the streambed. Vegetation is dependent upon annual rise in the water table or annual/periodic flooding and associated sediment scour for growth and reproduction. A dense understory layer of graminoids and forbs can be present on moist-mesic sites and can include woolly sedge (*Carex laevivaginata*), Torrey rush (*Juncus torreyi*), slender rush (*Juncus dudleyi*), hairy willowherb (*Epilobium ciliatum*), smooth horsetail (*Equisetum laevigatum*), rough bugleweed (*Lycopus asper*), threesquare bulrush (*Scirpus pungens*), and field horsetail (*Equisetum arvense*).

This habitat occurs along perennial and intermittent streams, lake or playa edges, and alkaline seeps and springs in lowland floodplains of wide valleys, but may extend into montane reaches up to 2,140 m (7,020 ft) in elevation. Stands are generally found on depositional side or island bars that are frequently flooded. As stands mature and bars accumulate additional sediments, bars are flooded less often, even as little as every 25 years. Occasionally, stands develop in backwater channels and around ponds. Soils are typically poorly developed in recent sediments. This habitat is often an early successional stage to Southwest Riparian Forest **[M036]** and Great Plains Floodplain Forest **[M028]**.

# Threats and Conservation Actions

Nine threats potentially could impact SGCN in six habitats within the Madrean Archipelago of New Mexico (Table 28). These threats are summarized below and listed in the order presented by the IUCN (2016). The list does not reflect the order of threat severity.

- Agriculture and Aquaculture: Grazing practices that impact SGCN habitat and groundwater withdrawal for crops.
- Energy and Mining: Habitat fragmentation from renewable energy development, especially solar, and associated water needs; new mining operations.
- Transportation and Utilities: New large transmission lines.
- Biological Resource Use: Collection of reptiles and amphibians
- Human Intrusion and Disturbance: Border security.
- Natural System Modifications: Groundwater withdrawal and fire in forests and woodlands.
- Invasive and Problematic Species: invasion of habitats by non-native trees and non-native invasive grasses.
- Pollution: Runoff from mining activities.
- Climate Change: Habitat alteration from prolonged drought.

Conservation concerns include managing livestock grazing to provide SGCN habitat, groundwater withdrawal, restoring the natural role of fire in forest and woodland habitats, and facilitating wildlife movements across Interstate 10. The challenge of maintaining cost-effective livestock grazing while conserving SGCN in this ecoregion is the same as in the Chihuahuan Desert ecoregion. In particular, forage availability is not predictable or particularly abundant because of unpredictable and limited precipitation. Nevertheless, sharing information and collaborating are important components of a successful strategy.

Withdrawal of groundwater for crop production has been implicated in the demise of several cienegas in this ecoregion. Determining sustainable levels of withdrawal and ways to more efficiently use available water are potential conservation actions.

The Peloncillo Mountains are a natural north-south corridor for wildlife. Interstate 10 bisects the mountains at Steins Pass, and the traffic there greatly diminishes movement by wildlife. Given the unique fauna of the Madrean ecosystem, facilitating passage through this barrier should be a high conservation priority.

Climate change is expected to cause a 66% decline in Chihuahuan Semi-Desert Grasslands and a 400% increase in Chihuahuan Desert Scrub habitat (Rehfeldt et al. 2006). In uplands, ocotillo (*Fouquieria splendens*) may decrease on south and west facing slopes (Munson et al. 2012) and creosote (*Larrea tridentata*) may decrease in response to predicted decreases in cool season precipitation and increasing aridity (Munson et al. 2012). Habitats with very high vulnerability to climate change are the Chihuahuan Semi-Desert Grassland, Chihuahuan Desert Scrub, and Cliff, Scree and Rock communities (Table 26; Triepke et al. 2014).

Table 28. Potential threats to habitat and associated SGCN in the Madrean Archipelago ecoregion.

Threat categories were derived from IUCN (2016). Habitats listed are those that are dominant in the amount of area they encompass or are particularly important to conserve (Tier 1 or 2) in this ecoregion.

| Habitat / Threat | Development | Agriculture & Aquaculture | Energy & Mining | Transportation & Utilities | Biological Resource Use | Human Intrusions & Disturbance | Natural System Modifications | Invasive & Problematic Species | Pollution | Climate Change |
|---|---|---|---|---|---|---|---|---|---|---|
| Chihuahuan Desert Scrub | | X | | | | X | X | X | | |
| Chihuahuan Semi-Desert Grassland | | X | X | X | X | X | X | X | X | X |
| Madrean Lowland Evergreen Woodland | | X | X | X | X | X | X | | X | X |
| Madrean Montane Forest and Woodland | | | | | | X | X | | X | X |
| Southwest Riparian Forest | | X | | | | X | X | X | X | X |
| Warm Desert Lowland Riparian Shrubland | | X | X | X | X | X | X | X | X | X |

The following are proposed conservation actions for the Madrean Archipelago ecoregion, listed in order of priority within each IUCN threat category. Threat categories are listed according to the order presented by IUCN (2016).

## *Agriculture and Aquaculture:*

- Determine where habitat restoration would benefit SGCN and work with federal, state, and private land managers to restore degraded rangelands to good or excellent condition. Monitor restoration results to develop and initiate any identified improvements to restoration practices. Potential collaborators: BLM, USFS, SLO, private land managers.
- Establish baseline composition, condition, and function of major range habitats to inform habitat restoration actions. Potential collaborators: BLM, USFS, universities.
- Determine how timing, intensity, and duration of livestock grazing affect SGCN and their habitats, including the interaction between grazing, fire, and the spread of invasive and problematic species. Potential collaborators: BLM, NRCS, USFS, NMDA, SLO, universities, private land managers.
- Promote expanded use of appropriate, cost effective, grazing practices that ensure long-term ecological sustainability for SGCN and their habitats (especially riparian habitats). These include actions that contribute to recovery of rangelands impacted by drought and allow restoration activities to be completed (Gripne 2005). Potential collaborators: BLM, USFS, SLO, private land managers.
- Promote grazing systems that address both livestock and SGCN habitat needs based on site-specific conditions. When particular habitat components need improvement, coordinate with ranchers and resource managers to identify and implement modifications that would provide the desired habitat outcomes. Potential collaborators: BLM, USFS, SLO, private landowners.
- Balance irrigation and groundwater demands with the needs of aquatic communities, particularly those supporting native amphibian and springsnail populations. Potential collaborators: BOR, ACOE, NMISC/OSE, water users
- Gather and assess current information on grazing practices and determine how the Department can support landowners that provide habitat for wildlife. Potential collaborators: BLM, USFS, NRCS, NMDA, SLO, private organizations.
- Promote use of devices and models that improve water conservation and irrigation efficiency (Schaible and Aillery 2012), to help conserve the structure and function of aquatic and riparian habitats. Potential collaborators: NRCS, NMOSE.
- Promote rest-rotation and/or deferred-rotation grazing systems that incorporate rested pastures and help improve overall range condition and enhanced wildlife habitat. When drought or other conditions that limits grazing occur, these rested pastures can provide forage reserves and relieve pressure on grazed pastures or allotments and provide time for owners to make contingency plans for excess livestock. Potential collaborators: BLM, USFWS, USFS, NRCS, SLO, private landowners.

## *Energy and Mining:*

- Minimize the impact of energy development and mining, especially habitat fragmentation, on SGCN. This includes mitigating the impact of renewable energy development projects, such as solar power plants (Lovich and Ennen 2011) and geothermal development, on wildlife. Potential collaborators: BLM, EMNRD, NMED, SLO, private industry.
- Prevent direct take of wildlife associated with energy development and mining. Potential collaborators: BLM, EMNRD, NMED, SLO, private industry.
- Where feasible, manage abandoned mines as habitat for bats and snakes by constructing appropriate bat gates on mine shafts and adits (Spanjer and Fenton 2005). Maintain open communication with mining and energy companies and land managers to minimize adverse impacts of development to SGCN. Potential collaborators: EMNRD, private industry, universities.

## *Transportation and Utilities:*

- Site and consolidate utility corridors to minimize adverse effects to SGCN. Potential collaborators: BLM, USFS, SLO, utility companies.
- Complete mitigation to facilitate safe passage across roads for SGCN. These include modifying barrier fences along roadways, and constructing road crossings that are permeable to SGCN. Monitor the efficacy of mitigation measures and initiate any identified maintenance and improvements. Potential collaborators: BLM, USFS, NMDOT, SLO.

## *Biological Resource Use:*

- Develop and implement strategies to sustainably harvest wood products that will maintain pine-oak regeneration, old-growth trees, large diameter snags, and coarse woody debris at densities needed by SGCN and the communities that support them. Potential collaborators: BLM, USFS, SFD, SLO, private landowners.
- Enforce laws that protect SGCN populations, especially reptiles and amphibians. Longer-lived species, such as turtles, may be especially threatened by over-collection (Fitzgerald et al. 2004). Potential collaborators: BLM, USFS.

## *Human Intrusions and Disturbance:*

- Identify and characterize areas and routes frequented by OHVs, and use that information to assess the potential impacts to SGCN and other wildlife. Potential collaborators: BLM, USFS, SLO.
- Identify, designate, and promote areas for OHV use that avoid disturbance to, or modification of, SGCN habitats. Potential collaborators: BLM, USFS, SLO.
- Initiate a public information campaign to inform and educate OHV users of permitted and prohibited activities that can impact SGCN and other wildlife. This may include public service announcements, print advertising, public meetings, and signs in areas frequented by OHV users. Potential collaborators: BLM, USFS, SLO.

- Work with public land management agencies to regularly review and update OHV travel routes and trails open to the public and appropriate restrictions necessary to protect SGCN and other wildlife. Potential collaborators: BLM, USFS, SLO.
- Work with land management agencies to improve OHV law enforcement with passive measures such as strategically located barricades and active measures including monitoring and enforcement patrols to reduce negative impacts of OHVs on SGCN and other wildlife. Potential collaborators: US Border Patrol, BLM, USFS, SLO,.
- Work with the public to educate residents and recreationists about restrictions on and potential negative impacts of free ranging domestic pets on SGCN and other wildlife. . Potential collaborators: universities, municipalities, local governments, non-profit organizations.
- Reduce adverse effects of border enforcement activities on SGCN and sensitive habitats. Potential collaborators: US Border Patrol.

## *Natural System Modifications:*

- Restore and protect aquatic and riparian habitats, particularly springs and cienegas, and the surface and ground water that supports them. Protection may involve conservation easements and acquisition of lands from willing sellers. Potential collaborators: ACOE, BLM, BOR, NRCS, USFS, USFWS, private landowners.
- Design and implement riparian and aquatic habitat restoration projects to benefit SGCN. This may include establishing priorities for habitat restoration and developing reach-specific plans. Monitor restoration projects to determine effectiveness (Block et al. 2001) and adaptability to management. Potential collaborators: ACOE, BLM, BOR, NPS, USFS, USFWS, NHNM, SFD, SLO, universities, private land managers.
- Determine historic fire frequency and intensity and work with land management agencies and private landowners to develop fire management plans and implement prescribed burns that mimic historic fire patterns and processes, avoid disturbing SGCN during sensitive periods (especially nesting violet-crowned hummingbird, Lucifer hummingbird, Costa’s hummingbird, and New Mexico ridge-nosed rattlesnake), do not adversely impact sensitive habitats (e.g., riparian habitat), without endangering people and property. Potential collaborators: USFS, BLM, SLO, SFD.
- Restore stands of trees in forests and woodlands to natural or historic densities that reduce the probability of insect and disease outbreaks and stand-replacing wildfires. Avoid unnecessary removal of large old-growth trees and snags, which serve as important wildlife habitat (Kalies and Rosenstock 2013). Potential collaborators: BLM, USFS, SFD, SLO, non-profit organizations.
- Determine responses of upland habitats and associated riparian/aquatic communities that include SGCN to prescribed burns and wildfires. Integrate fire and fuels. management into riparian ecosystem conservation. Design and implement projects that reduce unnaturally high fire risk associated with increased fuel loads or lack of moist soils in riparian areas. Methods may include flooding or mechanical removal of vegetation (Ellis 2001). Potential collaborators: ACOE, BLM, BOR, NPS, USFS, USFWS, NHNM, SLO, private land managers.

- Promote land management practices, standards, and guidelines to conserve and/or restore structure and function of corridors that provide important habitat for SGCN. This should include xeric riparian communities that serve as important migratory corridors for birds and other wildlife while providing ecosystem services, and wildlife corridors that link isolated mountain ranges (Powledge 2003) and coniferous forest patches. Potential collaborators: BLM, NPS, USFS, USFWS, NHNM, universities.
- Encourage sustainable groundwater use to protect cienegas and riparian habitats from lowered groundwater tables. Promote water conservation, such as use of devices and models that facilitate optimal irrigation (Schaible and Aillery 2012), to conserve the structure and function of aquatic and riparian habitats. Potential collaborators: NRCS, NMDA, SLO, municipalities, water management districts.
- Promote post-fire management activities that are beneficial to SGCN. Includes minimizing ash flow into streams. Potential collaborators: NRCS, NPS, USFS, SFD, SLO, non-profit organizations, private landowners.
- Restore, protect and monitor important disjunct wildlife habitats, such as caves, playas, and saline lakes. Potential collaborators: BLM, DOD, NPS, NRCS, USFWS, EMNRD, private interests.
- Reduce shrub encroachment in grassland habitats important to SGCN. This may be achieved through reduction of processes that promote shrub encroachment, implementation of a natural fire regime (Ravi et al. 2009), reseeding with native grasses, and shrub removal (Bestelmeyer et al. 2003).
- Implement protections to conserve aquatic habitats within closed basins or hydrologic units not currently designated as Waters of the United States.
- Implement a standardized method to inventory, assess, and monitor riparian and aquatic habitats and efforts to conserve them. Determine amount, status, and trend of habitat, levels of fragmentation and how SGCN might be affected. Potential collaborators: ACOE, BLM, BOR, NPS, USFS, USFWS, NHNM, NMED, SFD, SLO, universities.
- Survey and monitor perennial marshes/cienegas/springs/seeps habitats and the SGCN that inhabit them to determine changes in quantity and quality of habitat, as well as status and trend of SGCN. Potential collaborators: BLM, USFS, USFWS, NHNM, NMED, SLO, universities.
- Promote citizen participation in restoration and conservation of watersheds. Potential collaborators: ACOE, BOR, USFS, USFWS, NMED, universities, private land managers, non-profit organizations.
- Inform interested and affected members of the public about the value of riparian systems and maintaining in-stream flows in order to build support for conservation of riparian species and habitat restoration efforts. Potential collaborators: NRCS, USFS, universities, non-profit organization, private land managers.
- Examine the structural characteristics of habitat fragmentation and how it influences patch size, edge effect, dispersal behavior, and daily and seasonal movements/migrations by wildlife including SGCN. Focus on riparian and aquatic habitats. Potential collaborators: BLM, USFS, USFWS, NHNM, NMED, SLO, universities..

## *Invasive and Problematic Species:*

- Work with appropriate agencies to enforce regulations to prevent the introduction and spread of non-native species. Potential collaborators: BLM, USFS, SLO, NMDA.
- Implement early detection protocols and treatment to prevent invasive and problematic species and diseases from becoming established. Potential collaborators: BLM, USFS, SLO, NMDA, universities.
- Eradicate non-native species and restore native species. Potential collaborators: BLM, USFS, SLO, NMDA, universities.
- Determine the current distribution of invasive and problematic species and diseases and their impact on SGCN and associated habitats. Potential collaborators: BLM, USFS, SLO, NMDA, universities.
- Determine relationships between non-native and native riparian plant species. Potential collaborators: universities, private managers.
- Develop strategies to prevent emerging diseases from getting into the Madrean Archipelago ecoregion, as well as strategies that will inhibit the spread of diseases already in the ecoregion. Potential collaborators: BLM, USFS, SLO, NMDA, universities, non-profit organizations.

## *Pollution:*

- Work with appropriate agencies to enforce mining and energy development regulations, Best Management Practices, and safeguards that protect water quality and minimize mortality of SGCN. Potential collaborators: BLM, EMNRD, NMED, SLO.
- Assess impacts to habitat and SGCN from industrial activities, including mining and energy development. These impacts may include direct mortality, pollution from transport of extracted or waste products, acid mine drainage, and sediment runoff from roads. Potential collaborators: BLM, USFS, SLO, EMNRD, NMED, local governments, energy and mining companies.

## *Climate Change:*

- Determine how regional and global climate change will affect SGCN, vegetation patterns, and community and ecosystem processes and dynamics. Of importance are impacts on travel corridors, SGCN, habitat connectivity, and SGCN distribution. Plan and complete projects that help maintain the distribution and natural functioning of climate-impacted species and habitats. Potential collaborators: USFS, USFWS, USGS, universities.
- Determine ecology, distribution, status and trends of, and threats to SGCN (especially invertebrates that are not currently monitored and riparian-obligate species) and their habitats. Use this information to develop and implement effective monitoring protocols and conservation actions. Potential collaborators: BLM, USFS, universities, non-profit organizations, private industry.
- Assess the synergistic effects between climate change and other threats to SGCN and their habitats. Potential collaborators: USFS, USGS, universities.

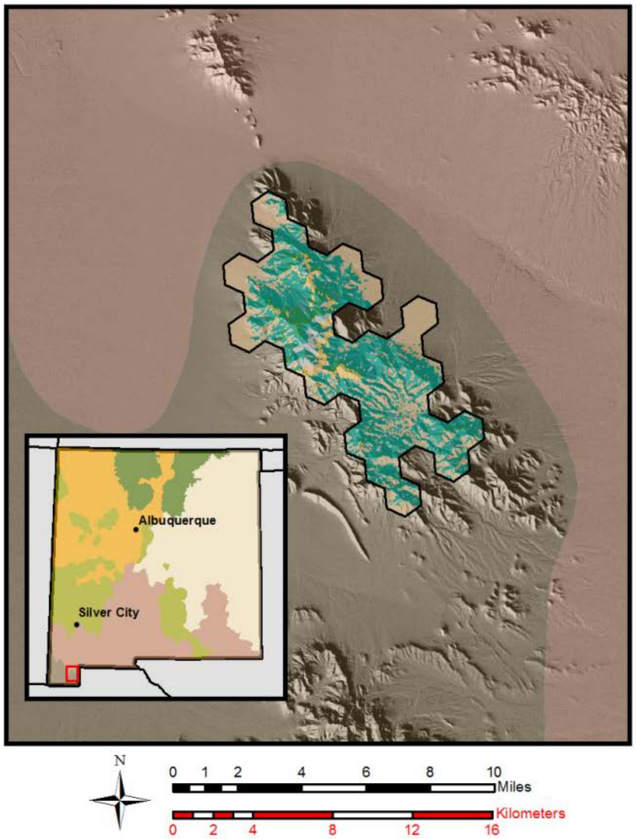
- Develop new species recovery plans that consider the current status of and limiting factors for species, as well as projected future conditions for both species and their habitats.
- Inform the public about potential adverse effects of climate change on SGCN and their habitats. Potential collaborators: USFS, USGS, universities, non-profit organizations.
- Monitor SGCN to determine long-term trends that correlate to ecosystem dynamics and habitat changes. Potential collaborators: BLM, USFS, universities, TNC.

## *Actions that Address Multiple Threats:*

- Identify or develop an accessible common database of information to document the status and condition of, threats to, and conservation actions implemented in Madrean Archipelago ecoregion habitats. Identify data gaps and varying data collection methodologies that provide a framework for identifying and promoting robust standard monitoring approaches. Potential collaborators: universities, NHNM.

# Conservation Opportunity Areas

## *Big Hatchet Mountains*




| Habitat | Tier | Area (ha) |
|---|---|---|
| *Chihuahuan Desert Scrub* | 4 | 1,163.6 |
| *Chihuahuan Semi-Desert Grassland* | 2 | 1,862.4 |
| *Cliff, Scree & Rock Vegetation* | 4 | 331.9 |
| *Madrean Lowland Evergreen Woodland* | 4 | 3,847.0 |
| *Madrean Montane Forest & Woodland* | 3 | 387.0 |
| *Rocky Mountain Pinyon - Juniper Woodland* | 4 | 8.7 |
| *Southwest Riparian Forest* | 1 | 58.1 |
| *Warm Interior Chaparral* | 4 | 367.6 |

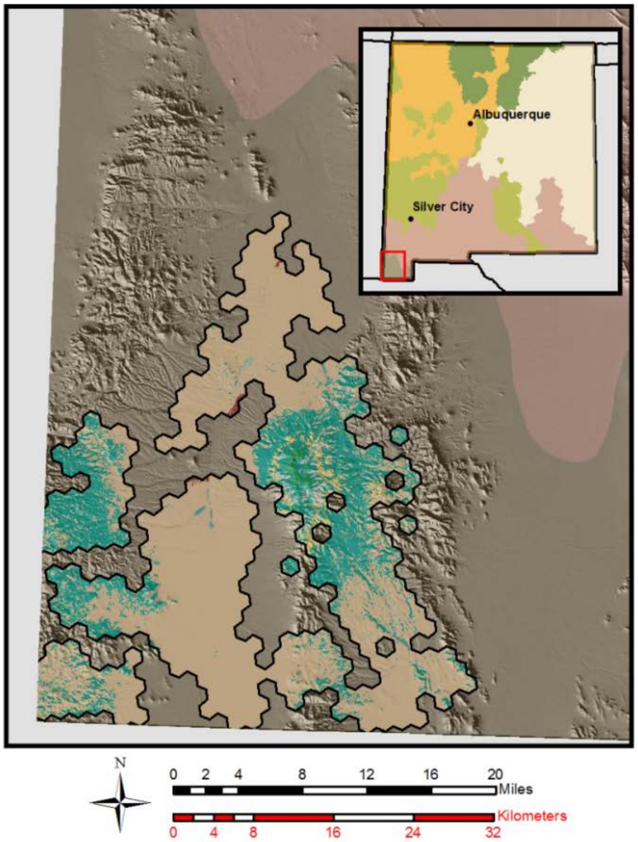
Figure 29. Big Hatchet Mountains Conservation Opportunity Area.

The Big Hatchet Mountains Conservation Opportunity Area (COA) (Figure 29) encompasses 8,042 ha (19,872 ac) 100 km (62 mi) southeast of Lordsburg. Almost all of the COA is managed by the BLM (82%) with a sizable portion managed by the SLO (18%). It contains one TNC conservation area (Hatches and Alamo Hueco Mountains); 81% of its lands are protected.

Landcover includes eight native vegetation habitats. The largest portion is Madrean Montane Lowland Evergreen Woodland (47%), but Chihuahuan Desert Scrub (14.4%) and Chihuahuan Semi-Desert Grassland (23%) are also prevalent. This COA contains no perennial aquatic habitat.

SGCN total nine, including three species of terrestrial molluscs (land snails) considered as SGCN based on their occurrence within very limited ranges or highly specialized habitats in the state.

## *Bootheel*




| Habitat | Tier | Area (ha) |
|---|---|---|
| Chihuahuan Desert Scrub | 4 | 4,505.9 |
| Chihuahuan Semi-Desert Grassland | 2 | 65,755.6 |
| Cliff, Scree & Rock Vegetation | 4 | 1,198.5 |
| Madrean Lowland Evergreen Woodland | 4 | 23,795.4 |
| Madrean Montane Forest & Woodland | 3 | 666.1 |
| Open Water | 5 | 2.2 |
| Recently Disturbed or Modified | 5 | 272.1 |
| Rocky Mountain Pinyon - Juniper Woodland | 4 | 6.8 |
| Rocky Mountain Subalpine-High Montane Conifer Forest | 4 | 13.9 |
| Southwest Riparian Forest | 1 | 416.2 |
| Warm Desert Lowland Riparian Shrubland | 1 | 55.4 |
| Warm Interior Chaparral | 4 | 2,045.3 |
| Warm-Desert Arroyo Riparian Scrub | 2 | 29.3 |

Figure 30. Bootheel Conservation Opportunity Area.

The Bootheel Conservation Opportunity Area (COA) (Figure 30) encompasses 98,892 ha (244,367 ac) in the Animas and Peloncillo Mountains, 100 km (62 mi) south of Lordsburg. Most of the COA is privately-owned (72.6%) with a sizable portion managed by USFS (15%). It contains four Important Bird Areas (Clanton Canyon, Guadalupe Canyon, Gray Ranch Grasslands, Animas Mountains) and one TNC conservation area (Sierra San Luis/Peloncillo Mountains). Sixty-two percent of the COA is protected. This COA contains no perennial aquatic habitat.

Landcover includes 11 native vegetation habitats plus open water and some disturbed lands. Dominant habitats are Chihuahuan Desert Scrub (65.5%) and Madrean Montane Lowland Evergreen Woodland (24%).

SGCN total 42, the most of any COA. These SGCN including three species categorized as Immediate Priority SGCN (Arizona grasshopper sparrow, gray vireo, white-sided jackrabbit).

# Chapter 10: Arizona/New Mexico Mountains Conservation Profile

## Species of Greatest Conservation Need (SGCN) and their Habitats

The Arizona/New Mexico Mountains ecoregion in New Mexico is comprised of nine separate mountain complexes totaling 46,870 $km^2$ (18,097 $mi^2$). The largest is part of an 83,000 $km^2$ (32,047 $mi^2$) complex that extends from western New Mexico through central Arizona. In New Mexico, elevations range from 1,300 to 3,800 m (4,300 to 12,400 ft) and terrain consists of steep mountains and some deeply dissected plateaus. Climates include desert, mid-latitude steppe, and subarctic. Mean annual temperatures range from 3 to19 $^{o}$C (37 to 66 $^{o}$F) depending largely upon elevation; annual precipitation averages 49 cm (19.3 in) (range: 27 to 100 cm (11-39 in)) with half occurring from December to March as rain or snow and half occurring from July to September as summer thundershowers.

This ecoregion contains the second largest number (102) of SGCN in New Mexico (Table 29, Table 31). Birds are the dominant taxa, comprising 49% of SGCN in the ecoregion. Species considered Susceptible made up the largest category (31%) of SGCN in the ecoregion (Table 29). Eighty-three percent of occurrences were based upon direct observations of SGCN within this ecoregion.

Table 29. Number of Species of Greatest Conservation Need in the Arizona-New Mexico Mountains ecoregion.

| Taxon \ Category[44] | I | H | S | D | F | Total |
|---|---|---|---|---|---|---|
| Amphibians | 0 | 2 | 4 | 1 | 1 | 8 |
| Birds | 14 | 5 | 19 | 8 | 3 | 49 |
| Crustaceans | 0 | 0 | 0 | 6 | 0 | 6 |
| Fish | 4 | 0 | 2 | 0 | 7 | 13 |
| Mammals | 3 | 0 | 2 | 0 | 5 | 10 |
| Molluscs | 0 | 6 | 2 | 0 | 2 | 10 |
| Reptiles | 0 | 0 | 3 | 1 | 2 | 6 |
| Total | 21 | 13 | 32 | 16 | 20 | 102 |

[44]Category abbreviations are: I = Immediate Priority, H = Limited Habitat, S = Susceptible, D = Data Needed, F = Federally-listed.

The Arizona-New Mexico Mountains support 31 terrestrial habitats, including 26 naturally vegetated, four unvegetated, and 1,800 ha (4,446 ac) of cultivated land (Table 30, Figure 31). Vegetation consists of chaparral at lower elevations, piñon-juniper and oak woodlands (including Madrean evergreen oak in the south) at mid-elevations, and coniferous forests of ponderosa pine (*Pinus ponderosa*) and Douglas fir (*Pseudotsuga menziesii)* at higher elevations. Above 3,300 m (10,800 ft), this ecoregion also supports the southern-most extent of spruce-fir forest. Three habitat types encompass two-thirds of the ecoregion: Rocky Mountain Lower Montane Forest (28%), Intermountain Juniper Woodland (23%), and Madrean Lowland Evergreen Woodland (16%).

This ecoregion contains 14 (four cold water, three warm water, seven both) publically-accessible reservoirs and ponds encompassing 560 ha (1,384 ac) (Figure 32). The largest, Bluewater Lake, accounts for almost half (249 ha (617 ac)) of that surface area. The ecoregion also contains 4,850 km (3,014 mi) of perennial streams, evenly split between cold water (2,372 km (1,483 mi)) and warm water (2,556 km (1,598 mi)) habitats.

Table 30. Terrestrial habitat types of the Arizona-New Mexico Mountains ecoregion.

| Habitat Category | USNVC Code | Habitat Name[45] | Tier[46] | Climate Vulnerability[47] | Area (km$^2$) | (mi$^2$) |
|---|---|---|---|---|---|---|
| Alpine and Montane Vegetation | M168 | Rocky Mountain Subalpine-High Montane Meadow | 2 | Moderate | 415 | 160 |
| | M011 | Madrean Montane Forest & Woodland | 3 | Low→Moderate | 2,344 | 905 |
| | M049 | Rocky Mountain Montane Shrubland | 3 | Moderate | 325 | 126 |
| | M022 | Rocky Mountain Lower Montane Forest | 4 | Moderate | 12,860 | 4,965 |
| | M026 | Intermountain Juniper Woodland | 4 | Low→Moderate | 10,815 | 4,176 |
| | M010 | Madrean Lowland Evergreen Woodland | 4 | Low→Moderate | 7,512 | 2,900 |
| | M027 | Rocky Mountain Piñon-Juniper Woodland | 4 | Low→Moderate | 2,381 | 919 |
| | M020 | Rocky Mountain Subalpine-High Montane Conifer Forest | 4 | Moderate | 791 | 306 |
| | M091 | Warm Interior Chaparral | 4 | Moderate | 677 | 262 |
| Plains-Mesa Grassland | M051 | Great Plains Mixedgrass Prairie | 2 | -- | 34 | 13 |
| | M053 | Great Plains Shortgrass Prairie | 3 | Moderate→Very High | 554 | 214 |
| Desert Grassland and Scrub | M087 | Chihuahuan Semi-Desert Grassland | 2 | Moderate | 3,868 | 1,493 |
| | M171 | Intermountain Dry Shrubland & Grassland | 2 | Low→Moderate | 2,289 | 884 |
| | M169 | Intermountain Tall Sagebrush Shrubland | 3 | Moderate | 98 | 38 |
| | M086 | Chihuahuan Desert Scrub | 4 | Moderate | 498 | 192 |
| | M093 | Intermountain Saltbush Shrubland | 4 | Moderate | 134 | 52 |

[45] Habitats were macrogroups identified in the US National Vegetation Classification System (USNVC), except Other Land Covers which were derived from Southwestern Regional Gap Analysis land cover classes.
[46] Tiers reflect the urgency for conservation and were based on the degree of imperilment within the United States according to the NatureServe Conservation Status Assessment (http://www.natureserve.org/conservation-tools/conservation-status-assessment) and the spatial pattern of the habitat.
[47] Climate vulnerability levels were based on a vulnerability analysis performed for Ecological Response Units (ERU) across New Mexico and Arizona (Triepke et al. (2014). The ERU classification system represents major ecosystem types of the Southwest. Vulnerability for each ERU was calculated as the relative probability of type conversion. The ERUs were then crosswalked to the habitats shown here.

| Habitat Category | USNVC Code | Habitat Name[45] | Tier[46] | Climate Vulnerability[47] | Area (km$^2$) | (mi$^2$) |
|---|---|---|---|---|---|---|
| | M170 | Intermountain Dwarf Sagebrush Shrubland | 4 | Moderate | 2 | 0.92 |
| Arroyo Riparian | M092 | Warm-Desert Arroyo Riparian Scrub | 2 | -- | 5 | 2 |
| Riparian Woodland and Wetland | M034 | Rocky Mountain Montane Riparian Forest | 1 | -- | 170 | 66 |
| | M036 | Southwest Riparian Forest | 1 | -- | 82 | 32 |
| | M082 | Desert Alkali-Saline Wetland | 1 | Moderate | 44 | 17 |
| | M075 | Montane-Subalpine Wet Shrubland & Wet Meadow | 1 | -- | 32 | 12 |
| | M888 | Arid West Interior Freshwater Emergent Marsh | 1 | -- | 7 | 3 |
| | M028 | Great Plains Floodplain Forest | 1 | -- | 5 | 2 |
| Cliff, Scree & Rock Veg. | M887 | Cliff, Scree & Rock Vegetation | 4 | Moderate | 677 | 261 |
| Semi-Natural Vegetation | M512 | Perennial Grassland | 5 | -- | 25 | 10 |
| Other Land Cover | N/A | Recently Disturbed or Modified | 5 | -- | 60 | 23 |
| | N/A | Herbaceous Agricultural Vegetation | 5 | -- | 19 | 7 |
| | N/A | Developed & Urban | 5 | -- | 56 | 22 |
| | N/A | Quarries, Mines, Gravel Pits and Oil Wells | 5 | -- | 60 | 23 |

Table 31. Species of Greatest Conservation Need (SGCN) in the Arizona-New Mexico Mountains ecoregion.

| Common Name | Scientific Name | Taxon | Category | Reason to Include[48] | Habitats[49] |
|---|---|---|---|---|---|
| Sacramento Mountain Salamander | *Aneides hardii* | Amphibians | H | V, E | M011, M020, M022, M034 |
| Lowland Leopard Frog | *Lithobates yavapaiensis* | Amphibians | H | V, Di | M010, M011, M026, M036, EC, EMCS, PCWS, PMCSS, PWWS |
| Arizona Treefrog | *Hyla wrightorum* | Amphibians | S | V | M010, M011, M020, M022, M034 |
| Northern Leopard Frog | *Lithobates pipiens* | Amphibians | S | De, V | M020, M022, M028, M034, M049, M051, M053, M075, M082, M888 |
| Plains Leopard Frog | *Lithobates blairi* | Amphibians | S | V | M028, M036, M082, M087, M888 |
| Boreal Chorus Frog | *Pseudacris maculata* | Amphibians | S | V | M020, M022, M028, M034, M051, M075, M168, EC, EMCS, PCWS, PLCP, PMCSS, PWWS |
| Arizona Toad | *Anaxyrus microscaphus* | Amphibians | D | V | M010, M011, M022, M026, M034, M036, M086, M087 |
| Chiricahua Leopard Frog | *Lithobates chiricahuensis* | Amphibians | F | De, V, Di | M010, M011, M020, M022, M034, M036, M075, EC, PCWS, PMCSS, PWWS |
| Bendire's Thrasher | *Toxostoma bendirei* | Birds | I | De, V | M026, M027, M028, M051, M082, M086, M087, M092, M093, M169, M170, M171, M887 |
| Juniper Titmouse | *Baeolophus ridgwayi* | Birds | I | De, V | M010, M011, M026, M027, M034, M036, M049, M887 |

[48] Reason to include indicates which of five criteria for inclusion on the SGCN list a particular species met. Abbreviations are as follows: De = Declining; Di = Disjunct; E = Endemic; K = Keystone; V = Vulnerable.
[49] Aquatic habitat abbreviations are as follows: PCWS = Perennial Cold Water Streams; PWWS = Perennial Warm Water Streams; PLCP = Perennial Lakes, Cirques, Ponds; PMCSS = Perennial Marshes/Cienegas/Springs/Seeps; PCWR = Perennial Cold Water Reservoirs; PWWR = Perennial Warm Water Reservoirs; EMCS = Ephemeral Marshes/Cienegas/Springs; EC = Ephemeral Catchments. Habitat codes refer to National Vegetation Classification designations, which are identified in Table 30 above.

| Common Name | Scientific Name | Taxon | Category | Reason to Include[48] | Habitats[49] |
|---|---|---|---|---|---|
| Chestnut-collared Longspur | *Calcarius ornatus* | Birds | I | De, V | M051, M053, M086, M087, M170, M171 |
| Pinyon Jay | *Gymnorhinus cyanocephalus* | Birds | I | De, V | M010, M011, M022, M026, M027, M028, M034, M049, M053, M169, M171, M887, M888 |
| Lewis's Woodpecker | *Melanerpes lewis* | Birds | I | De, V | M011, M020, M022, M028, M034, M036, M075 |
| Virginia's Warbler | *Oreothlypis virginiae* | Birds | I | De, V | M010, M011, M020, M022, M026, M027, M028, M034, M036, M049, M075, M091 |
| Flammulated Owl | *Psiloscops flammeolus* | Birds | I | V | M010, M011, M020, M022, M026, M027, M034, M036, M049, M051, M075, M168, M169, M171, M887 |
| Grace's Warbler | *Setophaga graciae* | Birds | I | De, V | M011, M022, M026, M027, M034, M036, M049. M171, M887 |
| Black-throated Gray Warbler | *Setophaga nigrescens* | Birds | I | De, V | M010, M011, M020, M022, M026, M027, M034, M036, M049, M075, M086, M091, M171, M887 |
| Black-chinned Sparrow | *Spizella atrogularis* | Birds | I | De, V | M010, M026, M027, M091 |
| Gray Vireo | *Vireo vicinior* | Birds | I | V | M010, M011, M022, M026, M027, M028, M034, M036, M049, M051, M082, M086, M087, M091, M092, M093, M169, M171, M887 |
| Mexican Whip-poor-will | *Antrostomus arizonae* | Birds | I | De, V | M020, M022, M027, M034 |
| Red-faced Warbler | *Cardellina rubrifrons* | Birds | I | V | M010, M011, M022, M034, M036, M887 |
| Painted Redstart | *Myioborus pictus* | Birds | I | V | M010, M011, M022, M034, M036 |
| Burrowing Owl | *Athene cunicularia* | Birds | H | De, V, Di | M026, M036, M051, M053, M082, M086, M087, M092, M093, M169, M170, M171, M887 |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[48] | Habitats[49] |
|---|---|---|---|---|---|
| Peregrine Falcon | *Falco peregrinus* | Birds | H | V, K | M010, M022, M026, M036, M082, M086, M087, M887 |
| Bald Eagle | *Haliaeetus leucocephalus* | Birds | H | V, K | M010, M011, M020, M022, M026, M027, M028, M034, M036, M049, M051, M053, M082, M086, M087, M091, M093, M168, M169, M170, M171, M887 |
| Bank Swallow | *Riparia riparia* | Birds | H | De, V, Di | M028, M034, M036, M092, M888 |
| Bell's Vireo | *Vireo bellii* | Birds | H | V, Di | M010, M011, M027, M028, M034, M036, M053, M086, M087 |
| Sagebrush Sparrow | *Artemisiospiza nevadensis* | Birds | S | De, V | M010, M026, M027, M034, M049, M051, M053, M082, M086, M087, M091, M093, M169, M170, M171, M887 |
| Costa's Hummingbird | *Calypte costae* | Birds | S | De, V | M010, M011, M020, M022, M034, M036, M086, M087, M092 |
| Mountain Plover | *Charadrius montanus* | Birds | S | De, V | M010, M026, M027, M051, M053, M082, M086, M087, M093, M168, M169, M171 |
| Common Nighthawk | *Chordeiles minor* | Birds | S | De, V | M010, M026, M027, M049, M051, M053, M086, M087, M168, M169, M170, M171, M887 |
| Evening Grosbeak | *Coccothraustes vespertinus* | Birds | S | De, V | M010, M011, M020, M022, M026, M027, M034, M887 |
| Olive-sided Flycatcher | *Contopus cooperi* | Birds | S | De, V | M010, M011, M020, M022, M026, M027, M034, M887 |
| Cassin's Finch | *Haemorhous cassinii* | Birds | S | De, V | M010, M011, M020, M022, M026, M027, M034, M169, M887 |
| Loggerhead Shrike | *Lanius ludovicianus* | Birds | S | De, V | M010, M011, M026, M027, M028, M034, M036, M049, M051, M053, M082, M086, M087, M091, M092, M093, M168, M169, M170, M171, M887 |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[48] | Habitats[49] |
|---|---|---|---|---|---|
| Whiskered Screech-Owl | *Megascops trichopsis* | Birds | S | De, V | M010, M011, M022, M036 |
| Red-headed Woodpecker | *Melanerpes erythrocephalus* | Birds | S | De, V | M028, M036, M053 |
| Gila Woodpecker | *Melanerpes uropygialis* | Birds | S | De, V | M010, M034, M036, M086, M087 |
| Varied Bunting | *Passerina versicolor* | Birds | S | De, V | M010, M036, M086, M087, M091, M092, M887 |
| Lucy's Warbler | *Oreothlypis luciae* | Birds | S | V | M010, M011, M022, M034, M036, M086, M087, M092, M512 |
| Williamson's Sapsucker | *Sphyrapicus thyroideus* | Birds | S | V | M011, M020, M022, M034, M887 |
| Clark's Nutcracker | *Nucifraga columbiana* | Birds | S | De | M010, M011, M020, M022, M026, M027, M034 |
| Vesper Sparrow | *Pooecetes gramineus* | Birds | S | De, V | M010, M026, M027, M036, M049, M051, M087, M168, M169, M170, M171, M512 |
| Mountain Bluebird | *Sialia currucoides* | Birds | S | De, | M010, M011, M020, M022, M026, M027, M034, M049, M051, M053, M086, M087, M091, M168, M887 |
| Western Bluebird | *Sialia mexicana* | Birds | S | De, V | M010, M011, M020, M022, M026, M027, M028, M034, M036, M049, M051, M075, M086, M087, M168, M171, M887 |
| Pygmy Nuthatch | *Sitta pygmaea* | Birds | S | De, V | M010, M011, M020, M022, M026, M027, M028, M034, M036, M049, M887 |
| Common Black Hawk | *Buteogallus anthracinus* | Birds | D | V | M010, M011, M022, M028, M034, M036, M086, M087, M091, M092, M887 |
| Lucifer Hummingbird | *Calothorax lucifer* | Birds | D | V | M010, M011, M036, M086, M087, M091, M887 |
| Broad-billed Hummingbird | *Cynanthus latirostris* | Birds | D | V | M034, M036, M087 |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[48] | Habitats[49] |
|---|---|---|---|---|---|
| Brown-capped Rosy-Finch | *Leucosticte australis* | Birds | D | V | M027, M168, M887 |
| Abert's Towhee | *Melozone aberti* | Birds | D | V | M036, M086, M087, M091, M092, M093 |
| Elegant Trogon | *Trogon elegans* | Birds | D | V | M010, M011, M036 |
| Clark's Grebe | *Aechmophorus clarkii* | Birds | D | V | M888, EC, PLCP, PMCSS, PWWR, PWWS |
| Elf Owl | *Micrathene whitneyi* | Birds | D | V | M010, M011, M036, M086, M087 |
| Southwestern Willow Flycatcher | *Empidonax traillii extimus* | Birds | F | V | M028, M034, M036, M082, M168, M888 |
| Yellow-billed Cuckoo | *Coccyzus americanus* | Birds | F | De, V, Di | M010, M011, M022, M027, M028, M034, M036, M049, M053, M082, M086, M087, M091, M092, M093, M169, M170, M171, M887, M888 |
| Mexican Spotted Owl | *Strix occidentalis lucida* | Birds | F | V | M010, M011, M020, M022, M026, M027, M034, M036, M049, M075, M091, M168, M887, M888 |
| Short Finger Clam Shrimp | *Lynceus brevifrons* | Crustaceans | D | V, Di | EC |
| Packard's Fairy Shrimp | *Branchinecta packardi* | Crustaceans | D | V, Di | EC |
| Mexican Clam Shrimp | *Cyzicus mexicanus* | Crustaceans | D | V, Di | EC |
| Clam Shrimp | *Eulimnadia follismilis* | Crustaceans | D | V, Di | EC |
| Great Plains Fairy Shrimp | *Streptocephalus texanus* | Crustaceans | D | V, Di | EC |
| Beavertail Fairy Shrimp | *Thamnocephalus platyurus* | Crustaceans | D | V, Di | EC |
| Headwater Chub | *Gila nigra* | Fish | I | De, V, Di | PCWS, PWWS |
| Rio Grande Sucker | *Catostomus plebeius* | Fish | I | De, V | PCWS, PWWS |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[48] | Habitats[49] |
|---|---|---|---|---|---|
| Rio Grande Chub | *Gila pandora* | Fish | I | V | PCWR, PCWS, PWWR, PWWS |
| Roundtail Chub | *Gila robusta* | Fish | I | De, V, Di | PWWS |
| Desert Sucker | *Catostomus clarkii* | Fish | S | De, V | PWWS |
| Sonora Sucker | *Catostomus insignis* | Fish | S | De, V | PWWS |
| Zuni Bluehead Sucker | *Catostomus discobolus yarrowi* | Fish | F | De, V, Di | PWWS |
| Gila Chub | *Gila intermedia* | Fish | F | De, V, Di | PWWS |
| Chihuahua Chub | *Gila nigrescens* | Fish | F | De, V, Di | PWWS |
| Spikedace | *Meda fulgida* | Fish | F | De, V, Di | PWWS |
| Gila Trout | *Oncorhynchus gilae* | Fish | F | De, V, E, Di | PCWS |
| Gila Topminnow | *Poeciliopsis occidentalis occidentalis* | Fish | F | De, V, Di | PMCSS |
| Loach Minnow | *Rhinichthys (Tiaroga) cobitis* | Fish | F | De, V, Di | PWWS |
| Peñasco Least Chipmunk | *Tamias minimus atristriatus* | Mammals | I | V, Di | M022, M027, M034, M168, M887 |
| Gunnison's Prairie Dog | *Cynomys gunnisoni* | Mammals | I | De, V, K | M022, M026, M027, M051, M053, M086, M087, M093, M168, M169, M170, M171 |
| Arizona Montane Vole | *Microtus montanus arizonensis* | Mammals | I | V, Di | M022, M034, EMCS. PMCSS |
| Pale Townsend's Big-eared Bat | *Corynorhinus townsendii* | Mammals | S | V | M010, M011, M020, M022, M026, M027, M034, M049, M086, M087, M091, M171, M887 |
| Spotted Bat | *Euderma maculatum* | Mammals | S | V | M010, M022, M026, M027, M034, M036, M075, M086, M092, M168, M171, M887, M888 |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[48] | Habitats[49] |
|---|---|---|---|---|---|
| Mexican Gray Wolf | *Canis lupus baileyi* | Mammals | F | De, V, K | M010, M011, M087 |
| Mexican Long-nosed Bat | *Leptonycteris nivalis* | Mammals | F | V | M010, M011, M034, M036, M086, M087, M091, M092, M887 |
| New Mexico Meadow Jumping Mouse | *Zapus hudsonius luteus* | Mammals | F | De, V, E | M011, M022, M028, M034, M036. EMCS, PCWS, PWWS |
| Lesser Long-nosed Bat | *Leptonycteris yerbabuenae* | Mammals | F | V | M010, M011, M086, M087, M887 |
| Jaguar | *Panthera onca* | Mammals | F | De, V, K | M010, M011, M036, M087, M887 |
| Cooke's Peak Woodlandsnail | *Ashmunella macromphala* | Molluscs | H | V, E, Di | M887 |
| Mineral Creek Mountainsnail | *Oreohelix pilsbryi* | Molluscs | H | V, E, Di | M034 |
| Gila Springsnail | *Pyrgulopsis gilae* | Molluscs | H | V, E, Di | PMCSS |
| New Mexico Hot Springsnail | *Pyrgulopsis thermalis* | Molluscs | H | V, E, Di | PMCSS |
| Silver Creek Woodlandsnail | *Ashmunella binneyi* | Molluscs | H | V, Di | M010, M022, M091 |
| Ovate Vertigo Snail | *Vertigo ovata* | Molluscs | H | De, V, Di | M086, M888 |
| False Marsh Snail | *Deroceras heterura* | Molluscs | S | V, Di | M010, M022, M034 |
| Obese Thorn Snail | *Carychium exiguum* | Molluscs | S | Di | PCWS, PMCSS |
| Alamosa Springsnail | *Pseudotryonia alamosae* | Molluscs | F | V, E, Di | PMCSS |
| Socorro Springsnail | *Pyrgulopsis neomexicana* | Molluscs | F | De, V, E, Di | PMCSS |
| Reticulate Gila Monster | *Heloderma suspectum suspectum* | Reptiles | S | V | M010, M036, M086, M087, M091 |
| Sonoran Mud Turtle | *Kinosternon sonoriense* | Reptiles | S | V | M010, PLCP, PMCSS |
| Gray-banded Kingsnake | *Lampropeltis alterna* | Reptiles | S | V | M086, M087, M092, M887 |

| Common Name | Scientific Name | Taxon | Category | Reason to Include[48] | Habitats[49] |
|---|---|---|---|---|---|
| Arizona Black Rattlesnake | *Crotalus cerberus* | Reptiles | D | V | M010, M011, M020, M027, M036, M086, M087, M091, M092, M168, M887, PMCSS |
| Mexican Gartersnake | *Thamnophis eques* | Reptiles | F | De, V | M011, M022, M036, EMCS, PCWS, PWWS |
| Narrow-headed Gartersnake | *Thamnophis rufipunctatus* | Reptiles | F | De, V | M010, M011, M022. M034. M036, PCWS, PWWS |

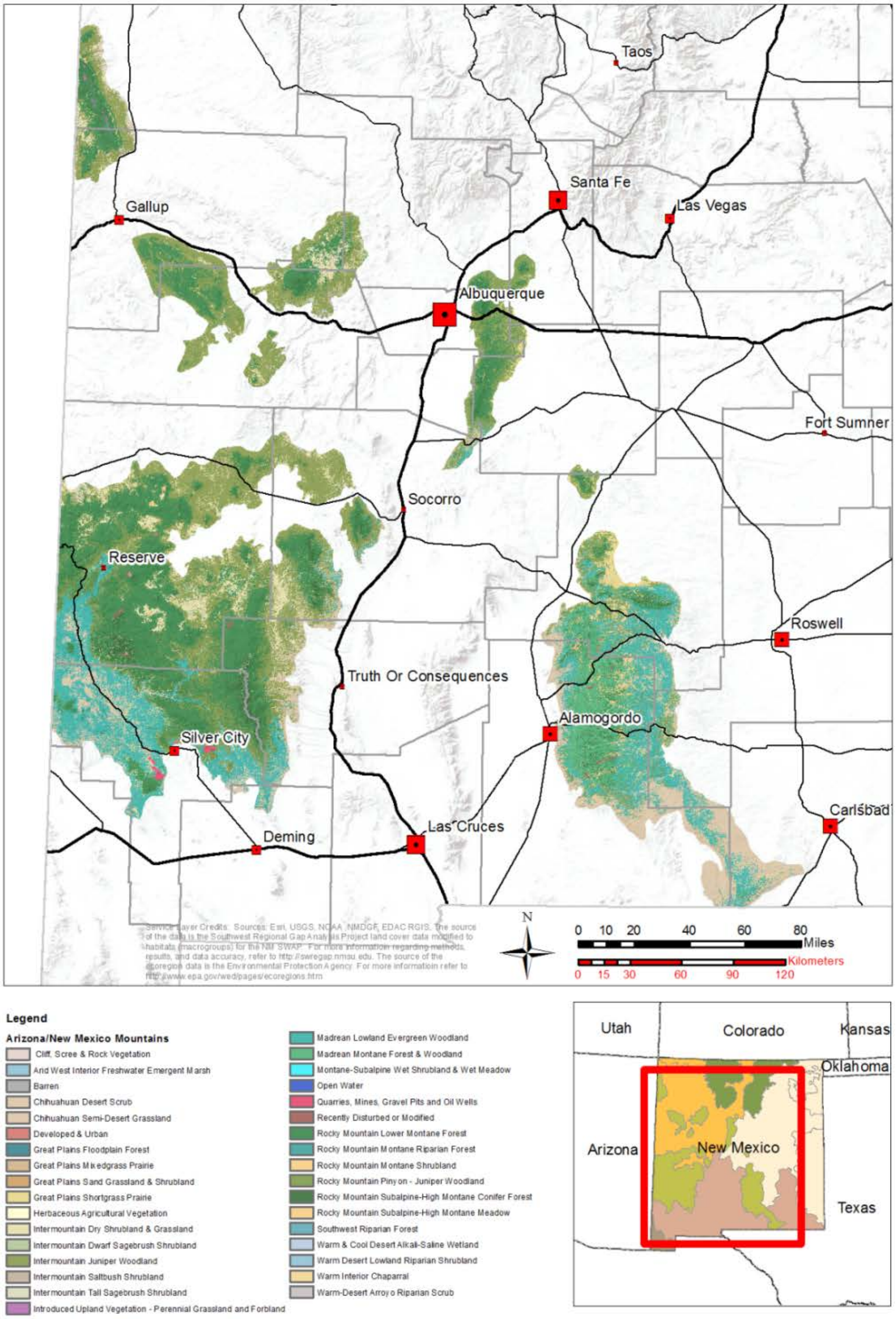



Figure 31. Terrestrial habitats in the Arizona-New Mexico Mountains ecoregion.

Delineations from US National Vegetation Classification macrogroups and SWReGAP landcover classes.

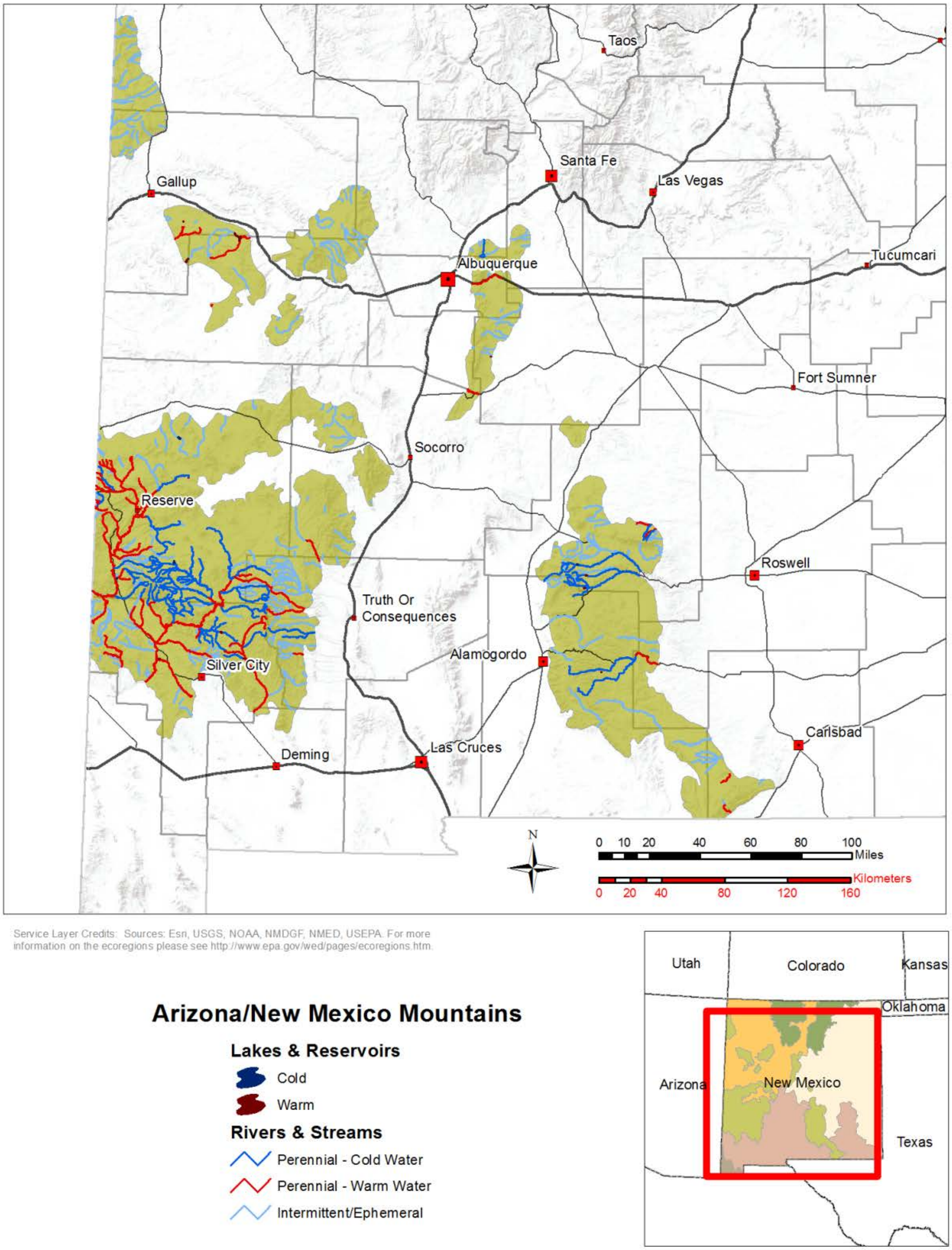



Figure 32. Aquatic habitats in the Arizona-New Mexico Mountains ecoregion.

# Habitat Descriptions

## *Madrean Montane Forest and Woodland*

The Madrean Montane Forest and Woodland **[M011]**[50] is found in lower to mid-montane elevations (1,460-2700 m (4,790-8860 ft)) of the Arizona-New Mexico Mountains and Madrean Archipelago ecoregions, and isolated locations in the mountains of the Chihuahuan Desert ecoregion. Tree canopies are 15-30 m (49-98 ft) tall and dominated or codominated by Arizona pine (*Pinus arizonica*), Apache pine (*P. engelmannii*), Chihuahuan pine (*P. leiophylla*), and occasionally Arizona cypress (*Cupressus arizonica*). Often, these species are codominated by evergreen oak trees such as Arizona white oak (*Quercus arizonica*), gray oak (*Q. grisea*), silverleaf oak (*Q. hypoleucoides*), canyon live oak (*Q. chrysolepis*), and Emory oak (*Q. emoryi*). An open to moderately dense shrub layer can be present and include encinal, chaparral, or montane shrub species such as agave (*Agave* spp.), pointleaf manzanita (*Arctostaphylos pungens*), Fendler's ceanothus (*Ceanothus fendleri*), alderleaf mountain mahogany (*Cercocarpus montanus*), Sonoran scrub oak (*Q. turbinella*), and Wright's silktassel (*Garrya wrightii*).

Substrates generally are rocky with lithic soils, but include finer-textured alluvial soils along streams. Stands with a grass-dominated understory tend to occur on less steep and rocky slopes and have finer-textured soils. Under historic natural conditions, lower to mid-elevation stands varied from open woodlands (10-20% cover), with pines dominating the overstory and perennial bunch grass dominating the understory, to moderately dense woodlands (20-40% tree cover), with a less dense herbaceous layer and more tree and shrub cover. Fire regimes vary from mixed severity (surface and canopy fires) to low severity (mostly frequent surface fires, e.g., savannas).

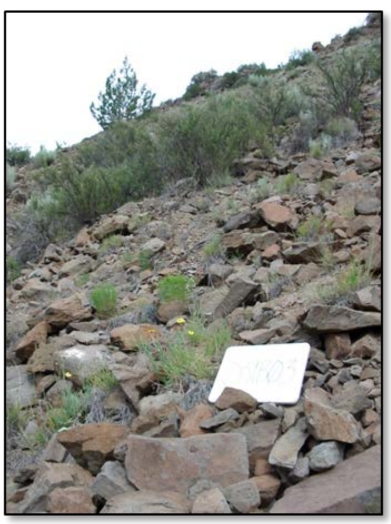
[50] Complete descriptions of habitats available by clicking on hyperlinked USNVC codes.

## *Warm Interior Chaparral*

The Warm Interior Chaparral **[M091]** is a moderate to dense evergreen shrub (<3 m (10 ft) tall) community of the Arizona-New Mexico Mountains ecoregion, as well as the mountains of the Chihuahuan Desert and Madrean Archipelago ecoregions. Sites tend to be steep and rocky and are dominated by scrub oaks (*Quercus* spp.) and sclerophyllous shrubs. Diagnostic species include Sonoran scrub oak, pointleaf manzanita and desert ceanothus (*Ceanothus greggii*). Other shrubs include hairy mountain mahogany (*Cercocarpus montanus* var. *paucidentatus*), Wright's silktassel, pungent oak (*Q. pungens*), Pinchot juniper (*Juniperus pinchotii*), and skunkbush sumac (*Rhus trilobata*). The herbaceous layer is variable in cover but often sparse. Common species include hairy grama (*Bouteloua hirsuta*), cane bluestem (*Bothriochloa barbinodis),* plains lovegrass (*Eragrostis intermedia*), common wolfstail (*Lycurus phleoides*), and bullgrass (*Muhlenbergia emersleyi*).

This habitat is found on foothills, xeric mountain slopes, and canyons in hotter and drier habitats and often is dominant along the mid-elevation (1,200 to 2,500 m (3,940 to 8,200 ft)) transition zone between desert scrub and montane woodlands. Many of the shrub species in this habitat are fire-adapted. The role of fire is complex, but, in general, it is responsible for maintaining this habitat across broad swaths of landscape.

## *Cliff, Scree and Rock Vegetation*



Cliff, Scree and Rock Vegetation **[M887]** occurs in all ecoregions and at all elevations of New Mexico. It consists of near barren and sparsely vegetated landscapes on a variety of substrates including mountain slopes, volcanic deposits, bedrock, badlands, outcrops, dunes, cliffs, narrow canyons, sandsheets, and unstable scree and talus that typically occur below cliffs. Physical properties of substrates that may limit plant growth include active substrates such as scree slopes, strong alkalinity and/or salinity with thin soil or unstable, eroding substrates, and heavy clay soils that reduce water infiltration or availability. Lower elevation sites often have some herbaceous or shrub species present, and montane sites may also include scattered trees. Most of these species are more common in adjacent habitats, but some are endemic perennial species that thrive in rocky habitats.

# Threats and Conservation Actions

Ten threats potentially could impact SGCN in 15 habitats within the Arizona-New Mexico Mountains ecoregion (Table 32). These threats are summarized below and listed in the order presented by the IUCN (2016). The list does not reflect the order of threat severity.

- Development: Home developments in forest and riparian areas.
- Agriculture and Aquaculture: Grazing practices that inhibit ecological processes of the Madrean forests and woodlands.
- Energy and Mining: Disturbance and habitat loss from mining.
- Transportation and Utilities: Safe passage across roads. Forest fragmentation from utility corridors.
- Biological Resource Use: Wood harvesting.
- Human Intrusion and Disturbance: Off-highway vehicle (OHV) use.
- Natural System Modifications: Unnaturally high densities of trees resulting in catastrophic wildfires.
- Invasive and Problematic Species: invasion of riparian habitats by tamarisk (*Tamarix* spp.) or other exotic plants.
- Pollution: Runoff from mining activities.
- Climate Change: Habitat alteration from prolonged drought.

Conservation concerns include restoring the natural role of fire in forest habitats, and restoring and conserving riparian and aquatic habitats. The largest, and likely the most intense, wildfires in New Mexico have occurred in this ecoregion during the past 15 years. This has been a result of unnatural densities of trees in conjunction with warm temperatures and drought. During this same period, some wildfires were allowed to burn and prescribed fires were set where no homes or developments were threatened. These fires reset forest conditions so that some future fires might be lower intensity and help to rejuvenate, rather than damage, forest habitats. Conservation actions to restore forest health, protect private property, and maintain the long-term suitability of SGCN habitat should be high priority for this ecoregion.

Areas within the Arizona-New Mexico Mountains ecoregion were warmer and drier than normal from 1991-2005, particularly from 2000-2005. Significant increases in average minimum temperatures were recorded in the Northern Black Range, Sacramento Mountains, Mogollon Divide, Mimbres River, and Gila River. Increasing average maximum temperatures also were recorded in the Sacramento Mountains.

This region contains a diverse set of habitats. With continued climate change, distribution and growth rates of two-needle piñon (*Pinus edulis*), Engelmann spruce (*Picea engelmannii*), Douglas-fir (*Pseudotsuga menziesii*), and Utah juniper (*Juniperus osteosperma*) are predicted to decline (Rehfeldt et al. 2006, Williams et al. 2010). These declines will be characterized by substantial shifts upslope (100-500 m (328-1,640ft)) and to more northerly aspects (Rehfeldt et al. 2006). Ponderosa pine (*Pinus ponderosa*) and Douglas-fir at lower elevations of their distribution are likely to be at greatest risk for drought-induced mortality, whereas two-needle piñon may be vulnerable to mortality throughout its range (Williams et al. 2010). In contrast, the distribution of Gambel's oak (*Quercus gambelii*) is expected to increase across the region

(Rehfeldt et al. 2006). The habitat with the greatest vulnerability to climate change in this ecoregion is Great Plains Shortgrass Prairie (medium to very high) (Table 30; Triepke et al. 2014).

Table 32. Potential threats to habitat and associated SGCN in the Arizona-New Mexico Mountains ecoregion.

Threat categories were derived from IUCN (2016). Habitats listed are those that are dominant in the amount of area they encompass or are particularly important to conserve (Tier 1 or 2) in this ecoregion.

| Habitat / Threat | Development | Agriculture & Aquaculture | Energy & Mining | Transportation & Utilities | Biological Resource Use | Human Intrusions & Disturbance | Natural System Modifications | Invasive & Problematic Species | Pollution | Climate Change |
|---|---|---|---|---|---|---|---|---|---|---|
| Chihuahuan Semi-Desert Grassland | | X | | X | | X | | | | X |
| Cliff, Scree & Rock Vegetation | | | X | | | X | | | | |
| Intermountain Dry Shrub & Grassland | | X | | X | | X | | | | |
| Intermountain Juniper Woodland | | | X | | X | | X | X | | X |
| Madrean Lowland Evergreen Woodland | X | X | X | X | X | X | X | | X | X |
| Madrean Montane Forest & Woodland | X | X | X | X | X | X | X | | | X |
| Rocky Mountain Lower Montane Forest | X | X | | | X | X | X | | | X |
| Rocky Mountain Piñon – Juniper Woodland | X | X | | | | | X | | | X |
| Rocky Mountain Montane Riparian Forest | | X | | | | X | X | X | | X |
| Southwest Riparian Forest | | X | | | | X | X | X | | X |
| Warm Interior Chaparral | | | | | | | | | | |
| Perennial Cold Water Streams | | X | X | | | | X | X | | X |
| Perennial Reservoirs | | | | | | | | X | | |
| Perennial Marshes/Cienegas/Springs/Seeps | | X | X | | | | X | X | X | X |
| Perennial Warm Water Streams | | X | | | | | X | X | X | X |

The following are proposed conservation actions for the Arizona-New Mexico Mountains ecoregion, listed in order of priority within each threat category (IUCN 2016). Threat categories are listed according to the order presented by IUCN (2016).

## *Development:*

- Reduce impacts of housing developments by establishing development standards that ensure habitat integrity and functionality. Include zoning regulations that minimize wildfire threats to private residences in the wildland urban interface. Potential collaborators: municipalities, local governments.

## *Agriculture and Aquaculture:*

- Determine where habitat restoration would benefit SGCN and work with federal, state, and private land managers to restore degraded rangelands to good or excellent condition. Monitor restoration results to develop and initiate any identified improvements to restoration practices. Potential collaborators: BLM, USFS, SLO, private land managers.
- Determine how timing, intensity, and duration of livestock grazing affect SGCN and their habitats, including the interaction between grazing, fire, and the spread of invasive and problematic species. Potential collaborators: BLM, NRCS, USFS, NMDA, SLO, universities, private land managers.
- Establish baseline composition, condition, and function of major range habitats to inform habitat restoration actions. Potential collaborators: BLM, USFS, universities.
- Promote expanded use of appropriate, cost effective, grazing practices that ensure long-term ecological sustainability for SGCN and their habitats (especially riparian habitats). These include actions that contribute to recovery of rangelands impacted by drought and allow restoration activities to be completed (Gripne 2005). Potential collaborators: BLM, USFS, SLO, private land managers.
- Promote grazing systems that address both livestock and SGCN habitat needs based on site-specific conditions. When particular habitat components need improvement, coordinate with ranchers and resource managers to identify and implement modifications that would provide the desired habitat outcomes. Potential collaborators: BLM, USFS, SLO, private landowners.
- Gather and assess current information on grazing practices and determine how the Department can support landowners that provide habitat for wildlife. Potential collaborators: BLM, NRCS, USFS, NMDA, SLO, private organizations.
- Balance irrigation and groundwater demands with the needs of aquatic communities, particularly those supporting native fish, amphibian, and springsnail populations. Potential collaborators: BOR, ACOE, NMISC/OSE, water users.
- Promote use of devices and models that improve water conservation and irrigation efficiency (Schaible and Aillery 2012), to help conserve the structure and function of aquatic and riparian habitats. Potential collaborators: NRCS, NMOSE.
- Promote rest-rotation and/or deferred-rotation grazing systems that incorporate rested pastures and help improve overall range condition and enhanced wildlife habitat. When

drought or other conditions that limits grazing occur, these rested pastures can provide forage reserves and relieve pressure on grazed pastures or allotments and provide time for owners to make contingency plans for excess livestock. Potential collaborators: BLM, NRCS, USFS, USFWS, SLO, private landowners.

## *Energy and Mining:*

- Restore habitats impacted by resource extraction as close as possible to pre-development conditions. This includes rehabilitating abandoned well pads and mining sites, removing unused transmission lines and access roads, and restoring native vegetation. Potential collaborators: BLM, USFS, EMNRD, NM Bureau of Geology and Mineral Resources, energy and mining companies, non-profit organizations, private landowners.
- Where feasible, maintain abandoned mines as habitat for bats and snakes by constructing appropriate bat gates on mine shafts and adits (Spanjer and Fenton 2005). Potential collaborators: BLM, EMNRD, private industry.
- Promote best management practices that minimize the impact of mining in both aquatic and terrestrial habitats crucial to SGCN. Potential collaborators: BLM, EMNRD, SLO, universities, energy and mining companies, non-profit organizations.
- Determine where mineral extraction currently, and in the future, may affect SGCN. Potential collaborators: BLM, USFS, EMNRD, NM Bureau of Geology and Mineral Resources, SLO, energy and mining companies.
- Maintain and foster open communication with mining and energy companies and land management agencies to minimize adverse impacts of development to SGCN. Potential collaborators: BLM, USFS, EMNRD, SLO, energy and mining companies.

## *Transportation and Utilities:*

- Complete mitigation measures to increase safe passage across roads for affected SGCN. These include modifying barrier fences along roadways, and constructing road crossings that are permeable to SGCN. Monitor the efficacy of mitigation measures and initiate any identified maintenance activities and improvements. Potential collaborators: NMDOT, private industry.
- Site and consolidate utility corridors to minimize adverse effects to SGCN and their habitats. Potential collaborators: BLM, USFS, SLO, utility companies.

## *Biological Resource Use:*

- Determine the distribution (historic and current), composition, and function of piñon-juniper woodlands needed by SGCN, as well as SGCN prevalence in these habitats. Potential collaborators: BLM, USFS, universities, private entities.

- Develop and implement strategies to sustainably harvest wood products to retain pine-oak regeneration, old-growth trees, large diameter snags, and coarse woody debris at densities needed by SGCN. Potential collaborators: BLM, USFS, SFD, SLO.

- Inform natural resource law enforcement officers of the distribution and habitat needs of SGCN. Partner with them to enforce laws to protect SGCN populations and habitats. Potential collaborators: BLM, NPS, USFS, USFWS.

## *Human Intrusions and Disturbance:*

- Identify and characterize areas and routes frequented by OHVs, and use that information to assess the potential impacts to SGCN and other wildlife. Potential collaborators: BLM, USFS, SLO.
- Identify, designate, and promote areas for OHV use that avoid disturbance to, or modification of, SGCN habitats. Potential collaborators: BLM, USFS, SLO.
- Initiate a public information campaign to inform and educate OHV users of permitted and prohibited activities that can impact SGCN and other wildlife. This may include public service announcements, print advertising, public meetings, and signs in areas frequented by OHV users. Potential collaborators: BLM, USFS, SLO, local governments, non-profit organizations.
- Work with public land management agencies to regularly review and update OHV travel routes and trails open to the public and appropriate restrictions necessary to protect SGCN and other wildlife. Potential collaborators: BLM, USFS, SLO.
- Work with land management agencies to improve OHV law enforcement with passive measures such as strategically located barricades and active measures including monitoring and enforcement patrols to reduce negative impacts of OHVs on SGCN and other wildlife. Potential collaborators: BLM, USFS, SLO.
- Work with the public to educate residents and recreationists about restrictions on and potential negative impacts of free ranging domestic pets on SGCN and other wildlife. Potential collaborators: municipalities, local governments, non-profit organizations.

## *Natural System Modifications:*

- Restore stands of trees in forests and woodlands to natural or historic densities that reduce the probability of insect and disease outbreaks and stand-replacing wildfires. Avoid unnecessary removal of large old-growth trees and snags, which serve as important wildlife habitat (Kalies and Rosenstock 2013). Potential collaborators: BLM, USFS, SFD, SLO, non-profit organizations.
- Restore and protect aquatic, riparian, and wetland habitats, particularly springs and cienegas, and the surface and ground water that supports them. Minimize activities that lead to gully formation and soil erosion. Potential collaborators: ACOE, BLM, BOR, NRCS, USFS, USFWS, private landowners.
- Design and implement riparian and aquatic habitat restoration projects to benefit SGCN. This may include establishing priorities for habitat restoration and developing reach-specific plans. Monitor restoration projects to determine effectiveness (Block et al. 2001) and adaptability to management. May also include specific actions such as reintroducing keystone species including beavers (*Castor canadensis*; Baker and Cade 1995, McKinstry et al. 2001) and native fishes. Potential collaborators: ACOE, BLM, BOR, NPS, USFS, USFWS, NHNM, SFD, SLO, universities, private land managers.

- Determine beneficial fire frequencies and intensities and work with land management agencies and private landowners to develop fire management plans and implement prescribed burns that avoid disturbing SGCN during sensitive periods (e.g., nesting), maintain condition of sensitive habitats (e.g., riparian habitat) and protect people and property. Potential collaborators: BLM, NPS, USFS, SLO, SFD, private landowners.
- Determine responses of upland habitats and associated riparian/aquatic communities that include SGCN to prescribed burns and wildfires. Integrate fire and fuels management into riparian ecosystem conservation. Design and implement projects that reduce unnaturally high fire risk associated with increased fuel loads or lack of moist soils in riparian areas. Methods may include flooding or mechanical removal of vegetation (Ellis 2001). Potential collaborators: ACOE, BLM, BOR, NPS, USFS, USFWS, NHNM, SLO, private land managers.
- Promote post-fire management activities that are beneficial to SGCN. Includes minimizing ash flow into streams. Potential collaborators: NRCS, NPS, USFS, SFD, SLO, non-profit organizations, private landowners.
- Protect and restore disjunct wildlife habitats, such as limestone outcrops, talus slopes, and caves, important to SGCN. Actions may include implementation of conservation easements and acquisition from willing sellers. Potential collaborators: BLM, USFS, SLO, non-profit organizations, private landowners.
- Assess the magnitude, frequency, timing, duration, and rate of change of flow and the effects of hydrologic alterations on different types of riparian systems. Determine flows needed to sustain SGCN and their habitats, and the effects of flow stabilization by upstream dams. Work with agencies that manage dams and reservoirs to ensure amounts and patterns of flows needed for persistence of SGCN. Potential collaborators: ACOE, BOR, USFWS, USGS, NMOSE, universities, private industry.
- Implement a standardized method to inventory, assess, and monitor riparian and aquatic habitats and efforts to conserve them. Determine amount, status, and trend of habitat, levels of fragmentation and how SGCN might be affected. Potential collaborators: ACOE, BLM, BOR, NPS, USFS, USFWS, NHNM, NMED, SFD, SLO, universities.
- Survey and monitor perennial marshes/cienegas/springs/seeps habitats and the SGCN that inhabit them to determine changes in quantity and quality of habitat, as well as status and trend of SGCN. Potential collaborators: BLM, USFS, USFWS, NHNM, NMED, SLO, universities.
- Promote land management practices, standards, and guidelines to conserve and/or restore structure and function of corridors that provide important habitat for SGCN. This should include xeric riparian communities that serve as important migratory corridors for birds and other wildlife while providing ecosystem services, and wildlife corridors that link isolated mountain ranges (Powledge 2003) and coniferous forest patches. Potential collaborators: BLM, NPS, USFS, USFWS, NHNM, universities.
- Encourage sustainable groundwater use to protect aquatic and riparian habitats. Promote water conservation, such as use of devices and models that facilitate optimal irrigation (Schaible and Aillery 2012), to conserve the structure and function of aquatic and riparian habitats. Potential collaborators: NRCS, NMDA, SLO, municipalities, water management districts.

- Promote citizen participation in restoration and conservation of watersheds. Potential collaborators: ACOE, BOR, USFS, USFWS, NMED, universities, private land managers, non-profit organizations.
- Inform interested and affected members of the public about the value of riparian systems and maintaining in-stream flows in order to build support for conservation of riparian species and habitat restoration efforts. Potential collaborators: NRCS, USFS, universities, non-profit organization, private land managers.
- Examine the structural characteristics of habitat fragmentation and how it influences patch size, edge effect, dispersal behavior, and daily and seasonal movements/migrations by wildlife including SGCN. Focus on riparian and aquatic habitats. Potential collaborators: BLM, USFS, USFWS, NHNM, NMED, SLO, universities.

## *Invasive and Problematic Species:*

- Determine the current distribution and impact on SGCN and disturbance regimes of invasive and problematic species and diseases. Potential collaborators: BLM, NRCS, USFS, SLO, private landowners.
- Design and implement protocols for early detection of invasive and problematic species and diseases. Quickly respond to detection. Potential collaborators: BLM, BOR, ACOE, USFWS, USFS, NRCS, NMDA, Soil and Water Conservation Districts, SFD, SLO, private landowners.
- Eradicate or control existing non-native and invasive species before they become established. Potential collaborators: BLM, BOR, ACOE, USFWS, USFS, NRCS, NMDA, Soil and Water Conservation Districts, SFD, SLO, private landowners.
- Determine historic and current SGCN habitats that have been infested with cheatgrass (*Bromus tectorum*) and restore them to native species. Promote land management strategies that will inhibit the further spread of cheatgrass. Potential collaborators: BLM, SLO, tribal resource management entities.
- Determine relationships between non-native and native riparian plant species. Potential collaborators: USFWS, USFS, USGS, universities.
- Inform anglers about the damage of invasive species. Enforce baitfish regulations to prevent introduction of non-native species. Potential collaborators:  USFS, anglers.
- Restore native riparian plants (e.g., cottonwood and willow) and natural riparian ecosystem processes and functions following tamarisk removal or biocontrol, and ensure maintenance of adequate water supply for native plants. At sites with low water availability, restoration of native xeric plants may be more appropriate than wetland plants. Potential collaborators: BLM, BOR, ACOE, USFS, SLO, NMED, universities, private land managers, non-profit organizations.
- Stage and balance tamarisk removal and native habitat restoration over time, to avoid rapid loss of exotic woody riparian habitats for wildlife until native habitats can be developed (Sogge et al. 2013). Potential collaborators: BLM, BOR, ACOE, USFS, SLO, NMED, universities, private land managers, non-profit organizations.
- Protect sustain, and proactively restore existing stands of native riparian vegetation that may serve as important refugia in areas currently or likely to be affected by the tamarisk beetle,

such as large tamarisk monocultures in the most hydrologically altered river systems) (Paxton et al. 2011, Sogge et al. 2013). Potential collaborators: BLM, BOR, ACOE, USFS, SLO, NMED, universities, private land managers, non-profit organizations.
- Develop explicit, measurable goals and objectives, site-specific plans, and post-implementation monitoring and maintenance for all riparian restoration projects. Document and report restoration approaches used, including successes and failures (Shafroth et al. 2008, Sogge et al. 2013). Potential collaborators: BLM, BOR, ACOE, USFWS, USFS, NRCS, NMDA, Soil and Water Conservation Districts, SFD, SLO, private landowners.

## *Pollution:*

- Work with appropriate agencies to enforce mining and energy development regulations, Best Management Practices, and safeguards that protect water quality and minimize mortality of SGCN. Potential collaborators: BLM, EMNRD, NMED.
- Assess impacts to habitat and SGCN from industrial activities, including mining and energy development. These impacts may include direct mortality, pollution from transport of extracted or waste products, acid mine drainage, and sediment runoff from roads. Potential collaborators: BLM, USFS, SLO, EMNRD, NMED, local governments, energy and mining companies.

## *Climate Change:*

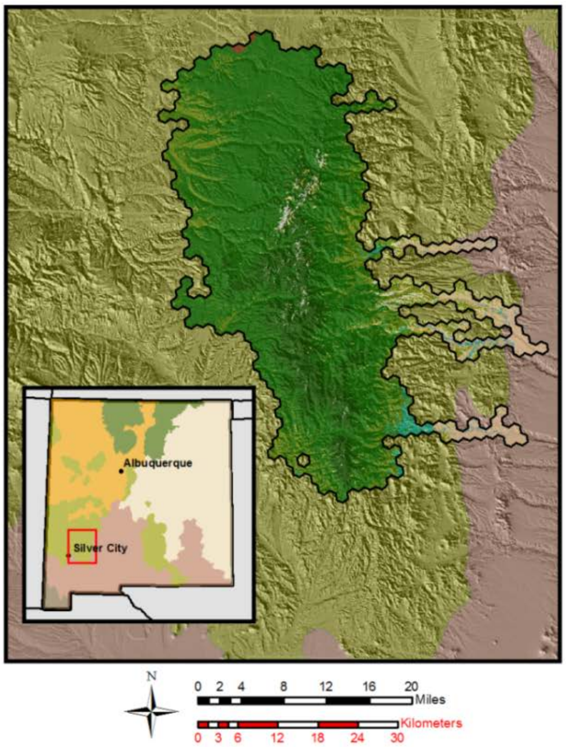
- Determine how regional and global climate change will affect SGCN, vegetation patterns, and community and ecosystem processes and dynamics. Of importance are impacts on travel corridors, SGCN, habitat connectivity, and SGCN distribution. Plan and complete projects that help maintain the distribution and natural functioning of climate-impacted species and habitats. Potential collaborators: USFS, USFWS, USGS, universities.
- Determine life history needs, ecology, distribution, status and trends of, and threats to, SGCN (especially invertebrates that are not currently monitored, riparian-obligate species, and rare native fishes) and their habitats. Use this information to develop and implement effective monitoring protocols and conservation actions. Potential collaborators: BLM, USFS, USFWS, SLO, universities, non-profit organizations, private industry.
- Assess the synergistic effects between climate change and other threats to SGCN and their habitats. Potential collaborators: USFS, USFWS, USGS, universities.
- Develop new species recovery plans that consider the current status of and limiting factors for species, as well as projected future conditions for both species and their habitats.
- Conserve habitat corridors, especially those that link isolated mountain ranges (Powledge 2003) and conifer forest patches. Potential collaborators: BLM, USFS, SLO, non-profit organizations, private landowners.
- Inform the public about the potential adverse effects of climate change on SGCN and their habitats. Potential collaborators: USFS, USFWS, USGS, universities, non-profit organizations.
- Monitor SGCN to determine long-term trends that correlate to ecosystem dynamics and habitat changes. Potential collaborators: NPS, USFS, tribal resource management entities, universities.

## *Actions that Address Multiple Threats:*

- Identify or develop an accessible common database of information to document the status and condition of, threats to, and conservation actions implemented in Arizona/New Mexico Mountains ecoregion habitats. Identify data gaps and varying data collection methodologies that provide a framework for identifying and promoting robust standard monitoring approaches. Potential collaborators: universities, NHNM.

# Conservation Opportunity Areas

## *Black Range*




| Habitat | Tier | Area (ha) |
|---|---|---|
| Arid West Interior Freshwater Emergent Marsh | 1 | 16.5 |
| Chihuahuan Desert Scrub | 4 | 424.2 |
| Chihuahuan Semi-Desert Grassland | 2 | 9,794.0 |
| Cliff, Scree & Rock Vegetation | 4 | 2,771.7 |
| Desert Alkali-Saline Wetland | 1 | 3.2 |
| Intermountain Dry Shrubland & Grassland | 2 | 1,069.7 |
| Intermountain Juniper Woodland | 4 | 21,511.9 |
| Intermountain Saltbush Shrubland | 4 | 84.5 |
| Intermountain Tall Sagebrush Shrubland | 3 | 45.5 |
| Madrean Lowland Evergreen Woodland | 4 | 1,978.4 |
| Madrean Montane Forest & Woodland | 3 | 235.0 |
| Montane-Subalpine Wet Shrubland & Wet Meadow | 1 | 19.5 |
| Recently Disturbed or Modified | 5 | 327.6 |
| Rocky Mountain Lower Montane Forest | 4 | 114,937.7 |
| Rocky Mountain Montane Riparian Forest | 1 | 2.2 |
| Rocky Mountain Montane Shrubland | 3 | 334.5 |
| Rocky Mountain Subalpine-High Montane Conifer Forest | 4 | 25,552.3 |
| Rocky Mountain Subalpine-High Montane Meadow | 1 | 445.1 |
| Southwest Riparian Forest | 1 | 980.4 |
| Warm Interior Chaparral | 4 | 1,038.4 |
| Warm-Desert Arroyo Riparian Scrub | 2 | 0.7 |

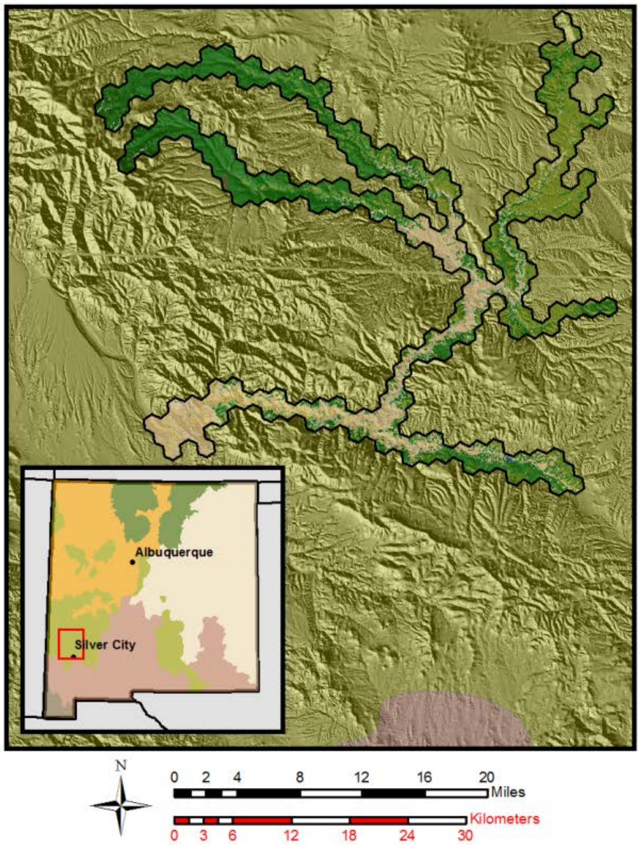
Figure 33. Black Range Conservation Opportunity Area.

The Black Range Conservation Opportunity Area (COA) (Figure 33) encompasses 181,729 ha (449,062 ac) in the Gila National Forest of western New Mexico. Almost all is managed by USFS (89%), but 10.4% is privately-owned. It contains one Important Bird Area (Ladder Ranch) and eight TNC conservation areas (Northern Black Range, Las Animas Creek, Gila River Complex, Hillsboro West, Ladder Ranch, Southern Black Range/Cooks Peak, Mineral Creek Mimbres River). Fifty-four percent of the COA is protected.

Landcover includes 20 native vegetation habitats and a small amount of disturbed lands. Rocky Mountain Lower Montane Forest covers the largest portion of the COA (40%) with smaller amounts covered by Rocky Mountain Subalpine High Montane Conifer Forest (14%) and Intermountain Juniper Woodland (12%). Perennial aquatic habitats include 215 km (134 mi) of warm water and 271 km (168 mi) of cold water streams.

SGCN total 19, including five species categorized as Immediate Priority SGCN (flammulated owl, gray vireo, red-faced warbler, Rio Grande chub, Rio Grande sucker).

## *Gila River Headwaters*




| Habitat | Tier | Area (ha) |
|---|---|---|
| Chihuahuan Desert Scrub | 4 | 62.6 |
| Chihuahuan Semi-Desert Grassland | 2 | 124.7 |
| Cliff, Scree & Rock Vegetation | 4 | 1,628.1 |
| Desert Alkali-Saline Wetland | 1 | 0.4 |
| Intermountain Dry Shrubland & Grassland | 2 | 465.6 |
| Intermountain Juniper Woodland | 4 | 13,286.8 |
| Madrean Lowland Evergreen Woodland | 4 | 11,086.4 |
| Madrean Montane Forest & Woodland | 3 | 659.3 |
| Montane-Subalpine Wet Shrubland & Wet Meadow | 1 | 1.8 |
| Open Water | 5 | 20.4 |
| Recently Disturbed or Modified | 5 | 50.1 |
| Rocky Mountain Lower Montane Forest | 4 | 23,589.3 |
| Rocky Mountain Montane Shrubland | 3 | 7.6 |
| Rocky Mountain Subalpine-High Montane Conifer Forest | 4 | 1,397.0 |
| Rocky Mountain Subalpine-High Montane Meadow | 2 | 3.9 |
| Southwest Riparian Forest | 1 | 117.5 |
| Warm Interior Chaparral | 4 | 2,138.8 |

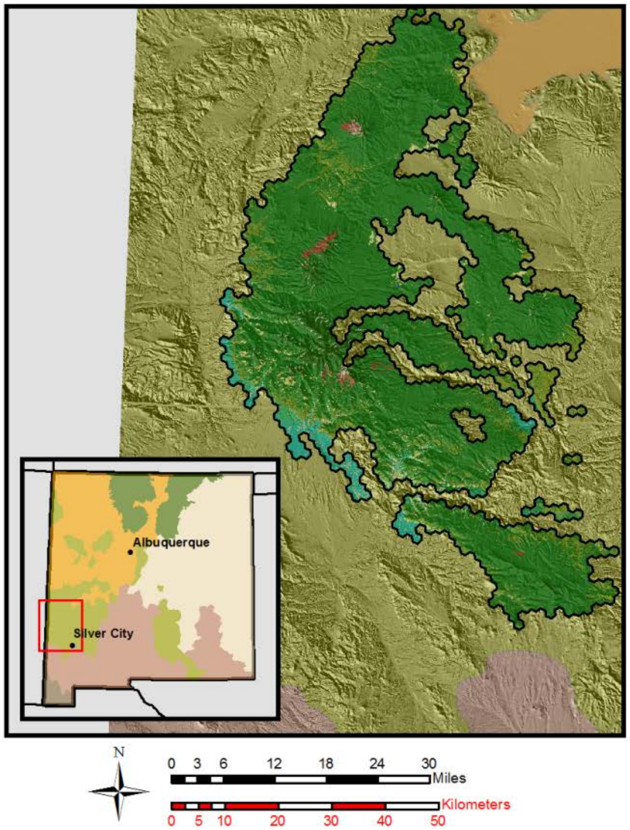
Figure 34. Gila River Headwaters Conservation Opportunity Area.

The Gila River Headwaters Conservation Opportunity Area (COA) (Figure 34) encompasses 54,733 ha (135,248 ac) in the Gila National Forest of western New Mexico. Almost all is managed by USFS (96%). It contains only one Important Bird Area (Gila-Cliff Area), but 77% of the COA is protected.

Landcover includes 15 native vegetation habitats plus open water and a small amount of disturbed lands. The COA is dominated by three native vegetation habitats: Rocky Mountain Lower Montane Forest (41.2%), Intermountain Juniper Woodland (24%), and Madrean Lowland Evergreen Woodland (20%). Perennial aquatic habitats include 285 km (177 mi) of warm water streams, 118 km (73 mi) of cold water streams, and 23.6 ha (58.3 ac) of reservoirs.

SGCN total 24, including six species categorized as Immediate Priority SGCN (Gunnison's prairie dog, headwater chub, pinyon jay, red-faced warbler, Rio Grande sucker, roundtail chub).

# Gila Highlands




| Habitat | Tier | Area (ha) |
|---|---|---|
| Arid West Interior Freshwater Emergent Marsh | 1 | 2.9 |
| Chihuahuan Desert Scrub | 4 | 48.5 |
| Chihuahuan Semi-Desert Grassland | 2 | 588.4 |
| Cliff, Scree & Rock Vegetation | 4 | 2,998.4 |
| Developed & Urban | 5 | 3.9 |
| Intermountain Dry Shrubland & Grassland | 2 | 2,377.5 |
| Intermountain Juniper Woodland | 4 | 36,877.6 |
| Intermountain Saltbush Shrubland | 4 | 3.2 |
| Madrean Lowland Evergreen Woodland | 4 | 14,624.0 |
| Madrean Montane Forest & Woodland | 3 | 4,137.8 |
| Montane-Subalpine Wet Shrubland & Wet Meadow | 1 | 6.9 |
| Open Water | 5 | 27.8 |
| Recently Disturbed or Modified | 5 | 2,566.4 |
| Rocky Mountain Lower Montane Forest | 4 | 268,741.2 |
| Rocky Mountain Montane Riparian Forest | 1 | 2.0 |
| Rocky Mountain Montane Shrubland | 3 | 1,783.5 |
| Rocky Mountain Subalpine-High Montane Conifer Forest | 4 | 15,378.5 |
| Rocky Mountain Subalpine-High Montane Meadow | 2 | 272.7 |
| Southwest Riparian Forest | 1 | 22.9 |
| Warm Interior Chaparral | 4 | 2,809.4 |

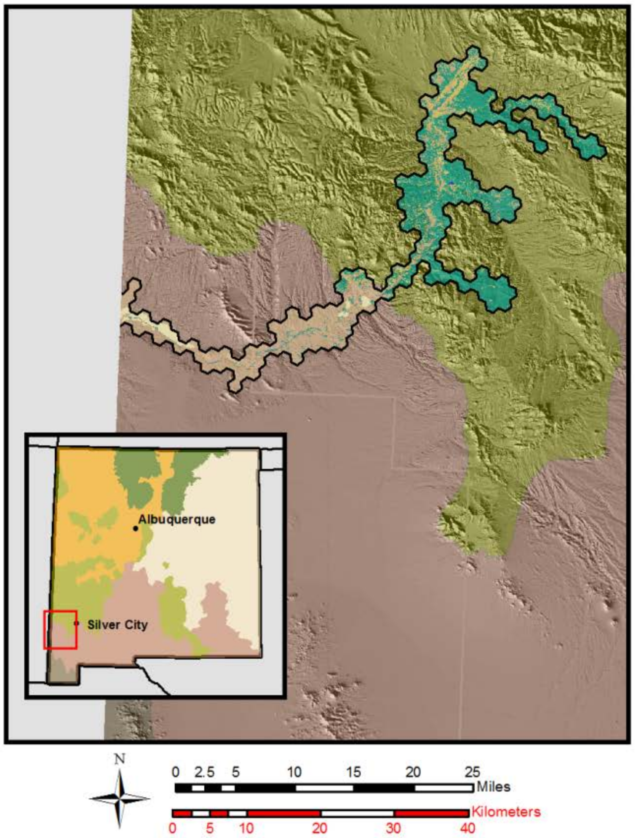
Figure 35. Gila Highlands Conservation Opportunity Area.

The Gila Highlands Conservation Opportunity Area (COA) (Figure 35) encompasses 353,910 ha (874,530 ac) in the Gila National Forest of western New Mexico. Almost all is managed by USFS (98%). It contains two TNC conservation areas (Gila River Complex, Mogollon Divide) and 46% of its lands are protected.

Landcover includes 17 native vegetation habitats plus open water and small amounts of disturbed and developed lands. Rocky Mountain Lower Montane Forest is dominant (76%). Intermountain Juniper Woodland (10.4%), Rocky Mountain Subalpine-High Montane Conifer Forest (4%), and Madrean Lowland Evergreen Woodland (4%) are the next most abundant. Perennial aquatic habitats include 118 km (73 mi) of warm water streams, 800 km (497 mi) of cold water streams, and 40 ha (99 ac) of cold water reservoirs.

SGCN total 22, including four species categorized as Immediate Priority SGCN (headwater chub, pinyon jay, red-faced warbler, Rio Grande sucker).

## Lower Gila River




| Habitat | Tier | Area (ha) |
|---|---|---|
| Chihuahuan Desert Scrub | 4 | 12,757.9 |
| Chihuahuan Semi-Desert Grassland | 2 | 2,930.9 |
| Cliff, Scree & Rock Vegetation | 4 | 53.0 |
| Herbaceous Agricultural Vegetation | 5 | 1,278.5 |
| Madrean Lowland Evergreen Woodland | 4 | 21,242.6 |
| Madrean Montane Forest & Woodland | 3 | 280.9 |
| Open Water | 5 | 21.1 |
| Rocky Mountain Lower Montane Forest | 4 | 64.8 |
| Southwest Riparian Forest | 1 | 1,078.6 |
| Warm Interior Chaparral | 4 | 4,374.6 |
| Warm-Desert Arroyo Riparian Scrub | 2 | 62.0 |

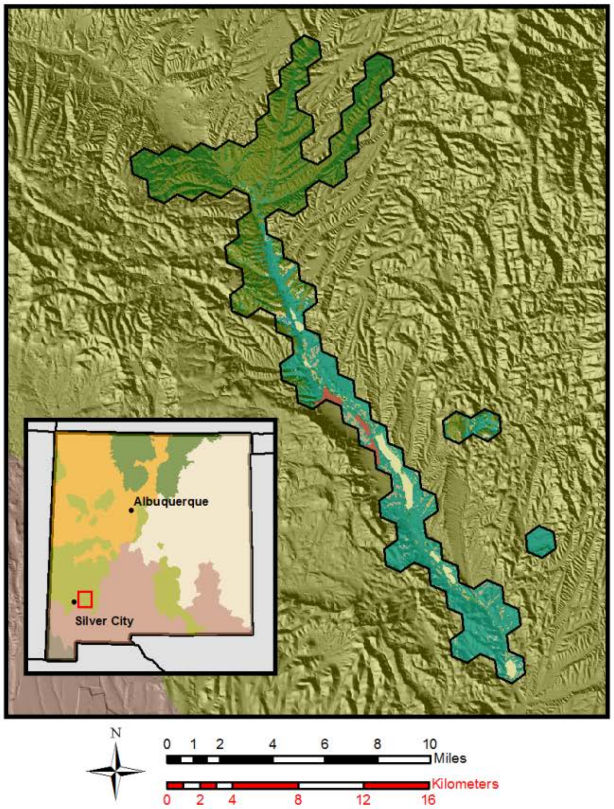
Figure 36. Lower Gila River Conservation Opportunity Area.

The Lower Gila River Conservation Opportunity Area (COA) (Figure 36) encompasses 44,248 ha (109,339 ac), split between the Arizona-New Mexico Mountains and Chihuahuan Desert ecoregions. The largest portion of the COA is privately-owned (45%), with substantial amounts managed by BLM (23%) and USFS (22%). It contains three Important Bird Areas (Gila Bird Area, Gila-Cliff Area, Lower Gila Box) and one TNC refuge (Gila River Complex), but only 9% of its lands are protected.

Landcover includes nine native vegetation habitats plus open water and agricultural lands. Almost half of the COA is covered by Madrean Lowland Evergreen Woodland (48%) with another third covered by Chihuahuan Desert Scrub (29%). Perennial aquatic habitats include 261 km (162 mi) of warm water streams and 25 ha (62 ac) of warm water reservoirs.

SGCN total 22, including three species categorized as Immediate Priority SGCN (pinyon jay, red-faced warbler, roundtail chub).

# Mimbres River




| Habitat | Tier | Area (ha) |
|---|---|---|
| Chihuahuan Desert Scrub | 4 | 13.4 |
| Chihuahuan Semi-Desert Grassland | 2 | 360.6 |
| Cliff, Scree & Rock Vegetation | 4 | 140.9 |
| Developed & Urban | 5 | 179.3 |
| Herbaceous Agricultural Vegetation | 5 | 377.1 |
| Intermountain Dry Shrubland & Grassland | 2 | 47.1 |
| Intermountain Juniper Woodland | 4 | 4,716.4 |
| Madrean Lowland Evergreen Woodland | 4 | 5,311.4 |
| Madrean Montane Forest & Woodland | 3 | 87.3 |
| Open Water | 5 | 1.7 |
| Rocky Mountain Lower Montain Forest | 4 | 3,527.1 |
| Rocky Mountain Montane Riparian Forest | 1 | 0.5 |
| Rocky Mountain Subalpine-High Montane Conifer Forest | 4 | 7.3 |
| Southwest Riparian Forest | 1 | 21.2 |
| Warm Interior Chaparral | 4 | 245.4 |

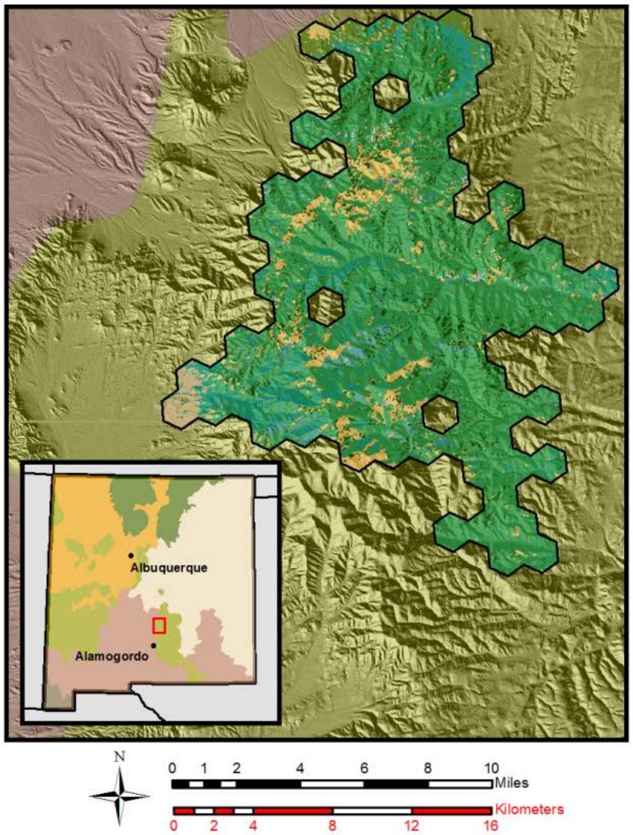
Figure 37. Mimbres River Conservation Opportunity Area.

The Mimbres River Conservation Opportunity Area (COA) (Figure 37) encompasses 15,038 ha (37,160 ac) 30 km (19 mi) west of Silver City. Almost half of the COA is privately-owned (48.5%) and half is managed by USFS (47%). It contains two Important Bird Areas (Mimbres River and Southern Black Range/Cooks Peak) and 38% of its lands are protected.

Landcover includes 12 native vegetation habitats plus open water, developed, and agricultural lands. Three habitats are dominant: Madrean Lowland Evergreen Woodland (35%), Intermountain Juniper Woodland (31.3%), and Rocky Mountain Lower Montane Forest (23.4%). Perennial aquatic habitats include 76 km (47 mi) of warm water streams, 44 km (27 mi) of cold water streams, and 11.6 ha (28.7 ac) of warm water reservoirs.

SGCN total 11, including two species categorized as Immediate Priority SGCN (red-faced warbler, Rio Grande sucker).

# Northern Sacramento Mountains




| Habitat | Tier | Area (ha) |
|---|---|---|
| Chihuahuan Desert Scrub | 4 | 20.2 |
| Chihuahuan Semi-Desert Grassland | 2 | 461.7 |
| Cliff, Scree & Rock Vegetation | 4 | 93.0 |
| Desert Alkali-Saline Wetland | 1 | 16.4 |
| Great Plains Shortgrass Prairie | 3 | 0.5 |
| Intermountain Dry Shrubland & Grassland | 2 | 7.9 |
| Madrean Lowland Evergreen Woodland | 4 | 2,749.1 |
| Madrean Montane Forest & Woodland | 3 | 18,320.3 |
| Montane-Subalpine Wet Shrubland & Wet Meadow | 1 | 0.2 |
| Rocky Mountain Lower Montane Forest | 4 | 1,155.3 |
| Rocky Mountain Montane Riparian Forest | 1 | 21.1 |
| Rocky Mountain Montane Shrubland | 3 | 1,288.3 |
| Rocky Mountain Pinyon - Juniper Woodland | 4 | 701.8 |
| Rocky Mountain Subalpine-High Montane Conifer Forest | 4 | 1,552.1 |
| Rocky Mountain Subalpine-High Montane Meadow | 2 | 878.2 |
| Southwest Riparian Forest | 1 | 1,013.8 |
| Warm Interior Chaparral | 4 | 224.7 |

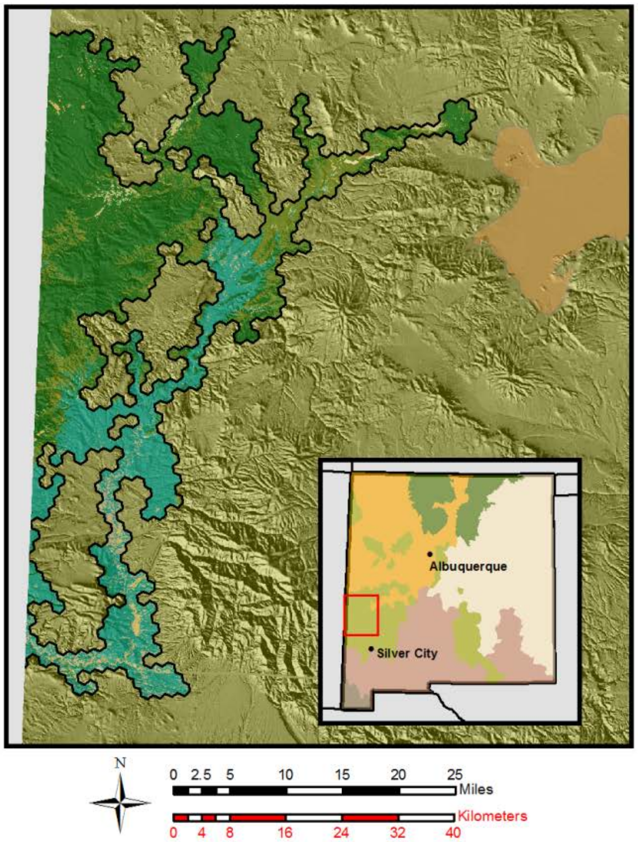
Figure 38. Northern Sacramento Mountains Conservation Opportunity Area.

The Northern Sacramento Mountains Conservation Opportunity Area (COA) (Figure 38) encompasses 28,470 ha (70,351 ac) of the Lincoln National Forest north of Ruidoso. Fifty-two percent of its lands are protected. The Sierra Blanca TNC refuge is located in this COA.

Landcover includes 17 native vegetation habitats. Madrean Montane Forest and Woodland is most dominant (64.4%). Perennial aquatic habitats include 124 km (77 mi) of cold water streams and 18.6 ha (46.0 ac) of cold water reservoirs.

SGCN total three, including one species considered as SGCN based on its occurrence within very limited ranges or highly specialized habitats in the state (Sacramento mountain salamander).

# San Francisco River




| Habitat | Tier | Area (ha) |
|---|---|---|
| Chihuahuan Desert Scrub | 4 | 2,046.5 |
| Chihuahuan Semi-Desert Grassland | 2 | 2,767.6 |
| Cliff, Scree & Rock Vegetation | 4 | 871.0 |
| Developed & Urban | 5 | 79.5 |
| Herbaceous Agricultural Vegetation | 5 | 149.1 |
| Intermountain Dry Shrubland & Grassland | 2 | 1,889.5 |
| Intermountain Juniper Woodland | 4 | 26,823.4 |
| Madrean Lowland Evergreen Woodland | 4 | 43,183.4 |
| Madrean Montane Forest & Woodland | 3 | 870.0 |
| Open Water | 5 | 4.1 |
| Rocky Mountain Lower Montane Forest | 4 | 81,358.7 |
| Rocky Mountain Montane Riparian Forest | 1 | 39.0 |
| Rocky Mountain Montane Shrubland | 3 | 157.9 |
| Rocky Mountain Subalpine-High Montane Conifer Forest | 4 | 170.0 |
| Rocky Mountain Subalpine-High Montane Meadow | 2 | 469.7 |
| Southwest Riparian Forest | 1 | 406.6 |
| Warm Interior Chaparral | 4 | 1,927.4 |
| Warm-Desert Arroyo Riparian Scrub | 2 | 1.0 |

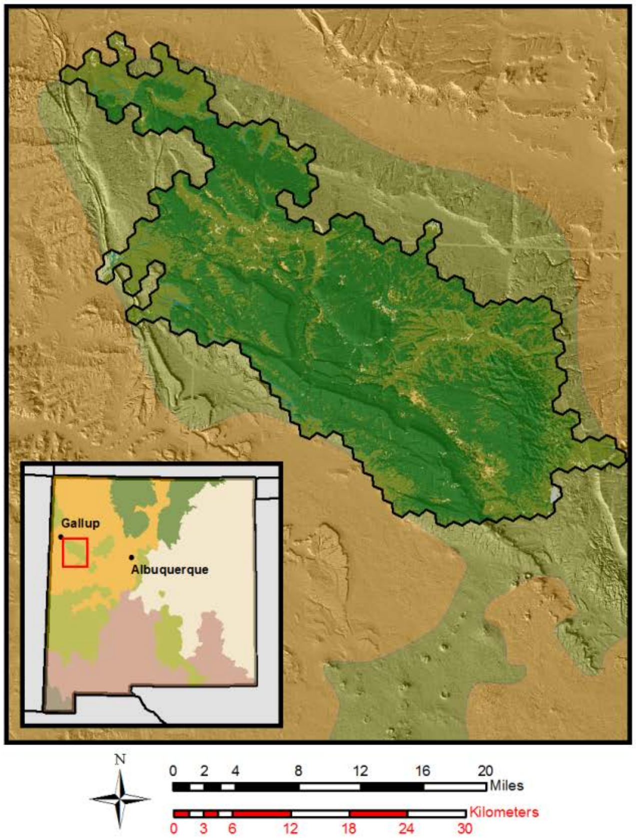
Figure 39. San Francisco River Conservation Opportunity Area.

The San Francisco River Conservation Opportunity Area (COA) (Figure 39) encompasses 163,724 ha (404,571 ac) 100 km (62 mi) north of Silver City. Most (89%) of it is managed by USFS. It contains three TNC conservation areas (Gila River Complex, Mogollon Divide, and Tularosa River); only 9% of its lands are protected.

Landcover includes 15 native vegetation habitats plus open water, developed, and agricultural lands. Three habitats are dominant: Rocky Mountain Lower Montane Forest (50%), Madrean Lowland Evergreen Woodland (26.4%), and Intermountain Juniper Woodland (16.4%). Perennial aquatic habitats include 523 km (325 mi) of warm water and 152 km (94 mi) of cold water streams.

SGCN total 28, the second largest number of any COA. These SGCN include six species categorized as Immediate Priority SGCN (Arizona montane vole, gray vireo, Gunnison's prairie dog, pinyon jay, red-faced warbler, Rio Grande sucker).

# Zuni Mountains




| Habitat | Tier | Area (ha) |
|---|---|---|
| *Arid West Interior Freshwater Emergent Marsh* | 1 | 1.5 |
| *Cliff, Scree & Rock Vegetation* | 4 | 280.0 |
| *Desert Alkali-Saline Wetland* | 1 | 37.5 |
| *Developed & Urban* | 5 | 16.9 |
| *Herbaceous Agricultural Vegetation* | 5 | 11.2 |
| *Intermountain Dry Shrubland & Grassland* | 2 | 1,381.5 |
| *Intermountain Juniper Woodland* | 4 | 40,438.4 |
| *Intermountain Saltbush Shrubland* | 4 | 9.2 |
| *Intermountain Tall Sagebrush Shrubland* | 3 | 22.5 |
| *Madrean Lowland Evergreen Woodland* | 4 | 16.0 |
| *Montane-Subalpine Wet Shrubland & Wet Meadow* | 1 | 21.2 |
| *Open Water* | 5 | 5.0 |
| *Rocky Mountain Lower Montane Forest* | 4 | 66,481.8 |
| *Rocky Mountain Montane Riparian Forest* | 1 | 981.0 |
| *Rocky Mountain Subalpine-High Montane Conifer Forest* | 4 | 457.6 |
| *Rocky Mountain Subalpine-High Montane Meadow* | 2 | 355.9 |
| *Warm Interior Chaparral* | 4 | 73.0 |

Figure 40. Zuni Mountains Conservation Opportunity Area.

The Zuni Mountains Conservation Opportunity Area (COA) (Figure 40) encompasses 110,750 ha (273,669 ac) west of Grants. Most (75%) of it is managed by USFS; 22.5% is privately-owned. It contains one Important Bird Area (Blackrock and Nutria Lakes) and two TNC refugia (Rio Nutria, Zuni Mountains), but none of its lands are protected.

Landcover includes 14 native vegetation habitats plus open water, developed, and agricultural lands. Two habitats are dominant: Rocky Mountain Lower Montane Forest (60%) and Intermountain Juniper Woodland (36.5%). Perennial aquatic habitat includes 59 km (37 mi) of warm water streams.

SGCN total 10, and include five species categorized as Immediate Priority SGCN (flammulated owl, Grace’s warbler, pinyon jay, Rio Grande sucker, Virginia’s warbler).

# Chapter 11: Monitoring

At its most basic level, monitoring functions to observe and assess the progress or quality of something over time. The nature of the characteristic or phenomenon being monitored helps to determine the duration of monitoring. This duration can vary from very short periods, for something like a colony of bacteria, to very long periods for long-lived animals and plant communities. The complexity of wildlife, habitats, and ecosystems means that there are countless combinations of species, interactions, and communities that could be observed and documented through monitoring. In addition to the range of subjects to be monitored, the purpose of monitoring helps to define and determine the monitoring approach. Lindenmayer and Likens (2010) categorize monitoring into three types: passive, mandated, and question-driven. Passive monitoring is that which is stimulated by curiosity or the love of learning. Mandated monitoring is required by statute or policy and typically tries to identify trends. Finally, question-driven monitoring is based on a conceptual model and can lead to testing predictions.

The State Wildlife Action Plan (SWAP) must incorporate three levels of monitoring to meet the requirements of the State Wildlife Grants (SWG) Program. These levels include: species and habitats, effectiveness of conservation actions, and adaptive management. Species and habitats and effectiveness of conservation actions both could be categorized as passive, mandated, or question-driven, depending on the context in which monitoring takes place. In contrast, adaptive management depends on question-driven monitoring to provide information that can lead to changes in management. Monitoring in this context is defined as "*the collection and analysis of repeated observations or measurements to evaluate changes in condition and progress toward meeting a management objective.*" In this chapter, we discuss the importance of monitoring in species and habitat conservation, identify some accepted approaches, and discuss data access and dissemination considerations for each level identified. The treatment will not be exhaustive but rather designed to provide a solid understanding of what and how monitoring needs to be done and an overview of how it can be most efficiently organized and presented. Appropriate citations will direct the reader to sources of more detailed information.

## Species and Habitat Monitoring

The first level of monitoring, species and habitats, encompasses a great diversity of potential data collection techniques. There are 235 Species of Greatest Conservation Need (SGCN) identified in this SWAP, any one of which could be a subject of monitoring. For any species, potential variables of concern could include factors acting at both the individual and population levels. These include but are not limited to: genetic diversity, growth rates, population composition, age structure, disease burden, parasite load, environmental contaminants, predation, and behavior. All wildlife species depend on suitable habitats. Even though humans classify vegetation communities into discrete assemblages, different species of wildlife have distinct requirements and utilize the same habitats differently. Assessing the condition or status of a habitat is frequently limited to fairly narrow observations of plant assemblage composition and structure that is used as a proxy for community and habitat health. Monitoring also can include assessing very specific components of a wildlife species' habitat that may have limited importance to the other species utilizing the same habitat. Ultimately, there are an infinite number of variables associated with a species or its habitat that could be monitored. Neither the New Mexico Department of Game and Fish (Department) nor any of the other entities engaged in monitoring in the State have the capacity to conduct comprehensive wildlife or habitat monitoring for all SGCN.

Specific Department mandates for species monitoring originate primarily through individual grant documents. Monitoring also is a requirement under the New Mexico Wildlife Conservation Act (WCA; 17-2-37 through 17-2-46 NMSA 1978).This includes the requirement to generate a biennial status assessment of all state Threatened or Endangered wildlife. These mandates cover only a fraction of the 235 SGCN. There are, however, many other potential sources of information that can provide data useful in assessing the status of species and habitats. Peer-reviewed publications are potentially a valuable source of species information that may address management concerns. Related sources of information include academic theses and dissertations that investigate questions and/or species of interest to the Department. The Department supports Share with Wildlife (SwW) projects that target SGCN and their habitats, and SwW project reports can provide valuable, though typically short-duration, monitoring data. In a related vein, the Department issues Scientific Collecting permits to scientists from institutions across the country. Annual collecting permit reports can provide data on both species and habitats when spatially explicit location information is included. As is the case with SwW projects, there may not be ongoing repeated monitoring data unless the research is being done as part of a multiyear project. There are a host of local, state, and federal agencies and institutions that conduct independent investigations that may include species and habitats in New Mexico, and thus could yield valuable species or habitat information. Whether this research is a result of permit compliance or other forms of mandated information collection or of academic studies with applications to wildlife conservation and management, it may be of use to the Department.

The Department and other interested parties may focus their efforts on answering the most pressing questions to effectively manage their resources. With 235 SGCN and 39 habitats, it is imperative that planned species and/or habitat monitoring initiatives be prioritized to focus resources where they will be most useful in supporting conservation needs. All of the SGCN and habitats described in the SWAP have been evaluated and assigned to categories of conservation priority, which can serve as an initial guide to selecting species or habitats for monitoring. Conservation Opportunity Areas (COAs) potentially could be used to further focus monitoring and conservation activities in areas of the State that contain especially high biodiversity.

# Effectiveness of Conservation Actions

The sheer number of species and habitats in New Mexico precludes the Department from attempting to intensively monitor even a fraction of those species and habitats. In contrast, the number of Department-implemented conservation actions is much smaller and within the capacity to monitor. Even when other agency and institution-supported conservation actions are taken into account, the overall number of actions is still limited and the potential to track and assess success is greater. At this level, not only is the universe of efforts limited, but funding sources for conservation actions often require subsequent monitoring of action success. As with species and habitats monitoring, there are multiple entities implementing conservation actions and monitoring results. Thus, the Department can benefit from monitoring efforts being carried out by other agencies and institutions and, where necessary, can target specific conservation actions lacking adequate monitoring when implementing its own monitoring programs. No comprehensive compilation, nor infrastructure for such compilation, currently exists for use in assessing whether the portfolio of implemented conservation actions is improving the overall status of wildlife species and habitats across the State. A coordinated effort among resource managers to compile in a database and disseminate results of monitoring programs in the State in a format that is comparable between projects and over time should be a priority for SWAP implementation.

At the project-level, targeted conservation actions with specific desired outcomes naturally lead to question-driven monitoring efforts that can help to identify success. There may be a limited number of conservation actions that need to be monitored, but there could be a wide range of variables that, if measured, would provide acceptable indicators of success. Thus, even with a limited number of projects, there could be a much larger number of suitable variables measured and monitoring approaches used. Monitoring of project-level success is therefore impractical for all conservation actions that are described in and may be implemented under the SWAP. However, by focusing conservation projects using COAs and other prioritization approaches, resource managers can collectively identify specific conservation targets to evaluate monitoring project success. Careful planning is a necessary component of developing monitoring programs that will yield suitable data to assess the success of conservation actions.

# Adaptive Management

The third SWG-required level of monitoring is that necessary to implement adaptive management. In New Mexico, the Department actively manages game and sport fish populations, which require ongoing monitoring to assess status relative to demand for resources. In contrast, there are many fewer Department-led active management programs for SGCN or other nongame species. The WCA-mandated biennial status assessments determine whether changes in species listing designations are warranted. The WCA does not however require that any particular conservation actions be developed or implemented as a result of those assessments. Active nongame species adaptive management programs in the State are primarily led by cooperating agencies participating in multi-agency initiatives focused on Threatened and/or Endangered species. In these cases, the Department is typically part of a collaborative effort that is responding to species-specific recovery objectives. Management actions taken by the Department involve measures such as conserving native fish through non-native removals or hatchery production of fry to augment wild populations. In most of these cases, the Department is not the lead agency, and results of monitoring do not necessarily lead directly to altered management. The noteworthy exceptions to this include efforts made with respect to the following species: Socorro isopod (*Thermosphaeroma thermophilum*), Gila trout (*Oncorhynchus gilae*), boreal toad (*Anaxyrus boreas*), Gould's wild turkey (*Meleagris gallopavo mexicana*), and River otter (*Lontra canadensis*). The Department will identify or develop an accessible common database of information to document the status and condition of identified threats and implemented conservation actions. It will also identify data gaps and varying data collection methodologies that provide a framework for promoting robust standard monitoring approaches.

# Sources of Monitoring Information

The scientific literature on wildlife and habitat monitoring is broad and complex with numerous references devoted to monitoring everything from single species to entire ecoregions. A compendium of current references would provide at best a cursory overview of existing sources. There are many online sources of scientific publications provided by government agencies, university libraries, and commercial and non-profit web search engines. Some of the websites that compile and provide this information are based at established institutions that will continue to provide this service and improve their performance over time. Other sources of information are the product of commercial ventures with variable durability. The Department has attempted to provide a starting point for locating references that can guide the user in designing effective and robust monitoring methodologies and programs. These websites, and others like them, can help provide access to the existing literature and identify additional portals for literature searches that will return numerous and diverse examples of wildlife and habitat monitoring approaches.

- US Fish and Wildlife Service Conservation Library: http://fwslibrary.worldcat.org/
- US Geological Survey, Publications Warehouse: http://pubs.er.usgs.gov/
- The Library of Congress, Virtual Reference Shelf: https://www.loc.gov/rr/askalib/virtualref.html
- Biodiversity Heritage Library: http://www.biodiversitylibrary.org/
- Public Library of Science: https://www.plos.org/
- Science.gov: http://www.science.gov/browse/w_115.htm

In addition to these websites, several potentially useful foundational sources include:

- Gitzen, R. A., J. J. Millspaugh, A. B. Cooper, and D. S. Licht. 2012. Design and analysis of long-term ecological monitoring studies. Cambridge University Press, Cambridge, UK.
- Elzinga, C. L., D. W. Salzer, and J. W. Willoughby. 1998. Measuring and monitoring plant populations. US Department of the Interior, Bureau of Land Management Technical Reference 1730-1, Denver, Colorado, USA.
- Busch, D. E., and J. C. Trexler. 2003. Monitoring ecosystems: interdisciplinary approaches for evaluating ecoregional initiatives. Island Press, Washington, D.C., USA.

# Guidance for Monitoring SGCN

Based on the limited resources available, the Department’s proposed strategy for addressing the needs of wildlife and associated habitats in the State will include: relying on partners; facilitating data organization and storage; using indices, targeted monitoring, and new technologies. Employing these approaches will permit the Department to maximize the impact of limited resources, develop stronger collaborative relationships, benefit from a diverse array of perspectives, build on extant information management efforts, and contribute to efficient and economical monitoring approaches. In summary, the SWAP monitoring approach will consist of: 1) a coordinated, centralized effort that pulls together results of biological monitoring from multiple entities in New Mexico; 2) selected species and habitat-specific monitoring that address mandates of collaborators across the State and emerging high-priority conservation needs; 3) monitoring of broad-scale environmental variables that serve as ecological drivers for SGCN populations; 4) identifying and promoting monitoring techniques that efficiently generate community-level or multi-species status information; 5) utilizing biological monitoring results to assess the success of representative conservation actions described in this Plan; and 6) compiling and disseminating monitoring results in formats that can serve resource managers across the State. A brief explanation of these approaches will clarify how they complement one another in positioning the Department and its collaborators to understand and track the status of species, habitats, and conservation actions.

Despite the numerous examples of monitoring-related efforts in which the Department has participated (Table 33), the fact that many of them are led or contributed to by other entities is evidence that the Department is not alone in performing wildlife-related monitoring activities. The Department recognizes that it lacks the capacity to accomplish all needed monitoring, especially for SGCN and priority habitats. However, responsibilities of other agencies include: monitoring of listed species and wildlife of conservation concern related to land management planning; and monitoring as described in established recovery plans, conservation agreements, and other documents. As the only agency in New Mexico with specific mandates for management of wildlife populations across the State, the Department is uniquely positioned to coordinate assistance from its collaborators in compiling and disseminating monitoring results statewide. By encouraging land management agencies, educational institutions, environmental consulting companies, non-profit environmental organizations, and independent researchers to refer to the SWAP and incorporate its guidance into decisions on what and where to monitor, the Department can increase monitoring of SGCN and priority habitats. The Department will need to maintain active ongoing communication with existing partners, promote the SWAP, and try to cultivate new collaborators in performing and compiling information on monitoring. Active communication has the added benefit of putting the Department in a position of potentially being able to influence the kind of monitoring that is conducted and the utility of the data produced.

Table 33: Current monitoring of Species of Greatest Conservation Need.

Data gathered include current status, presence/absence, population trend, and other demographic parameters. Conservation actions that support and/or direct monitoring are recovery plans, conservation agreements, and conservation teams. This list does not identify all species monitored or all monitoring efforts for each species.

| SGCN Common Name | SGCN Scientific Name | Taxonomic Group | Category | Monitoring Action[51] | Other Monitoring Entities or Partners |
|---|---|---|---|---|---|
| Boreal Toad | *Anaxyrus boreas* | Amphibians | I | CA, CT, M(a) | USFS, University, Private |
| Sonoran Desert Toad | *Incilius alvarius* | Amphibians | H | M(o) | University |
| Western Narrow-mouthed Toad | *Gastrophryne olivacea* | Amphibians | H | M(o) | University |
| Lowland Leopard Frog | *Lithobates yavapaiensis* | Amphibians | H | M(o) | USFS |
| Sacramento Mountain Salamander | *Aneides hardii* | Amphibians | H | CT, M(a) | USFS, University |
| Boreal Chorus Frog | *Pseudacris maculata* | Amphibians | S | M(p) | University |
| Arizona Treefrog | *Hyla wrightorum* | Amphibians | S | M(o) | |
| Northern Leopard Frog | *Lithobates pipiens* | Amphibians | S | M(p) | USFS, University, Private |
| Plains Leopard Frog | *Lithobates blairi* | Amphibians | S | M(o) | University |
| Rio Grande Leopard Frog | *Lithobates berlandieri* | Amphibians | S | M(o) | |
| Arizona Toad | *Anaxyrus microscaphus* | Amphibians | D | M(a) | USFS, USFWS, University |
| Eastern Barking Frog | *Craugastor augusti latrans* | Amphibians | D | M(p) | University |
| Chiricahua Leopard Frog | *Lithobates chiricahuensis* | Amphibians | F | CT, M(a) | USFS, USFWS, NGO |
| Jemez Mountains Salamander | *Plethodon neomexicanus* | Amphibians | F | CT, M(a) | USFS, USFWS, NPS, University |
| White-tailed Ptarmigan | *Lagopus leucura* | Birds | I | M(o) | NGO |
| Flammulated Owl | *Psiloscops flammeolus* | Birds | I | M(o) | NGO, Private |
| Mexican Whip-poor-will | *Antrostomus arizonae* | Birds | I | M(a) | USGS |

[51] CA = Conservation Agreement or Recovery Plan; CT = Conservation/Recovery Team; M = Monitoring (a) = at least once per year; (p) = periodically (but less than annually); (o) = opportunistically

| SGCN Common Name | SGCN Scientific Name | Taxonomic Group | Category | Monitoring Action[51] | Other Monitoring Entities or Partners |
|---|---|---|---|---|---|
| Lewis's Woodpecker | *Melanerpes lewis* | Birds | I | M(a) | USGS |
| Gray Vireo | *Vireo vicinior* | Birds | I | CT, M(a) | USGS, Tribe, NGO, Private |
| Pinyon Jay | *Gymnorhinus cyanocephalus* | Birds | I | M(a) | USGS, Private |
| Juniper Titmouse | *Baeolophus ridgwayi* | Birds | I | M(a) | USGS, Private |
| Bendire's Thrasher | *Toxostoma bendirei* | Birds | I | CT, M(a) | USFWS, USGS |
| Sprague's Pipit | *Anthus spragueii* | Birds | I | M(o) | USFWS |
| Painted Redstart | *Myioborus pictus* | Birds | I | M(a) | USGS, Private |
| Grace's Warbler | *Setophaga graciae* | Birds | I | M(a) | USGS, NGO, Private |
| Black-throated Gray Warbler | *Setophaga nigrescens* | Birds | I | M(a) | USGS, NGO, Private |
| Red-faced Warbler | *Cardellina rubrifrons* | Birds | I | M(a) | USGS, Private |
| Virginia's Warbler | *Oreothlypis virginiae* | Birds | I | M(a) | USGS, NGO, Private |
| Black-chinned Sparrow | *Spizella atrogularis* | Birds | I | M(a) | USGS, University, Private |
| Arizona Grasshopper Sparrow | *Ammodramus savannarum ammolegus* | Birds | I | M(a) | NGO |
| Chestnut-collared Longspur | *Calcarius ornatus* | Birds | I | M(a) | NGO |
| McCown's Longspur | *Rhynchophanes mccownii* | Birds | I | M(a) | NGO |
| Gould's Wild Turkey | *Meleagris gallopavo mexicana* | Birds | H | CT, M(a) | USFS |
| Eared Grebe | *Podiceps nigricollis* | Birds | H | M(a) | USGS |
| American Bittern | *Botaurus lentiginosus* | Birds | H | M(a) | USGS |
| Bald Eagle | *Haliaeetus leucocephalus* | Birds | H | M(a) | USFWS, NGO, Private |
| Peregrine Falcon | *Falco peregrinus* | Birds | H | M(a) | USFWS, USGS, NGO, Private |
| Boreal Owl | *Aegolius funereus* | Birds | H | M(o) | NGO |
| Burrowing Owl | *Athene cunicularia* | Birds | H | CT, M(a) | USGS, University, Private |

| SGCN Common Name | SGCN Scientific Name | Taxonomic Group | Category | Monitoring Action[51] | Other Monitoring Entities or Partners |
|---|---|---|---|---|---|
| Black Swift | *Cypseloides niger* | Birds | H | M(a) | USGS |
| Bell's Vireo | *Vireo bellii* | Birds | H | M(a) | USGS, NGO |
| Bank Swallow | *Riparia riparia* | Birds | H | M(a) | USGS |
| Lesser Prairie-Chicken | *Tympanuchus pallidicinctus* | Birds | S | CT, M(a) | BLM, USGS, NGO |
| Mountain Plover | *Charadrius montanus* | Birds | S | M(a) | USGS |
| Snowy Plover | *Charadrius nivosus* | Birds | S | M(a) | NGO |
| Long-billed Curlew | *Numenius americanus* | Birds | S | M(a) | USGS, NGO |
| Neotropic Cormorant | *Phalacrocorax brasilianus* | Birds | S | M(a) | USGS, Private |
| Common Ground-dove | *Columbina passerina* | Birds | S | M(a) | USGS |
| Whiskered Screech-Owl | *Megascops trichopsis* | Birds | S | M(a) | USGS |
| Common Nighthawk | *Chordeiles minor* | Birds | S | M(a) | USGS |
| Costa's Hummingbird | *Calypte costae* | Birds | S | M(o) | NGO |
| Violet-crowned Hummingbird | *Amazilia violiceps* | Birds | S | M(o) | NGO |
| Williamson's Sapsucker | *Sphyrapicus thyroideus* | Birds | S | M(a) | USGS, Private |
| Gila Woodpecker | *Melanerpes uropygialis* | Birds | S | M(a) | USGS, University |
| Red-headed Woodpecker | *Melanerpes erythrocephalus* | Birds | S | M(a) | USGS |
| Northern Beardless Tyrannulet | *Camptostoma imberbe* | Birds | S | M(o) | NGO, Private Landowner |
| Olive-sided Flycatcher | *Contopus cooperi* | Birds | S | M(a) | USGS, Private |
| Thick-billed Kingbird | *Tyrannus crassirostris* | Birds | S | M(o) | NGO |
| Loggerhead Shrike | *Lanius ludovicianus* | Birds | S | M(a) | USGS, University, NGO |
| Clark's Nutcracker | *Nucifraga columbiana* | Birds | S | M(a) | USGS, Private |
| Pygmy Nuthatch | *Sitta pygmaea* | Birds | S | M(a) | USGS, Private |
| Mountain Bluebird | *Sialia currucoides* | Birds | S | M(a) | USGS |
| Western Bluebird | *Sialia mexicana* | Birds | S | M(a) | USGS, Private |
| Lucy's Warbler | *Oreothlypis luciae* | Birds | S | M(a) | USGS |

| SGCN Common Name | SGCN Scientific Name | Taxonomic Group | Category | Monitoring Action[51] | Other Monitoring Entities or Partners |
|---|---|---|---|---|---|
| Yellow-eyed Junco | *Junco phaeonotus* | Birds | S | M(o) | NGO |
| Baird's Sparrow | *Ammodramus bairdii* | Birds | S | M(a) | University, NGO |
| Cassin's Sparrow | *Peucaea cassinii* | Birds | S | M(a) | USGS, NGO |
| Sagebrush Sparrow | *Artemisiospiza nevadensis* | Birds | S | M(a) | USGS |
| Vesper Sparrow | *Pooecetes gramineus* | Birds | S | M(a) | USGS, University |
| Varied Bunting | *Passerina versicolor* | Birds | S | M(o) | NGO |
| Cassin's Finch | *Haemorhous cassinii* | Birds | S | M(a) | USGS, NGO, Private |
| Evening Grosbeak | *Coccothraustes vespertinus* | Birds | S | M(a) | USGS, NGO, Private |
| Clark's Grebe | *Aechmophorus clarkii* | Birds | D | M(a) | USGS |
| Common Black Hawk | *Buteogallus anthracinus* | Birds | D | M(a) | USGS |
| Elf Owl | *Micrathene whitneyi* | Birds | D | M(a) | USGS |
| Broad-billed Hummingbird | *Cynanthus latirostris* | Birds | D | M(a) | NGO |
| Lucifer Hummingbird | *Calothorax lucifer* | Birds | D | M(n) | NGO, Private landowner |
| Elegant Trogon | *Trogon elegans* | Birds | D | M(n) | NGO |
| Botteri's Sparrow | *Peucaea botterii* | Birds | D | M(a) | USGS, NGO |
| Abert's Towhee | *Melozone aberti* | Birds | D | M(a) | USGS, University |
| Brown-capped Rosy-Finch | *Leucosticte australis* | Birds | D | M(a) | NGO, Private |
| Aplomado Falcon | *Falco femoralis* | Birds | F | CT, M(a) | USFWS, USGS |
| Least Tern | *Sternula antillarum* | Birds | F | CT, M(o) | USFWS |
| Yellow-billed Cuckoo | *Coccyzus americanus* | Birds | F | CT, M(a) | USFWS, USGS, NGO |
| Mexican Spotted Owl | *Strix occidentalis lucida* | Birds | F | CT, M(a) | USFS, Private |
| Southwestern Willow Flycatcher | *Empidonax traillii extimus* | Birds | F | CT, M(a) | BOR, USFWS , NGO |
| Conchas Crayfish | *Orconectes deanae* | Crustaceans | H | M(o) | EMNRD |
| BLNWR cryptic species Amphipod | *Gammarus* sp. (unnamed) | Crustaceans | D | M(n) | USFWS |

| SGCN Common Name | SGCN Scientific Name | Taxonomic Group | Category | Monitoring Action[51] | Other Monitoring Entities or Partners |
|---|---|---|---|---|---|
| Sitting Bull Spring cryptic species Amphipod | *Gammarus* sp. (unnamed) | Crustaceans | D | M(n) | USFS |
| Western Plains Crayfish | *Orconectes causeyi* | Crustaceans | D | M(n) | |
| Southern Plains Crayfish | *Procambarus simulans* | Crustaceans | D | M(n) | |
| Moore's Fairy Shrimp | *Streptocephalus moorei* | Crustaceans | D | M(n) | |
| Brine Shrimp | *Artemia franciscana* | Crustaceans | D | M(n) | |
| Colorado Fairy Shrimp | *Branchinecta coloradoensis* | Crustaceans | D | M(n) | |
| Versatile Fairy Shrimp | *Branchinecta lindahli* | Crustaceans | D | M(n) | |
| Alkali Fairy Shrimp | *Branchinecta mackini* | Crustaceans | D | M(n) | |
| Packard's Fairy Shrimp | *Branchinecta packardi* | Crustaceans | D | M(n) | |
| Sublette's Fairy Shrimp | *Phallocryptis subletti* | Crustaceans | D | M(n) | |
| Knobblip Fairy Shrimp | *Eubranchipus bundyi* | Crustaceans | D | M(n) | |
| Dumont's Fairy Shrimp | *Streptocephalus henridumontis* | Crustaceans | D | M(n) | |
| Bowman's Fairy Shrimp | *Streptocephalus thomasbowmani* | Crustaceans | D | M(n) | |
| Great Plains Fairy Shrimp | *Streptocephalus texanus* | Crustaceans | D | M(n) | |
| Mexican Beavertail Fairy Shrimp | *Thamnocephalus mexicanus* | Crustaceans | D | M(n) | |
| Beavertail Fairy Shrimp | *Thamnocepahlus platyurus* | Crustaceans | D | M(n) | University |
| Mexican Clam Shrimp | *Cyzicus mexicanus* | Crustaceans | D | M(n) | |
| Swaybacked Clam Shrimp | *Eocyzicus concavus* | Crustaceans | D | M(n) | |
| Straightbacked Clam Shrimp | *Eocyzicus digueti* | Crustaceans | D | M(n) | |
| Fuzzy Cyst Clam Shrimp | *Eulimnadia antlei* | Crustaceans | D | M(n) | |
| Cylindrical Cyst Clam Shrimp | *Eulimnadia cylindrova* | Crustaceans | D | M(n) | |

| SGCN Common Name | SGCN Scientific Name | Taxonomic Group | Category | Monitoring Action[51] | Other Monitoring Entities or Partners |
|---|---|---|---|---|---|
| Diversity Clam Shrimp | *Eulimnadia diversa* | Crustaceans | D | M(n) | |
| Clam Shrimp | *Eulimnadia follismilis* | Crustaceans | D | M(n) | |
| Texan Clam Shrimp | *Eulimnadia texana* | Crustaceans | D | M(n) | |
| Short Finger Clam Shrimp | *Lynceus brevifrons* | Crustaceans | D | M(n) | |
| Lynch Tadpole Shrimp | *Lepidurus lemmoni* | Crustaceans | D | M(n) | |
| Socorro Isopod | *Thermosphaeroma thermophilum* | Crustaceans | F | M(a) | USFWS, Private landowners |
| Noel's Amphipod | *Gammarus desperatus* | Crustaceans | F | CA, CT, M(p) | USFWS |
| Rio Grande Chub | *Gila pandora* | Fish | I | M(o) | Private landowner |
| Headwater Chub | *Gila nigra* | Fish | I | CA, M(a) | USFWS |
| Roundtail Chub | *Gila robusta* | Fish | I | CA, M(a) | USFWS, Tribes |
| Peppered Chub | *Macrhybopsis tetranema* | Fish | I | M(o) | |
| Gray Redhorse | *Moxostoma congestum* | Fish | I | M(p) | |
| Blue Sucker | *Cycleptus elongatus* | Fish | I | M(p) | |
| Rio Grande Sucker | *Catostomus plebeius* | Fish | I | M(o) | University, Private landowner |
| Pecos Pupfish | *Cyprinodon pecosensis* | Fish | I | CA, CT, M(a) | USFWS, University |
| White Sands Pupfish | *Cyprinodon tularosa* | Fish | I | CA, CT, M(a) | DOD, USFWS |
| Greenthroat Darter | *Etheostoma lepidum* | Fish | H | M(o) | USFWS |
| Bigscale Logperch (native pop.) | *Percina macrolepida* | Fish | H | M(o) | USFWS |
| Southern Redbelly Dace | *Phoxinus erythrogaster* | Fish | S | M(p) | Private, Private landowner |
| Suckermouth Minnow | *Phenacobius mirabilis* | Fish | S | M(o) | Private |
| Desert Sucker | *Catostomus clarkii* | Fish | S | M(o) | |
| Sonora Sucker | *Catostomus insignis* | Fish | S | M(o) | |
| Mexican Tetra | *Astyanax mexicanus* | Fish | S | M(o) | |
| Chihuahua Chub | *Gila nigrescens* | Fish | F | CA, CT, M(a) | USFS |
| Gila Chub | *Gila intermedia* | Fish | F | CA, M(a) | USFS |
| Loach Minnow | *Rhinichthys (Tiaroga) cobitis* | Fish | F | CA, CT, M(a) | USFS, USFWS |

| SGCN Common Name | SGCN Scientific Name | Taxonomic Group | Category | Monitoring Action[51] | Other Monitoring Entities or Partners |
|---|---|---|---|---|---|
| Rio Grande Silvery Minnow | *Hybognathus amarus* | Fish | F | CA, CT, M(a) | BOR, USFWS, |
| Arkansas River Shiner (native pop.) | *Notropis girardi* | Fish | F | CT, M(a) | USFWS, University |
| Pecos Bluntnose Shiner | *Notropis simus pecosensis* | Fish | F | CT, M(a) | USFWS, University |
| Spikedace | *Meda fulgida* | Fish | F | CA, CT, M(a) | USFS, USFWS |
| Colorado Pikeminnow | *Ptychocheilus lucius* | Fish | F | CA, M(a) | USFWS, Tribes |
| Zuni Bluehead Sucker | *Catostomus discobolus yarrowi* | Fish | F | CA, M(a) | USFS, USFWS, , NGO, Tribe |
| Razorback Sucker | *Xyrauchen texanus* | Fish | F | CA, M(a) | USFWS, Tribes |
| Gila Trout | *Oncorhynchus gilae* | Fish | F | CA, M(a) | USFS, USFWS |
| Pecos Gambusia | *Gambusia nobilis* | Fish | F | M(o) | USFWS, University |
| Gila Topminnow | *Poeciliopsis occidentalis occidentalis* | Fish | F | CA, M(p) | Private landowner |
| American Mink | *Vison vison* | Mammals | I | M(o) | |
| North American River Otter | *Lontra canadensis* | Mammals | I | M(o) | Tribes |
| Organ Mountains Colorado Chipmunk | *Tamias quadrivittatus australis* | Mammals | I | M(o) | Private |
| Oscura Mountains Colorado Chipmunk | *Tamias quadrivittatus oscuraensis* | Mammals | I | M(o) | |
| Peñasco Least Chipmunk | *Tamias minimus atristriatus* | Mammals | I | M(p) | Private |
| Black-tailed Prairie Dog | *Cynomys ludovicianus* | Mammals | I | CT, M(a) | BLM |
| Gunnison's Prairie Dog | *Cynomys gunnisoni* | Mammals | I | CT, M(a) | BLM, USFS,USFWS, University, NGO, Private landowner |
| Arizona Montane Vole | *Microtus montanus arizonensis* | Mammals | I | M(o) | USFS |

| SGCN Common Name | SGCN Scientific Name | Taxonomic Group | Category | Monitoring Action[51] | Other Monitoring Entities or Partners |
|---|---|---|---|---|---|
| White-sided Jackrabbit | *Lepus callotis* | Mammals | I | M(o) | Private |
| Arizona Shrew | *Sorex arizonae* | Mammals | H | M(o) | |
| Least Shrew | *Cryptotis parva* | Mammals | H | M(o) | |
| American Pika | *Ochotona princeps* | Mammals | H | M(p) | |
| Pale Townsend's Big-eared Bat | *Corynorhinus townsendii* | Mammals | S | CT, M(o) | University, NGO |
| Spotted Bat | *Euderma maculatum* | Mammals | S | CT, M(o) | University |
| Pacific Marten | *Martes caurina* | Mammals | S | M(p) | USFS, Private |
| Mexican Long-tongued Bat | *Choeronycteris mexicana* | Mammals | D | CT, M(n) | |
| Western Yellow Bat | *Lasiurus xanthinus* | Mammals | D | CT, M(n) | |
| Southern Pocket Gopher | *Thomomys umbrinus* | Mammals | D | M(n) | Private landowner |
| Mexican Long-nosed Bat | *Leptonycteris nivalis* | Mammals | F | CT, M(o) | |
| Lesser Long-nosed Bat | *Leptonycteris yerbabuenae* | Mammals | F | CT, M(o) | |
| Mexican Gray Wolf | *Canis lupus baileyi* | Mammals | F | CT, M(a) | USFWS, AGFD |
| Jaguar | *Panthera onca* | Mammals | F | CT, M(o) | |
| Black-footed Ferret | *Mustela nigripes* | Mammals | F | CT, M(o) | Private landowner |
| New Mexico Meadow Jumping Mouse | *Zapus hudsonius luteus* | Mammals | F | M(a) | USFS, USFWS, University, Private |
| Texas Hornshell | *Popenaias popeii* | Molluscs | I | CA, M(a) | USFWS, University, Private landowners |
| New Mexico Hot Springsnail | *Pyrgulopsis thermalis* | Molluscs | H | M(o) | |
| Gila Springsnail | *Pyrgulopsis gilae* | Molluscs | H | M(o) | |
| Pecos Springsnail | *Pyrgulopsis pecosensis* | Molluscs | H | M(o) | |
| Tularosa Springsnail | *Juturnia tularosae* | Molluscs | H | M(o) | |
| Star Gyro | *Gyraulus crista* | Molluscs | H | M(o) | |
| New Mexico Ramshorn Snail | *Pecosorbis kansasensis* | Molluscs | H | M(o) | |

| SGCN Common Name | SGCN Scientific Name | Taxonomic Group | Category | Monitoring Action[51] | Other Monitoring Entities or Partners |
|---|---|---|---|---|---|
| Lang Canyon Talussnail | *Sonorella painteri* | Molluscs | H | M(o) | |
| Shortneck Snaggletooth Snail | *Gastrocopta dalliana* | Molluscs | H | M(o) | |
| Ovate Vertigo Snail | *Vertigo ovata* | Molluscs | H | M(o) | |
| Ruidoso Snaggletooth Snail | *Gastrocopta ruidosensis* | Molluscs | H | M(o) | |
| Cross Holospira Snail | *Holospira crossei* | Molluscs | H | M(o) | |
| Animas Mountains Holospira Snail | *Holospira animasensis* | Molluscs | H | M(o) | |
| Mineral Creek Mountainsnail | *Oreohelix pilsbryi* | Molluscs | H | M(o) | |
| Hacheta Grande Woodlandsnail | *Ashmunella hebardi* | Molluscs | H | M(o) | |
| Cooke's Peak Woodlandsnail | *Ashmunella macromphala* | Molluscs | H | M(o) | |
| Sangre de Cristo Woodlandsnail | *Ashmunella thomsoniana* | Molluscs | H | M(o) | |
| Jemez Woodlandsnail | *Ashmunella ashmuni* | Molluscs | H | M(o) | |
| Silver Creek Woodlandsnail | *Ashmunella binneyi* | Molluscs | H | M(o) | |
| Doña Ana Talussnail | *Sonorella todseni* | Molluscs | H | M(o) | |
| New Mexico Talussnail (Big Hatchet Mountains) | *Sonorella hachitana* | Molluscs | H | M(o) | |
| New Mexico Talussnail (Florida Mountains) | *Sonorella hachitana flora* | Molluscs | H | M(o) | |
| Paper Pondshell | *Utterbackia imbecillis* | Molluscs | H | M(o) | |
| Swamp Fingernailclam | *Musculium partumeium* | Molluscs | H | M(o) | |
| Lilljeborg's Peaclam | *Pisidium lilljeborgi* | Molluscs | H | M(o) | |
| Lake Fingernailclam | *Musculium lacustre* | Molluscs | H | M(o) | |
| Long Fingernailclam | *Musculium transversum* | Molluscs | H | M(o) | |

| SGCN Common Name | SGCN Scientific Name | Taxonomic Group | Category | Monitoring Action[51] | Other Monitoring Entities or Partners |
|---|---|---|---|---|---|
| Obese Thorn Snail | *Carychium exiguum* | Molluscs | S | M(o) | |
| False Marsh Snail | *Deroceras heterura* | Molluscs | S | M(o) | |
| Texas Liptooth Snail | *Linisa texasiana* | Molluscs | S | M(o) | |
| Wrinkled Marshsnail | *Stagnicola caperata* | Molluscs | D | M(n) | |
| Creeping Ancylid Snail | *Ferrissia rivularis* | Molluscs | D | M(n) | |
| Vallonia Snail | *Vallonia sonorana* | Molluscs | D | M(n) | |
| Metcalf Holospira Snail | *Holospira metcalfi* | Molluscs | D | M(n) | |
| Fringed Mountainsnail | *Radiocentrum ferrissi* | Molluscs | D | M(n) | |
| Woodlandsnail | *Ashmunella amblya cornudasensis* | Molluscs | D | M(n) | |
| Animas Peak Woodlandsnail | *Ashmunella animasensis* | Molluscs | D | M(n) | |
| New Mexico Talussnail (Peloncillo Mountains) | *Sonorella hachitana peloncillensis* | Molluscs | D | M(n) | |
| Animas Talussnail | *Sonorella animasensis* | Molluscs | D | M(n) | |
| Sangre De Cristo Peaclam | *Pisidium sanguinichristi* | Molluscs | D | M(n) | |
| Alamosa Springsnail | *Pseudotryonia alamosae* | Molluscs | F | M(a) | |
| Chupadera Springsnail | *Pyrgulopsis chupaderae* | Molluscs | F | M(o) | Private landowner |
| Koster's Springsnail | *Juturnia kosteri* | Molluscs | F | CA, CT, M(p) | USFWS |
| Roswell Springsnail | *Pyrgulopsis roswellensis* | Molluscs | F | CA, CT, M(p) | USFWS |
| Socorro Springsnail | *Pyrgulopsis neomexicana* | Molluscs | F | M(o) | Private landowner |
| Pecos Assiminea | *Assiminea pecos* | Molluscs | F | CA, CT, M(p) | USFWS |
| Western River Cooter | *Pseudemys gorzugi* | Reptiles | I | M(p) | University, Private |
| Slevin's Bunchgrass Lizard | *Sceloporus slevini* | Reptiles | H | M(o) | |
| Dunes Sagebrush Lizard | *Sceloporus arenicolus* | Reptiles | H | CT, M(a) | BLM, University, NGO, Private |
| Mountain Skink | *Plestiodon callicephalus* | Reptiles | H | M(o) | |
| Gray-checkered Whiptail | *Aspidoscelis dixoni* | Reptiles | H | M(o) | |

| SGCN Common Name | SGCN Scientific Name | Taxonomic Group | Category | Monitoring Action[51] | Other Monitoring Entities or Partners |
|---|---|---|---|---|---|
| Giant Spotted Whiptail | *Aspidoscelis stictogramma* | Reptiles | H | M(o) | |
| California Kingsnake | *Lampropeltis californiae* | Reptiles | H | M(p) | Private |
| Sonoran Mud Turtle | *Kinosternon sonoriense* | Reptiles | S | M(a) | University |
| Reticulate Gila Monster | *Heloderma suspectum suspectum* | Reptiles | S | M(o) | |
| Gray-banded Kingsnake | *Lampropeltis alterna* | Reptiles | S | CA, M(a) | NPS |
| Green Rat Snake | *Senticolis triaspis* | Reptiles | S | M(o) | University, Private landowner |
| Arid Land Ribbonsnake | *Thamnophis proximus* | Reptiles | S | M(p) | USFWS |
| Rock Rattlesnake | *Crotalus lepidus* | Reptiles | S | M(o) | DOD, NPS, University |
| Arizona Black Rattlesnake | *Crotalus cerberus* | Reptiles | D | M(n) | |
| Big Bend Slider | *Trachemys gaigeae* | Reptiles | D | M(p) | USFWS, NEMNRD, Private |
| Plain-bellied Water Snake | *Nerodia erythrogaster* | Reptiles | D | M(n) | Private |
| Desert Massasauga | *Sistrurus catenatus* | Reptiles | D | M(p) | USFWS, University |
| Mexican Gartersnake | *Thamnophis eques* | Reptiles | F | CT, M(o) | USFS, USFWS, Private |
| Narrow-headed Gartersnake | *Thamnophis rufipunctatus* | Reptiles | F | CA, CT, M(a) | USFS, USFWS, University |
| New Mexico Ridge-nosed Rattlesnake | *Crotalus willardi obscurus* | Reptiles | F | M(o) | USFS, Private Landowners |

As monitoring data are generated by the Department and collaborators, ensuring that it is as widely available as possible will amplify the value of the effort and the utility of the results. The Department is working closely with NHNM who maintain the Biota Information System for New Mexico (BISON-M), New Mexico Crucial Habitat Assessment Tool (CHAT), and collection permit data, and serve as a repository for SWAP revision data. NHNM works closely with the Museum of Southwestern Biology at the University of New Mexico to record observations gleaned from and through the Museum collection. The Department, in collaboration with NHNM, has been exploring several opportunities for creating a Conservation Information System (CIS) that would serve the needs of the conservation community in New Mexico. This community is mostly composed of federal and state land and natural resources management agencies. Through the development and maturation of the CIS, an actively engaged conservation community that communicates regularly, can promote the CIS as a repository of monitoring activities and data.

A readily available comprehensive source of information about monitoring that has been or is being done in New Mexico provides context for the Department to identify specific needs for monitoring that it is uniquely qualified to perform. When the Department can effectively prioritize where to use its limited resources, it can be instrumental in addressing specific needs. Many of those needs are likely to be related to conservation program efficacy. Because the Department receives a significant share of its funding through the Wildlife and Sportfish Restoration Program, especially the State Wildlife Grants Program, there are reporting requirements and identified outcomes that must be achieved. Focusing on an appropriate subset of those conservation actions with reporting requirements will permit the Department to meet its obligations to these grant programs and continue to conserve New Mexico’s wildlife.

At the other end of the spectrum from specific, tightly-focused monitoring efforts is the general assessment of the status of habitats and species on an annual or seasonal basis. Weather or climate metrics are simple diagnostic quantities used to characterize geophysical drivers of biological systems and communities. There are many different climate indices that have been developed to assess climate conditions around the world, in the southwestern United States, and within New Mexico (e.g., Enquist et al. 2008, Williams et al. 2013). The Department will seek to identify an appropriate existing index that will be able to characterize conditions affecting both winter conditions (including precipitation and snowpack) and the summer monsoon season. This latter period may be especially important because that is when much of the State’s precipitation falls that generates plant growth and has a direct impact on the environmental conditions controlling the survival and reproduction of most SGCN. An index that summarizes recent past conditions is more useful than a predictive index with its potential error. These environmental indices can then be calibrated using long-term data sets for species with extensive population survey data. One or a few summary indicators of conditions statewide will provide Department biologists with a systematic unbiased assessment that can be used to evaluate the likely condition of habitats and species. With this information, the Department will be in a better position to anticipate whether and where conditions could be of concern. With that information, the Department could proactively consider additional or more intensive monitoring of particular species or habitats.

The Department also will try to identify and assess emerging technologies that can facilitate accurate species and habitat monitoring and do it more efficiently. One such technology is isolation of environmental DNA which is becoming a valuable tool for detecting presence of rare and difficult to detect aquatic species (Spear et al. 2015), and Andersen et al. (2012) demonstrated that short mitochondrial DNA fragments from animals can be recovered from soils in temperate climatic regions. The following is taken from Thomsen and Willerslev (2015):

"*All conservation efforts to save biodiversity essentially depend on the monitoring of species and populations to obtain reliable distribution patterns and population size estimates. Such monitoring has traditionally relied on physical identification of species by visual surveys and counting of individuals. However, traditional monitoring techniques remain problematic due to difficulties associated with correct identification of cryptic species or juvenile life stages, a continuous decline in taxonomic expertise, non-standardized sampling, and the invasive nature of some survey techniques. Hence, there is urgent need for alternative and efficient techniques for large-scale biodiversity monitoring. Environmental DNA (eDNA) – defined here as: genetic material obtained directly from environmental samples (soil, sediment, water, etc.) without any obvious signs of biological source material – is an efficient, non-invasive and easy-to-standardize sampling approach. Coupled with sensitive, cost-efficient and ever-advancing DNA sequencing technology, it may be an appropriate candidate for the challenge of biodiversity monitoring*".

Over the period in which this SWAP is used as a guide, the Department will continue to assess needs for and opportunities to monitor the species, habitats, and conservation actions identified in this document. Venues such as a CIS and BISON-M represent important avenues where conservation information can be efficiently distributed among natural resource managers to inform and improve future conservation actions for SGCN.

# Chapter 12: Implementation, Review, and Revision

**Element 6** requires that the SWAP describe periodic review procedures at intervals not to exceed 10 years. **Element 7** requires plans for coordinating SWAP development, implementation, review and revision with federal, state, and local agencies and Indian tribes that manage significant land and water areas or administer programs that affect the conservation of SGCN or their habitats. **Element 8** affirms that broad public participation is an essential element of developing and implementing the SWAP. This chapter addresses future compliance with these requirements.

## Implementation

The SWAP development process has provided a strategic level of planning that has identified numerous prioritized conservation actions and many research, survey, and monitoring needs. Operational planning will include coordination with local, state, and federal government agencies, tribes, non-governmental organizations, and interested publics and invite these entities to contribute to project design and implementation. The Department will encourage partnering and cost sharing with these interests and, where necessary, engage and oversee contractors to implement some projects. The Department will, to the extent practical, integrate with action planning associated with USFS Forest Management Plans, BLM Resource Management Plans, DOD Integrated Natural Resource Management Plans, and land use allocation by the State Land Office; a collective endeavor that addresses habitat and wildlife resources on about 46% of New Mexico's land surface. Formal agency and tribal coordination and public involvement approaches for implementation will follow the processes described below under Review and Revision.

## Review and Revision

The Department will be responsive to changing conditions and new information and, in collaboration with partners and interested publics, may amend the SWAP before 2025 if conditions warrant.

## Agency Coordination and Public Involvement

Approximately 55% of New Mexico's land area is under federal, state, and tribal jurisdiction; of that, the Department directly controls only 166,000 acres. The ability to substantially affect a significant portion of key habitats and associated SGCN will therefore depend upon close collaboration with federal, state, and tribal governments. To facilitate future coordination, review, and revision of the SWAP, the Department will request that each federal, state, or local agency identify a designated contact person who can help plan and facilitate communication with appropriate agency program personnel at multiple staff levels within each agency. For tribal coordination, the Department will follow the Governor's established protocols for government-to-government relationships between the tribes and the State that recognize both the sovereignty of tribal governments and the state citizenship of tribal members. Accordingly, tribal leaders will be notified in writing of opportunities for participation in the implementation, review or revision of the SWAP and invited to designate appropriate persons to represent them in consultation and collaboration. Through this process the Department will coordinate with federal, state, local and tribal governments to review and revise the SWAP as well as design, implement, and fund monitoring, survey, research, and other projects that are consistent with our respective conservation interests.

Approximately 45% of New Mexico lands are under private management and many private entities have economic and recreational interests in the use of State and federal lands. The inter-related challenges of maintaining a healthy economy, accommodating growth, and conserving the State's biodiversity only can be overcome through the awareness and support of a broad spectrum of decision makers and publics. The Department will therefore broadly publicize its intent to review and revise the SWAP early in the decision-making process so that interested and affected parties may be well aware of the consideration, express their views, exchange information, and otherwise influence decisions.

Effective agency coordination or public participation and avoidance of conflict require that all parties possess a clear understanding of the sequence and timing of the decision-making process and make relevant contributions at appropriate stages. Therefore, in planning both agency coordination and public involvement the Department will:

- Establish a clear decision-making process for the SWAP implementation, review, or revision event under consideration.
- Designate stages within the decision-making process warranting inter-agency coordination or public involvement.
- For each stage so designated, specify the objectives for involving agencies or publics and identify the information exchange required to attain coordination or involvement objectives.
- Identify agencies and publics that are affected by or who might otherwise inform or collaborate in the decision-making process.
- Identify special considerations that may influence the process through which the information exchange might be best be accomplished and design and implement appropriate techniques or events.

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# Appendices

# Appendix A: Entities invited to help create New Mexico’s 2016-2025 State Wildlife Action Plan

| Federal | Academic | Native American Tribes |
|---|---|---|
| Bureau of Reclamation | University of New Mexico | Mescalero Apache Tribe |
| Army Corps of Engineers | Department of Biology | Jicarilla Apache Nation |
| White Sands Missile Range | Natural Heritage New Mexico | Pueblo of Santa Clara |
| Bureau of Land Management | New Mexico State University | Pueblo of Santa Ana |
| Forest Service | Department of Fish, Wildlife, and Conservation Ecology | Pueblo of Sandia |
| Fish and Wildlife Service | Range Improvement Task Force | Pueblo of San Ildefonso |
| Natural Resources Conservation Service | New Mexico Cooperative Fish and Wildlife Research Unit | Pueblo of San Felipe |
| | Western New Mexico University | Pueblo of Pojoaque |
| | Department of Natural Sciences | Pueblo of Santo Domingo |
| **State** | Eastern New Mexico University | Navajo Nation |
| Department of Game and Fish | Biology Department | Pueblo of Nambe |
| Energy, Minerals, and Natural Resources Department | | Pueblo of Laguna |
| State Parks | | Pueblo of Jemez |
| State Forestry | | Pueblo of Isleta |
| State Land Office | | Pueblo of Picuris |
| Environment Department | | Ohkay Owingeh |
| Surface Water Bureau, Watershed Protection Division | | Pueblo of Cochiti |
| | | Pueblo of Acoma |
| **Regional** | | Pueblo of Taos |
| Mid-Region Council of Governments | | Pueblo of Tesuque |
| | | Pueblo of Zia |
| | | Pueblo of Zuni |

# Appendix B: Participants in the Core Team to revise New Mexico's 2016-2025 State Wildlife Action Plan

| Agency | Name |
|---|---|
| US Bureau of Reclamation | V. Ryan, L. Walton |
| US Army Corps of Engineers | M. Porter, S. Ryan |
| US Bureau of Land Management | M. Ramsey, J. Sherman |
| US Forest Service | B. Dykstra, S. Sartorius |
| US Fish and Wildlife Service | K. Granillo, L. Bonner |
| US National Park Service | M. Wrigley, M. Sturm |
| New Mexico State Parks | D. Certain |
| New Mexico Environment Department | D. Sarabia, A. Franklin, J. Money |
| New Mexico State Land Office | C. Montoya-Hendricks |
| New Mexico Department of Game and Fish | M. Wunder, C. Hayes, M. Watson, V. Seamster, L. Pierce, D. Weybright, K. Patten, M. Ruhl, R. Jankowitz, K. Cunningham, R. Kellermueller, and M. Volke |
| Natural Heritage New Mexico | E. Muldavin, R. McCollough |
| University of New Mexico | J. Dunnum |
| New Mexico State University, Range Improvement Task Force | S. Smallidge, N. Ashcroft, D. Cram |
| New Mexico State University | K. Boykin |
| Big Picture Conservation | B. Dunn |

# Appendix C: Taxon experts invited to review potential Species of Greatest Conservation Need for New Mexico's 2016-2025 State Wildlife Action Plan

**First Formal Review**

Amphibians: L. Pierce, Department, R. Jennings, Western New Mexico University (WNMU), and B. Christman, private.

Aquatic Invertebrates: J. Jacobi, private and A. Burdett, NM Museum of Natural History and Science.

Birds: M. Darr, and K. Madden, Department

Crustaceans, Fish, and Molluscs: M. Ruhl and K. Patten.

Lepidopterans (Butterflies and Moths): S. Cary, NM Audubon, J. McIntrye, USFWS, and E. Metzler, private.

Mammals: J. Stuart, Department, C. Hayes, Department, and M. Ramsey, BLM.

Odonates (Carnivorous Insects): B. Larsen, private and K. Gaines, UNM.

Reptiles: L. Pierce and J. Stuart, Department; B. Blais and B. Smith, Black Hills State University[52]; R. Jennings, WNMU, and B. Christman, private.

**Second Formal Review**

Amphibians: R. Jennings, WNMU; B. Christman, private; and H. Snell and D. Lightfoot, UNM.

Birds: NM Avian Conservation Partners

Fish: D. Propst, S. Platania, and T. Turner, UNM.

Lepidopterans: S. Cary, NM Audubon

Mammals: J. Frey, NMSU and J. Cook, UNM

[52] Reviewed smooth green snake

# Appendix D: Participants at a workshop of the 2015 Joint Annual Meeting of the Arizona and New Mexico Chapters of The Wildlife Society

The purpose of the workshop was to present and discuss criteria for selecting Species of Greatest Conservation Need (SGCN) and a draft list of species selected as SGCN for New Mexico's 2016-2025 State Wildlife Action Plan.

| Name | Affiliation | Name | Affiliation |
|---|---|---|---|
| McBee, R. | Department | Haynes, L. | University of Arizona (UA) |
| Hayes, C. | Department | Lang, L. | UA |
| Darr, M. | Department | Robledo, Y. | UA |
| Wunder, M. | Department | Jones, A. | UNM |
| Pierce, L. | Department | Ryan, M. | UNM |
| Teran, R. | Department | Giermakowski, T. | UNM |
| Stuart, J. | Department | Goehring, D. | Prescott College |
| Osborn, R. | Department | Simpson, J. | Prescott College |
| Farmer, G. | Department | Riegner, M. | Prescott College |
| Madden, K. | Department | Riso, N. | Prescott College |
| Robb, N. | AGFD | Alonso, R. | Furman University |
| Werner, B. | BLM | Perkins-Taylor, I. | NMSU |
| Ramsey, M. | BLM | Brusuelas, J. | NMSU |
| Williams, V. | BLM | Seamster, V. | NMSU |
| Smallwood, A. | BLM | Frey, J. | NMSU |
| Guzman, M. | BLM | Campbell, C. | NMSU |
| Olsker, N. | BOR | Castillo, P. | NMSU |
| Evans, C. | BOR | Conway, W. | Texas Tech University |
| Weisenberger, M. | USFWS | Reilly, M. | Northern AZ University |
| Granillo, K. | USFWS | Thomas, S. | Bat Conservation International |
| Rogers, T. | USFWS | Beidleman, C. | Audubon New Mexico |
| Sanchez, R. | USFS | Seamster, T. | Sierra Club |
| DeRosier, S. | USFS | Dunn, B. | Big Picture Conservation |
| Kerns, J. | WSMR | Davis, D. | Turner Biological |
| Jones, A. | Arizona State University (ASU) | Ramakka, J. | BLM-retired |
| Wilson, J. | ASU | Reiser, H. | None |
| Latzko, J. | ASU | | |

# Appendix E: Entities and individuals providing comment on draft versions of the SWAP

Catron County Commission

Defenders of Wildlife

Devon Energy Production Company, L.P.

Eric H. Metzler; Research Collaborator at the U.S. National Museum of Natural History

Independent Petroleum Association of New Mexico

John Crenshaw

National Park Service

New Mexico Association of Conservation Districts

New Mexico Cattle Growers Association

New Mexico Chapter of The Wildlife Society

New Mexico Council of Outfitters and Guides

New Mexico Department of Agriculture

New Mexico Farm and Livestock Bureaus

New Mexico Federal Lands Council

New Mexico Native Plant Society

New Mexico Oil and Gas Association

New Mexico State University; Range Improvement Task Force

New Mexico Wildlife Federation

New Mexico Woolgrowers Association

Northern New Mexico Group: Rio Grande Chapter of the Sierra Club

Southwest Environmental Center

Stephen H. Henry

Strata Production Company

Teresa Seamster

The Nature Conservancy

Trout Unlimited

William Bramble

# Appendix F: Threats and factors that may influence New Mexico Species of Greatest Conservation Need (SGCN), 2016-2025

Threats are listed in Table 8 and follow Salafsky et al. (2008) and IUCN (2016), while factors were adapted from Comprehensive Wildlife Conservation Strategy for New Mexico (CWCS; NMDGF 2006). Taxa not included as SGCN in the CWCS are indicated as New SGCN under the Factors column. Please see Literature Cited section that follows this table for complete information about sources.

| **Common Name** | **Scientific Name** | **Taxon**[53] | **Category** | **Threats** | **Factors Influencing SGCN** | **References** |
|---|---|---|---|---|---|---|
| Boreal Toad | *Anaxyrus boreas* | Amph. | I | Invasive and problematic species Natural system modification | Disease, introduced trout, habitat alteration | Hammerson 1999; Muths and Nanjappa 2005 |
| Sonoran Desert Toad | *Incilius alvarius* | Amph. | H | Natural system modification, Agriculture and aquaculture, Transportation and service corridors | Modification of wetland habitat, conversion to agriculture, highway mortality | pers. comm., C. Painter, NMDGF; Degenhardt et al. 1996; Fouquette et al. 2005 |
| Western Narrow-mouthed Toad | *Gastrophryne olivacea* | Amph. | H | Natural system modification, Agriculture and aquaculture, Invasive and problematic species | Elimination of wetland habitat, conversion to agriculture, non-native predators (bullfrogs) | Stuart and Painter 1996; Sredl and Field 2005 |
| Lowland Leopard Frog | *Lithobates yavapaiensis* | Amph. | H | Invasive and problematic species, Natural system modification | Disease, non-native predators (bullfrogs, non-native fishes, crawfish), limited range in NM | Degenhardt et al. 1996; Sredl 2005; Savage et al. 2011; NMDGF 2014 |

[53] Amph. = Amphibians, Crust. = Crustaceans, Mam. = Mammals, Mol. = Molluscs, Rept. = Reptiles.

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Sacramento Mountain Salamander | *Aneides hardii* | Amph. | H | Invasive and problematic species, Biological resource use, Natural system modification | Disease, Silvicultural activities, drought, wildfire | Ramotnik 2005; NMDGF 2014 |
| Boreal Chorus Frog | *Pseudacris maculata* | Amph. | S | Invasive and problematic species, Natural system modification, Pollution, Climate change | Disease, non-native predators (bullfrogs, non-native fishes, crawfish), conversion of habitat to agriculture, draining of wetlands | pers. comm., C. Painter, NMDGF; Moriarty and Lannoo 2005; Amburgey et al. 2012 |
| Arizona Treefrog | *Hyla wrightorum* | Amph. | S | Invasive and problematic species, Natural system modification | Disease, habitat modification | pers. comm., C. Painter, NMDGF; Degenhardt et al. 1996; Gergus et al. 2005 |
| Northern Leopard Frog | *Lithobates pipiens* | Amph. | S | Invasive and problematic species, Natural system modification, Climate change, Agriculture and aquaculture | Disease, non-native predators (bullfrogs, non-native fishes, crawfish), habitat modification, drought | pers. comm., C. Painter, NMDGF; Degenhardt et al. 1996; Rorabaugh 2005; USFWS 2011 |
| Plains Leopard Frog | *Lithobates blairi* | Amph. | S | Invasive and problematic species, Natural system modification, Climate change | Disease, non-native predators (bullfrogs, non-native fishes, crawfish), habitat modification, drought | pers. comm., C. Painter, NMDGF; Crawford et al. 2005 |
| Rio Grande Leopard Frog | *Lithobates berlandieri* | Amph. | S | Invasive and problematic species, Natural system modification, Climate change | Disease, non-native predators (bullfrogs, non-native fishes, crawfish), habitat modification, drought | pers. comm., C. Painter, NMDGF |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Arizona Toad | *Anaxyrus microscaphus* | Amph. | D | Invasive and problematic species, Agriculture and aquaculture, Natural system modification | Disease, hybridization, conversion of habitat to agriculture | pers. comm., C. Painter, NMDGF; Degenhardt et al. 1996; Schwaner and Sullivan 2005; Ryan et al. 2014; Sullivan et al. 2015; |
| Eastern Barking Frog | *Craugastor augusti latrans* | Amph. | D | Natural system modification | No specific factors identified, considered vulnerable due to limited distribution in New Mexico | pers. comm., C. Painter, NMDGF; BISON-M 2016 |
| Chiricahua Leopard Frog | *Lithobates chiricahuensis* | Amph. | F | Invasive and problematic species, Natural system modification | Disease, non-native predators (bullfrogs, non-native fishes, crawfish), habitat modification, drought | Sredl and Jennings 2005 |
| Jemez Mountains Salamander | *Plethodon neomexicanus* | Amph. | F | Invasive and problematic species, Biological resource use | Disease, silvicultural activities, drought, wildfire | pers. comm., C. Painter, NMDGF; Degenhardt et al. 1996; Painter 2005; Cummer and Painter 2007; USFWS 2013a |
| White-tailed Ptarmigan | *Lagopus leucura* | Birds | I | Invasive and problematic species, Natural system modification, Human intrusions and disturbance, Residential and commercial development | Loss or alteration of limited alpine tundra habitat through overuse by grazing ungulates including elk and bighorn, increased human use, ski area development, construction of snow catchment fences, construction and operation of microwave relay stations | Martin et al. 2015; NMDGF 2014 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Flammulated Owl | *Psiloscops flammeolus* | Birds | I | Biological resource use, Natural system modification | New SGCN | Arsenault 2010 |
| Mexican Whip-poor-will | *Antrostomus arizonae* | Birds | I | Natural system modification, Climate change | New SGCN | pers. comm., M. Darr, NMDGF; NMACP 2007 |
| Lewis's Woodpecker | *Melanerpes lewis* | Birds | I | Natural system modification, Biological resource use, Agriculture and aquaculture | Loss or alteration of ponderosa pine nesting habitat from altered fire regimes, timber harvest including salvage logging, improper grazing practices, progressive loss of mature cottonwood bosque breeding habitat | NMACP 2007 |
| Gray Vireo | *Vireo vicinior* | Birds | I | Biological resource use, Agriculture and aquaculture, Invasive and problematic species | Loss or alteration of quality juniper-grassland habitat from clearing, burning, and improper grazing practices, cowbird parasitism | NMDGF 2014 |
| Pinyon Jay | *Gymnorhinus cyanocephalus* | Birds | I | Natural system modification, Biological resource use, Human intrusions and disturbance, Agriculture and aquaculture, Climate change | Loss, degradation, or fragmentation of piñon - juniper woodlands from conversion, clearing, firewood cutting, improper grazing practices, and altered fire regimes, illegal shooting | Balda 2002 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Juniper Titmouse | *Baeolophus ridgwayi* | Birds | I | Biological resource use | Rangewide declining trends potentially related to loss of piñon -juniper habitat from clearing, range conversion, excessive firewood and fence post cutting | Cicero 2000 |
| Bendire's Thrasher | *Toxostoma bendirei* | Birds | I | Natural system modification, Invasive and problematic species | Total population small and restricted, significant rangewide population declines potentially related to habitat changes or to unknown factors | pers. comm., S. Williams, NMDGF; M. Darr, NMDGF; D. Krueper, USFWS; NMACP 2007 |
| Sprague's Pipit | *Anthus spragueii* | Birds | I | Agriculture and aquaculture, Energy production and mining | Loss or fragmentation of native grassland habitats from improper grazing practices, land conversion, brush encroachment, and oil and gas development | pers. comm., W. Howe, USFWS; Jones 2010 |
| Painted Redstart | *Myioborus pictus* | Birds | I | Biological resource use, Natural system modification, Climate change, Human intrusions and disturbance | Loss or alteration of middle elevation oak and pine-oak riparian woodlands from timber management, fire, and drought, human disturbance to nesting birds | pers. comm., S. Williams, NMDGF |
| Grace's Warbler | *Setophaga graciae* | Birds | I | Biological resource use, Agriculture and aquaculture, Natural system modification, Residential and commercial development | Loss, alteration, or fragmentation of ponderosa pine habitat from timber harvest, firewood harvest, improper grazing practices, fire suppression, and urban development | Block and Finch 1997; Stacier and Guzy 2002 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Black-throated Gray Warbler | *Setophaga nigrescens* | Birds | I | Biological resource use, Natural system modification, Invasive and problematic species | Loss or alteration of piñon - juniper and oak-juniper woodlands through thinning, clearing, fire, or disease | pers. comm., W. Howe, USFWS; Gorbet 2011 |
| Red-faced Warbler | *Cardellina rubrifrons* | Birds | I | Biological resource use, Natural system modification, Agriculture and aquaculture, Human intrusions and disturbance | Loss or alteration of undisturbed montane riparian and forest habitats from timber harvest, catastrophic fire, and improper grazing practices, human disturbance to nesting birds | NMACP 2007; Kalies et al. 2010 |
| Virginia's Warbler | *Oreothlypis virginiae* | Birds | I | Natural system modification, Invasive and problematic species, Climate change | New SGCN | pers. comm, M. Darr, NMDGF; NMACP 2007; Martin and Maron 2012 |
| Black-chinned Sparrow | *Spizella atrogularis* | Birds | I | Natural system modification, Climate change | New SGCN | pers. comm., M. Darr, NMDGF; NMACP 2007 |
| Arizona Grasshopper Sparrow | *Ammodramus savannarum ammolegus* | Birds | I | Natural system modification, Climate change | Loss or degradation of native grassland habitat, primarily from improper grazing practices and ill-timed (late spring-early summer) fires | NMDGF 2014 |
| Chestnut-collared Longspur | *Calcarius ornatus* | Birds | I | Natural system modification, Climate change, Invasive and problematic species | New SGCN | pers. comm., M. Darr, NMDGF |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| McCown's Longspur | *Rhynchophanes mccownii* | Birds | I | Natural system modification | New SGCN | pers. comm., M. Darr, NMDGF; NMACP 2007; Environment Canada 2014 |
| Gould's Wild Turkey | *Meleagris gallopavo mexicana* | Birds | H | Natural system modification, Agriculture and aquaculture, Invasive and problematic species, Human intrusions and disturbance | Habitat loss from removal of vegetation, fire, improper grazing practices, lack of water sources, hybridization with non-native turkeys, human killing and disturbance | NMDGF 2014 |
| Eared Grebe | *Podiceps nigricollis* | Birds | H | Agriculture and aquaculture, Natural system modification | Loss/degradation of higher elevation wetland breeding habitat through drainage, conversion, flooding and/or dewatering for irrigation, grazing of emergent vegetation, contaminants | pers. comm., D. Krueper, USFWS; Cullen et al. 1999 |
| American Bittern | *Botaurus lentiginosus* | Birds | H | Natural system modification, Agriculture and aquaculture, Human intrusions and disturbance | Loss, degradation, or fragmentation of wetland habitat, pesticides and contaminants, acid precipitation, human disturbance, small, isolated populations | Lowther et al. 2009 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Bald Eagle | *Haliaeetus leucocephalus* | Birds | H | Human intrusions and disturbance, Natural system modification, Transportation and service corridors, Biological resource use | Human disturbance to nests and winter roosts, loss/degradation of breeding and wintering habitat, including declines in prey populations and in nest/roost site availability, environmental contamination, electrocution, illegal killing by shooting and poisoning | USFWS 2009; Stahlecker and Walker 2010; Stauber et al. 2010; NMDGF 2014 |
| Peregrine Falcon | *Falco peregrinus* | Birds | H | Pollution, Human intrusions and disturbance | Chemical contamination of environment, disturbance of nesting pairs, illegal taking | NMDGF 2014 |
| Boreal Owl | *Aegolius funereus* | Birds | H | Biological resource use | Loss of undisturbed spruce-fir and similar forests from timber harvest or other factors | Hayward and Hayward 1993; Koopman et al. 2007; Stahlecker 2010; NMDGF 2014 |
| Burrowing Owl | *Athene cunicularia* | Birds | H | Agriculture and aquaculture, Residential and commercial development, Natural system modification, Human intrusions and disturbance | Loss or fragmentation of grassland habitat to agricultural conversion or urbanization, elimination of burrowing rodents such as prairie dogs, improper grazing practices, burning, mowing, illegal shooting | Desmond 2010 |
| Black Swift | *Cypseloides niger* | Birds | H | Human intrusions and disturbance, Natural system modification | Disturbance at nesting caves | pers. comm., S. Williams, NMDGF; Nebel et al. 2010 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Bell's Vireo | *Vireo bellii* | Birds | H | Residential and commercial development, Agriculture and aquaculture, Biological resource use, Natural system modification, Invasive and problematic species | Loss or fragmentation of dense shrubby/woody riparian habitats from urbanization, agricultural conversion, improper grazing practices, firewood cutting, flood control, and reservoir construction, cowbird parasitism | Sogge et al. 2008; Brand and Noon 2011; NMDGF 2014 |
| Bank Swallow | *Riparia riparia* | Birds | H | Natural system modification, Residential and commercial development | Destruction or alteration of streambank nesting habitat from flood- and erosion-control projects, bank stabilization projects, inundation, road building | Garrison 1999 |
| Lesser Prairie-Chicken | *Tympanuchus pallidicinctus* | Birds | S | Natural system modification, Energy production and mining, Transportation and service corridors, Agriculture and aquaculture | Loss, degradation, fragmentation of habitat through improper grazing practices, shrub control, and oil and gas development, small-population phenomena | Wolfe et al. 2007; Pruett et al. 2009; Bell et al. 2010; Hunt and Best 2010; USFWS 2014a |
| Mountain Plover | *Charadrius montanus* | Birds | S | Agriculture and aquaculture, Energy production and mining, Invasive and problematic species, Natural system modification, Pollution, Climate change | Loss or alteration of prairie breeding areas from agricultural conversion, energy development, surface mining, exotic vegetation, loss of native grazers including prairie dogs, loss or fragmentation of migration and wintering areas from conversion, urbanization | Knopf 1994; Augustine et al. 2008; Dinsmore 2008; Andres and Stone 2010 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Snowy Plover | *Charadrius nivosus* | Birds | S | Climate change, Invasive and problematic species, Human intrusions and disturbance | Loss or degradation of breeding alkali flats and playas from flooding, drying, and/or vegetation encroachment, disturbance to nesting birds | USFWS 2007 |
| Long-billed Curlew | *Numenius americanus* | Birds | S | Agriculture and aquaculture, Residential and commercial development, Invasive and problematic species | Loss, alteration, and fragmentation of native prairie breeding habitat from agricultural conversion, urbanization, improper grazing practices, shrub encroachment | Jones et al. 2008; Saalfeld et al. 2010 |
| Neotropic Cormorant | *Phalacrocorax brasilianus* | Birds | S | Natural system modification, Human intrusions and disturbance, Biological resource use | Loss/degradation of breeding sites, including loss of trees/snags for nest substrate, disturbance to breeding colonies, fluctuations in fish prey base, illegal shooting and other persecution | NMDGF 2014 |
| Common Ground-dove | *Columbina passerina* | Birds | S | Natural system modification | Loss of lower elevation riparian shrublands, altered hydrology leading to dewatered riparian areas | NMDGF 2014 |
| Whiskered Screech-Owl | *Megascops trichopsis* | Birds | S | Natural system modification, Human intrusions and disturbance | Loss of pine-oak and oak woodland within restricted range from vegetation removal and natural and prescribed fires, human disturbance | Gelbach and Gelbach 2010; NMDGF 2014 |
| Common Nighthawk | *Chordeiles minor* | Birds | S | Natural system modification | New SGCN | Nebel et al. 2010 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Costa's Hummingbird | *Calypte costae* | Birds | S | Agriculture and aquaculture, Natural system modification | Loss of native xeric hillside vegetation and adjacent riparian habitats in southwestern New Mexico from burning or improper grazing practices | NMDGF 2014 |
| Violet-crowned Hummingbird | *Amazilia violiceps* | Birds | S | Natural system modification | Loss of low-elevation broadleaf riparian canyon woodlands, especially loss of scarce big-tree riparian habitats from fire, loss of food sources such as agaves from fire | Williams 2002; NMDGF 2014 |
| Williamson's Sapsucker | *Sphyrapicus thyroideus* | Birds | S | Natural system modification, Biological resource use | Loss or alteration of mature mixed and deciduous forest habitats, especially mature aspen groves, from fire and timber operations | Gyug et al. 2012; NMACP 2007 |
| Gila Woodpecker | *Melanerpes uropygialis* | Birds | S | Natural system modification, Invasive and problematic species | Habitat destruction from cutting or other destructive clearing (burning, inundation) of mature cottonwood and sycamore riparian stands, progressive fragmentation of remaining habitat patches, competition for nest sites with exotic European starlings | NMDGF 2014 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Red-headed Woodpecker | *Melanerpes erythrocephalus* | Birds | S | Residential and commercial development, Agriculture and aquaculture, Invasive and problematic species | Loss or degradation of breeding habitat, especially mature cottonwood bosque, from urbanization, clearing and other cutting, agricultural conversion, river channelization, competition for nest sites with exotic European starlings | pers. comm., W. Howe, USFWS; Frei et al. 2015 |
| Northern Beardless Tyrannulet | *Camptostoma imberbe* | Birds | S | Natural system modification, Agriculture and aquaculture | Loss or degradation of native riparian habitat through clearing, burning, and improper grazing practices | Sogge et al. 2008; Graham and Hudak 2011 |
| Olive-sided Flycatcher | *Contopus cooperi* | Birds | S | Biological resource use, Natural system modification | Significant and accelerating rangewide population declines potentially linked to forest habitat losses from timber management or fire suppression | Robertson and Hutto 2007 |
| Thick-billed Kingbird | *Tyrannus crassirostris* | Birds | S | Natural system modification, Agriculture and aquaculture | Loss or degradation of broadleaf riparian woodland habitat from fire, lowered water tables, improper grazing practices | Sogge et al. 2008; NMDGF 2014 |
| Loggerhead Shrike | *Lanius ludovicianus* | Birds | S | Agriculture and aquaculture, Transportation and service corridors, Pollution | Significant rangewide declines potentially linked to habitat loss/degradation from changing agricultural practices, brush control programs or other land use changes, pesticide contamination, collision with vehicles | Pruitt 2000 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Clark's Nutcracker | *Nucifraga columbiana* | Birds | S | Natural system modification, Climate change | New SGCN | pers. comm., M. Darr, NMDGF |
| Pygmy Nuthatch | *Sitta pygmaea* | Birds | S | Natural system modification, Climate change | New SGCN | pers. comm., M. Darr, NMDGF |
| Mountain Bluebird | *Sialia currucoides* | Birds | S | Natural system modification, Climate change, Invasive and problematic species | New SGCN | pers. comm., M. Darr, NMDGF; NMACP 2007 |
| Western Bluebird | *Sialia mexicana* | Birds | S | Natural system modification, Climate change, Invasive and problematic species | New SGCN | pers. comm., M. Darr, NMDGF; NMACP 2007 |
| Lucy's Warbler | *Oreothlypis luciae* | Birds | S | Natural system modification, Biological resource use, Agriculture and aquaculture | Loss or degradation of southwestern riparian habitats from clearing, firewood cutting, improper grazing practices, fire, and inundation | Johnson et al. 2012 |
| Yellow-eyed Junco | *Junco phaeonotus* | Birds | S | Natural system modification | Small, isolated populations vulnerable to montane forest habitat loss or modification | NMDGF 2014 |
| Baird's Sparrow | *Ammodramus bairdii* | Birds | S | Natural system modification, Agriculture and aquaculture | Loss or degradation of native grassland habitat from improper grazing practices, shrub encroachment, land development, and oil and gas development | NMDGF 2014 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Cassin's Sparrow | *Peucaea cassinii* | Birds | S | Natural system modification, Climate change, Invasive and problematic species | New SGCN | pers. comm., M. Darr, NMDGF |
| Sagebrush Sparrow | *Artemisiospiza nevadensis* | Birds | S | Biological resource use, Agriculture and aquaculture, Natural system modification, Invasive and problematic species | Rangewide declines linked to fragmentation, degradation, or destruction of sagebrush habitat from mechanical, chemical, and burning programs, improper grazing practices of disturbed/treated sagelands, altered fire regimes, exotic plant encroachment | Martin and Carlson 1998 |
| Vesper Sparrow | *Pooecetes gramineus* | Birds | S | Natural system modification, Climate change, Agriculture and aquaculture | New SGCN | pers. comm., M. Darr, NMDGF; NMACP 2007 |
| Varied Bunting | *Passerina versicolor* | Birds | S | Natural system modification, Agriculture and aquaculture, Residential and commercial development | Loss of dense, shrubby riparian habitats from clearing, conversion, burning, improper grazing practices, and/or urbanization | Groschupf, and Thompson. 1998; NMDGF 2014 |
| Cassin's Finch | *Haemorhous cassinii* | Birds | S | Natural system modification, Climate change | New SGCN | pers. comm., M. Darr, NMDGF |
| Evening Grosbeak | *Coccothraustes vespertinus* | Birds | S | Natural system modification, Climate change | New SGCN | pers. comm., M. Darr, NMDGF |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Clark's Grebe | *Aechmophorus clarkii* | Birds | D | Natural system modification, Human intrusions and disturbance | New SGCN | pers. comm., M. Darr, NMDGF; NMACP 2007 |
| Common Black Hawk | *Buteogallus anthracinus* | Birds | D | Natural system modification, Human intrusions and disturbance | Loss/fragmentation/degradation of southwestern cottonwood-sycamore riparian habitat, stream dewatering, human disturbance at nest sites, illegal shooting | Sadoti 2010; NMDGF 2014 |
| Elf Owl | *Micrathene whitneyi* | Birds | D | Natural system modification, Human intrusion and disturbance | Loss or degradation of mature riparian and canyon forest nesting habitat, human disturbance | NMACP 2007 |
| Broad-billed Hummingbird | *Cynanthus latirostris* | Birds | D | Natural system modification, Agriculture and aquaculture | Loss of southwestern riparian canyon woodlands from fire, improper grazing practices, and clearing | NMDGF 2014 |
| Lucifer Hummingbird | *Calothorax lucifer* | Birds | D | Natural system modification, Human intrusions and disturbance | Loss of native dry-canyon/hillside habitats, including loss of food plants from burning or improper grazing practices | Rappole et al. 2007; NMDGF 2014 |
| Elegant Trogon | *Trogon elegans* | Birds | D | Natural system modification, Biological resource use, Agriculture and aquaculture, Human intrusions and disturbance | Loss of limited broadleaf riparian foraging and breeding habitat, including large trees with suitable nesting cavities, from fire, wood cutting, and improper grazing practices, human disturbance of nesting birds | NMDGF 2014 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Botteri's Sparrow | *Peucaea botterii* | Birds | D | Agriculture and aquaculture, Natural system modification | Loss or degradation of limited tall-grass habitat from improper grazing practices and fire | pers. comm., S. Williams, NMDGF |
| Abert's Towhee | *Melozone aberti* | Birds | D | Agriculture and aquaculture, Natural system modification | Loss, alteration, or degradation of native southwestern riparian habitats from improper grazing practices, clearing, or conversion | NMDGF 2014 |
| Brown-capped Rosy-Finch | *Leucosticte australis* | Birds | D | Natural system modification, Climate change | New SGCN | pers. comm., M. Darr, NMDGF; NMACP 2007 |
| Aplomado Falcon | *Falco femoralis* | Birds | F | Natural system modification, Agriculture and aquaculture, Poison, Transportation and service corridors, Human intrusions and disturbance | Loss, degradation, or alteration of desert grassland habitat leading to reduced grass cover, increased brush encroachment, and reduced prey populations, resulting from improper grazing practices or agricultural conversion, fire, pesticides and other contaminants | USFWS 1990; Keddy-Hector 2000; Young and Young 2010; Hunt et al. 2013; NMDGF 2014 |
| Least Tern | *Sternula antillarum* | Birds | F | Natural system modification, Human intrusions and disturbance | Loss or alteration of riverine habitats from altered flow regimes, channelization, inundation, chemical contamination of prey base, human disturbance of nesting flats | NMDGF 2014 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Yellow-billed Cuckoo | *Coccyzus americanus* | Birds | F | Residential and commercial development, Agriculture and aquaculture, Natural system modification | Loss, fragmentation, and degradation of riparian habitats from clearing for urban or agricultural development, improper grazing practices, flood control, schemes to eradicate exotic vegetation | pers. comm., S. Williams, NMDGF; Goodwin and Shriver 2011; USFWS 2014b |
| Mexican Spotted Owl | *Strix occidentalis lucida* | Birds | F | Natural system modification, Biological resource use, Invasive and problematic species | Loss of preferred mature and old-growth forest habitat from timber harvest and other cutting, altered fire regimes, stand-replacing fires | Ishak et al. 2008; Stacey 2010; USFWS 2012d |
| Southwestern Willow Flycatcher | *Empidonax traillii extimus* | Birds | F | Natural system modification, Biological resource use, Human intrusions and disturbance, Invasive and problematic species | Loss, fragmentation, or alteration of riparian habitat from water manipulation, urbanization, improper grazing practices, fire, and vegetation eradication programs, negative impacts from recreation and research, demography of fragmented populations | Brodhead et al. 2007; Sogge et al. 2008; NMDGF 2014 |
| Conchas Crayfish | *Orconectes deanae* | Crust. | H | Natural system modification, Invasive and problematic species | Stream channel incisement/aggradation from poor watershed management practices, non-native molluscs and crayfish | Lang and Mehlhop 1996 |
| BLNWR cryptic species Amphipod | *Gammarus* sp. (unnamed) | Crust. | D | Natural system modification, Pollution, Invasive and problematic species | Groundwater depletion, spring habitat alterations, wildfire, ground/surface water contamination, non-native molluscs | Lang 2005; NMDGF 2005a |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Sitting Bull Spring cryptic species Amphipod | *Gammarus* sp. (unnamed) | Crust. | D | Natural system modification, Invasive and problematic species | Spring habitat alterations, wildfire, non-native molluscs and crayfish | pers. comm., B. Lang, NMDGF; Fernandez and Rosen 1996 |
| Western Plains Crayfish | *Orconectes causeyi* | Crust. | D | Invasive and problematic species | Non-native molluscs and crayfish | Lang and Mehlhop 1996 |
| Southern Plains Crayfish | *Procambarus simulans* | Crust. | D | Natural system modification, Invasive and problematic species | Regulated flows, stream channel incisement/aggradation, non-native molluscs and crayfish | Taylor et al. 1996; Lodge et al. 2000 |
| Moore's Fairy Shrimp | *Streptocephalus moorei* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Leibowitz and Nadeau 2003 |
| Brine Shrimp | *Artemia franciscana* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Liebowitz and Nadeau 2003 |
| Colorado Fairy Shrimp | *Branchinecta coloradoensis* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Liebowitz and Nadeau 2003 |
| Versatile Fairy Shrimp | *Branchinecta lindahli* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Liebowitz and Nadeau 2003 |
| Alkali Fairy Shrimp | *Branchinecta mackini* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Liebowitz and Nadeau 2003 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Packard's Fairy Shrimp | *Branchinecta packardi* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Liebowitz and Nadeau 2003 |
| Sublette's Fairy Shrimp | *Phallocryptis subletti* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Liebowitz and Nadeau 2003 |
| Knobblip Fairy Shrimp | *Eubranchipus bundyi* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Liebowitz and Nadeau 2003 |
| Dumont's Fairy Shrimp | *Streptocephalus henridumontis* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Liebowitz and Nadeau 2003 |
| Bowman's Fairy Shrimp | *Streptocephalus thomasbowmani* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Liebowitz and Nadeau 2003 |
| Great Plains Fairy Shrimp | *Streptocephalus texanus* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Liebowitz and Nadeau 2003 |
| Mexican Beavertail Fairy Shrimp | *Thamnocepahlus mexicanus* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Liebowitz and Nadeau 2003 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Beavertail Fairy Shrimp | *Thamnocepahlus platyurus* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Liebowitz and Nadeau 2003 |
| Mexican Clam Shrimp | *Cyzicus mexicanus* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Liebowitz and Nadeau 2003 |
| Swaybacked Clam Shrimp | *Eocyzicus concavus* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Leibowitz and Nadeau 2003 |
| Straightbacked Clam Shrimp | *Eocyzicus digueti* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Leibowitz and Nadeau 2003 |
| Fuzzy Cyst Clam Shrimp | *Eulimnadia antlei* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Liebowitz and Nadeau 2003 |
| Cylindrical Cyst Clam Shrimp | *Eulimnadia cylindrova* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Liebowitz and Nadeau 2003 |
| Diversity Clam Shrimp | *Eulimnadia diversa* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Liebowitz and Nadeau 2003 |
| Clam Shrimp | *Eulimnadia follismilis* | Crust. | D | Natural system modification | Hydroperiod alteration | Lang and Rogers 2002 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Texan Clam Shrimp | *Eulimnadia texana* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Liebowitz and Nadeau 2003 |
| Short Finger Clam Shrimp | *Lynceus brevifrons* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Leibowitz and Nadeau 2003 |
| Lynch Tadpole Shrimp | *Lepidurus lemmoni* | Crust. | D | Natural system modification, Pollution | Wetland jurisdiction, hydroperiod alteration, non-point discharge of contaminants | Lang and Rogers 2002; Leibowitz and Nadeau 2003 |
| Socorro Isopod | *Thermosphaeroma thermophilum* | Crust. | F | Human intrusions and disturbance, Natural system modification | Habitat vandalism, diminution/loss of spring flow | NMDGF 2014 |
| Noel’s Amphipod | *Gammarus desperatus* | Crust. | F | Natural system modification, Invasive and problematic species, Pollution | Groundwater depletion, spring habitat alterations, wildfire, ground/surface water contamination, non-native molluscs | Lang 2005; NMDGF 2005a; NMDGF 2014 |
| Rio Grande Chub | *Gila pandora* | Fish | I | Natural system modification, Invasive and problematic species | Habitat deterioration, non-native species, water diversion | Propst 1999; Douglas and Douglas 2003 |
| Headwater Chub | *Gila nigra* | Fish | I | Invasive and problematic species, Natural system modification | Non-native predators (mainly centrarchids and ictalurids), habitat modification (sedimentation, bank erosion, debris removal), wildfire ash flows, woody riparian vegetation removal, disease | Pilger et al. 2010 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Roundtail Chub | *Gila robusta* | Fish | I | Invasive and problematic species, Natural system modification, Climate change | Non-native fishes (particularly predators), habitat fragmentation (dams, diversions), habitat desiccation (irrigation withdrawals/diversions), habitat modification (channelization, vegetation removal, bank revetments), modified flow regimes (loss of springs) | Propst 1999; UDNR 2004 |
| Peppered Chub | *Macrhybopsis tetranema* | Fish | I | Natural system modification | Water diversion, groundwater pumping, regulated reservoir releases | Propst 1999; Durham and Wilde 2008; NMDGF 2014 |
| Gray Redhorse | *Moxostoma congestum* | Fish | I | Climate change, Invasive and problematic species | Drying of habitat, golden algae blooms | Larson 2004 |
| Blue Sucker | *Cycleptus elongatus* | Fish | I | Natural system modification, Climate change, Invasive and problematic species | Habitat fragmentation, water diversion, drying of habitat, golden algae blooms | Propst 1999; Larson 2004; Bessert and Orti 2008 |
| Rio Grande Sucker | *Catostomus plebeius* | Fish | I | Natural system modification, Invasive and problematic species | Habitat deterioration, non-native species, disease | Sublette et al. 1990; NMDGF 2014 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Pecos Pupfish | *Cyprinodon pecosensis* | Fish | I | Natural system modification, Invasive and problematic species | Lowered water tables, drying of springs, hybridization with *C. variegatus* | Brooks and Wood 1988; Minckley et al. 1991;Hoagstrom and Brooks 1998; TPWD et al. 1998; Platania 2001; Hoagstrom 2009 |
| White Sands Pupfish | *Cyprinodon tularosa* | Fish | I | Natural system modification, Invasive and problematic species, Human intrusions and disturbance | Habitat loss due to drought and water withdrawal, non-native species, military maneuvers | Propst 1999 |
| Greenthroat Darter | *Etheostoma lepidum* | Fish | H | Natural system modification, Invasive and problematic species | Lowered water tables, drying of springs, predation by introduced centrarchids, predation by non-native fishes, sediment deposition, water diversion | Hubbs and Strawn 1957; Cowley and Sublette 1987; Brooks and Wood 1988; Sublette et al. 1990; Propst 1999 |
| Bigscale Logperch (native pop.) | *Percina macrolepida* | Fish | H | Invasive and problematic species, Climate change | Predation by non-native fishes, fluctuating water levels, drying of habitat, predation by non-native centrarchids | Propst 1999 |
| Southern Redbelly Dace | *Phoxinus erythrogaster* | Fish | S | Natural system modification | Dewatering of springs, sedimentation | Propst 1999; NMDGF 2014 |
| Suckermouth Minnow | *Phenacobius mirabilis* | Fish | S | Natural system modification | Sedimentation, habitat desiccation and fragmentation. | Propst 1999; NMDGF 2014 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Desert Sucker | *Catostomus clarkii* | Fish | S | Invasive and problematic species, Natural system modification | Non-native predators (mainly centrarchids and ictalurids), sedimentation, band erosion, in-channel debris removal, channelization, stream desiccation, wildfire ash flows, disease | Jelks et al. 2008 |
| Sonora Sucker | *Catostomus insignis* | Fish | S | Invasive and problematic species, Natural system modification | Non-native predators (mainly centrarchids and ictalurids), sedimentation, band erosion, in-channel debris removal, channelization, stream desiccation, wildfire ash flows, disease | Rinne and Carter 2008 |
| Mexican Tetra | *Astyanax mexicanus* | Fish | S | Natural system modification, Climate change | Lowered water tables, drying of springs | Propst 1999 |
| Chihuahua Chub | *Gila nigrescens* | Fish | F | Invasive and problematic species, Climate Change, Natural system modification | Non-native predators (salmonids and centrarchids) and competitors (longfin dace and rainbow trout), stream desiccation, habitat loss (debris removal, bank erosion, channelization), range fragmentation, irrigation diversion entrainment, parasites, disease | Propst 2004; Osborne et al. 2012 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Gila Chub | *Gila intermedia* | Fish | F | Invasive and problematic species, Natural system modification | Non-native predators (mainly centrarchids and ictalurids), habitat modification (sedimentation, bank erosion, debris removal), wildfire ash flows, disease | Propst 1999; NMDGF 2014 |
| Loach Minnow | *Rhinichthys (Tiaroga) cobitis* | Fish | F | Invasive and problematic species, Natural system modification | Non-native predators (mainly centrarchids and ictalurids) and competitors (mainly red shiner *Cyprinella lutrensis*), substrate armoring, bank instability, loss riparian vegetation, stream drying (diversion and groundwater pumping), sedimentation, channelization | Propst et al. 2008; Pilger et al. 2015 |
| Rio Grande Silvery Minnow | *Hybognathus amarus* | Fish | F | Natural system modification, Invasive and problematic species | Water withdrawal, habitat fragmentation, channelization, water quality, non-native species | Sublette et al. 1990; USFWS 1999; Magana 2012 |
| Arkansas River Shiner (native pop.) | *Notropis girardi* | Fish | F | Natural system modification | New SGCN | Dudley and Platania 2007; Perkin and Gido 2011 |
| Pecos Bluntnose Shiner | *Notropis simus pecosensis* | Fish | F | Natural system modification | Drying of habitat, altered flow regimes | USFWS 1992; USFWS 2002; Hoagstrom 2003; Hoagstrom et al. 2008a; Hoagstrom et al. 2008b; Osborne et al. 2010 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
| --- | --- | --- | --- | --- | --- | --- |
| Spikedace | *Meda fulgida* | Fish | F | Invasive and problematic species, Natural system modification | Non-native predators (mainly centrarchids and ictalurids) and competitors (mainly red shiner *Cyprinella lutrensis*), substrate armoring, bank instability, riparian vegetation loss, stream drying (diversion and groundwater pumping), sedimentation, channelization | Carveth et al. 2007; Pilger et al. 2010; Stefferud et al. 2011; NMDGF 2014 |
| Colorado Pikeminnow | *Ptychocheilus lucius* | Fish | F | Invasive and problematic species, Natural system modification | Non-native fishes (particularly predators such as channel catfish), habitat fragmentation (diversion dams), loss of low-velocity habitats, entrainment in irrigation systems, modified flow regimes (loss of peaking flows as spawning cue), insufficiency of prey base, disease | USFWS 1991; Propst 1999; USFWS 2003a; Franssen et al. 2007; Franssen and Durst 2014 |
| Zuni Bluehead Sucker | *Catostomus discobolus yarrowi* | Fish | F | Natural system modification, Invasive and problematic species | Habitat degradation and loss, non-native aquatic species | Propst and Hobbes 1996; Propst 1999; NMDGF 2005b; USFWS 2014c |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Razorback Sucker | *Xyrauchen texanus* | Fish | F | Invasive and problematic species, Natural system modification | Nonnative fishes (predators), habitat modification (channelization, bank revetments), modified flow regimes, irrigation diversion entrainment, range fragmentation (diversion dams), modified flow regime, temperature modification, loss of debris pool habitats | USFWS 2003b |
| Gila Trout | *Oncorhynchus gilae* | Fish | F | Invasive and problematic species, Human intrusions and disturbance, Climate Change | Non-native competitors (mainly brown trout) and congenerics (hybridizing rainbow trout), illegal angling, wildfire ash flows, disease, habitat loss (bank erosion), sedimentation | Kennedy et al. 2009 |
| Pecos Gambusia | *Gambusia nobilis* | Fish | F | Natural system modification, Invasive and problematic species | Lowered water tables, drying of springs, predation by introduced centrarchids, hybridization with *G. affinis*, loss of habitat | USFWS 1983; Brooks and Wood 1988; Echelle et al. 1989; Sei et al. 2009; Gumm et al. 2011; Paciorek et al. 2014 |
| Gila Topminnow | *Poeciliopsis occidentalis occidentalis* | Fish | F | Invasive and problematic species, Natural system modification | Interactions with introduced gambusia species, lowered water levels | Sublette et al. 1990; Propst 1999 |
| American Mink | *Vison vison* | Mam. | I | Natural system modification | New SGCN | pers. comm., J. Stuart, NMDGF |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| North American River Otter | *Lontra canadensis* | Mam. | I | Natural system modification, Pollution | Riverine habitat loss/conversion, water pollution | pers. comm., J. Frey, NMSU |
| Organ Mountains Colorado Chipmunk | *Tamias quadrivittatus australis* | Mam. | I | Natural system modifications | Habitat conversion, fire management | NMDGF 2014 |
| Oscura Mountains Colorado Chipmunk | *Tamias quadrivittatus oscuraensis* | Mam. | I | Natural system modifications | Habitat conversion, fire management | NMDGF 2014 |
| Peñasco Least Chipmunk | *Tamias minimus atristriatus* | Mam. | I | Natural system modification, Invasive and problematic species | Habitat loss/fragmentation, species competition | Frey and Boykin 2007; NMDGF 2014 |
| Black-tailed Prairie Dog | *Cynomys ludovicianus* | Mam. | I | Invasive and problematic species, Natural system modification, Human intrusions and disturbance | Sylvatic plague, habitat loss/fragmentation, unregulated taking | NWF 1998 |
| Gunnison's Prairie Dog | *Cynomys gunnisoni* | Mam. | I | Invasive and problematic species, Natural system modification, Human intrusions and disturbance | Sylvatic plague, unregulated taking, habitat loss/fragmentation | USFWS 2013b |
| Arizona Montane Vole | *Microtus montanus arizonensis* | Mam. | I | Agriculture and aquaculture, Natural system modification | Improper grazing practices, wetland habitat loss/conversion, small populations | Allen and Ramstead 2010; NMDGF 2014 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| White-sided Jackrabbit | *Lepus callotis* | Mam. | I | Agriculture and aquaculture, Natural system modification | Improper grazing practices, habitat loss/conversion, small populations | Traphagen 2011; NMDGF 2014 |
| Arizona Shrew | *Sorex arizonae* | Mam. | H | Natural system modification | Habitat loss/conversion, wildfire, small populations | NMDGF 2014 |
| Least Shrew | *Cryptotis parva* | Mam. | H | Agriculture and aquaculture, Natural system modification, Climate change | Improper grazing practices, habitat loss/conversion, wetland drying | NMDGF 2014 |
| American Pika | *Ochotona princeps* | Mam. | H | Natural system modification, Climate change | Habitat loss/conversion, climate change, small populations | pers. comm., J. Stuart, NMDGF; Erb et al. 2011 |
| Pale Townsend's Big-eared Bat | *Corynorhinus townsendii* | Mam. | S | Energy production and mining | New SGCN | Graham and Hudak 2011 |
| Spotted Bat | *Euderma maculatum* | Mam. | S | Human intrusions and disturbance, Pollution | Roost/foraging habitat disturbance, pesticides | Luce and Keinath 2007; NMDGF 2014 |
| Pacific Marten | *Martes caurina* | Mam. | S | Biological resource use, Natural system modification, Climate change | Timber overharvest, forest habitat loss/conversion, wildfire | Wasserman et al. 2013; NMDGF 2014 |
| Mexican Long-tongued Bat | *Choeronycteris mexicana* | Mam. | D | Human intrusions and disturbance, Natural system modification | Roost disturbance, wildfire, loss of nectar plants | NMDGF 2014 |
| Western Yellow Bat | *Lasiurus xanthinus* | Mam. | D | Natural system modification | Riparian habitat loss/conversion, small populations | NMDGF 2014 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Southern Pocket Gopher | *Thomomys umbrinus* | Mam. | D | Natural system modification, Human intrusions and disturbance, Pollution | Habitat loss/conversion, wildfire, small populations | Smith et al. 2008; Gruver and Keinath. 2012; NMDGF 2014, |
| Mexican Long-nosed Bat | *Leptonycteris nivalis* | Mam. | F | Human intrusions and disturbance, Natural system modification | Roost disturbance, wildfire, loss of nectar plants | NMDGF 2014 |
| Lesser Long-nosed Bat | *Leptonycteris yerbabuenae* | Mam. | F | Human intrusions and disturbance, Natural system modification | Roost disturbance, wildfire, loss of nectar plants | NMDGF 2014 |
| Mexican Gray Wolf | *Canis lupus baileyi* | Mam. | F | Human intrusions and disturbance, Invasive and problematic species, Natural system modification | Illegal killing, road mortality, disease, small populations, habitat fragmentation | NMDGF 2014 |
| Jaguar | *Panthera onca* | Mam. | F | Natural system modification, Human intrusions and disturbance | Habitat loss/conversion/fragmentation, illegal shooting | McCain and Childs 2008; USFWS 2014f |
| Black-footed Ferret | *Mustela nigripes* | Mam. | F | Natural system modification | New SGCN | Chipault 2010; USFWS 2013c |
| New Mexico Meadow Jumping Mouse | *Zapus hudsonius luteus* | Mam. | F | Agriculture and aquaculture, Natural system modification | Improper grazing practices, wetland habitat loss/conversion, small populations | Frey and Malaney 2009; USFWS 2013d; NMDGF 2014; Wright and Frey 2015 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Texas Hornshell | *Popenaias popeii* | Mol. | I | Natural system modification, Climate change, Invasive and problematic species, Pollution | Habitat modification (damming, diversion), aquifer depletion, surface water contamination, drought, sedimentation, non-native molluscs, golden algae | Lang 2004; NMDGF 2007b; Inoue et al. 2013 |
| New Mexico Hot Springsnail | *Pyrgulopsis thermalis* | Mol. | H | Human intrusions and disturbance, Invasive and problematic species | Recreational bathing, non-native species (crayfish, New Zealand mudsnail) | Brown et al. 2008; NMDGF 2014 |
| Gila Springsnail | *Pyrgulopsis gilae* | Mol. | H | Human intrusions and disturbance, Invasive and problematic species | Recreational bathing, non-native species (crayfish, New Zealand mudsnail) | Brown et al. 2008; NMDGF 2014 |
| Pecos Springsnail | *Pyrgulopsis pecosensis* | Mol. | H | Natural system modification, Agriculture and aquaculture, Invasive and problematic species | Spring diversion/impoundment, improper grazing practices riparian corridor, groundwater depletion/contamination, non-native species (crayfish, New Zealand mudsnail) | Lang 2005; NMDGF 2014 |
| Tularosa Springsnail | *Juturnia tularosae* | Mol. | H | Natural system modification, Invasive and problematic species | Diminution/loss of spring flow, non-native species (tamarisk, molluscs, crayfish), wetland jurisdiction (SWANCC) | pers. comm., S. Carman, NMDGF; Fernandez and Rosen 1996; Leibowitz and Nadeau 2003 |
| Star Gyro | *Gyraulus crista* | Mol. | H | Natural system modification | Habitat modification (wetland filling, change in hydrology) | NMDGF 2014 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| New Mexico Ramshorn Snail | *Pecosorbis kansasensis* | Mol. | H | Natural system modification, Climate change | Arroyo entrenchment/sedimentation, hydroperiod alteration, drought, human alteration of swales and depressions | pers. comm., B. Lang, NMDGF; Taylor 1985; Leibowitz and Nadeau 2003 |
| Lang Canyon Talussnail | *Sonorella painteri* | Mol. | H | Natural system modification, Energy production and mining, Biological resource use | Fire, mining, deforestation | Sullivan 1997; Lang 2001; Lang 2005 |
| Shortneck Snaggletooth Snail | *Gastrocopta dalliana* | Mol. | H | Natural system modification, Biological resource use, Agriculture and aquaculture | Fire, mining, deforestation | Lang 2001; Lang 2004 |
| Ovate Vertigo Snail | *Vertigo ovata* | Mol. | H | Natural system modification, Agriculture and aquaculture | Groundwater depletion, wetland habitat alterations (improper grazing practices, human modification) | Metcalf and Smartt 1997 |
| Ruidoso Snaggletooth Snail | *Gastrocopta ruidosensis* | Mol. | H | No specific threats identified, considered vulnerable due to limited distribution in New Mexico | New SGCN | BISON-M 2016 |
| Cross Holospira Snail | *Holospira crossei* | Mol. | H | Natural system modification, Energy production and mining, Biological resource use | Fire, mining, deforestation | Sullivan 1997; Lang 2001; Lang 2005 |
| Animas Mountains Holospira Snail | *Holospira animasensis* | Mol. | H | Natural system modification, Energy production and mining, Biological resource use | Fire, mining, deforestation | Sullivan 1997; Lang 2001; Lang 2005 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Mineral Creek Mountainsnail | *Oreohelix pilsbryi* | Mol. | H | Natural system modification, Biological resource use, Agriculture and aquaculture | Fire, mining, deforestation | Lang 2001; Lang 2004 |
| Hacheta Grande Woodlandsnail | *Ashmunella hebardi* | Mol. | H | Natural system modification, Biological resource use, Agriculture and aquaculture | Fire, mining, deforestation | Lang 2001; Lang 2004 |
| Cooke's Peak Woodlandsnail | *Ashmunella macromphala* | Mol. | H | Natural system modification, Biological resource use, Agriculture and aquaculture | Fire, mining, deforestation, improper grazing practices | Lang 2001; Lang 2004 |
| Sangre de Cristo Woodlandsnail | *Ashmunella thomsoniana* | Mol. | H | Natural system modification, Energy production and mining, Transportation and service corridors, Residential and commercial development | Fire, mining, deforestation, road and building construction | Sullivan 1997; Lang 2001; Lang 2005 |
| Jemez Woodlandsnail | *Ashmunella ashmuni* | Mol. | H | Natural system modification, Energy production and mining, Transportation and service corridors, Residential and commercial development | Fire, mining, deforestation, road and building construction | Sullivan 1997; Lang 2001; Lang 2005 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Silver Creek Woodlandsnail | *Ashmunella binneyi* | Mol. | H | No specific threats identified, vulnerable due to limited distribution in New Mexico | New SGCN | BISON-M 2016 |
| Doña Ana Talussnail | *Sonorella todseni* | Mol. | H | Natural system modification, Biological resource use, Agriculture and aquaculture | Fire, mining, deforestation | Lang 2001; Lang 2004 |
| New Mexico Talussnail (Big Hatchet Mountains) | *Sonorella hachitana* | Mol. | H | Natural system modification, Biological resource use, Agriculture and aquaculture | Fire, mining, deforestation | Lang 2001; Lang 2004 |
| New Mexico Talussnail (Florida Mountains) | *Sonorella hachitana flora* | Mol. | H | Natural system modification, Energy production and mining, Biological resource use | Fire, mining, deforestation | Sullivan 1997; Lang 2001; Lang 2005 |
| Paper Pondshell | *Utterbackia imbecillis* | Mol. | H | Natural system modification, Invasive and problematic species | Habitat modification (damming, stream channelization, regulated flows), non-native bivalves | Lang and Mehlhop 1996; NMDGF 2014 |
| Swamp Fingernailclam | *Musculium partumeium* | Mol. | H | Natural system modification, Pollution | Stream channel incisement/aggradation from poor watershed management practices, water pollution | NMDGF 2014 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Lilljeborg's Peaclam | *Pisidium lilljeborgi* | Mol. | H | No specific threats identified, considered vulnerable due to limited distribution in New Mexico | No specific threats identified | BISON-M 2016 |
| Lake Fingernailclam | *Musculium lacustre* | Mol. | H | Natural system modification, Pollution | Stream channel incisement/aggradation from poor watershed management practices, water pollution | NMDGF 2014 |
| Long Fingernailclam | *Musculium transversum* | Mol. | H | Natural system modification, Pollution | Stream channel incisement/aggradation from poor watershed management practices, water pollution | NMDGF 2014 |
| Obese Thorn Snail | *Carychium exiguum* | Mol. | S | Natural system modification | Human alteration of habitat | Metcalf and Smartt 1997 |
| False Marsh Snail | *Deroceras heterura* | Mol. | S | Natural system modification, Energy production and mining, Transportation and service corridors, Residential and commercial development | Fire, mining, deforestation, road and building construction | Sullivan 1997; Lang 2001; Lang 2005 |
| Texas Liptooth Snail | *Linisa texasiana* | Mol. | S | Natural system modification, Pollution, Invasive and problematic species, Agriculture and aquaculture | Groundwater depletion, spring habitat alterations, wildfire, ground/surface water contamination, human habitat modification, saltcedar invasion, improper grazing practices | pers. comm., B. Lang, NMDGF; Metcalf and Smartt 1997 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Wrinkled Marshsnail | *Stagnicola caperata* | Mol. | D | Agriculture and aquaculture, Natural system modification, Climate change, Pollution | Habitat loss (improper grazing practices, arroyo entrenchment/sedimentation, fire frequency), drought, water contamination from sewage effluent, hydroperiod alteration, vegetative loss within drainage catchment | Lang 2005; NMDGF 2014 |
| Creeping Ancylid Snail | *Ferrissia rivularis* | Mol. | D | Natural system modification, Invasive and problematic species | Habitat modification (damming, diversion), non-native fish introductions | Hovingh 2004 |
| Vallonia Snail | *Vallonia sonorana* | Mol. | D | Natural system modification, Energy production and mining | Fire, mining, deforestation | Sullivan 1997; Lang 2001; Lang 2005 |
| Metcalf Holospira Snail | *Holospira metcalfi* | Mol. | D | Natural system modification, Energy production and mining, Biological resource use | fire, mining, deforestation | Sullivan 1997; Lang 2001; Lang 2005 |
| Fringed Mountainsnail | *Radiocentrum ferrissi* | Mol. | D | Natural system modification, Biological resource use, Agriculture and aquaculture | Fire, mining, deforestation | Lang 2001; Lang 2004 |
| Woodlandsnail | *Ashmunella amblya cornudasensis* | Mol. | D | Natural system modification, Energy production and mining, Biological resource use | Fire, mining, deforestation | Sullivan 1997; Lang 2001; Lang 2005 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Animas Peak Woodlandsnail | *Ashmunella animasensis* | Mol. | D | Natural system modification, Energy production and mining, Biological resource use | Fire, mining, deforestation | Sullivan 1997; Lang 2001; Lang 2005 |
| New Mexico Talussnail (Peloncillo Mountains) | *Sonorella hachitana peloncillensis* | Mol. | D | Natural system modification, Energy production and mining, Biological resource use | Fire, mining, deforestation | Sullivan 1997; Lang 2001; Lang 2005 |
| Animas Talussnail | *Sonorella animasensis* | Mol. | D | Natural system modification, Energy production and mining, Biological resource use | Fire, mining, deforestation | Sullivan 1997; Lang 2001; Lang 2005 |
| Sangre De Cristo Peaclam | *Pisidium sanguinichristi* | Mol. | D | Natural system modifications, Climate change, Invasive and problematic species, Pollution | Recreational use, pollution and modification of natural processes, non-native/invasive species | NMDGF 2014 |
| Alamosa Springsnail | *Pseudotryonia alamosae* | Mol. | F | Energy production and mining, Invasive and problematic species | Beryllium mining, non-native species (crayfish, New Zealand mudsnail, tamarisk) | NMDGF 2014 |
| Chupadera Springsnail | *Pyrgulopsis chupaderae* | Mol. | F | Natural system modification, Agriculture and aquaculture, Invasive and problematic species | Spring diversion/impoundment, improper grazing practices riparian corridor, non-native species (crayfish, New Zealand mudsnail) | USFWS 2012a; Hershler et al. 2014; NMDGF 2014 |
| Koster's Springsnail | *Juturnia kosteri* | Mol. | F | Natural system modification, Invasive and problematic species Pollution | Groundwater depletion, spring habitat alterations, wildfire, ground/surface water contamination, non-native molluscs | Lang 2005; NMDGF 2005a; NMDGF 2014 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Roswell Springsnail | *Pyrgulopsis roswellensis* | Mol. | F | Natural system modification, Invasive and problematic species, Pollution | Groundwater depletion, spring habitat alterations, wildfire, ground/surface water contamination, non-native molluscs | Lang 2005; NMDGF 2005a; NMDGF 2014 |
| Socorro Springsnail | *Pyrgulopsis neomexicana* | Mol. | F | Natural system modification, Invasive and problematic species | Spring diversion/impoundment, non-native crayfish | Hershler et al. 2014; NMDGF 2014 |
| Pecos Assiminea | *Assiminea pecos* | Mol. | F | Natural system modification, Invasive and problematic species, Pollution | Groundwater depletion, spring habitat alterations, wildfire, ground/surface water contamination, non-native molluscs | Lang 2005; NMDGF 2005a; NMDGF 2014 |
| Western River Cooter | *Pseudemys gorzugi* | Rept. | I | Human intrusions and disturbance, Climate change, Natural system modification | Indiscriminate shooting, drought, water diversion, pet trade, market hunting | Degenhardt et al. 1996; NMDGF 2014 |
| Slevin's Bunchgrass Lizard | *Sceloporus slevini* | Rept. | H | Agriculture and aquaculture, Natural system modification | Improper grazing practices, wildfire, conversion of habitat | Painter 2009; NMDGF 2014 |
| Dunes Sagebrush Lizard | *Sceloporus arenicolus* | Rept. | H | Natural system modification, Energy production and mining | Habitat conversion, herbicide spraying, oil/gas exploration and development | Painter et al. 1999; Fitzgerald and Painter 2009; USFWS 2012b; Leavitt and Fitzgerald 2013 |
| Mountain Skink | *Plestiodon callicephalus* | Rept. | H | Natural system modification | Wildfire, conversion of habitat | pers. comm., C. Painter, NMDGF |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Gray-checkered Whiptail | *Aspidoscelis dixoni* | Rept. | H | Agriculture and aquaculture, Natural system modification | Improper grazing practices, competition with native species (genetic swamping), herbicide treatment of creosotebush | pers. comm., C. Painter, NMDGF; Cole et al. 2007 |
| Giant Spotted Whiptail | *Aspidoscelis stictogramma* | Rept. | H | Natural system modification | Wildfire, conversion of habitat | pers. comm., C. Painter, NMDGF |
| California Kingsnake | *Lampropeltis californiae* | Rept. | H | Transportation and service corridors | Highway mortality, limited NM range, pet trade | pers. comm., C. Painter, NMDGF; Fitzgerald et al. 2004 |
| Sonoran Mud Turtle | *Kinosternon sonoriense* | Rept. | S | Natural system modification, Climate change | Habitat modification, drought | pers. comm., C. Painter, NMDGF |
| Reticulate Gila Monster | *Heloderma suspectum suspectum* | Rept. | S | Natural system modification, Agriculture and aquaculture, Human intrusions and disturbance, Biological resource use | Wildfire, habitat conversion to agriculture, indiscriminate killing, pet trade | pers. comm., C. Painter, NMDGF; Beck 2005; Beck 2009 |
| Gray-banded Kingsnake | *Lampropeltis alterna* | Rept. | S | Biological resource use | Pet trade, lack of life history data, isolated small population, periphery of range | Hakkila 1994; NMDGF 2002; Fitzgerald et al. 2004 |
| Green Rat Snake | *Senticolis triaspis* | Rept. | S | Natural system modification, Biological resource use | Wildfire, limited NM distribution, isolated, small population, pet trade | pers. comm., C. Painter, NMDGF; Degenhardt et al. 1996 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Arid Land Ribbonsnake | *Thamnophis proximus* | Rept. | S | Natural system modification, Invasive and problematic species, Human intrusions and disturbance | Limited NM distribution, draining of wetlands, non-native predators, indiscriminate killing | pers. comm., C. Painter, NMDGF; Degenhardt et al. 1996 |
| Rock Rattlesnake | *Crotalus lepidus* | Rept. | S | Biological resource use, Human intrusions and disturbance | Commercial trade, indiscriminate killing, addition of new roads opening habitat and thus exposure to people | pers. comm., C. Painter, NMDGF; Degenhardt et al. 1996; Fitzgerald et al. 2004; BISON-M 2016 |
| Arizona Black Rattlesnake | *Crotalus cerberus* | Rept. | D | Climate Change | New SGCN | pers. comm., T. Giermakowski, UNM; van Riper III et al. 2014 |
| Big Bend Slider | *Trachemys gaigeae* | Rept. | D | Human intrusions and disturbance, Invasive and problematic species, Natural system modification, Biological resource use | Indiscriminate shooting, drought, water diversion, pet trade, market hunting | Stuart and Ward 2009; Forstner et al. 2014 |
| Plain-bellied Water Snake | *Nerodia erythrogaster* | Rept. | D | Human intrusions and disturbance, Natural system modification, Biological resource use | Indiscriminate shooting, drought, water diversion, pet trade | pers. comm., C. Painter, NMDGF; Degenhardt et al. 1996; Christman and Kamees 2007; BISON-M 2016 |

| Common Name | Scientific Name | Taxon[53] | Category | Threats | Factors Influencing SGCN | References |
|---|---|---|---|---|---|---|
| Desert Massasauga | *Sistrurus catenatus* | Rept. | D | Agriculture and aquaculture, Biological resource use, Human intrusions and disturbance | Conversion of grasslands to agriculture herbicide spraying, poorly managed grazing practices, pet trade, indiscriminate killing, fragmentation of populations (=habitat) | Hammerson 1999; Holycross 2002; USFWS 2012c |
| Mexican Gartersnake | *Thamnophis eques* | Rept. | F | Natural system modification, Invasive and problematic species, Human intrusions and disturbance | Limited NM distribution, draining and destruction of wetlands, non-native predators, indiscriminate killing | Degenhardt et al. 1996; USFWS 2014d |
| Narrow-headed Gartersnake | *Thamnophis rufipunctatus* | Rept. | F | Invasive and problematic species, Agriculture and aquaculture, Natural system modification, Human intrusions and disturbance | Disease, non-native predators (bullfrogs, non-native fishes, crawfish), improper grazing practices of streamside vegetation, erosion of banks, siltation, recreational use of habitat, indiscriminate killing | Degenhardt et al. 1996; NMDGF 2007a; Hibbitts et al. 2009; USFWS 2014d. |
| New Mexico Ridge-nosed Rattlesnake | *Crotalus willardi obscurus* | Rept. | F | Natural system modification, Human intrusions and disturbance | Wildfire, commercial trade, small isolated population | pers. comm., C. Painter, NMDGF; Degenhardt et al. 1996; Holycross 2002; BISON-M 2016 |

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# Appendix G: Species of Greatest Conservation Need in 16 Conservation Opportunity Areas (COAs) in New Mexico

| COA | Taxon[54] | Common Name | Scientific Name | Category | Federal Status | State Status |
|---|---|---|---|---|---|---|
| Big Hatchet Mountains | Mam. | Mexican Long-tongued Bat | *Choeronycteris mexicana* | D | | |
| | Mam. | Mexican Long-nosed Bat | *Leptonycteris nivalis* | F | E | E |
| | Mam. | Lesser Long-nosed Bat | *Leptonycteris yerbabuenae* | F | E | T |
| | Mam. | Mexican Gray Wolf | *Canis lupus baileyi* | F | E | E |
| | Mol. | Shortneck Snaggletooth Snail | *Gastrocopta dalliana* | H | | T |
| | Mol. | Cross Holospira Snail | *Holospira crossei* | H | | |
| | Mol. | Hacheta Grande Woodlandsnail | *Ashmunella hebardi* | H | | T |
| | Mol. | Vallonia Snail | *Vallonia sonorana* | D | | |
| | Mol. | Fringed Mountainsnail | *Radiocentrum ferrissi* | D | | |
| Black Range | Amph. | Arizona Treefrog | *Hyla wrightorum* | S | | |
| | Amph. | Arizona Toad | *Anaxyrus microscaphus* | D | | |
| | Amph. | Chiricahua Leopard Frog | *Lithobates chiricahuensis* | F | T | |
| | Birds | Flammulated Owl | *Psiloscops flammeolus* | I | | |
| | Birds | Gray Vireo | *Vireo vicinior* | I | | T |
| | Birds | Red-faced Warbler | *Cardellina rubrifrons* | I | | |
| | Birds | Williamson's Sapsucker | *Sphyrapicus thyroideus* | S | | |
| | Birds | Common Black Hawk | *Buteogallus anthracinus* | D | | T |

[54] Mam = Mammals, Mol. = Molluscs, Amph. = Amphibians, Rept. = Reptiles, Crust. = Crustaceans.

| COA | Taxon[54] | Common Name | Scientific Name | Category | Federal Status | State Status |
|---|---|---|---|---|---|---|
| | Birds | Yellow-billed Cuckoo | *Coccyzus americanus* | F | T | |
| | Birds | Mexican Spotted Owl | *Strix occidentalis lucida* | F | T | |
| | Fish | Rio Grande Chub | *Gila pandora* | I | | |
| | Fish | Rio Grande Sucker | *Catostomus plebeius* | I | | |
| | Fish | Desert Sucker | *Catostomus clarkii* | S | | |
| | Fish | Sonora Sucker | *Catostomus insignis* | S | | |
| | Fish | Loach Minnow | *Rhinichthys (Tiaroga) cobitis* | F | E | E |
| | Fish | Spikedace | *Meda fulgida* | F | E | E |
| | Fish | Gila Trout | *Oncorhynchus gilae* | F | T | T |
| | Mol. | Gila Springsnail | *Pyrgulopsis gilae* | H | C | T |
| | Mol. | Mineral Creek Mountainsnail | *Oreohelix pilsbryi* | H | | T |
| Bootheel | Amph. | Sonoran Desert Toad | *Incilius alvarius* | H | | T |
| | Amph. | Lowland Leopard Frog | *Lithobates yavapaiensis* | H | | E |
| | Amph. | Chiricahua Leopard Frog | *Lithobates chiricahuensis* | F | T | |
| | Birds | Gray Vireo | *Vireo vicinior* | I | | T |
| | Birds | Arizona Grasshopper Sparrow | *Ammodramus savannarum ammolegus* | I | | E |
| | Birds | Gould's Wild Turkey | *Meleagris gallopavo mexicana* | H | | T |
| | Birds | Burrowing Owl | *Athene cunicularia* | H | | |
| | Birds | Bell's Vireo | *Vireo bellii* | H | | T |
| | Birds | Mountain Plover | *Charadrius montanus* | S | | |
| | Birds | Common Ground-dove | *Columbina passerina* | S | | E |
| | Birds | Whiskered Screech-Owl | *Megascops trichopsis* | S | | T |

| COA | Taxon[54] | Common Name | Scientific Name | Category | Federal Status | State Status |
|---|---|---|---|---|---|---|
| | Birds | Costa's Hummingbird | *Calypte costae* | S | | T |
| | Birds | Violet-crowned Hummingbird | *Amazilia violiceps* | S | | T |
| | Birds | Gila Woodpecker | *Melanerpes uropygialis* | S | | T |
| | Birds | Northern Beardless Tyrannulet | *Camptostoma imberbe* | S | | E |
| | Birds | Thick-billed Kingbird | *Tyrannus crassirostris* | S | | E |
| | Birds | Yellow-eyed Junco | *Junco phaeonotus* | S | | T |
| | Birds | Baird's Sparrow | *Ammodramus bairdii* | S | | T |
| | Birds | Varied Bunting | *Passerina versicolor* | S | | T |
| | Birds | Broad-billed Hummingbird | *Cynanthus latirostris* | D | | T |
| | Birds | Lucifer Hummingbird | *Calothorax lucifer* | D | | T |
| | Birds | Elegant Trogon | *Trogon elegans* | D | | E |
| | Birds | Botteri's Sparrow | *Peucaea botterii* | D | | |
| | Birds | Yellow-billed Cuckoo | *Coccyzus americanus* | F | T | |
| | Birds | Mexican Spotted Owl | *Strix occidentalis lucida* | F | T | |
| | Mam. | White-sided Jackrabbit | *Lepus callotis* | I | | T |
| | Mam. | Arizona Shrew | *Sorex arizonae* | H | | E |
| | Mam. | Mexican Long-tongued Bat | *Choeronycteris mexicana* | D | | |
| | Mam. | Western Yellow Bat | *Lasiurus xanthinus* | D | | T |
| | Mam. | Mexican Long-nosed Bat | *Leptonycteris nivalis* | F | E | E |
| | Mam. | Lesser Long-nosed Bat | *Leptonycteris yerbabuenae* | F | E | T |
| | Mam. | Mexican Gray Wolf | *Canis lupus baileyi* | F | E | E |
| | Mam. | Jaguar | *Panthera onca* | F | E | |
| | Mol. | Shortneck Snaggletooth Snail | *Gastrocopta dalliana* | H | | T |

| COA | Taxon[54] | Common Name | Scientific Name | Category | Federal Status | State Status |
|---|---|---|---|---|---|---|
| | Mol. | Animas Peak Woodlandsnail | *Ashmunella animasensis* | D | | |
| | Mol. | Animas Talussnail | *Sonorella animasensis* | D | | |
| | Rept. | Slevin's Bunchgrass Lizard | *Sceloporus slevini* | H | | T |
| | Rept. | Mountain Skink | *Plestiodon callicephalus* | H | | T |
| | Rept. | Reticulate Gila Monster | *Heloderma suspectum suspectum* | S | | E |
| | Rept. | Green Rat Snake | *Senticolis triaspis* | S | | T |
| | Rept. | Rock Rattlesnake | *Crotalus lepidus* | S | | |
| | Rept. | New Mexico Ridge-nosed Rattlesnake | *Crotalus willardi obscurus* | F | T | E |
| Gila Highlands | Amph. | Arizona Treefrog | *Hyla wrightorum* | S | | |
| | Amph. | Arizona Toad | *Anaxyrus microscaphus* | D | | |
| | Amph. | Chiricahua Leopard Frog | *Lithobates chiricahuensis* | F | T | |
| | Birds | Pinyon Jay | *Gymnorhinus cyanocephalus* | I | | |
| | Birds | Red-faced Warbler | *Cardellina rubrifrons* | I | | |
| | Birds | Williamson's Sapsucker | *Sphyrapicus thyroideus* | S | | |
| | Birds | Common Black Hawk | *Buteogallus anthracinus* | D | | T |
| | Birds | Yellow-billed Cuckoo | *Coccyzus americanus* | F | T | |
| | Birds | Mexican Spotted Owl | *Strix occidentalis lucida* | F | T | |
| | Fish | Roundtail Chub | *Gila robusta* | I | C | E |
| | Fish | Rio Grande Sucker | *Catostomus plebeius* | I | | |
| | Fish | Desert Sucker | *Catostomus clarkii* | S | | |
| | Fish | Sonora Sucker | *Catostomus insignis* | S | | |

| COA | Taxon[54] | Common Name | Scientific Name | Category | Federal Status | State Status |
|---|---|---|---|---|---|---|
| | Fish | Gila Chub | *Gila intermedia* | F | E | E |
| | Fish | Loach Minnow | *Rhinichthys (Tiaroga) cobitis* | F | E | E |
| | Fish | Spikedace | *Meda fulgida* | F | E | E |
| | Fish | Gila Trout | *Oncorhynchus gilae* | F | T | T |
| | Mam. | Spotted Bat | *Euderma maculatum* | S | | T |
| | Mam. | Mexican Gray Wolf | *Canis lupus baileyi* | F | E | E |
| | Mol. | New Mexico Hot Springsnail | *Pyrgulopsis thermalis* | H | C | T |
| | Mol. | Gila Springsnail | *Pyrgulopsis gilae* | H | C | T |
| | Rept. | Narrow-headed Gartersnake | *Thamnophis rufipunctatus* | F | T | T |
| Gila River Headwaters | Amph. | Arizona Toad | *Anaxyrus microscaphus* | D | | |
| | Amph. | Chiricahua Leopard Frog | *Lithobates chiricahuensis* | F | T | |
| | Birds | Pinyon Jay | *Gymnorhinus cyanocephalus* | I | | |
| | Birds | Red-faced Warbler | *Cardellina rubrifrons* | I | | |
| | Birds | Williamson’s Sapsucker | *Sphyrapicus thyroideus* | S | | |
| | Birds | Common Black Hawk | *Buteogallus anthracinus* | D | | T |
| | Birds | Yellow-billed Cuckoo | *Coccyzus americanus* | F | T | |
| | Birds | Mexican Spotted Owl | *Strix occidentalis lucida* | F | T | |
| | Birds | Southwestern Willow Flycatcher | *Empidonax traillii extimus* | F | E | E |
| | Fish | Headwater Chub | *Gila nigra* | I | C | E |
| | Fish | Roundtail Chub | *Gila robusta* | I | C | E |
| | Fish | Rio Grande Sucker | *Catostomus plebeius* | I | | |
| | Fish | Desert Sucker | *Catostomus clarkii* | S | | |

| COA | Taxon[54] | Common Name | Scientific Name | Category | Federal Status | State Status |
|---|---|---|---|---|---|---|
| | Fish | Sonora Sucker | *Catostomus insignis* | S | | |
| | Fish | Gila Chub | *Gila intermedia* | F | E | E |
| | Fish | Loach Minnow | *Rhinichthys (Tiaroga) cobitis* | F | E | E |
| | Fish | Spikedace | *Meda fulgida* | F | E | E |
| | Fish | Gila Trout | *Oncorhynchus gilae* | F | T | T |
| | Mam. | Gunnison's Prairie Dog | *Cynomys gunnisoni* | I | | |
| | Mam. | Spotted Bat | *Euderma maculatum* | S | | T |
| | Mol. | New Mexico Hot Springsnail | *Pyrgulopsis thermalis* | H | C | T |
| | Mol. | Gila Springsnail | *Pyrgulopsis gilae* | H | C | T |
| | Rept. | Sonoran Mud Turtle | *Kinosternon sonoriense* | S | | |
| | Rept. | Narrow-headed Gartersnake | *Thamnophis rufipunctatus* | F | T | T |
| Jemez Mountains | Amph. | Northern Leopard Frog | *Lithobates pipiens* | S | | |
| | Amph. | Jemez Mountains Salamander | *Plethodon neomexicanus* | F | E | E |
| | Birds | Flammulated Owl | *Psiloscops flammeolus* | I | | |
| | Birds | Gray Vireo | *Vireo vicinior* | I | | T |
| | Birds | Pinyon Jay | *Gymnorhinus cyanocephalus* | I | | |
| | Birds | Peregrine Falcon | *Falco peregrinus* | H | | T |
| | Birds | Black Swift | *Cypseloides niger* | H | | |
| | Birds | Williamson's Sapsucker | *Sphyrapicus thyroideus* | S | | |
| | Birds | Mexican Spotted Owl | *Strix occidentalis lucida* | F | T | |
| | Fish | Rio Grande Chub | *Gila pandora* | I | | |
| | Fish | Rio Grande Sucker | *Catostomus plebeius* | I | | |

| COA | Taxon[54] | Common Name | Scientific Name | Category | Federal Status | State Status |
|---|---|---|---|---|---|---|
| | Fish | Rio Grande Silvery Minnow | *Hybognathus amarus* | F | E | E |
| | Mam. | Gunnison's Prairie Dog | *Cynomys gunnisoni* | I | | |
| | Mam. | American Pika | *Ochotona princeps* | H | | |
| | Mam. | Pale Townsend's Big-eared Bat | *Corynorhinus townsendii* | S | | |
| | Mam. | Spotted Bat | *Euderma maculatum* | S | | T |
| | Mam. | New Mexico Meadow Jumping Mouse | *Zapus hudsonius luteus* | F | E | E |
| | Mol. | Wrinkled Marshsnail | *Stagnicola caperata* | D | | E |
| Lower Gila River | Amph. | Lowland Leopard Frog | *Lithobates yavapaiensis* | H | | E |
| | Amph. | Arizona Toad | *Anaxyrus microscaphus* | D | | |
| | Amph. | Chiricahua Leopard Frog | *Lithobates chiricahuensis* | F | T | |
| | Birds | Pinyon Jay | *Gymnorhinus cyanocephalus* | I | | |
| | Birds | Red-faced Warbler | *Cardellina rubrifrons* | I | | |
| | Birds | Bell's Vireo | *Vireo bellii* | H | | T |
| | Birds | Gila Woodpecker | *Melanerpes uropygialis* | S | | T |
| | Birds | Common Black Hawk | *Buteogallus anthracinus* | D | | T |
| | Birds | Abert's Towhee | *Melozone aberti* | D | | T |
| | Birds | Yellow-billed Cuckoo | *Coccyzus americanus* | F | T | |
| | Birds | Mexican Spotted Owl | *Strix occidentalis lucida* | F | T | |
| | Birds | Southwestern Willow Flycatcher | *Empidonax traillii extimus* | F | E | E |
| | Fish | Roundtail Chub | *Gila robusta* | I | C | E |
| | Fish | Desert Sucker | *Catostomus clarkii* | S | | |

| COA | Taxon[54] | Common Name | Scientific Name | Category | Federal Status | State Status |
|---|---|---|---|---|---|---|
| | Fish | Sonora Sucker | *Catostomus insignis* | S | | |
| | Fish | Gila Chub | *Gila intermedia* | F | E | E |
| | Fish | Loach Minnow | *Rhinichthys (Tiaroga) cobitis* | F | E | E |
| | Fish | Spikedace | *Meda fulgida* | F | E | E |
| | Fish | Gila Trout | *Oncorhynchus gilae* | F | T | T |
| | Rept. | Sonoran Mud Turtle | *Kinosternon sonoriense* | S | | |
| | Rept. | Reticulate Gila Monster | *Heloderma suspectum suspectum* | S | | E |
| | Rept. | Narrow-headed Gartersnake | *Thamnophis rufipunctatus* | F | T | T |
| Lower Pecos, Black Rivers | Amph. | Rio Grande Leopard Frog | *Lithobates berlandieri* | S | | |
| | Birds | Bell's Vireo | *Vireo bellii* | H | | T |
| | Birds | Snowy Plover | *Charadrius nivosus* | S | | |
| | Birds | Yellow-billed Cuckoo | *Coccyzus americanus* | F | T | |
| | Fish | Gray Redhorse | *Moxostoma congestum* | I | | E |
| | Fish | Blue Sucker | *Cycleptus elongatus* | I | | E |
| | Fish | Pecos Pupfish | *Cyprinodon pecosensis* | I | | T |
| | Fish | Greenthroat Darter | *Etheostoma lepidum* | H | | T |
| | Fish | Bigscale Logperch (native pop.) | *Percina macrolepida* | H | | T |
| | Fish | Mexican Tetra | *Astyanax mexicanus* | S | | T |
| | Fish | Rio Grande Silvery Minnow | *Hybognathus amarus* | F | E | E |
| | Fish | Arkansas River Shiner (native pop.) | *Notropis girardi* | F | T | E |
| | Fish | Pecos Bluntnose Shiner | *Notropis simus pecosensis* | F | T | E |

| COA | Taxon[54] | Common Name | Scientific Name | Category | Federal Status | State Status |
|---|---|---|---|---|---|---|
| | Fish | Pecos Gambusia | *Gambusia nobilis* | F | E | E |
| | Mam. | Least Shrew | *Cryptotis parva* | H | | T |
| | Mol. | Texas Hornshell | *Popenaias popeii* | I | C | E |
| | Mol. | Pecos Springsnail | *Pyrgulopsis pecosensis* | H | | T |
| | Mol. | Ovate Vertigo Snail | *Vertigo ovata* | H | | T |
| | Rept. | Western River Cooter | *Pseudemys gorzugi* | I | | T |
| | Rept. | Arid Land Ribbonsnake | *Thamnophis proximus* | S | | T |
| | Rept. | Plain-bellied Water Snake | *Nerodia erythrogaster* | D | | E |
| Mescalero Sands | Birds | Burrowing Owl | *Athene cunicularia* | H | | |
| | Birds | Lesser Prairie-Chicken | *Tympanuchus pallidicinctus* | S | | |
| | Birds | Mountain Plover | *Charadrius montanus* | S | | |
| | Birds | Long-billed Curlew | *Numenius americanus* | S | | |
| | Birds | Yellow-billed Cuckoo | *Coccyzus americanus* | F | T | |
| | Birds | Southwestern Willow Flycatcher | *Empidonax traillii extimus* | F | E | E |
| | Mam. | Black-tailed Prairie Dog | *Cynomys ludovicianus* | I | | |
| | Mam. | Pale Townsend's Big-eared Bat | *Corynorhinus townsendii* | S | | |
| | Rept. | Dunes Sagebrush Lizard | *Sceloporus arenicolus* | H | | E |
| Middle Pecos River | Birds | Bank Swallow | *Riparia riparia* | H | | |
| | Birds | Lesser Prairie-Chicken | *Tympanuchus pallidicinctus* | S | | |
| | Birds | Snowy Plover | *Charadrius nivosus* | S | | |
| | Birds | Least Tern | *Sternula antillarum* | F | E | E |

| COA | Taxon[54] | Common Name | Scientific Name | Category | Federal Status | State Status |
|---|---|---|---|---|---|---|
| | Birds | Yellow-billed Cuckoo | *Coccyzus americanus* | F | T | |
| | Crust. | Noel's Amphipod | *Gammarus desperatus* | F | E | E |
| | Fish | Gray Redhorse | *Moxostoma congestum* | I | | E |
| | Fish | Pecos Pupfish | *Cyprinodon pecosensis* | I | | T |
| | Fish | Greenthroat Darter | *Etheostoma lepidum* | H | | T |
| | Fish | Bigscale Logperch (native pop.) | *Percina macrolepida* | H | | T |
| | Fish | Suckermouth Minnow | *Phenacobius mirabilis* | S | | T |
| | Fish | Mexican Tetra | *Astyanax mexicanus* | S | | T |
| | Fish | Rio Grande Silvery Minnow | *Hybognathus amarus* | F | E | E |
| | Fish | Arkansas River Shiner (native pop.) | *Notropis girardi* | F | T | E |
| | Fish | Pecos Bluntnose Shiner | *Notropis simus pecosensis* | F | T | E |
| | Fish | Pecos Gambusia | *Gambusia nobilis* | F | E | E |
| | Mam. | Black-tailed Prairie Dog | *Cynomys ludovicianus* | I | | |
| | Mam. | Least Shrew | *Cryptotis parva* | H | | T |
| | Mol. | Texas Hornshell | *Popenaias popeii* | I | C | E |
| | Mol. | Wrinkled Marshsnail | *Stagnicola caperata* | D | | E |
| | Mol. | Koster's Springsnail | *Juturnia kosteri* | F | E | E |
| | Mol. | Roswell Springsnail | *Pyrgulopsis roswellensis* | F | E | E |
| | Mol. | Pecos Assiminea | *Assiminea pecos* | F | E | E |
| | Rept. | Arid Land Ribbonsnake | *Thamnophis proximus* | S | | T |
| Middle Rio Grande | Birds | Bell's Vireo | *Vireo bellii* | H | | T |
| | Birds | Bank Swallow | *Riparia riparia* | H | | |

| COA | Taxon[54] | Common Name | Scientific Name | Category | Federal Status | State Status |
|---|---|---|---|---|---|---|
| | Birds | Mountain Plover | *Charadrius montanus* | S | | |
| | Birds | Snowy Plover | *Charadrius nivosus* | S | | |
| | Birds | Common Black Hawk | *Buteogallus anthracinus* | D | | T |
| | Birds | Yellow-billed Cuckoo | *Coccyzus americanus* | F | T | |
| | Birds | Southwestern Willow Flycatcher | *Empidonax traillii extimus* | F | E | E |
| | Fish | Rio Grande Chub | *Gila pandora* | I | | |
| | Fish | Rio Grande Silvery Minnow | *Hybognathus amarus* | F | E | E |
| | Mam. | New Mexico Meadow Jumping Mouse | *Zapus hudsonius luteus* | F | E | E |
| | Rept. | Big Bend Slider | *Trachemys gaigeae* | D | | |
| Mimbres River | Amph. | Arizona Toad | *Anaxyrus microscaphus* | D | | |
| | Amph. | Chiricahua Leopard Frog | *Lithobates chiricahuensis* | F | T | |
| | Birds | Red-faced Warbler | *Cardellina rubrifrons* | I | | |
| | Birds | Common Black Hawk | *Buteogallus anthracinus* | D | | T |
| | Birds | Yellow-billed Cuckoo | *Coccyzus americanus* | F | T | |
| | Birds | Mexican Spotted Owl | *Strix occidentalis lucida* | F | T | |
| | Fish | Rio Grande Sucker | *Catostomus plebeius* | I | | |
| | Fish | Desert Sucker | *Catostomus clarkii* | S | | |
| | Fish | Chihuahua Chub | *Gila nigrescens* | F | T | E |
| | Fish | Gila Trout | *Oncorhynchus gilae* | F | T | T |
| | Mam. | Pale Townsend's Big-eared Bat | *Corynorhinus townsendii* | S | | |

| COA | Taxon[54] | Common Name | Scientific Name | Category | Federal Status | State Status |
|---|---|---|---|---|---|---|
| Northern Sacramento Mountains | Amph. | Sacramento Mountain Salamander | *Aneides hardii* | H | | T |
| | Birds | Broad-billed Hummingbird | *Cynanthus latirostris* | D | | T |
| | Birds | Mexican Spotted Owl | *Strix occidentalis lucida* | F | T | |
| San Francisco River | Amph. | Lowland Leopard Frog | *Lithobates yavapaiensis* | H | | E |
| | Amph. | Arizona Treefrog | *Hyla wrightorum* | S | | |
| | Amph. | Arizona Toad | *Anaxyrus microscaphus* | D | | |
| | Amph. | Chiricahua Leopard Frog | *Lithobates chiricahuensis* | F | T | |
| | Birds | Gray Vireo | *Vireo vicinior* | I | | T |
| | Birds | Pinyon Jay | *Gymnorhinus cyanocephalus* | I | | |
| | Birds | Red-faced Warbler | *Cardellina rubrifrons* | I | | |
| | Birds | Bald Eagle | *Haliaeetus leucocephalus* | H | | T |
| | Birds | Peregrine Falcon | *Falco peregrinus* | H | | T |
| | Birds | Williamson's Sapsucker | *Sphyrapicus thyroideus* | S | | |
| | Birds | Common Black Hawk | *Buteogallus anthracinus* | D | | T |
| | Birds | Elegant Trogon | *Trogon elegans* | D | | E |
| | Birds | Yellow-billed Cuckoo | *Coccyzus americanus* | F | T | |
| | Birds | Mexican Spotted Owl | *Strix occidentalis lucida* | F | T | |
| | Birds | Southwestern Willow Flycatcher | *Empidonax traillii extimus* | F | E | E |
| | Fish | Rio Grande Sucker | *Catostomus plebeius* | I | | |
| | Fish | Desert Sucker | *Catostomus clarkii* | S | | |

| COA | Taxon[54] | Common Name | Scientific Name | Category | Federal Status | State Status |
|---|---|---|---|---|---|---|
| | Fish | Sonora Sucker | *Catostomus insignis* | S | | |
| | Fish | Gila Chub | *Gila intermedia* | F | E | E |
| | Fish | Loach Minnow | *Rhinichthys (Tiaroga) cobitis* | F | E | E |
| | Fish | Spikedace | *Meda fulgida* | F | E | E |
| | Fish | Gila Trout | *Oncorhynchus gilae* | F | T | T |
| | Fish | Gila Topminnow | *Poeciliopsis occidentalis occidentalis* | F | E | T |
| | Mam. | Gunnison's Prairie Dog | *Cynomys gunnisoni* | I | | |
| | Mam. | Arizona Montane Vole | *Microtus montanus arizonensis* | I | | E |
| | Rept. | Sonoran Mud Turtle | *Kinosternon sonoriense* | S | | |
| | Rept. | Narrow-headed Gartersnake | *Thamnophis rufipunctatus* | F | T | T |
| San Juan River | Amph. | Northern Leopard Frog | *Lithobates pipiens* | S | | |
| | Birds | Bank Swallow | *Riparia riparia* | H | | |
| | Birds | Yellow-billed Cuckoo | *Coccyzus americanus* | F | T | |
| | Birds | Southwestern Willow Flycatcher | *Empidonax traillii extimus* | F | E | E |
| | Fish | Roundtail Chub | *Gila robusta* | I | C | E |
| | Fish | Colorado Pikeminnow | *Ptychocheilus lucius* | F | E | E |
| | Fish | Razorback Sucker | *Xyrauchen texanus* | F | E | |
| | Mam. | Pale Townsend's Big-eared Bat | *Corynorhinus townsendii* | S | | |
| | Rept. | California Kingsnake | *Lampropeltis californiae* | H | | |
| Zuni Mountains | Amph. | Northern Leopard Frog | *Lithobates pipiens* | S | | |
| | Birds | Flammulated Owl | *Psiloscops flammeolus* | I | | |

| COA | Taxon[54] | Common Name | Scientific Name | Category | Federal Status | State Status |
|---|---|---|---|---|---|---|
| | Birds | Pinyon Jay | *Gymnorhinus cyanocephalus* | I | | |
| | Birds | Grace’s Warbler | *Setophaga graciae* | I | | |
| | Birds | Virginia’s Warbler | *Oreothlypis virginiae* | I | | |
| | Birds | Peregrine Falcon | *Falco peregrinus* | H | | T |
| | Birds | Williamson’s Sapsucker | *Sphyrapicus thyroideus* | S | | |
| | Birds | Mexican Spotted Owl | *Strix occidentalis lucida* | F | T | |
| | Birds | Southwestern Willow Flycatcher | *Empidonax traillii extimus* | F | E | E |
| | Fish | Rio Grande Sucker | *Catostomus plebeius* | I | | |
| | Fish | Zuni Bluehead Sucker | *Catostomus discobolus yarrowi* | F | E | E |

# Appendix H: Glossary of terms used in the State Wildlife Action Plan

**Abiotic resource use**- The use of non-living natural resources, e.g., hard-rock mining.

**Adaptive management**- A natural resources management process under which planning, implementation, monitoring, research, evaluation, and incorporation of new information are combined into a management approach that: 1) is based on scientific findings and the needs of society; 2) treats management actions as experiments; 3) acknowledges the complexity of these systems and scientific uncertainty; and 4) uses the resulting new information to modify future management methods and policy.

**Alien species**- Species that are not native to the ecosystem.

**Amphibian**- Any cold-blooded vertebrate of the class Amphibia, comprising frogs and toads, newts and salamanders, and caecilians, the larvae being typically aquatic, breathing by gills, and the adults being typically semiterrestrial, breathing by lungs and through the moist, glandular skin.

**Argillic**- Of or relating to clay or clay minerals.

**Arroyo**- Also called a wash, is a dry creek, streambed or gulch that temporarily or seasonally fills and flows after sufficient rain. Flash floods are common in arroyos following thunderstorms.

**Arthropod**- An invertebrate animal having an exoskeleton (external skeleton), a segmented body, and jointed appendages (paired appendages). Arthropods form the phylum Arthropoda, which includes the insects, arachnids, myriapods, and crustaceans.

**ATV**- All-terrain vehicle. Also known as a quad, quad bike, three-wheeler, four-wheeler, or quadricycle, is a vehicle that travels on low-pressure tires, with a seat that is straddled by the operator, along with handlebars for steering control. As the name implies, it is designed to handle a wider variety of terrain than most other vehicles.

**Avifauna-** The birds of a specific region or period.

**Bajada**- Consists of a series of coalescing alluvial fans along a mountain front. These fan-shaped deposits form from the deposition of sediment within a stream onto flat land at the base of a mountain.

**Biodiversity**- A contraction of “biological diversity”, generally refers to the variety and variability of life on Earth. This can refer to genetic variation, ecosystem variation, or species variation (number of species) within a specified region.

**Biomass**- The total mass of living material within a given unit of area.

**BISON-M database**- A natural history database containing information to over 5,750 species in New Mexico and some species in Arizona and Colorado. <http://bison-m.org>.

**Birds**- A group of endothermic (warm-blooded) vertebrates, characterized by feathers, toothless beaked jaws, the laying of hard-shelled eggs, a high metabolic rate, a four-chambered heart, and a lightweight but strong skeleton.

**Bosque**- The forested area on either side of a watercourse, typically in the American southwest.

**Brackish**- Water that has more salinity than fresh water, but not as much as seawater.

**Caliche**- A layer of soil in which the soil particles have been cemented together by lime (calcium carbonate, $CaCO_3$).

**Carrying capacity**- Maximum number of individuals that a given environment can support without detrimental effects.

**Centrarchids**- The sunfish family that includes over 30 species in the order Perciformes, including bass and crappie.

**Channelization**- Mechanical redirecting of a streambed in more or less a straight line.

**Chaparral-** A hardy, fire-prone plant community characterized by evergreen shrubs.

**Cienega-** A freshwater or alkaline wet meadow with a shallow gradient and permanently saturated soils in an otherwise arid landscape. Occurs where the geomorphology forces water to the surface.

**Closed basin**- A geographic area where all surface waters drain into a basin with no outlet.

**Consumptive biological use**- The use of living natural resources, e.g., hunting, fishing, and logging.

**CRP-** Conservation Reserve Program. A federal program that pays a yearly rental payment in exchange for farmers removing environmentally sensitive land from agricultural production and planting species that will improve environmental health and quality.

**Crustaceans**- Predominantly aquatic species of the class Crustacea, including lobsters, crabs, shrimp, and barnacles, characteristically having a segmented body, a chitinous exoskeleton, and paired, jointed limbs.

**CWCS**- Comprehensive Wildlife Conservation Strategy.

**Desertification**- The process by which fertile land becomes desert, typically as a result of drought, deforestation, or inappropriate agriculture.

**Desiccation**- The state of extreme dryness, or the process of extreme drying.

**Ecological sustainability-** A human system of natural resource use that can be maintained into the future. The long-term maintenance of ecosystem functions, processes, and services over time.

**Ecosystem**- A biological community plus all of the abiotic factors influencing that community.

**Endangered species**- Species of plants or animals of concern that have the potential of becoming extinct.

**Endemic-** Native to or confined to a certain region. For this document, the term specifically refers to taxa that are limited to New Mexico.

**Entisols-** Soils of recent origin, developed in unconsolidated parent material, usually with no genetic horizons except an A horizon. Any soil not otherwise categorized are classified as entisols.

**Ephemeral**- Channel or basin which carries water only during and immediately after periods of rainfall or snowmelt.

**Ericaceous**- Of, relating to, or belonging to the Ericaceae, a family of flowering plants, commonly known as the heath or heather family, found most commonly in acid and infertile growing conditions. Includes heather, rhododendron, azalea, and arbutus.

**Exotic species**- Species that are not native to the ecosystem, introduced from elsewhere.

**Extinct-** No longer existing or living.

**Fish-** Any of a large group of cold-blooded aquatic vertebrates having jaws, gills, and usually fins and a skin covered in scales.

**Flow regime**- The flow of a moving body of water, i.e., river or stream, over time and space.

**GIS**– Geographic Information System.

**Gleying**- Soil forming process occurring in waterlogged, anaerobic conditions when iron compounds are reduced and either removed from the soil, or segregated out as mottles or concretions in the soil.

**Graminoids**- Herbaceous plants with hollow jointed stems and narrow long-bladed leaves commonly known as grasses.

**Habitat-** An ecological area inhabited by a particular organism, where the organism can find food, shelter, and reproductive opportunities.

**Hectare**- A metric unit of area equal to 10,000 $m^2$ (2.471 acres).

**Herbivorous animals**- Plant-eating animals.

**Herpetofauna-** The amphibians and reptiles of a specific region or period.

**Hybridization**- The act of mating different species or varieties of animals or plants to produce hybrids.

**Inundation**- Flooding, by the rise and spread of water, of a land surface that is not normally submerged.

**Invasive species**- An exotic species whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

**Invertebrates**- Animals that do not possess or develop a spinal column. Includes insects and crustaceans.

**Keystone species**- Species that have a greater overall effect on ecosystem structure or function than would be indicated by its relative abundance, e.g., prairie dogs, beaver, and bison.

**Macrogroup-** A particular classification of vegetation from the USNVC Database. The classification is based on dominant and diagnostic growth forms and species composition similarity.

**Mammals**- A warm-blooded vertebrate animal of a class that is distinguished by the possession of hair or fur, the secretion of milk by females for the nourishment of the young, and (typically) the birth of live young.

**Marsh-** A type of wetland, featuring grasses, rushes, reeds, typhas, sedges, and other herbaceous plants in a context of shallow water.

**Mollisols-** Are prairie or grassland soils that have a dark-colored surface horizon. They are highly fertile and rich in chemical “bases” such as calcium and magnesium.

**Mollusc**- An invertebrate of a large phylum that includes snails, slugs, mussels, and octopuses. They have a soft, unsegmented body and live in aquatic or damp habitats, and most kinds have an external calcareous shell.

**Montane**- Of, growing in, or inhabiting mountain areas.

**Native species**- Originating and adapted in a certain place or region; indigenous.

**Neotropical migrant**- A bird that breeds in Canada and the United States during the summer and spends the winter in Mexico, Central America, South America or the Caribbean islands.

**Non-native species**- Species that are not native to the ecosystem, introduced from elsewhere.

**Obligate**- Plants or animals able to exist or survive only in a particular environment or by assuming a particular role.

**Perennial**- Body of water, which contains water at all times except during extreme drought.

**Playa**- A desert basin with no outlet which periodically fills with water to form a temporary lake.

**Prescribed burning**- Planned burning by land management agencies under specific weather conditions to remove excess plant material and replicate natural fire regimes.

**Recruitment**- Reinforcement of a population of a species with new members through reproduction or immigration.

**Reptile**- A cold-blooded vertebrate of a class that includes snakes, lizards, crocodiles, turtles, and tortoises. They are distinguished by having a dry scaly skin, and typically laying soft-shelled eggs on land.

**Riparian habitat**- Transitional semiterrestrial areas regularly influenced by fresh water, usually extending from the edges of water bodies to the edges of upland communities.

**Savannas**- Grassland habitats with intermittent trees or shrubs.

**Seep**- A generally small area where water percolates slowly to the ground surface, typically without a well-defined point of origin.

**Spring**- The location where an underground source of water emerges from the ground, generally from a single point of origin.

**Steppe**- A semiarid grassland that occurs in temperate climates.

**SWANCC Supreme Court decision**- A Supreme Court decision that limited the US Army Corps of Engineers Clean Water Act authority over a human-created water feature.

**SWReGAP**- Southwest Regional Gap Analysis Project. A mapping assessment of land cover, habitats, (floral and faunal) biodiversity, and land management status for the five-state region of AZ, CA, NV, NM, and UT (http://fws-nmcfwru.nmsu.edu/swregap/).

**Talus slope**- Slope formed by an accumulation of broken rock debris, as at the base of a cliff or other high place.

**Taxa**- Taxonomic categories or groups, such as a phylum, order, family, genus, or species.

**Threatened species**- Species of plants or animals of concern that have the potential of becoming endangered.

**Vertebrates**- Animals that have a spinal column.

**Watershed**- Also known as a catchment or basin, is a topographically delineated area drained by a stream system; that is, the total land area above some point on a stream or river than drains past that point.

**Wildland-urban interface**- Zone of contact between human development and undeveloped forested habitats.

**Xeric habitat**- Habitats found in arid regions.