Climate Change Vulnerability Assessment
For
Species of Greatest Conservation Need
in
New Mexico

Version 1.0

January 2025

Project Prepared for
New Mexico Department of Game and Fish
Santa Fe, New Mexico

Project Prepared by
Texas A&M Natural Resources Institute
College Station, Texas

ACKNOWLEDGEMENTS

This document was prepared by the Texas A&M Natural Resources Institute (NRI) in cooperation with the New Mexico Department of Game and Fish (NMDGF). We would like to recognize and thank the following individuals who provided substantive information and/or insights for this report: Virginia Seamster, NMDGF; Jody Fraser, NRI; Claire Jackson, NRI; Jake Kindle, NRI; Michael Marshall, NRI; Allison Pullin, NRI; Dianne Robinson, NRI.

EXECUTIVE SUMMARY

Climate change is a constant threat in today's world, with impacts being felt by both human and wildlife populations. The State of New Mexico is no different. While some of the more visible impacts of a warming planet, including sea-level rise and ocean acidification, are not of immediate concern in New Mexico, the State boasts diverse ecosystems ranging from arid deserts to alpine forests, all having the potential to be impacted by climate change in different ways. Determining climate change vulnerability for the vertebrate Species of Greatest Conservation Need (SGCN) identified in the New Mexico Department of Game and Fish's State Wildlife Action Plan (SWAP) is key to developing effective climate adaptation actions to be implemented under the fully revised, 2025 plan. We use the Climate Change Vulnerability Index (CCVI) that includes several different factors, described below and then in depth in the Methods section, to identify higher-risk species and subspecies, which can help highlight specific areas of focus for conservation action in New Mexico and inform species-specific methods to improve resilience under changing environmental conditions.

We assessed and ranked the relative climate change vulnerability of 295 vertebrate animal species and subspecies (hereafter, species) in New Mexico that have been selected as SGCN for the 2025 SWAP for New Mexico. We compiled natural history and distribution information for each species. We used the CCVI, Version 4.0 to assess the relative climate change vulnerability of each species. The CCVI was created by NatureServe and the U.S. Geological Survey (USGS) and allows for a rapid assessment of climate change vulnerability. The CCVI assessment considers the following metrics when scoring a species' climate change vulnerability: exposure to local climate change, exposure to sea-level rise, overall adaptive capacity and sensitivity, other extrinsic factors (i.e., "threat multipliers") that affect climate change vulnerability, and documented or modeled response to climate change.

Analyses across taxonomic classes showed increased climate change vulnerability under the Representative Concentration Pathway (RCP) 8.5 Scenario (24% of species identified as Highly or Extremely Vulnerable; Figure 4) relative to the RCP 4.5 Scenario (14% of species identified as Highly or Extremely Vulnerable; Figure 3, Table 2). All species were analyzed at the State level for exposure to local climate change and thus were all characterized as experiencing a high degree of local climate change. Birds, mammals, and reptiles all ranked lower in overall climate change vulnerability while fishes and amphibians ranked higher in overall climate change vulnerability. Fishes and amphibians generally have more specific Life History and Abiotic Niche requirements and are generally less mobile, which heightens their climate change vulnerability. Amphibians and mammals will experience the biggest shift in climate change vulnerability under a more severe RCP Scenario, with 20% and 11% of amphibian and mammal SGCNs, respectively, ranked as Highly or Extremely Vulnerable under the RCP 4.5 Scenario, compared to 54% and 21%, respectively, under the RCP 8.5 Scenario (Figure 3, Figure 4).

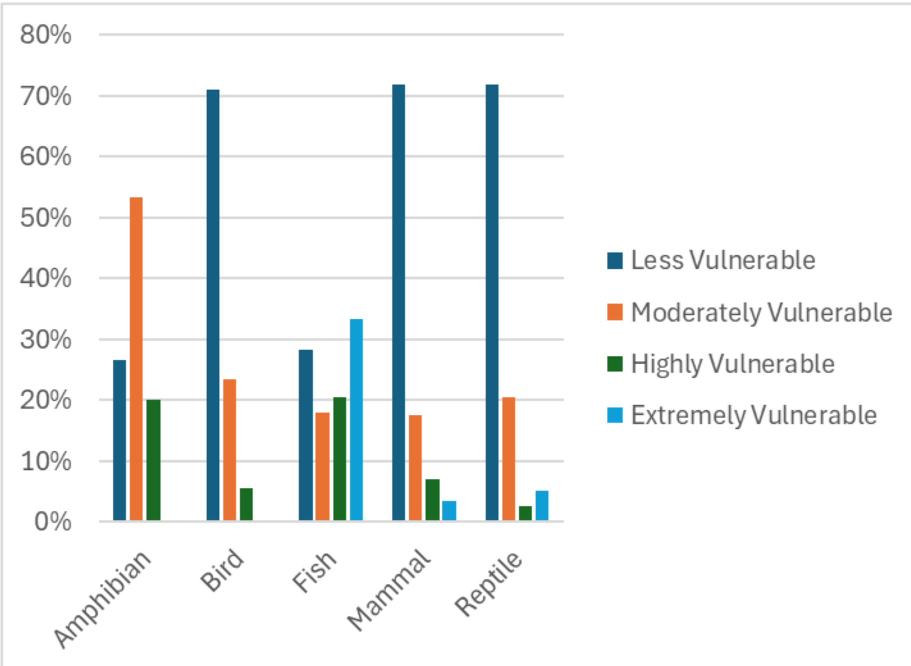

Figure 1. Climate change vulnerability scores for all analyzed Species of Greatest Conservation Need. Species are organized by taxonomic class and vulnerability was assessed based on the Representative Concentration Pathway 4.5 Scenario.

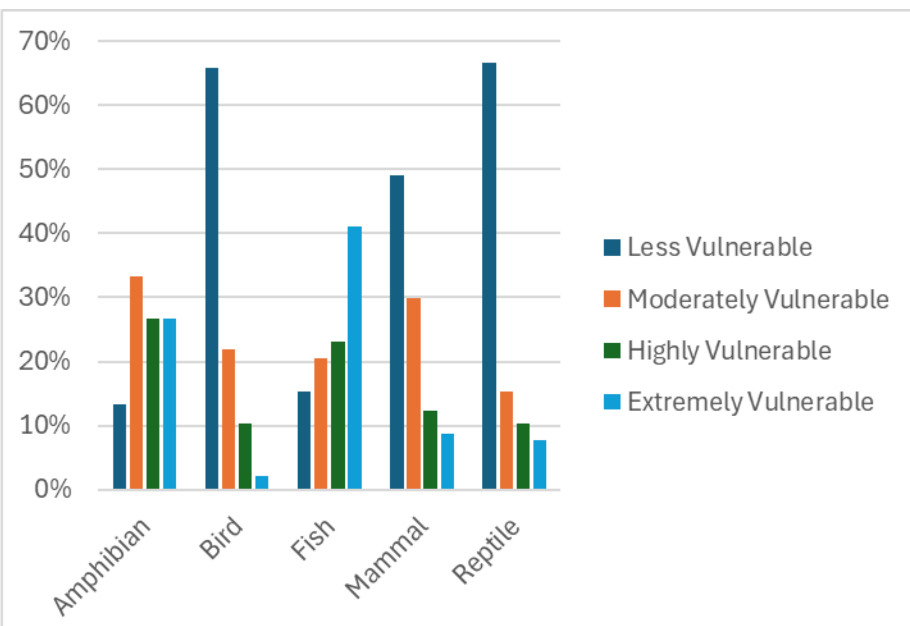

Figure 2. Climate change vulnerability scores for all analyzed Species of Greatest Conservation Need. Species are organized by taxonomic class and vulnerability was assessed based on the Representative Concentration Pathway 8.5 Scenario.

Overall, climate change vulnerability is important to consider when undertaking conservation planning efforts, especially with the possibility that climate-related impacts could overwhelm conservation efforts if effective climate adaptation strategies are not implemented. Fish SGCN overall were the most vulnerable of all SGCN to climate change, in part because many are desert fishes that are likely to experience significant direct and indirect impacts from climate change. Amphibian SGCN overall were also very vulnerable to climate change, with this vulnerability centered on an inability to shift in space in response to climate change that is likely driven by the narrow climatic niche breadths of many amphibians. Mammal and reptile SGCN climate change vulnerability varied with the taxonomic family or order that was considered. Bird SGCN generally were able to shift in space due to their highly mobile nature. However, most migratory birds showed an inability to persist in place, which impacted their climate change vulnerability.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Climate change is a constant threat in today's world, with impacts being felt in both human and wildlife populations. While the full extent of climate change-related damage remains to be seen, researchers are confident that major changes are expected in the way that species and habitats interact. Although climate change has outsized impacts in certain ecosystems, such as arctic and tropical regions, effects on wildlife behaviors, demography, and status, such as range shifts, population fluctuations, and reproduction-related changes will be felt in all areas of the globe.

The State of New Mexico is no different. While some of the more visible impacts of a warming planet, including sea level rise and ocean acidification, are not of immediate concern in New Mexico, the State boasts diverse ecosystems ranging from arid deserts to alpine forests, all having the potential to be impacted by climate change. Recent global climate models show that the average temperature in the State has increased by approximately 1.6°C (3°F) over the last 50 years and project an average increase of 2.8-3.9°C (5-7°F) over the next half century (Dunbar et al. 2022).

Precipitation has also been impacted by changing environmental conditions. While precipitation can be highly variable, between 2011 and 2014, New Mexico experienced the second-worst statewide drought since the early 1950s, leading to water levels remaining below normal through 2022 (NOAA 2022). New Mexico is also an outlier as, unlike other states, it has not experienced an upward trend in the frequency of extreme precipitation events. For this reason, the dry season in New Mexico is projected to become drier and the entire State will continue to experience more intense droughts (NOAA 2022).

This continuation of rising temperatures and lack of precipitation will lead to decreased flows in major rivers, increased severity of wildfires, changes in pathogen and pest prevalence, and extreme heat (EPA 2016). Due to the intersectionality of humans and surrounding ecosystems, anthropogenic factors may lead to an acceleration of these changes and associated negative effects. These shifts in environmental conditions, as well as other impacts from climate change, regardless of the degree of severity, are stressors to wildlife and their habitats.

Many of the more sensitive taxonomic groups, such as amphibians, are already being negatively impacted by New Mexico's changing climate (Hatten et al. 2016). An important piece of understanding the vulnerability of a species to climate change is its adaptative capacity, or its ability to adapt over time to changing environmental conditions (Dawson et al. 2011). Thurman et al. (2020) developed a framework to evaluate the adaptive capacity of species and populations that allow them to either "persist in place or shift in space". Thurman et al.'s (2020) framework looks to rank each specific evolutionary attribute as low-moderate-or high and factors in both quantitative and qualitative criteria. While every species is assumed to have some inherent adaptive capacity, extrinsic factors, including climate change, can impact a species' ability to adapt. The higher a species' adaptive capacity, the better its potential to be able to adapt to climate change. We utilize Thurman et al.'s (2020) framework within our own analysis.

Effects like increasing temperatures, habitat drying, and increasing frequency and intensity of extreme weather events, such as droughts and floods (TWS 2008; IPCC 2014; Thurman et al. 2020), are imminent threats for the wildlife and habitats within New Mexico. Natural resource managers must consider questions and associated conservation actions related to biodiversity loss, expansion of invasive species, and deteriorating ecosystems, and an important step in understanding the current effects and future changes associated with persistent environmental change is to analyze the vulnerability of different species to climate change. The New Mexico Department of Game and Fish (NMDGF) is currently reviewing and revising its current State Wildlife Action Plan (SWAP), which was approved by the U.S. Fish and Wildlife Service (USFWS) in 2017. Determining climate change vulnerability for the Species of Greatest Conservation Need (SGCN) identified in NMDGF's SWAP is key to developing effective climate adaptation strategies to be implemented under the fully revised, 2025 plan. We use the Climate Change Vulnerability Index (CCVI) that includes several different factors, described in the Methods section, to identify higher-risk species and subspecies, which can help highlight specific areas of focus for conservation action in New Mexico and inform species-specific methods to improve resilience within an altered environment. Adaptation to climate change will involve strategic techniques to conserve the habitats of susceptible species, along with broader ecosystems. In this report, we describe our process and provide recommendations based on the analyzed results.

METHODS

We assessed and ranked the relative climate change vulnerability of 295 animal species and subspecies (hereafter, species) in New Mexico that have been selected as SGCN for the 2025 SWAP for New Mexico. The species assessed can be organized into 5 distinct taxonomic classes (Table 1).

Table 1. Table of all species assessed, organized by taxonomic classification.

Taxonomic Class	Number Assessed
Amphibians	15
Birds	145
Fishes	39
Mammals	57
Reptiles	39
Total	**295**

We compiled natural history and distribution information for each species. NMDGF and partners maintain the Biota Information System of New Mexico (BISON-M), which contains species accounts for vertebrate and invertebrate wildlife species known to occur in New Mexico (almost 6,000 species). NatureServe Explorer is an online guide developed by NatureServe, a United States-based non-profit organization, that provides information on 100,000 rare and Endangered species and ecosystems in the Americas. We used BISON-M and NatureServe Explorer as our primary resources to compile natural history and distribution information pertinent to the climate change vulnerability for each species. As available, we also used a variety of other resources to fill in knowledge gaps as available, including but not limited to Species Status Assessments (SSAs), peer-reviewed publications, and published reports.

To assess the relative climate change vulnerability for each species, we used the CCVI Version 4.0 to score each species. The CCVI was created by NatureServe and the U.S. Geological Survey (USGS) and allows for a rapid assessment of climate change vulnerability (Lyons et al. 2024). The CCVI assessment considers the following metrics when scoring a species' climate change vulnerability: exposure to local climate change, exposure to sea level rise, overall adaptive capacity and sensitivity, other extrinsic factors (i.e., "threat multipliers") that affect climate change vulnerability, and documented or modeled response to climate change. This tool has been updated from the version developed by Young et al. (2012) and incorporates the framework for measuring adaptive capacity described by Thurman et al. (2020). The metrics are explained in detail in Lyons et al. (2024), but we also provide an overview of each section below.

1. Exposure to local climate change: This was calculated within the CCVI tool, as the rescaled, combined change in temperature and climatic water deficit, comparing historic data from 1971-2000 to multi-model mean projections for 2040-2069 (Abatzoglou and Brown 2012; Hegewisch et al. 2018). Exposure to climate change was calculated for the Representative Concentration Pathways (RCP) 4.5 (intermediate) Scenario and for the RCP 8.5 (worst-case) Scenario.
2. Exposure to sea level rise: This factor measured the effects of sea level rise and the consequent influence of storm surges and intrusion of salt water on a specific species. This was determined to be negligible within our New Mexico assessment area.
3. Overall adaptive capacity and sensitivity: This section assessed 37 species- or population-level factors from Thurman et al. (2020) to evaluate adaptive capacity (the ability of a species to cope with or adjust to climatic changes) and sensitivity (the degree to which a species is affected by or susceptible to a climate-related change) (IPCC 2014). These 37 factors are broken into seven distinct categories, below.
    - A) Distribution and Movement factors broadly consider the geographic extent of a species and the capacity of an individual from that species to move through a landscape. These factors are related to a species' ability to "shift in space" in response to climate change. Thirteen factors were considered to impact a species' ability to shift in space, including the primary drivers Extent of Occurrence, Habitat Specialization, Commensalism with Humans, and Dispersal Distance.
    - B) Life History and Demography factors consider the capacity an individual animal has to acclimate to changing climates in situ and reflect the species' overall ability to "persist in place". Thirteen factors were considered to impact a species ability to persist in place, including the primary drivers Fecundity and Life Span.
    - C) Evolutionary Potential, Ecological Role, and Abiotic Niche can influence a species' ability to both "shift in space" and "persist in place". Eleven factors fell under these three categories, including the primary drivers Genetic Diversity, Population Size, Diet Breadth, Climate Niche Breadth, and Physiological Tolerances.

4. Threat multipliers or other extrinsic factors: This section considered five factors that can affect climate change vulnerability in a species, such as barriers to movement and anthropogenic or biologic stressors, and whose impacts could be magnified by climate change.
5. Documented or modeled response to climate change: This section considered five factors that assessed known responses to climate change and modeling of changes to species distribution and population due to climate change that were supported by peer-reviewed literature.

CCVI results were compiled and analyzed to (a) highlight those species most (and least) vulnerable to climate change, (b) identify and rank impactful factors, and (c) identify geographic areas or habitat types at high risk.

RESULTS

Analyses across taxonomic classes showed increased climate change vulnerability under the RCP 8.5 Scenario (24% of species identified as Highly or Extremely Vulnerable; Figure 4, Table 3) relative to the RCP 4.5 Scenario (14% of species identified as Highly or Extremely Vulnerable; Figure 3, Table 2). All species were analyzed at the state level for exposure to local climate change and thus were all characterized as experiencing a high degree of local climate change.

Birds, mammals and reptiles all ranked lower in overall climate change vulnerability, while fishes and amphibians ranked higher in overall climate change vulnerability. Fishes and amphibians generally have more specific Life History and Abiotic Niche requirements and are generally less mobile, which impacted their climate change vulnerability. Mammals and reptiles climate change vulnerability seemed to change when considered at the Order or Family taxonomic level. Additionally, amphibians and mammals will experience the biggest shift in climate change vulnerability under a more severe RCP Scenario, with 20% and 11% of amphibian and mammal SGCNs respectively ranked as Highly or Extremely Vulnerable under the RCP 4.5 Scenario, compared to 54% and 21% under the RCP 8.5 Scenario (Figure 3, Figure 4).

Species with habitat requirements dependent on higher altitudes or specific aquatic environments (e.g., Brown-capped Rosy Finch (*Leucosticte australis*), American Pika (*Ochotona princeps incana, saxatilis*), Pecos Bluntnose Shiner (*Notropis simus pecosensis*)) were generally ranked higher in overall climate change vulnerability. Species dependent on a specific microhabitat niche (e.g., Yarrow's Spiny Lizard (*Sceloporus jarrovii*), Sacramento Mountain Salamander (*Aneides hardii*)) were also generally ranked higher in overall climate change vulnerability.

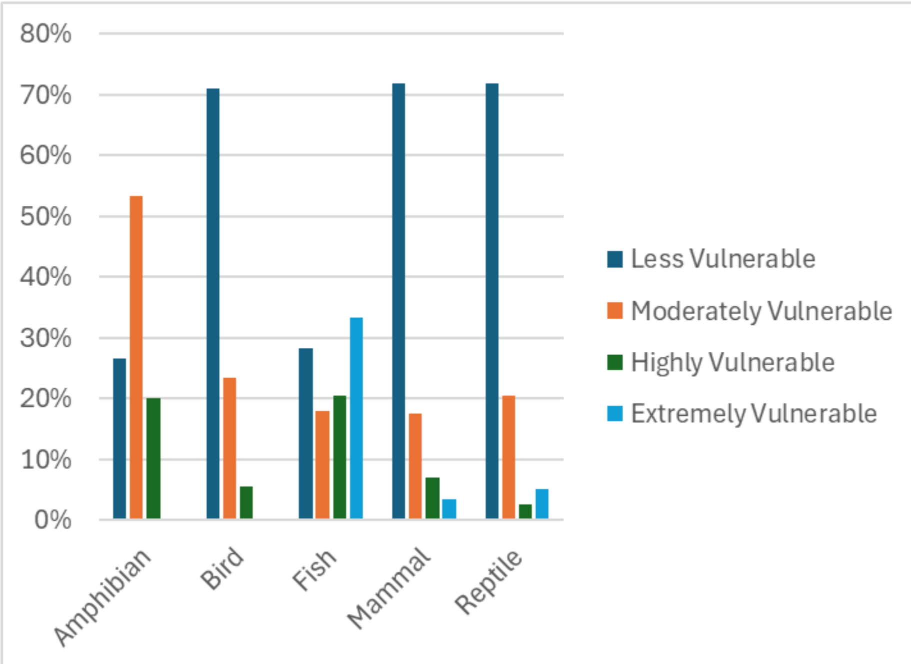

Figure 3. Climate change vulnerability scores for all analyzed Species of Greatest Conservation Need. Species are organized by taxonomic class and vulnerability was assessed based on the Representative Concentration Pathway 4.5 Scenario.

Table 2. Climate change vulnerability scores for all analyzed Species of Greatest Conservation Need. Species are organized by taxonomic class and vulnerability was assessed based on the Representative Concentration Pathway 4.5 Scenario.

	Amphibian	**Bird**	**Fish**	**Mammal**	**Reptile**	**Total**
Less Vulnerable	4	103	11	41	28	187
Moderately Vulnerable	8	34	7	10	8	67
Highly Vulnerable	3	8	8	4	1	24
Extremely Vulnerable	0	0	13	2	2	17
Total	15	145	39	57	39	295

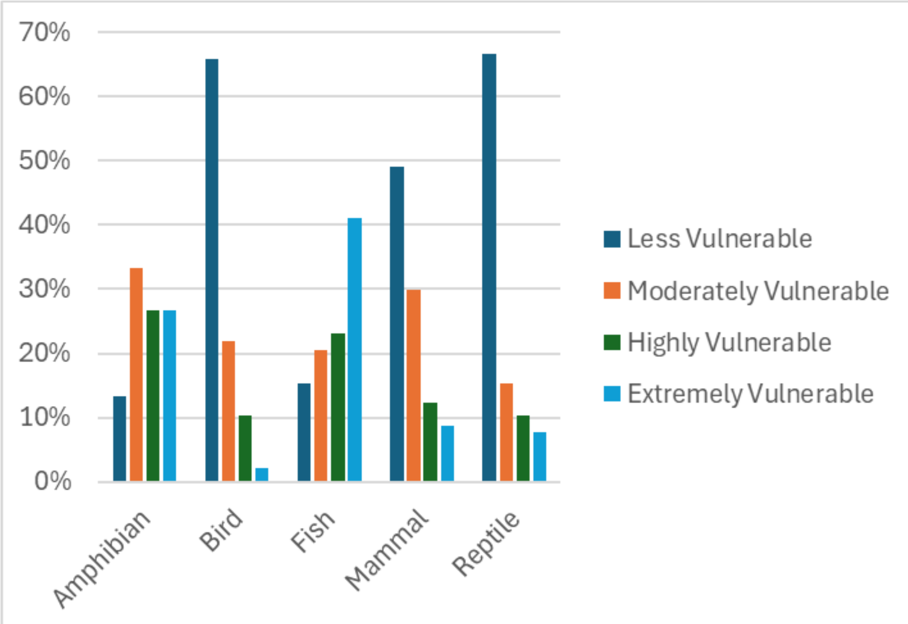

Figure 4. Climate change vulnerability scores for all analyzed Species of Greatest Conservation Need. Species are organized by taxonomic class and vulnerability was assessed based on the Representative Concentration Pathway 8.5 Scenario.

Table 3. Climate change vulnerability scores for all analyzed Species of Greatest Conservation Need. Species are organized by taxonomic class and vulnerability was assessed based on the Representative Concentration Pathway 8.5 Scenario.

	Amphibian	Bird	Fish	Mammal	Reptile	Total
Less Vulnerable	2	96	6	28	26	158
Moderately Vulnerable	5	31	8	17	6	67
Highly Vulnerable	4	15	9	7	4	39
Extremely Vulnerable	4	3	16	5	3	31
Total	15	145	39	57	39	295

AMPHIBIANS

As a taxonomic group, amphibians are characterized as being Highly Vulnerable to negative impacts from climate change. Of the amphibian SGCN, 20% were considered Highly Vulnerable to climate change under the RCP 4.5 Scenario, but 50% of the amphibian species assessed were considered Highly or Extremely vulnerable to climate change under the RCP 8.5 Scenario (Figure 5, Figure 6). Amphibians appear well able to persist in place, but are not as capable of shifting in space, with 93% of the evaluated species at risk from Movement factors and 50% at risk from Distribution factors (Appendix 1, Appendix 7). All amphibian SGCN are potentially at risk from the fungus *Batrachochytrium dendrobatidis* (Bd); of all amphibians, five (30%) were impacted by threat multipliers, that can magnify the impacts a species could experience due to climate change. Four of the five species were significantly impacted by anthropogenic or topographic barriers and biologic threats such as disease *Bd* or invasive species (Appendix 1, Appendix 7). All amphibians will likely experience direct and indirect effects from climate change due to their anticipated high levels of evaporative water loss and associated indirect effects on reproduction and their relatively narrow climatic niche breadths (Graeter et al. 2013; Appendix 1, Appendix 7). Forty-seven% of amphibians had moderately-low adaptive capacity, with two (29%) being Highly Vulnerable to impacts from climate change at the RCP 4.5 Scenario and five (71%) being Highly or Extremely Vulnerable to impacts of climate change at the RCP 8.5 Scenario (Appendix 1, Appendix 7).

At the intermediate RCP 4.5 emission Scenario, the Chiricahua Leopard Frog (*Lithobates chiricahuensis*), Jemez Mountain Salamander (*Plethodon neomexicanus*) and Sacramento Mountain Salamander (*Aneides hardii*) are Highly Vulnerable to climate change; none are Extremely Vulnerable to climate change. At the "worst-case" RCP 8.5 emission Scenario, the Boreal Toad (*Anaxyrus boreas boreas*), Eastern Barking Frog (*Craugastor augusti latrans*), Lowland Leopard Frog (*Lithobates yavapaiensis*), and the Western Narrow-mouthed Toad (*Gastrophryne olivacea*) are Extremely Vulnerable to climate change; these four species are habitat or diet specialists and have relatively small ranges within New Mexico. The Plains Leopard Frog (*Lithobates blairi*) and Rio Grande Leopard Frog (*Lithobates berlandieri*) are the only two amphibian species assessed that were Less Vulnerable to climate change through the RCP 8.5 emission Scenario, likely due to being habitat generalists. All other species were Moderately, Highly or Extremely Vulnerable to climate change (Appendix 1, Appendix 7).

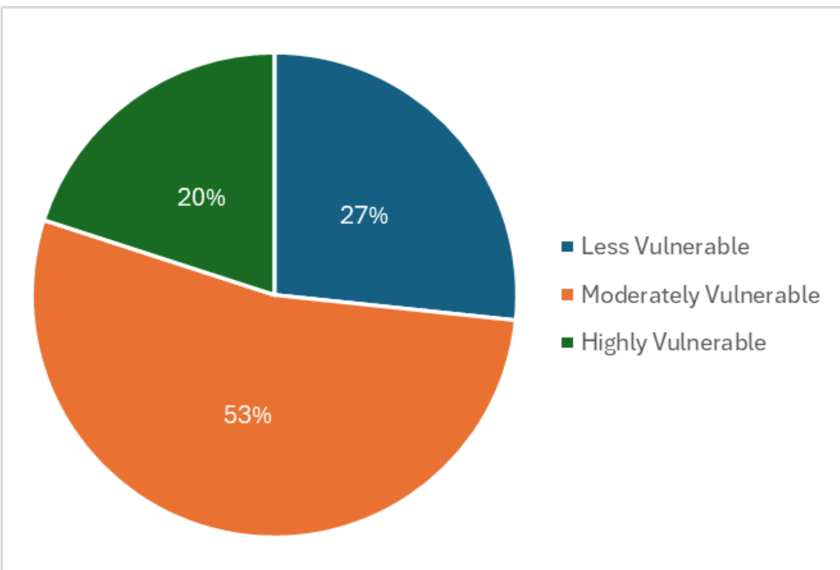

Figure 5. Climate change vulnerability scores for amphibians under the Representative Concentration Pathway 4.5 Scenario.

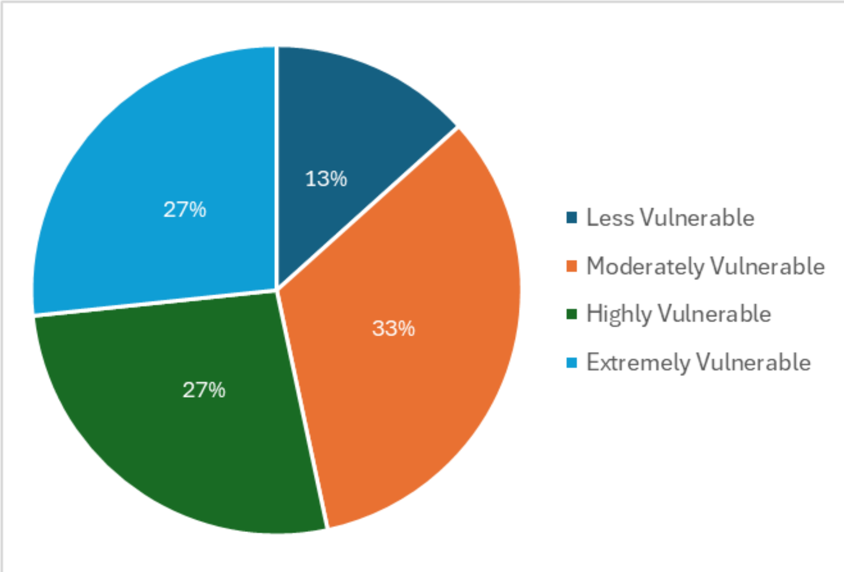

Figure 6. Climate change vulnerability scores for amphibians under the Representative Concentration Pathway 8.5 Scenario.

BIRDS

As a taxonomic group, bird species are characterized as being Less Vulnerable to negative impacts from climate change. Under the RCP 4.5 Scenario, only 6% of bird SGCN were considered Highly Vulnerable to climate change, and no birds were considered Extremely Vulnerable (Figure 7). Under the RCP 8.5 Scenario, 12% of bird SGCN were considered Highly or Extremely Vulnerable to climate change, a slight increase from the RCP 4.5 Scenario (Figure 8). The majority of bird SGCN were Less Vulnerable to climate change, 71% and 66% under the RCP 4.5 and RCP 8.5 Scenarios, respectively (Figure 7, Figure 8Figure 9).

Many bird species exhibit long-distance migration, so while they are relatively mobile as a group, those long-distance migrants are less adapted to be able to shift in space. As such, 89% of birds had low adaptive capacity associated with Movement and Distribution factors (Appendix 2, Appendix 7). Of all bird SGCN, 62% were impacted by Life History factors, but only 4% were impacted by Demography factors. This suggests that while some birds are less adapted to persist in place, this is primarily related to reproductive characteristics, such as reproductive phenology and parental investment, than it is related to life span or recruitment (Appendix 2, Appendix 7). Only eight (5%) of all birds were significantly impacted by threat multipliers, which can magnify the impacts of climate change on a species (Appendix 2, Appendix 7). Seven birds were impacted by other biologic threats, such as invasive species (e.g. Brown-headed Cowbirds [*Molothrus ater*]) or disease; five birds were impacted by topographic or anthropogenic barriers; four birds were impacted by land-use changes and other anthropogenic effects (e.g., overharvest).

Only nine bird species across seven families had a low or moderately low adaptative capacity; eight species were impacted by Movement, Distribution, and Abiotic factors. Of those, only the Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*; both populations) and the Boreal Owl

(*Aegolius funereus*) were considered Extremely Vulnerable to climate change and only under the RCP 8.5 Scenario. Both of these species have relatively small existing populations within New Mexico, with a narrow diet niche and known habitat loss concerns. Both species also have specific temperature restrictions that impact their Abiotic Niche and increases their vulnerability to climate change (Appendix 2, Appendix 7).

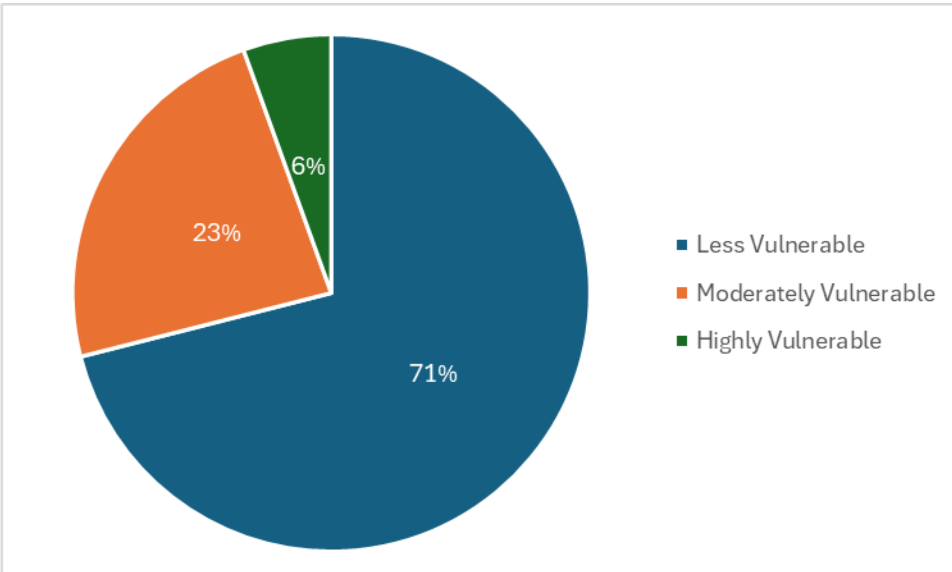

Figure 7. Climate change vulnerability scores for birds under the Representative Concentration Pathway 4.5 Scenario.

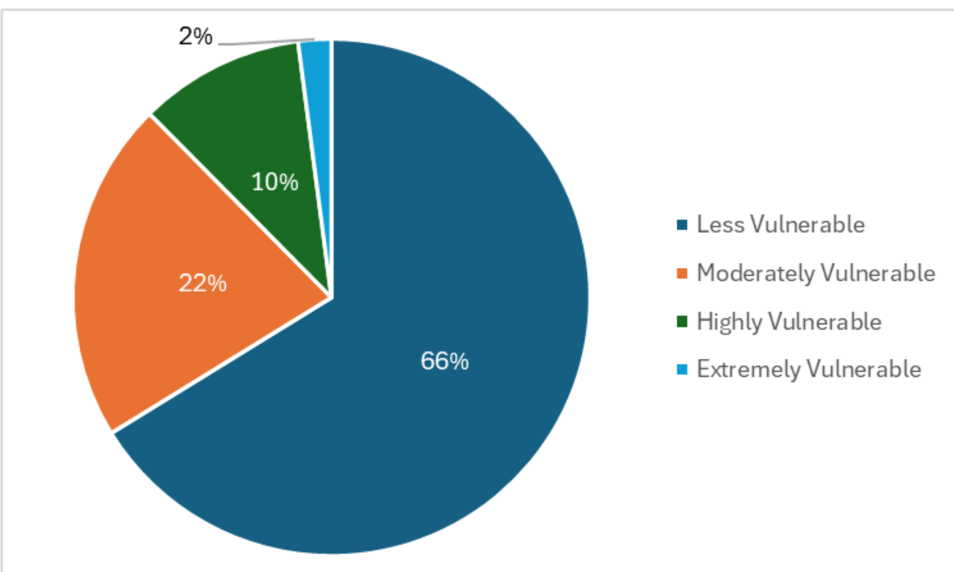

Figure 8. Climate change vulnerability scores for birds under the Representative Concentration Pathway 8.5 Scenario.

FISHES

As a taxonomic group, fishes are characterized as being Highly Vulnerable to climate change. Under the RCP 4.5 Scenario, 54% of all SGCN fish species were considered Highly or Extremely Vulnerable to climate change (Figure 9), and that percentage jumped to 64% under the RCP 8.5 Scenario (Figure 10). Many fish SGCN are desert fish that will likely be significantly impacted by an increase in air temperature due to climate change that could result in increased water temperatures or desiccation of desert streams. Because of this unique niche, most fish were not well adapted to shift in space (77%) or persist in place (62%), and 80% were sensitive to additional influencers, in particular sensitivity to Abiotic Niche factors (70%; Appendix 3, Appendix 7).

Distribution factors were significant for fish SGCN, with 62% of the species having already experienced range contractions, habitat fragmentation, and decreased abundance due to various historic and current anthropogenic and environmental influences (Appendix 3, Appendix 7). Life History factors would affect 59% of the fishes, partially due to low adaptive capacity relative to their reproductive modes (i.e., oviparous or pelagic spawning) and phenology, being somewhat reliant on environmental cues that may shift under a changing climate (Appendix 3, Appendix 7). Twenty-two (56%) of all fishes were significantly impacted by threat multipliers, that can magnify the impacts a species could experience due to climate change (Appendix 3, Appendix 7). All 22 fishes were impacted by topographic or anthropogenic barriers (e.g., dams) and other anthropogenic effects (e.g., overharvest); 20 fishes were impacted by other biologic threats such as invasive species or disease; 17 fishes were impacted by land-use changes (Appendix 3, Appendix 7).

Of all fish SGCN, 13 were characterized as Extremely Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios, and all 13 had a low adaptive capacity (Figure 9, Figure 10; Appendix 3, Appendix 7). Of those 13 fish, 11 (85%) were susceptible to threat multipliers, 12 (92%) were limited in their ability to shift in space, and all 13 were sensitive to additional influencers, specifically Abiotic Niche factors and Evolutionary Potential factors (Appendix 3, Appendix 7). A total of six fish were assessed as Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios and all six had a high adaptive capacity. Of those six assessed, only the Longnose Gar (*Lepisosteus osseus*) was sensitive to additional influencers, and only the Sonora Sucker (*Catostomus insignis*) had limited ability to shift in space; the other four fish had limited ability to persist in place (Appendix 3, Appendix 7). Overall, 10 different fish families were represented in this assessment, with 49% of them in the Cyprinidae family. Of these, 53% are extremely and highly vulnerable under the RCP 4.5 Scenario, and 63% are extremely and highly vulnerable under the RCP 8.5 Scenario. While their life histories are variable, most of these species do not disperse from their natal habitats and they do not migrate; therefore, when potentially faced with contracting habitats under a regime influenced by climate change, many of these species may be unable to shift in space or persist in place.

It is important to note that for many of these species, there is a lack of quantitative data relative to life histories, population numbers, and the extent and magnitude of threats facing them.

Despite this, because of their dependence on perennially waters, fishes in the Southwest are inherently at an elevated risk from the effects of climate change. While the direct and indirect effects of climate change are unknown, projected increases in water temperatures, reduced flows, increased sediment input, shifts in precipitation patterns, earlier snowmelt, and shifts in storm intensity and flood events are likely to cause imminent and future reductions in available fish habitats. These changes are likely to result in reduced population sizes, contraction of geographic distribution due to drying of habitats exposing topographic barriers to movement, and further population isolation (Friggens 2015).

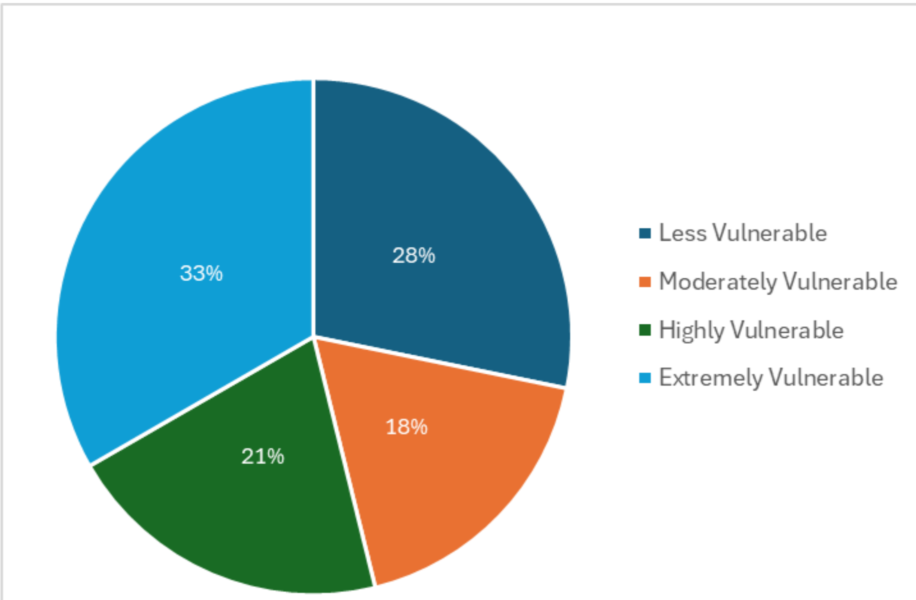

Figure 9. Climate change vulnerability scores for fishes under the Representative Concentration Pathway 4.5 Scenario.

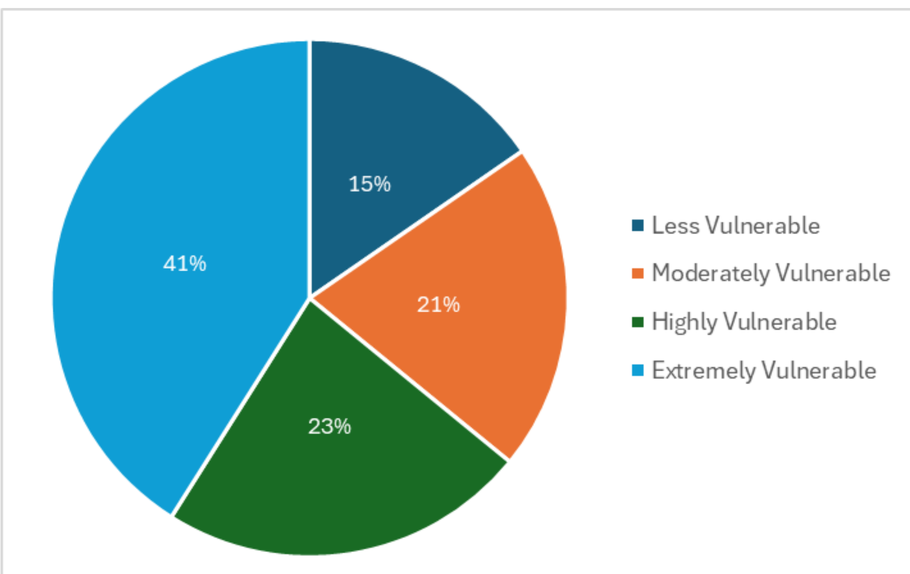

Figure 10. Climate change vulnerability scores for fishes under the Representative Concentration Pathway 8.5 Scenario.

MAMMALS

Of all mammal SGCN, 83% had high or moderately-high adaptive capacity; this is reflected in comparatively low climate change vulnerability scores under the RCP 4.5 and RCP 8.5 Scenarios for most mammals; only 10% and 21% of mammals were determined to be Highly or Extremely Vulnerable, respectively (Figure 11, Figure 12; Appendix 4, Appendix 7). Mammal SGCN generally appear well adapted to persist in place, but are less adapted to shift in space, with 84% of the mammals displaying relatively low adaptive capacity in Movement and/or Distribution factors but only 30% displaying low adaptive capacity in Demography and/or Life History factors. However, as a taxonomic class, mammals are variable in their response to climate change.

Breaking this class down to taxonomic orders, all bat SGCN and 80% of rodent SGCN were sensitive to Abiotic Niche factors, but only 50% of carnivore and lagomorph SGCN were sensitive to Abiotic Niche factors (Appendix 4, Appendix 7). Of carnivore species, 70% had low adaptive capacity associated with Ecological Role and/or Evolutionary Potential factors, possibly because a number of these carnivores have very limited distributions within New Mexico (i.e. Jaguar (*Panthera onca*), Black-Footed Ferret (*Mustela nigripes*)), suggesting they may find it more difficult to respond to climate change. Additionally, 37% of rodents had low adaptive capacity scores associated with threat multipliers, suggesting climate change impacts may increase for these rodents in the future (Appendix 4, Appendix 7). Of all mammal SGCN, for 66% there was no change in their vulnerability rank between the RCP 4.5 and the RCP 8.5 Scenario; 68% of those that did change their vulnerability level only shifted from Less to Moderately Vulnerable (Appendix 4, Appendix 7).

Of all mammals, only 11 (19%) were significantly impacted by threat multipliers that can magnify the impacts of climate change on a species (Appendix 4, Appendix 7). Only two of these species, the Mexican Gray Wolf (*Canis lupus baileyi*) and the Tricolored Bat (*Perimyotis subflavus*), were not rodent species; the Mexican Gray Wolf was impacted by topographic or anthropogenic barriers (e.g., roads), land-use changes, and other anthropogenic factors (e.g., illegal shooting, trapping, and poisoning), and the Tricolored Bat was impacted by land-use changes, other anthropogenic effects (e.g., wind turbines), and other biologic factors (e.g., white-nosed syndrome). Of the nine rodent species that were significantly impacted by threat multipliers, all were impacted by topographic or anthropogenic barriers (e.g., mountain ranges, roads); seven were impacted by other biologic effects (e.g., disease), six were impacted by land-use changes (e.g., urbanization), and five were impacted by other anthropogenic factors (e.g., persecution).

The Black-footed Ferret and Peñasco Least Chipmunk (*Neotamias minimus atristriatus*) were both assessed as Extremely Vulnerable to climate change at both RCP 4.5 and RCP 8.5 Scenarios; both of these species have very limited distributions within New Mexico, and the Black-footed Ferret has a very small population size with known genetic diversity concerns (Appendix 4, Appendix 7). Under the RCP 8.5 Scenario, the Gunnison's Prairie Dog (*Cynomys gunnisoni*), New Mexico Jumping Mouse (*Zapus hudsonius luteus*), and Mexican Gray Wolf are also Extremely Vulnerable to climate change. All of these species also have limited distributions within New Mexico and known genetic diversity concerns. They are also at risk from threat multipliers that could result in increased impacts from climate change in the future (Appendix 4, Appendix 7).

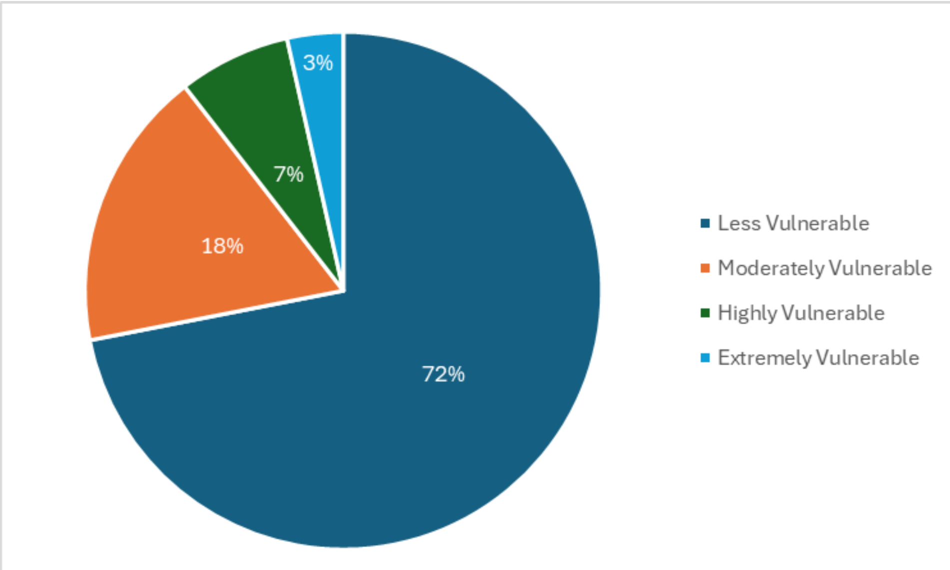

Figure 11. Climate change vulnerability scores for mammals under the Representative Concentration Pathway 4.5 Scenario.

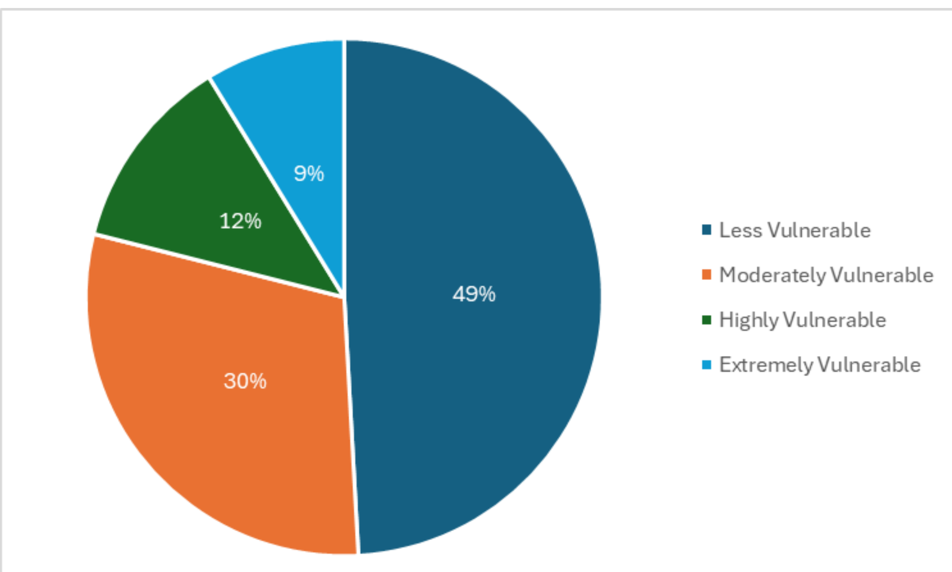

Figure 12. Climate change vulnerability scores for mammals under the Representative Concentration Pathway 8.5 Scenario.

REPTILES

As a whole, reptile SGCN were relatively adaptable to climate change, with 72% and 67% of all reptiles ranked as Less Vulnerable under the RCP 4.5 and RCP 8.5 Scenarios, respectively, and only 8 and 18% of SGCN reptiles ranked as Highly or Extremely Vulnerable under the RCP 4.5 and RCP 8.5 Scenarios, respectively (Figure 13, Figure 14). Adaptive capacity was extremely indicative of climate change vulnerability; all reptiles with a high adaptive capacity were considered Less Vulnerable to climate change. Of the reptile SGCN, 62% were significantly impacted by Distribution or Movement factors, reflecting an inability to shift in space, and 74% were significantly impacted by Demography or Life History factors, reflecting an inability to persist in place (Appendix 5, Appendix 7). All but one reptile, the Banded Rock Rattlesnake (*Crotalus lepidus klauberi*), were significantly impacted by Abiotic Niche factors, representing 97% of reptiles. This is corroborated by literature that cites climate change as a concern for reptiles based on their ectothermic physiology and relatively narrow thermal niche requirements (Graeter et al. 2013, Hatten et al. 2016; Appendix 5, Appendix 7).

Climate change vulnerability in reptiles also appears to be at least partly dependent on taxonomy information. All snake SGCN had high adaptive capacity and were Less Vulnerable to climate change except for the Mexican Gartersnake (*Thamnophis eques megalops*), which has a very limited distribution in New Mexico and experiences significant impacts from threat multipliers. Snakes generally are more mobile than other reptile species, with only 50% of snakes impacted by Distribution or Movement factors (Appendix 5, Appendix 7). Conversely, only one turtle SGCN, the relatively widespread Western Painted Turtle (*Chrysemys picta bellii*), had high adaptive capacity and was Less Vulnerable to climate change. All turtles SGCN were significantly impacted by Demography factors (e.g., life span, age of sexual maturity), and six (n=7) were impacted by Life History factors (e.g., sexual determination), suggesting an inability to persist in place as the climate changes (Appendix 5, Appendix 7). Of all reptile SGCN, only 13 (33%) were significantly impacted by threat multipliers. Of those 13, all were impacted by anthropogenic or topographic barriers and land-use changes, 11 were impacted by other anthropogenic factors (e.g., overharvest, persecution), and ten were impacted by biologic factors (e.g., disease, invasive species; Appendix 5, Appendix 7).

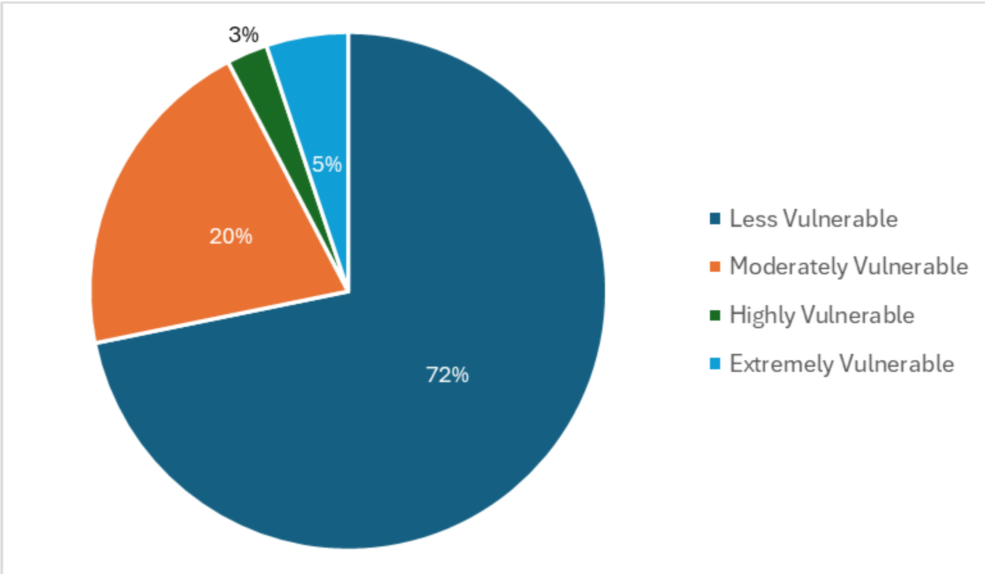

Figure 13. Climate change vulnerability scores for reptiles under the Representative Concentration Pathway 4.5 Scenario.

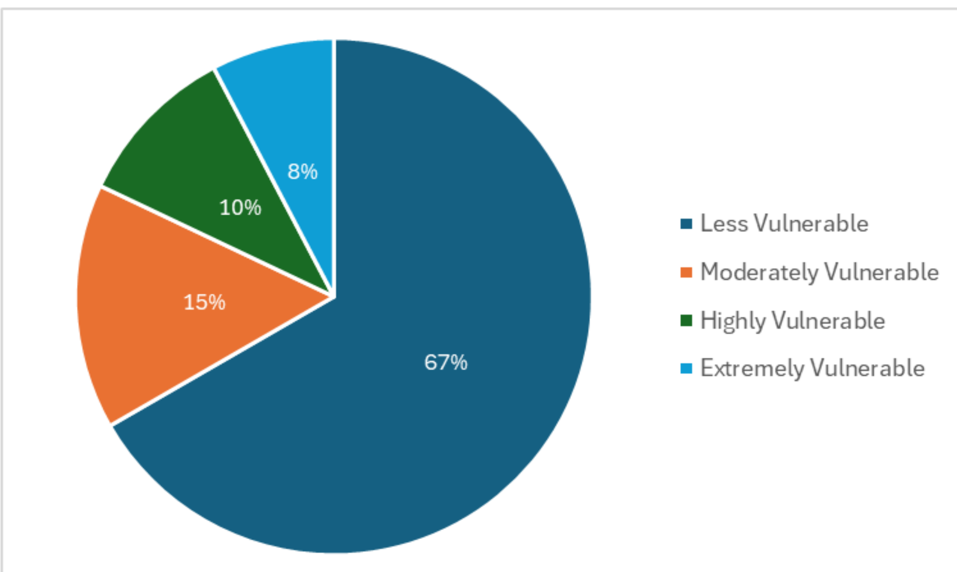

Figure 14. Climate change vulnerability scores for reptiles under the Representative Concentration Pathway 8.5 Scenario.

DISCUSSION

Overall, climate change vulnerability is important to consider when undertaking conservation planning efforts, especially with the possibility that climate-related impacts could overwhelm conservation efforts if effective climate adaptation strategies are not implemented. While quantifying climate change vulnerability of a broad ecosystem has its merits, this will not necessarily result in the conservation of all susceptible species, such as species with unique Abiotic Niche requirements or limiting Evolutionary Potential. This report provides a detailed analysis of all vertebrate New Mexico SGCN to better inform natural resource managers in the context of managing and mitigating the effects of climate change on specific species.

For many SGCN, climate change vulnerability is determined by a variety of factors that interact in different ways, and it cannot be assumed that climate change vulnerability will be the same for all species across an entire habitat type, location, global or status rank, or taxonomic group. Fish SGCN overall were the most vulnerable of all SGCN to climate change, in part because many are desert fishes that are likely to experience significant direct and indirect impacts from climate change. Specifically, fish SGCN in the Cyrinidae family (almost half of all fish SGCN evaluated) experienced outsized impacts from climate change, likely related to their low dispersal rates and lack of migration. Amphibian SGCN overall were also very vulnerable to climate change, with this vulnerability centered on an inability to shift in space in response to climate change that is likely driven by narrow climatic niche breadths for many amphibians, which have been documented in the literature (Graeter et al. 2013).

Mammal and reptile SGCN all saw varying degrees of climate change vulnerability based on what taxonomic family or order was considered. Bats and rodents had higher overall climate change vulnerability scores when compared to other mammal SGCN that were primarily associated with increased vulnerability to Abiotic Niche Factors. Nearly all snake SGCN were resilient to climate change, and all but one turtle SGCN was vulnerable to climate change. Bird SGCN generally were able to shift in space, reflected by their highly mobile nature. However, most migratory birds showed an inability to persist in place, again reflecting an important trait that determines climate change vulnerability.

REFERENCES CITED

Abatzoglou, J. T., and T. J. Brown. 2012. A comparison of statistical downscaling methods suited for wildfire applications. International Journal of Climatology 32(5):772–780.

Beever, E. A., J. O'leary, C. Mengelt, J. M. West, S. Julius, N. Green, D. Magness, L. Petes, B. Stein, A. B. Nicotra, and J. J. Hellmann. 2016. Improving conservation outcomes with a new paradigm for understanding species' fundamental and realized adaptive capacity. Conservation Letters 9(2):131-137.

Dawson, T. P., S. T. Jackson, J. I. House, I. C. Prentice, and G. M. Mace. 2011. Beyond projections: biodiversity conservation in a changing climate. Science 332(6025):53-58.

Dunbar, N.W., D. S. Gutzler, K. S. Pearthree, F. M. Phillips, and P. W. Bauer. 2022. Climate change in New Mexico over the next 50 years: impacts on water resources. Bureau of Geology and Mineral Resources, Socorro, New Mexico, USA.

[EPA] Environmental Protection Agency. 2016. What climate change means for New Mexico. U.S. Environmental Protection Agency, EPA 430-F-16-033, Washington, D.C., USA.

Frankson, R., K. E. Kunkel, L. E. Stevens, and D. R. Easterling. 2022. National centers for environmental information, state climate summaries 2022: New Mexico. National Oceanic and Atmospheric Administration, Washington, D.C., USA.

Friggens, M. 2015. State Wildlife Action Plan climate change chapter. U.S. Forest Service, Rocky Mountain Research Station, Albuquerque, New Mexico, USA.

Graeter, G. J., K. A. Buhlman, L. R. Wilkinson, and J. W. Gibbons, editors. 2013. Inventory and monitoring: recommended techniques for reptiles and amphibians. Partners in Amphibian and Reptile Conservation Technical Publication IM-1, Birmingham, Alabama, USA.

Hatten, J. R., J. T. Giermakowski, J. A. Holmes, E. M. Nowak, M. J. Johnson, K. E. Ironside, C. van Riper, III, M. Peters, C. Truettner, and K. L. Cole. 2016. Identifying bird and reptile vulnerabilities to climate change in the southwestern United States. U.S. Department of the Interior, U.S. Geological Survey, Open-File Report 2016-1085, Reston, Virginia, USA.

Hegewisch, K. C., J. T. Abatzoglou, O. Chegwidden, and B. Nijssen. 2018. 'Climate Mapper' web tool. Climate Toolbox, University of California Merced, California, USA. <https://climatetoolbox.org/>.

[IPCC] Intergovernmental Panel on Climate Change. 2014. Climate change 2014: synthesis report. R. K. Pachauri and L. A. Meyer, editors. Contribution of working groups I, II, and III to the fifth assessment report of the intergovernmental panel on climate change. Geneva, CHE.

Lyons, M. P., J. R. Stevenson, L. L. Thurman, and B. E. Young. 2024. Guidelines for using the NatureServe Climate Change Vulnerability Index, version 4.0. NatureServe, Arlington, Virginia, USA.

Price, J. P. 2002. Global warming and songbirds: New Mexico. American Bird Conservancy, Boulder, Colorado, USA.

Rosenberg, K. V., J. A. Kennedy, R. Dettmers, R. P. Ford, D. Reynolds, J. D. Alexander, C. J. Beardmore, P. J. Blancher, R. E. Bogart, G. S. Butcher, A. F. Camfield, A. Couturier, D. W. Demarest, W. E. Easton, J. J. Giocomo, R. H. Keller, A. E. Mini, A. O. Panjabi, D. N. Pashley, T. D. Rich, J. M. Ruth, H. Stabins, J. Stanton, and T. Will. 2016. Partners in flight landbird conservation plan: 2016 revision for Canada and continental United States. Partners in Flight Science Committee, Ithaca, New York, USA.

Stein, B.A., A. Staudt, M. S. Cross, N. S. Dubois, C. Enquist, R. Griffis, L. J. Hansen, J. J. Hellmann, J. J. Lawler, E. J. Nelson, and A. Pairis. 2013. Preparing for and managing change: climate adaptation for biodiversity and ecosystems. Frontiers in Ecology and the Environment 11(9):502-510.

Thurman, L. L., B. A. Stein, E. A. Beever, W. Foden, S. R. Geange, N. Green, J. E. Gross, D. J. Lawrence, O. LeDee, J. D. Olden, and L. M. Thompson. 2020. Persist in place or shift in space? Evaluating the

adaptive capacity of species to climate change. Frontiers in Ecology and the Environment 18(9):520-528.
[TWS] The Wildlife Society. 2008. Special issue on adapting to climate change. Wildlife Professional 2(3):9-68.
Wells, S. G., and N. Dunbar. 2020. New Mexico earth matters. New Mexico Bureau of Geology and Mineral Resources Volume 20(2):1-5.
Wilsey, C., B. Bateman, L. Taylor, J. X. Wu, G. LeBaron, R. Shepherd, C. Koseff, S. Friedman, and R. Stone. 2019a. Survival by degrees: 389 bird species on the brink. National Audubon Society, New York, New York, USA.
Wilsey, C. B., J. Grand, J. Wu, N. Michel, J. Grogan-Brown, and B. Trusty. 2019b. North American grasslands and birds report. National Audubon Society, New York, New York, USA.
Young, B. E., K. R. Hall, E. Byers, K. Gravuer, G. Hammerson, A. Redder, and K. Szabo. 2012. Rapid assessment of plant and animal vulnerability to climate change. Pages 129-150 *In*: J. F. Brodie, E. S. Post, and D. F. Doak, editors. Wildlife conservation in a changing climate. University of Chicago Press, Chicago, Illinois, USA.

APPENDIX 1. Assessment summaries for all amphibian Species of Greatest Conservation Need.

Arizona Toad

The Arizona Toad (*Anaxyrus microscaphus microscaphus*) will experience a high degree of climate change exposure and has a moderately-high adaptive capacity. Overall, it has a Climate Change Vulnerability Index (CCVI) ranking of Moderately Vulnerable under the Representative Concentration Pathway (RCP) 4.5 Scenario and Highly Vulnerable under the RCP 8.5 scenario. The Arizona Toad's climate change vulnerability is impacted by factors related to movement, demography and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It is also impacted by barriers, land-use changes and other anthropogenic factors, which could increase the effects of climate change.

The Arizona Toad has relatively specific habitat requirements and is found primarily in the Gila National Forest (Ryan et al. 2017). The toad is found along rocky streams in pine-oak forests at 1,800 to 2,600 m (5,900 to 8,500 ft) elevation and require shallow, slow-flowing streams with clear water conditions and sand or cobble substrates for breeding (Painter 1985; Ryan et al. 2014). This habitat is threatened by urbanization and conversion to agricultural land and construction of impoundments and other water control structures has resulted in loss of breeding habitat (NMDGF 2016; Ryan et al. 2014). Recent surveys have shown that Arizona Toads are absent from approximately 70% of historic sites in New Mexico (Ryan et al. 2017). The Arizona Toad is known to hybridize with the Woodhouse Toad (*Anaxyrus woodhousii*) and produce fertile offspring, although over time the Woodhouse Toad alleles dominate those of the Arizona Toad alleles (NMDGF 2016; Ryan et al. 2017). There are concerns over predation of the Arizona Toad by introduced bullfrogs and game fish (NMDGF 2016). The chytrid fungus *Batrachochytrium dendrobatidis* (Bd) has been found in Arizona Toads and has been linked to population declines in other amphibians (Christman 2009; Ryan et al. 2015a; Voyles 2015). Iridovirus (*Ranavirus* sp.) can result in massive die-offs in larval, metamorphosing, and recently metamorphosed amphibians, and climate change could increase the spread of *Bd* and iridovirus within amphibian populations (Graeter et al. 2013). Amphibians generally are likely to experience direct and indirect effects from climate change, including elevated levels of evaporative water loss associated with increasing temperatures and indirect effects on reproductive success as reductions in regional rainfall will reduce available larval habitat for aquatic and semi-aquatic species (Graeter et al. 2013).

Arizona Treefrog

The Arizona Treefrog (*Hyla [Dryophytes] wrightorum*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Arizona Treefrog's climate change vulnerability is impacted by factors related to movement, distribution, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by land-use changes that could increase the effects of climate change.

This frog will overwinter in trees, moving to ephemeral ponds above 5,000 m (16,400 ft) in elevation to breed (NMDGF 2007). Their movement is generally limited by roads and urban areas (NMDGF 2007). Research of Arizona populations of the Arizona Treefrog has found low levels of genetic heterozygosity and increased inbreeding depression, although more research needs to be done to determine genetic diversity across the species (Gergus et al. 2004). The Eastern Barking Frog is threatened by the chytrid fungus *Bd* (Kriger and Hero 2009). Iridovirus can result in massive die-offs in larval, metamorphosing, and recently metamorphosed amphibians, and climate change could increase the spread of *Bd* and iridovirus within amphibian populations (Graeter et al. 2013). The Arizona Treefrog is predated on by non-native bullfrogs, game fish and crayfish and Arizona Treefrog tadpoles experience a five-fold increase in survival when no Tiger Salamanders (*Ambystoma tigrinum*) are present (AGFD 1996; NMDGF 2007).

Blanchard's Cricket Frog

The Blanchard's Cricket Frog (*Acris blanchardi*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Blanchard's Cricket Frog's climate change vulnerability is impacted by factors related to movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Blanchard's Cricket Frog is limited to the lower and middle sections of the Pecos River drainage in southeastern New Mexico and requires still, shallow water for reproduction at 900 to 1,275 m (2,950 to 4,180 ft) elevation (Hubbard et al. 1979; Degenhardt et al. 1996; Painter et al. 2017). It is active at 5 to 38°C (42 to 100°F) and overwinters in cracks and crevices; winter survival is likely limited by frost depth (Regan 1972; Hammerson 1982; Gray 1983). The Blanchard's Cricket Frog lays a single clutch of approximately 300 eggs between April and July; adults rarely survive to their second year (Hubbard et al. 1979; Hammerson 1982; Gray 1983). The Blanchard's Cricket Frog is threatened by the chytrid fungus *Bd* (Kriger and Hero 2009). Iridovirus can result in massive die-offs in larval, metamorphosing, and recently metamorphosed amphibians, and climate change could increase the spread of *Bd* and iridovirus within amphibian populations (Graeter et al. 2013). Habitat loss and destruction from road construction, agricultural development and riparian alterations are of concern (Hubbard et al. 1979; Hammerson and Livo 1999).

Boreal Chorus Frog

The Boreal Chorus Frog (*Pseudacris maculata*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Boreal Chorus Frog's climate change vulnerability is impacted by factors related to movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It is also impacted by barriers, land-use changes and diseases that could increase the effects of climate change.

The Boreal Chorus Frog reproduces in temporary and permanent shallow, slow-moving water sources and feeds in adjacent wet meadows and grassy areas (Spencer 1964; Amburgey et al. 2012; Voyles 2014). Life history differs significantly between montane and piedmont populations. Montane populations migrate to breeding pools seasonally, breed later in the season, and generally breed into their seventh year (Spencer 1964; Tordoff 1971). Montane frogs display high site fidelity, rarely traveling more than 762 m (2,500 ft) from their breeding pool (Spencer 1964; Miller 1977). Piedmont frogs are larger, appear to handle higher temperatures better than montane frogs, display less site fidelity, and rarely live past one year of age (Spencer 1964; Tordoff 1971). Within breeding pools, sex ratios have been documented as high as 20 males to one female (Matthews 1971). The Boreal Chorus Frog cannot survive temperatures above 38°C (100°F) and will burrow under rocks, logs and in cracks to escape extreme heat or cold (Spencer 1964; Miller 1977). The Boreal Chorus Frog is predated on by non-native American Bullfrogs, game fish, and crayfish (NMDGF 2016). The chytrid fungus *Bd* has been found at a relatively high prevalence in the Boreal Chorus Frog (Kriger and Hero 2009; Voyles 2015). Iridovirus can result in massive die-offs in larval, metamorphosing, and recently metamorphosed amphibians, and climate change could increase the spread of *Bd* and iridovirus within amphibian populations (Graeter et al. 2013).

Boreal Toad

The Boreal Toad (*Anaxyrus boreas boreas*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Extremely Vulnerable under the RCP 8.5 Scenario. The Boreal Toad's climate change vulnerability is impacted by factors related to distribution, movement, life history, evolutionary potential and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It is also impacted by land-use changes that could increase the effects of climate change.

The Boreal Toad is on the southern edge of its range in New Mexico, only found in alpine wetlands above 2,600 m (8,530 ft) elevation in Rio Arriba County and is dependent on still or nearly still water for breeding (NMDGF 1988; Hammerson 1999; NMDGF 2020b). This toad occurs in grasslands and dry habitats, migrating up to 4 km (2.5 miles) to wet alpine meadows and lowland springs and streams to breed (NMDGF 1988; Finch 1992; Hammerson 1999). Habitat degradation is of concern, particularly from grazing, agriculture conversion and wildfire (USFS 2020). Boreal Toads cannot handle extreme heat or cold and are generally not active at temperatures above 20°C (68°F) or below 3°C (37°F) (Campbell 1970; Hammerson 1999) .They hibernate during the winter in rodent burrows and beaver lodges, and burrow under logs, rocks, soil, and leaf litter during the day to reduce impacts from extreme heat (Campbell 1970; Finch 1992; Hammerson 1999; USFS 2020). Boreal Toads adults and tadpoles are predated by a variety of native and non-native predators (Finch 1992; Hammerson 1999). The Boreal Toad is highly susceptible to the chytrid fungus Bd, and a 75% *Bd* prevalence has been detected in New Mexico populations (Pounds et al. 2006; Rödder et al. 2008). Iridovirus can result in massive die-offs in larval, metamorphosing, and recently-metamorphosed amphibians, and climate change could increase the spread of *Bd* and iridovirus within amphibian populations (Graeter et al. 2013).

Boreal Toads were historically found in three disjunct populations in Rio Arriba County but were extirpated from the state as of 2006 (Christman 2006). They are currently being reintroduced at a single site in the state, although they have experienced significant declines due to *Bd* within that population (Painter et al. 2017; NMDGF 2018b).

Chiricahua Leopard Frog

The Chiricahua Leopard Frog (*Lithobates chiricahuensis*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Chiricahua Leopard Frog's climate change vulnerability is impacted by factors related to distribution, movement, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by barriers, land-use changes and diseases that could increase the effects of climate change.

The Chiricahua Leopard Frog is a habitat specialist. It resides in riparian montane habitats at 1,000 to 2,600 m (3,280 to 8,530 ft) and requires a permanent water source for all life stages and as protection from predators (Stuart 1996; Watson 2017). The Chiricahua Leopard Frog generally breeds once or less per year and has a short reproductive season (Friggens 2015). Water and air temperatures are known to impact the activity level, including the reproductive activity, of the Chiricahua Leopard Frog (Jennings 1988; Jennings 1990; Degenhardt et al. 1996). Most populations are small and separated by large distances of scrub desert and low elevation, thus catastrophic storms, in particular droughts and floods, could have significant impacts on this species (Platz and Meacham 1984; Jennings and Scott 1991; USFWS 2011c). The Chiricahua Leopard Frog has experienced forested habitat loss from grazing and wildfire and negative impacts from road, urban, and agricultural development, including de-watering and impacts from increased irrigation (Jennings 1988; NMDGF 2016). It is preyed on by a variety of invasive and non-native predators, including the American Bullfrog, catfishes (*Ictalurus spp*. and *Pylodictus oliveris*), trout (*Salmo spp*. and *Salvelinus spp*.) and crayfish (*Orconectes virilis*) (USFWS 2007a). The Chiricahua Leopard Frog has experienced a 70% decline in its Arizona and New Mexico populations, primarily due to the chytrid fungus *Bd* (Christman 2009). Iridovirus can result in massive die-offs in larval, metamorphosing, and recently metamorphosed amphibians, and climate change could increase the spread of *Bd* and iridovirus within amphibian populations (Graeter et al. 2013). Although there are no data available on genetic diversity, data suggest the Chiricahua Leopard Frog has experienced a 50% decline in occurrence at historically-occupied sites in the United States (Snyderman 1995).

Eastern Barking Frog

The Eastern Barking Frog (*Craugastor augusti latrans*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Extremely Vulnerable under the RCP 8.5 Scenario. The Eastern Barking Frog's climate change vulnerability is impacted by factors related to distribution, movement, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Eastern Barking Frog is a habitat specialist, spending most of its time underground in caves, crevices, and ledges at 900 to 1,200 m elevation (2,950 to 3,930 ft) within the southcentral part of the state (Garrett and Barker 1987; Degenhardt et al. 1996; Ryan et al. 2015b). Within New Mexico, the Eastern Barking Frog has a small and disjunct distribution with little to no population connectivity, which could have severe population impacts (Ryan et al. 2015b). Breeding and dispersal events are closely tied to heavy rainfall events, and the Eastern Barking Frog reproduces via direct development (does not require standing water for larval development) with eggs and larvae requiring moist soil for survival. Extreme floods and droughts are of particular concern because of this unique reproductive strategy (Ryan et al. 2015b). The Eastern Barking Frog is threatened by the chytrid fungus *Bd* (Kriger and Hero 2009). Iridovirus can result in massive die-offs in larval, metamorphosing, and recently-metamorphosed amphibians, and climate change could increase the spread of *Bd* and iridovirus within amphibian populations (Graeter et al. 2013). Eastern Barking Frogs use burrows created by prairie dogs and other rodents, and these are likely a limiting factor (Radke 2001; Malone 2002).

Jemez Mountains Salamander

The Jemez Mountains Salamander (*Plethodon neomexicanus*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Jemez Mountains Salamander's climate change vulnerability is impacted by factors related to distribution, movement, evolutionary potential and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by barriers, land-use changes and diseases that could increase the effects of climate change.

The Jemez Mountains Salamander is a habitat specialist. It is restricted to mixed-conifer forests in the Jemez Mountains at 2,200 to 2,900 m (7,220 to 9,220 ft) elevation within three counties in the northwestern part of New Mexico (Degenhardt et al. 1996; Cummer 2005). Preferred microhabitat is characterized by relatively high humidity and soils that contain deep, igneous, subsurface rock that is fractured vertically and horizontally to allow the species to retreat underground to below the frost line (NMEST 2000). The Jemez Mountains Salamander has a small home range, generally spending their entire lives within an area less than 15 m^2 (160 ft^2) (Merchant 1972; Kleeberger and Werner 1982). They are negatively impacted by extensive road construction, intensive logging, overgrazing, and wildfires (NMEST 2000; USFWS 2013b). The chytrid fungus *Bd* has been found in Jemez Mountains Salamanders (Kriger and Hero 2009; USFWS 2013b). Iridovirus can result in massive die-offs in larval, metamorphosing, and recently-metamorphosed amphibians, and climate change could increase the spread of *Bd* and iridovirus within amphibian populations (Graeter et al. 2013). The salamander population consists of a few distinct subpopulations with no interbreeding; significant impacts to any single subpopulation could substantively impact genetic diversity for the entire species (Ramotnik 1986; Degenhardt et al. 1996). Additionally, the Jemez Mountains Salamander has been found to be absent from more than 60% of historically occupied sites during occupancy surveys conducted in the last 25 years (Cummer et al. 2003, 2004; NMDGF 2006c). Recent wildfires have resulted in habitat loss and indirect impacts to salamander populations (Cummer et al. 2005; Cummer and Painter 2007).

Lowland Leopard Frog

The Lowland Leopard Frog (*Lithobates yavapaiensis*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Extremely Vulnerable under the RCP 8.5 Scenario. The Lowland Leopard Frog's climate change vulnerability is impacted by factors related to distribution, movement, evolutionary potential, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Lowland Leopard Frog may have been extirpated from New Mexico; only a single individual was reported in the state in 2000 (Christman 2009; Painter et al. 2017). However, it is still State-listed as Endangered in New Mexico. It resides in ponds and deep pools at less than 1,000 m (3,280 ft) elevation near grassland, desert, oak, and oak-pine woodlands (Painter 1985; NMDGF 1988). The decline of the Lowland Leopard Frog in Arizona and New Mexico is likely due to competition with American Bullfrogs; predation by a variety of introduced game fish (Schwalbe and Rosen 1988; Jennings and Scott 1991; Corn 1994); and habitat alteration and fragmentation from agricultural development, grazing, channelization and diversion of aquatic systems, and urban development (Jennings and Hayes 1994), exacerbated by catastrophic floods and droughts (Jennings 1995). The chytrid fungus *Bd* affects the Lowland Leopard Frog, particularly in the winter; climate change may increase its spread (Kriger and Hero 2009; Savage et al. 2011). Iridovirus can result in massive die-offs in larval, metamorphosing, and recently-metamorphosed amphibians, and climate change could increase the spread of *Bd* and iridovirus within amphibian populations (Graeter et al. 2013).

Northern Leopard Frog

The Northern Leopard Frog (*Lithobates pipiens*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Boreal Chorus Frog's climate change vulnerability is impacted by factors related to movement, demography, ecological role, evolutionary potential, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

Northern Leopard Frogs are found in permanent, slow-moving wetlands adjacent to a variety of upland habitat (Finch 1992). Road mortality is high in Northern Leopard Frogs, limiting movement opportunities as climate change potentially alters existing habitat (Carr and Fahrig 2001). The chytrid fungus *Bd* has been found in Northern Leopard Frog populations at a high prevalence and intensity (Voyles 2014; Voyles 2015). Iridovirus can result in massive die-offs in larval, metamorphosing, and recently-metamorphosed amphibians, and climate change could increase the spread of *Bd* and iridovirus within amphibian populations (Graeter et al. 2013). Competition and predation by American Bullfrogs and predation by introduced fish species have resulted in population declines of the Northern Leopard Frog (Jennings 1995). Of particular concern is competition for food sources with the Northern Crayfish (*Faxonius virilis*); where this crayfish is abundant, the Northern Leopard Frog is rare or absent (Fernandez and Rosen 1996). The Northern Leopard Frog has been found to hybridize with the Plains Leopard Frog (*Lithobates blairi*); female frogs respond negatively to calls from hybridized individuals (Fritts et al. 1984), which could impact future reproductive success rates if hybridization continues. Although population-level genetic diversity is not known, many local Northern Leopard Frog populations have been lost, with others experiencing significant declines; this has likely reduced overall genetic diversity across the species' range (AGFD 1988; AGFD 1996).

Plains Leopard Frog

The Plains Leopard Frog will experience a high degree of climate exposure and has high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Plains Leopard Frog's climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Plains Leopard Frog is found in still and shallow permanent or non-permanent pools and ponds generally adjacent to grasslands or aquatic woodlands (Post 1972; Pace 1974; Hammerson 1982). Depending on the permanence of their breeding site, they may migrate to a new breeding site each year, migrating an average of 3 km (1.9 mi) between sites (Gillis 1975). The Plains Leopard Frog is threatened by high rates of predation by non-native American Bullfrogs and invasive game fish and habitat loss and alteration from agricultural development and grazing (Corn 1994; AGFD 1996). The chytrid fungus *Bd* has been found in the Plains Leopard Frog (Christman 2009; Kriger and Hero 2009). Iridovirus can result in massive die-offs in larval, metamorphosing, and recently-metamorphosed amphibians, and climate change could increase the spread of *Bd* and iridovirus within amphibian populations (Graeter et al. 2013). The Plains Leopard Frog has been found to hybridize with the Northern Leopard Frog; female frogs respond negatively to calls from hybridized individuals (Fritts et al. 1984), which could impact future reproductive success rates if hybridization continues. Declines have been documented within other parts of the Plains Leopard Frog's range and in other ranid frogs. However, the specific rates of decline are not known (Corn 1994; Jennings 1995).

Rio Grande Leopard Frog

The Rio Grande Leopard Frog (*Lithobates berlandieri*) will experience a high degree of climate exposure and has high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Rio Grande Leopard Frog's climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Rio Grande Leopard Frog resides in clear, flowing water and is limited to the lower Pecos River Basin in the southeastern corner of New Mexico (Fritts et al. 1984; Painter et al. 2017). The Rio Grande Leopard Frog is threatened by habitat loss and alteration and is also sensitive to predation from non-native American Bullfrogs and predatory gamefish (Jennings and Scott 1991; NMDGF 2016). The Rio Grande Leopard Frog is also threatened by the chytrid fungus *Bd* (Kriger and Hero 2009). Iridovirus can result in massive die-offs in larval, metamorphosing, and recently-metamorphosed amphibians, and climate change could increase the spread of *Bd* and iridovirus within amphibian populations (Graeter et al. 2013).

Sacramento Mountain Salamander

The Sacramento Mountain Salamander (*Aneides hardii*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Sacramento Mountain Salamander's climate change vulnerability is impacted by factors related to distribution, movement, demography, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Sacramento Mountain Salamander is only found within three mountain ranges in two counties in southcentral New Mexico. Genetic diversity and bottleneck potentials are a concern, with high diversity and deeper divergence among haplotypes within the Capital Mountain population, very low genetic diversity in the White Mountains population, and high diversity with low divergence among haplotypes in the Sacramento Mountain population (NMDGF 2018b). Females lay eggs every three years, averaging five eggs per clutch (Degenhardt 1974; Williams 1978). The Sacramento Mountain Salamander is particularly threatened by the chytrid fungi *Bd* and *Batrachochytrium salamandrivorans* (Bsal) (Longcore et al. 1999; Richgels et al. 2016; Cordova 2017). Iridovirus can result in massive die-offs in larval, metamorphosing, and recently-metamorphosed amphibians, and climate change could increase the spread of *Bd*, Bsal, and iridovirus within amphibian populations (Graeter et al. 2013). Like the Jemez Mountains Salamander, the Sacramento Mountain Salamander is associated with cool, moist islands of montane forests and talus rocks at high elevations and is susceptible to microhabitat changes, specifically changes in soil moisture content, forest floor debris, and leaf litter, which can be negatively affected by forest fires, logging, and overgrazing (NMDGF 1988; Cordova and Rawlinson 2015). The Sacramento Mountain Salamander is threatened by direct mortality and habitat fragmentation resulting from urban development, particularly roads and road construction (NMDGF 2004; Watson and Gruber 2006).

Sonoran Desert Toad

The Sonoran Desert Toad (*Incilius alvarius*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Sonoran Desert Toad's climate change vulnerability is impacted by factors related to movement, demography, life history and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

In New Mexico, the Sonoran Desert Toad is only found in the far southwestern corner of the state, at 1,200 to 1,500 m (3,940 to 4,920 ft) elevation in scrub and shrub habitat and occasionally in riparian woodlands (Stebbins 1985; Jones 1988; NMDGF 1988). The toad breeds for a few days following a major rainfall event, breeding and laying eggs in ponds and slow-moving water (Sullivan and Malmos 1994). The Sonoran Desert Toad is inactive in cold weather and in hot, dry weather, so it spends much of its time underground in rodent holes (Stebbins 1985; NMDGF 1994). The Sonoran Desert Toad is threatened by urban and road development, direct mortality from vehicle collisions, water diversions, water pollution, and overcollection (NMDGF 1988; NMDGF 1996). The Sonoran Desert Toad is also threatened by the chytrid fungus *Bd* (Kriger and Hero 2009). Iridovirus can result in massive die-offs in larval, metamorphosing, and recently-metamorphosed amphibians, and climate change could increase the spread of *Bd* and iridovirus within amphibian populations (Graeter et al. 2013).

Western Narrow-mouthed Toad

The Western Narrow-mouthed Toad (*Gastrophryne olivacea*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Extremely Vulnerable under the RCP 8.5 Scenario. The Western Narrow-mouthed Toad's climate change vulnerability is impacted by factors related to distribution, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and to climate change impacts.

The Western Narrow-mouthed Toad is an underground species that burrows in grassland and desert grasslands, only coming above ground during heavy rains to breed in shallow, temporary pools and ponds (Hammerson 1982; NMDGF 1988). The combination of high humidity and mild temperatures typical between March and September is needed to stimulate reproduction; climate change could impact this relatively narrow reproductive window (Stuart 1993; Graeter et al. 2013). In terms of diet, the Western Narrow-mouthed Toad is an ant specialist (Stuart 1992). It is threatened by the chytrid fungus *Bd* (Kriger and Hero 2009). Iridovirus can result in massive die-offs in larval, metamorphosing, and recently-metamorphosed amphibians, and climate change could increase the spread of *Bd* and iridovirus within amphibian populations (Graeter et al. 2013). Habitat loss and degradation resulting from grazing, agricultural development, road and urban development, and stream and river modification threaten the Western Narrow-mouthed Toad (NMDGF 1988; NMDGF 1996).

APPENDIX 2. Assessment summaries for all bird Species of Greatest Conservation Need.

Abert's Towhee

The Abert's Towhee (*Melozone aberti aberti*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a Climate Change Vulnerability Index (CCVI) ranking of Less Vulnerable under both Representative Concentration Pathway (RCP) 4.5 and RCP 8.5 Scenarios. The Abert's Towhee's climate change vulnerability is impacted by factors related to evolutionary potential and abiotic niche, which influence its ability to respond to climate change impacts. It is also impacted by other anthropogenic factors and biologic factors that could increase the effects of climate change.

This subspecies is found only in two counties in the far southwest corner of the State and is a skulking species, generally hard to locate within thick shrubby vegetation (NMDGF 1988). The Abert's Towhee primarily resides in riparian woodlands, nesting within the low and middle canopy of scrub and shrub species (NMDGF 1988; DeGraaf et al. 1991). The primary threat to this species is habitat loss, specifically the loss and degradation of native riparian habitat within its restricted New Mexico range resulting from wildfires, intensive grazing, urban and agricultural development, and hydrologic changes (DeGraaf et al. 1991; NMDGF 1996; NMDGF 2016; Smith and Finch 2017; NMDGF 2020b). Brood parasitism from Brown-headed Cowbirds (*Molothrus ater*) is known to impact reproductive success (Finch 1983). Incidental observations of Abert's Towhee have declined 25 to 70% in the past 50 years (NMDGF 1988; NMDGF 1996). Climate change vulnerability modeling results suggest the Abert's Towhee will experience a 42% breeding range loss and an 82% breeding range gain by 2050; much of that range gain will occur in New Mexico (Wilsey et al. 2019a).

American Bittern

The American Bittern (*Botaurus lentiginosus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The American Bittern's climate change vulnerability is impacted by factors related to movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The American Bittern breeds and resides solely in wetlands (Finch 1992; NMDGF 2016). It is a shy and secretive species and is intolerant of human disturbance (Hubbard 1978). The American Bittern is threatened by habitat destruction and degradation resulting from dredging, channelization, and flood-control, and by wildfires (AGFD 1996). Climate change vulnerability modeling results suggest the American Bittern will see a 24% range contraction by 2050, primarily in the southern portion of its range, which will potentially exclude New Mexico from their breeding range (Wilsey et al. 2019a).

American Dipper

The American Dipper (*Cinclus mexicanus unicolor*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The American Dipper's climate change vulnerability is impacted by factors related to movement, life history and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The American Dipper is generally found in riparian habitat that include mixed conifers above 1,500 m (5,000 ft) elevation (Hubbard 1978; Stahlecker et al. 1989; DeGraaf et al. 1991). They require clear running water to locate and capture prey, and they conceal their nests on rocky outcroppings such as cliffs or ledges, or under logs (Hann 1950). There is some evidence of nest failure resulting from flooding, which may increase in frequency as the climate change (Hann 1950). American Dippers feed primarily on aquatic insect adults and larvae in the Ephemeroptera, Plecoptera, and Trichoptera families, although they will also feed on other insects and small fish fingerlings (Bent 1948; Thut 1970). The American Dipper has seen a 4% population decrease since 1970 (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest the American Dipper will experience a 25% breeding range loss and a 37% winter range loss by 2050, which could result in a 30% range contraction in New Mexico (Wilsey et al. 2019a).

American Kestrel

The American Kestrel (*Falco sparverius sparverius*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The American Kestrel's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The American Kestrel generally hunts in grasslands and open habitats that are dependent on a regular fire regime, even hunting within freshly-burned areas (Smallwood et al. 1982; DeGraaf et al. 1991). They are cavity nesters, nesting in a variety of woodlands and dependent on naturally-occurring cavities or cavities excavated by woodpeckers (Palmer 1988; Baltosser 1991). The American Kestrel has experienced a 48% population decline since 1970, but a recent assessment indicated it is expected to be resilient to changes in habitat caused by climate change (Friggens et al. 2013; Rosenberg et al. 2016).

American Pipit

The American Pipit (*Anthus rubescens*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The American Pipit's climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The American Pipit breeds in open grasslands within alpine tundra habitat above the timberline in New Mexico, a habitat type likely to shrink in New Mexico due to climate change (Baltosser 1991; Black 1997). The American Pipit winters at lower elevations throughout much of the State, generally found foraging adjacent to grasslands and other open habitat along the edge of open water for aquatic insects and invertebrates (Hubbard 1978; Baltosser 1991). The American Pipit has experienced a 30% population decline since 1970 (Rosenberg et al. 2016). Climate change vulnerability modeling projects a 43% breeding range loss by 2050, which could potentially exclude New Mexico from their breeding range (Wilsey et al. 2019a).

American Tree Sparrow

The American Tree Sparrow (*Spizelloides arborea ochracea*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The American Tree Sparrow's climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The American Tree Sparrow is a regular winter resident in New Mexico from November to March, breeding primarily in Canada and Alaska (Terres 1980; Johnson and Herter 1989). New Mexico has seen an increase in the average temperature of about 0.3°C (0.6°F) per decade since 1970, and, as temperatures continue to increase because of continuing climate change, these changes will likely exacerbate the effects on American Tree Sparrow breeding patterns (Tebaldi et al. 2012; Funk et al. 2016). The sparrow's population is generally limited by predators and weather; they must take in about 30% of their body weight in food and water daily or they experience a significant decline in body temperature that can be fatal (Baumgarten 1968; Cornell Lab 2024). The American Tree Sparrow has experienced a 53% population decline since 1970 (Rosenberg et al. 2016). Climate change vulnerability modeling projects a 52% breeding range loss by 2050 and an 8% wintering range loss in primarily the southern portion of its winter range, which could reduce New Mexico winter habitat by as much as 30% (Wilsey et al. 2019a).

Aplomado Falcon

The Aplomado Falcon (*Falco femoralis septentrionalis*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Highly Vulnerable under the RCP 8.5 Scenario. The Aplomado Falcon's climate change vulnerability is impacted by factors related to movement, demography, life history and evolutionary potential, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Aplomado Falcon hunts and breeds on grassy plains that include mesquite and yuccas, and hunt for insects or other small prey that are flushed by grass fires and other predators (NMDGF 1991; Haynes and Schuetze 1997). The Aplomado Falcon was likely widespread across New Mexico prior to the mid-1900s; they became quite rare in the State, and the rest of the United States (U.S), in the last few decades (NMDGF 1991). The last breeding record in New Mexico for the Aplomado Falcon is from 1952, with a handful of verified and unverified sightings since then (NMDGF 1991; NMDGF 1994). This population decline in New Mexico is likely to the result of the degradation of grassland habitat by overgrazing, fire exclusion, and conversion to agricultural lands. This species is also threatened by oil and gas development and pesticide use (NMDGF 2016; Wilsey et al. 2019b; NMDGF 2020b). Starting in 2006, Aplomado Falcons were released in New Mexico as an experimental population. Detailed surveys have not been conducted, but it appears most of these released individuals have dispersed or perished, mostly due to predation (NMDGF 2020b). Climate change vulnerability modeling projects a 47% range contraction and 63% range expansion by 2050 across the entire Aplomado Falcon range; New Mexico is projected to experience a more than 70% range loss (Wilsey et al. 2019a).

Arizona Grasshopper Sparrow

The Arizona Grasshopper Sparrow (*Ammodramus savannarum ammolegus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Arizona Grasshopper Sparrow's climate change vulnerability is impacted by distribution factors, which influence its ability to shift in space. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Arizona Grasshopper Sparrow is found on a single private property in the far southwest corner of New Mexico (NMDGF 1990b; Williams 1993). The Arizona Grasshopper Sparrow is a grassland specialist and has likely experienced habitat degradation and destruction driven by overgrazing, wildfires, and drought (NMDGF 1990b; NMDGF 2016; NMDGF 2020b). It is also threatened by pesticide use (Mineau and Whiteside 2013; Hallman et al. 2014). Surveys have shown steep declines in the Arizona Grasshopper Sparrow subspecies since 1987 (NMDGF 1994; NMDGF 1996; Williams 1993), and the species has experienced a 68% population decline across its range since 1970 (Rosenberg et al. 2016). The species is expected to experience a 50% decline within the next 15 years, with over half of the known range in New Mexico projected to be lost (Wilsey et al. 2019a; PIF 2024).

Arizona Woodpecker

The Arizona Woodpecker (*Dryobates arizonae*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Arizona Woodpecker's climate change vulnerability is impacted by factors related to distribution and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Arizona Woodpecker is on the northern end of its range and relatively rare in New Mexico, occurring on a single private ranch in Hidalgo County (Black 1997). It resides in Sonoran Desert scrub habitat adjacent to arid-land riparian woodlands with mature trees (particularly cottonwoods [*Populus* spp.]) available for creation of cavity nests (DeGraaf et al. 1991). Arid-land riparian woodlands are expected to decline and be replaced by other woody species, in part due to climate change, increased occurrence of wildfires, and hydrologic changes (NMDGF 1994). It is estimated there were less than 5,000 Arizona Woodpeckers in the U.S. as of 2014, representing a 14 to 50% population decline in the past 44 years (Rosenberg et al. 2016). Climate change vulnerability modeling projects a 48% range loss by 2050 (Wilsey et al. 2019a).

Baird's Sparrow

The Baird's Sparrow (*Centronyx bairdii*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Baird's Sparrow's climate change vulnerability is impacted by factors related to distribution, movement and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

This species breeds in the northern Great Plains and migrates to its winter range in New Mexico and south into Mexico (Green et al. 2020). The Baird's Sparrow breeds and winters in native grasslands and shortgrass prairies (Ehrlich et al. 1988; NMDGF 1988). This habitat is threatened by human activities such as oil and gas development, biofuel production, and increased agricultural development and fire suppression, woody encroachment, and an increasing frequency of droughts resulting from climate change (Ehrlich et al. 1988; Rosenberg et al. 2016; Somershoe 2018; Wilsey et al. 2019b). This bird is also threatened by pesticide use (Mineau and Whiteside 2013; Hallman et al. 2014). The Baird's Sparrow experiences relatively high nest parasitism rates within its breeding range (Wilsey et al. 2019b) and high predation rates, particularly within its wintering range (Somershoe 2018). The Baird's Sparrow has experienced a 72% population decline since 1970 and is expected to lose more than 95% of its current distribution due to climate change (Rosenberg et al. 2016; Wilsey et al. 2019b; NABCI 2022).

Bald Eagle

The Bald Eagle (*Haliaeetus leucocephalus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Bald Eagle's climate change vulnerability is impacted by factors related to movement, demography and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Bald Eagle is highly dependent on aquatic habitats in general for feeding and breeding, although they are not dependent on any specific aquatic habitats (AGFD 1988). Their diet primarily consists of fish, particularly later in the nesting season (Grubb 1995; Haynes and

Schuetze 1997). Climate change and increased construction of water-control structures could reduce the amount of aquatic habitat available for fishes. Bald Eagles are threatened by winter habitat loss and degradation, decreases in prey availability and roost site availability, and wind turbine construction (NMDGF 1994; NMDGF 1996). Other threats to Bald Eagles include the H5N1 strain of avian influenza, nest disturbance, illegal poaching, and bioaccumulation of heavy metals (NMDGF 1994; NMDGF 1996; NMDGF 2015a; TWS 2023a). The oldest recorded Bald Eagle died at 38 years of age, although they will generally survive 20 to 30 years in the wild (Cornell Lab 2024). Climate change vulnerability modeling projects Bald Eagles to experience a 14% range expansion, primarily in the northern part of its range, and a 10% range contraction, primarily in the southeastern and southwestern U.S., by 2050; more than half of the current range in New Mexico is anticipated to be lost (Wilsey et al. 2019a).

Band-tailed Pigeon

The Band-tailed Pigeon (*Patagioenas fasciata*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Band-tailed Pigeon's climate change vulnerability is impacted by factors related to movement, demography and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Band-tailed Pigeon breeds in temperate and montane coniferous and mixed forests and woodlands across much of New Mexico, migrating short distances to the southern part of the State (Braun 1994). It is a diet generalist, feeding on berries, acorns, and waste grain. It does appear to be relatively dependent on mineral salts, particularly calcium and sodium, as it is often found around salt licks and natural mineral sources (Jeffrey 1980; Sanders and Jarvis 2000). The Band-tailed Pigeon is threatened by an epizootic disease caused by the parasite *Trichomonas gallinae* (Braun 1994). It has experienced a 60% population decline in the past 50 years, likely due to overhunting and habitat degradation and destruction resulting from unmanaged logging and deforestation and changing forest conditions (NMDGF 1988; Rosenberg et al. 2016). Climate change vulnerability modeling results suggest the Band-tailed Pigeon will overall experience a 37% range contraction and a 28% range expansion; in New Mexico at least 50% of the current range will likely be lost (Wilsey et al. 2019a).

Bank Swallow

The Bank Swallow (*Riparia riparia riparia*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Bank Swallow's climate change vulnerability is impacted by factors related to distribution, movement, demography, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Bank Swallow burrows into riparian banks for nesting and is highly dependent on riparian habitat within their breeding range (Terres 1980). They are negatively impacted by roads and paved surfaces, often confusing these areas for riparian corridors (NMDGF 2016). Bank Swallow mortality has been documented that resulted from floods and droughts, and they are highly dependent on aerial insects in their diet, which means they are particularly susceptible to insecticides (Ehrlich et al. 1988; Friggens et al. 2013; Hallman et al. 2014). Bank Swallow populations have seen an 89% decline in the past 50 years (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest the Bank Swallow summer range will contract by 10% by 2050, resulting in more than 50% of the New Mexico range being lost (Wilsey et al. 2019a).

Bell's Vireo

The Bell's Vireo (*Vireo belli*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Bell's Vireo's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Bell's Vireo primarily nests in riparian corridors within desert scrub habitat, preferring dense, moist nest sites over drier sites (NMDGF 1996; NMDGF 2007). Its habitat is threatened by habitat destruction and degradation resulting from urban development, water control, increased agriculture and grazing, and oil and gas development (NMDGF 1996; Rosenberg et al. 2016). Bell's Vireos are highly susceptible to nest parasitism from Brown-headed Cowbirds, with up to 70% of nests affected (Barlow 1962). The Bell's Vireo is sensitive to human presence and human activity can cause nest abandonment and increased predation (Barlow 1962; Parody 2001; NMDGF 2016). They feed on a variety of insects and are particularly susceptible to impacts from insecticides (Hallman et al. 2014). Surveys suggest Bell's Vireos have experienced a 33% population increase since 1970 (Rosenberg et al. 2016), and climate-based habitat models suggest their breeding range may expand in the future (Price 2002; Wilsey et al. 2019a).

Bendire's Thrasher

The Bendire's Thrasher (*Toxostoma bendirei*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Bendire's Thrasher's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Bendire's Thrasher is a desert species (DeGraaf et al. 1991). They are threatened by habitat destruction and degradation resulting from increasing urbanization, climate change, agricultural conversion, increased grazing, and energy and resource extraction and are sensitive to human presence and activity (Rosenberg et al. 2016; NABCI 2022). Competition with Curve-billed Thrashers (*Toxostoma curvirostre*), Northern Mockingbirds (*Mimus polyglottos*), and Cactus

Wrens (*Campylorhynchus brunneicapillus*) has been documented, particularly in dry years (Salas and Desmond 2019). The Bendire's Thrasher has experienced an 87% population decline since 1970 and is expected to decline across its range by 30% in the next 15 years and 50% within 20 years (Rosenberg et al. 2016; Desmond and Sutton 2017; NABCI 2022).

Bewick's Wren

The Bewick's Wren (*Thryomanes bewickii*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Bewick's Wren's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Bewick's Wren is a habitat generalist, breeding in mixed woodlands, grasslands, shrublands, and scrubby riparian habitat across much of New Mexico (Schmitt 1976; DeGraaf et al. 1991). They are cavity nesters that are dependent on naturally-occurring cavities or woodpeckers for excavation; they are also known to nest in artificial nest boxes (Bent 1948; Scott et al. 1977). There is some documented competition between Bewick's Wrens and House Sparrows (*Passer domesticus*), House Wrens (*Troglodytes aedon*), and European Starlings (*Sturnus vulgaris*) for nest sites (Simpson 1978). Both adults and juveniles experience predation from hawks, owls, and snakes, although rates are unknown (Simpson 1978). Bewick's Wrens are expected to be relatively resilient to phenology changes anticipated under future climatic conditions (Friggens et al. 2013), and habitat models suggest there will be little shift in their summer range due to climate change (Price 2002). However, they have experienced a 31% population decline since 1970, with another 50% decline expected in the next 47 years (Rosenberg et al. 2016).

Black Rosy-Finch

The Black Rosy-Finch (*Leucosticte atrata*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Black Rosy-Finch's climate change vulnerability is impacted by factors related to distribution, movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Black Rosy-Finch breeds in alpine tundra habitat above the timberline and migrates downslope to winter on open mountain meadows (Ligon 1961; Hendricks 1977; USFS 2020). This species is rarely found breeding below 2,100 m (7,000 ft) elevation and winters at 850 to 1,670 m (2,800 to 5,500 ft) elevation (Ligon 1961; Hubbard 1978). Alpine tundra habitat is dependent on cool temperatures to maintain year-round snowpack and is expected to disappear as montane forests expand to higher elevations as temperatures increase due to climate change (Rosenberg et al. 2016). On both winter and breeding grounds, males outnumber females with a sex ratio of six males to one female in the summer, which can impact population growth (Bent

1968). The Clark's Nutcracker (*Nucifraga columbiana*) is a major predator on eggs and juvenile Black Rosy-Finches (Hendricks 1977). The Black Rosy-Finch has experienced a 95% population decline since 1970 and is expected to experience at least another 50% population decline within the next 50 years (Rosenberg et al. 2016; NABCI 2022).

Black Swift

The Black Swift (*Cypseloides niger*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Black Swift's climate change vulnerability is impacted by factors related to distribution, movement, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Black Swift has highly specific nesting requirements, nesting in crevices and caves in high cliffs adjacent to falling water (Knorr 1961; Hunter and Baldwin 1962; Levad 2003). Although the Black Swift breeds across much of the western U.S., it is a rare breeder in New Mexico, with a small number of nests at only a single colony observed near waterfalls in Sandoval County in northern New Mexico (NMDGF 1994; Howe 2021). There are concerns about human disturbance reducing nest success at this single nesting colony (NMDGF 1994). The Black Swift has a relatively specific diet, depending on aerial insects as their primary food source, and are sensitive to impacts from insecticide use (UDWR 1997; Hallman et al. 2014). Research indicates Black Swift populations have declined 50 to 94% in the past 50 years with another 50% decline anticipated in the next 16 years (Rosenberg et al. 2016; NABCI 2022). Climate change vulnerability modeling results suggest that the Black Swift's range will disappear completely in New Mexico (Wilsey et al. 2019a).

Black-billed Magpie

The Black-billed Magpie (*Pica hudsonia*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Black-billed Magpie's climate change vulnerability is impacted by life history factors, which influence its ability to persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Black-billed Magpie is found in various landscapes including forests, riparian woodlands, farms, and urbans areas (DeGraaf et al. 1991). The species does not migrate and can be found across the western U.S., including Alaska, and southwestern Canada (Trost 2020). The Black-billed Magpie is omnivorous and opportunistic, feeding on insects, small mammals and birds, and carrion (Hall 1994). Threats to the Black-billed Magpie include nesting habitat degradation; deforestation; and the use of pesticides, herbicides, and insecticides (Eisler 1991; AGFD 1996). The North American Breeding Bird Survey indicates a population decline of 9% per year and a total decline of 38% from 1966 to 2019 for this species (Sauer et al. 2019). Climate-based habitat models suggest their breeding range may experience a 28% reduction by 2050, resulting in a 50% reduction in New Mexico (Wilsey et al. 2019a).

Black-chinned Sparrow

The Black-chinned Sparrow (*Spizella atrogularis evura*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Black-chinned Sparrow's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Black-chinned Sparrow breeds in shrubby, semi-open montane habitat such as chaparral, sagebrush, and arid scrub, generally on gentle to steep slopes up to 2,400 m (8,000 ft) elevation (DeGraaf et al. 1991; Tenney 1997; Watson 2017). This habitat is threatened by urban development, changing fire regimes, and overgrazing and is relatively dependent on management actions including prescribed fire and mechanical vegetation removal (Tenney 1997; Watson 2017). The Black-chinned Sparrow is sensitive to human presence, particularly noise disturbance (Watson 2017). The Black-chinned Sparrow has experienced a 61% population decline in the last 50 years and is projected to lose another 50% of its population in the next 50 years (Rosenberg et al. 2016; NABCI 2022).

Black-headed Grosbeak

The Black-headed Grosbeak (*Pheucticus melanocephalus*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Black-headed Grosbeak's climate change vulnerability is impacted by factors related to movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Black-headed Grosbeak is migratory and breeds across the western U.S. and winters in Mexico (Ehrlich et al. 1988). The species can be found in riparian and woodland areas, usually associated with water (DeGraaf et al. 1991). The Black-headed Grosbeak feeds on insects, invertebrates, fruits, and seeds (Torgerson et al. 1990; Puckett and van Riper 2014). The species is sensitive to noise disturbance and is adversely affected by urbanization (Francis et al. 2005; Ortega and Hill 2010). Since 1970, there has been an increase in population numbers for the species except in coastal California and New Mexico (Rosenberg et al. 2016; Sauer et al. 2019). However, Scrub Jays (*Aphelocoma* spp.) and Steller's Jays (*Cyanocitta stelleri*) are significant predators of Black-billed Grosbeak nests (Ortega and Hill 2010). Additionally, the Black-headed Grosbeak is expected to experience a high degree of climate exposure within its migratory range, with climate change habitat modeling projecting a 22% breeding range contraction by 2050 (Rosenberg et al. 2016; Wilsey et al. 2019a).

Black-throated Gray Warbler

The Black-throated Gray Warbler (*Setophaga nigrescens*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Black-throated Gray Warbler's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Black-throated Gray Warbler breeds in a variety of forested habitats, including semi-arid woodland, piñon (*Pinus* spp.)-juniper (*Juniperus* spp.) woodland, mixed-oak (*Quercus* spp.) scrub, chaparral, and brushlands at 1,670 to 2,400 m (5,500 to 8,000 ft) elevation (Bent 1953; Bailey and Niedrach 1965; Dunn and Garrett 1997). Some research suggests that Black-throated Gray Warblers avoid recently-burned areas (Blake 1982). The Black-throated Gray Warbler is threatened by habitat destruction and degradation resulting from intense, stand-replacing fires; overgrazing; and energy exploration and related resource excavation (Gillihan 2006). It is a host species for the Brown-headed Cowbird and consistently experiences a high degree of nest parasitism, up to 75% parasitism in some situations (Gillihan 2006). The Black-throated Gray Warbler is also sensitive to noise disturbance, although some research suggests there is no significant impact on the species from noise, and insecticide use (Ehrlich et al. 1988; Francis et al. 2005; Hallman et al. 2014). The Black-throated Gray Warbler has experienced significant population declines in the last 30 years, with a suspected 49% decline in the last 50 years (Sauer et al. 2006; Rosenberg et al. 2016). Climate change vulnerability suggests the Black-throated Gray Warbler may experience a 64% breeding range expansion in the northern part of its range and a 36% breeding range loss in the southern part of its range by 2050; New Mexico will experience a higher degree of loss than expansion (Wilsey et al. 2019a).

Black-throated Sparrow

The Black-throated Sparrow (*Amphispiza bilineata*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Black-throated Sparrow's climate change vulnerability is impacted by movement factors, which influence its ability to shift in space.

The Black-throated Sparrow is a short-distance migrant and can be found in the western U.S. and Mexico (Johnson et al. 2002). The species inhabits grassland, scrub, riparian, and shrubland areas (DeGraaf et al. 1991; AIBAP 2018). The Black-throated Sparrow eats a variety of insects, invertebrates, and seeds (van Riper et al. 2014). The Black-throated Sparrow is a victim of Brown-headed Cowbird parasitism and is experiencing habitat loss due to urbanization (Johnson et al. 2002). Partners in Flight indicate a 42% population decline since 1970 (Rosenberg et al. 2016). Additionally, the species is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016). As the climate changes, this species' range is projected to increase by 9% by 2039 and 47% by 2099 compared to its current range (Hatten et al. 2016).

Boreal Owl

The Boreal Owl (*Aegolius funereus*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under the RCP 4.5 Scenario and Extremely Vulnerable under the RCP 8.5 Scenario. The Boreal Owl's climate change vulnerability is impacted by factors related to distribution, movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

This small owl resides in only three mountain ranges in the northcentral part of New Mexico. This species has specific habitat requirements and is generally found between 2,800 and 3,350 m (9,200 and 11,000 ft) elevation in old-growth spruce (*Picea* spp.)-fir forests (Hayward et al. 1987; Ryder et al. 1987; Stahlecker and Duncan 1996). This habitat is threatened by degradation and destruction resulting from intense, stand replacing fires and timber harvest (NMDGF 2020b). In addition to specific habitat requirements, this species is also restricted by cyclic rodent populations, specifically vole species, that can limit owl abundance (Löfgren et al. 1986; Korpimaki 1988; Finch 1992). Male owls will remain on their breeding territory year round, defending it from other males, while females and juveniles will move in response to prey availability (Lundberg 1979). The Boreal Owl is a secondary cavity nester, dependent on large cavities constructed by large woodpeckers in mature trees greater than 30.5 cm (12 in) diameter at breast height (Evans and Conner 1979; Webb 1982). The Boreal Owl is expected to experience a 57% range reduction by 2050 due to climate change, which will include an almost complete loss of the species' range within New Mexico (Wilsey et al. 2019a).

Brewer's Sparrow

The Brewer's Sparrow (*Spizella breweri*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Brewer's Sparrow's climate change vulnerability is impacted by factors related to distribution, movement and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Brewer's Sparrow breeds in sagebrush/grassland habitat and mixed shrub habitat, at low and middle elevations (Hubbard 1978; USFWS 1980a; Stahlecker et al. 1989; Williams 1993). The Brewer's Sparrow is threatened by habitat degradation and destruction due to overgrazing, changing fire regime, spread of non-native grasses, agricultural development and energy exploration and extraction (Bock et al. 1992; AIBAP 2018; Wilsey et al. 2019b). The Brewer's Sparrow is also at risk from increasing predation, brood parasitism and pesticide use (Biermann et al. 1987; Rotenberry et al. 1999; Schroeder and Sturges 1975). The Brewer's Sparrow has experienced a 35% population decline since 1970 (Rosenberg et al. 2016). A 50% population decline is expected within the next 25 years, and a 44% range contraction is expected by 2099 across the species range, with a range contraction likely excluding New Mexico from the summer range (Price 2002; Hatten et al. 2016).

Broad-billed Hummingbird

The Broad-billed Hummingbird (*Cynanthus latirostris magicus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Broad-billed Hummingbird's climate change vulnerability is impacted by movement factors, which influence its ability to shift in space.

Broad-billed Hummingbird breeds in a few counties in the far southwestern corner of New Mexico, although occurrence records have been documented across New Mexico (NMDGF 1996). Although the Broad-billed Hummingbird is a habitat generalist across much of its range, it is a habitat specialist in New Mexico, nesting in desert riparian habitat with a dependence on desert streams and seeps (Baltosser 1980; DeGraaf et al. 1991; NMDGF 1994). This habitat may be threatened by increased intensity of storms and wildfires anticipated as the climate changes (NMDGF 1994; NMDGF 2006b). The Broad-billed Hummingbird is also expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016). The population is relatively stable, although the New Mexico subspecies only consists of approximately 25 individuals; any significant destructive event (wildfire, disease) within New Mexico could negatively impact this subspecies (NMDGF 1988; NMDGF 2006b).

Broad-tailed Hummingbird

The Broad-tailed Hummingbird (*Selasphorus platycercus platycercus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Broad-tailed Hummingbird's climate change vulnerability is impacted by movement factors, which influence its ability to shift in space. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Broad-tailed Hummingbird preferred nesting habitat in New Mexico consists of thickets near canyon edges, but they also inhabit montane shrublands and woodlands, residential areas, and open meadows at low and middle elevations, provided nectar plants are available (DeGraaf et al. 1991; USFS 2017). Broad-tailed hummingbirds experience feeding competition with Calliope (*Selasphorus calliope*) and Rufous Hummingbirds (*Selasphorus rufus*), with some documented nest failure resulting from this competition (Austin 1970; Calder 1973). Broad-tailed Hummingbirds are nectivores; they are primarily dependent on red and yellow flowers, such as red columbine (*Aquilegia* spp.), Indian paintbrush (*Castilleja* spp.), and sage species but also feed on other flowers typically not used by other hummingbird species, as well as aerial insects (USFS 2017). Phenological changes in nectar resources have been documented in the northern portion of its breeding range resulting from climate change, which could constrain breeding success (McKinney et al. 2012). Broad-tailed Hummingbirds have experienced a 49% population decline since 1970, with another 50% population decline expected within the next 25 years (Rosenberg et al. 2016; PIF 2024).

Brown Pelican

The Brown Pelican (*Pelecanus occidentalis carolinensis*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Brown Pelican's climate change vulnerability is impacted by factors related to distribution, movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Brown Pelican breeds along the coast but is an increasingly regular visitor to New Mexico, primarily in May to October, with a total of 100 records since 1978, averaging three to four sightings annually (NMDGF 1996; Howe 2021). It feeds on a variety of fish in warmer water of marine habitats and is found on large lakes or major rivers in New Mexico (NMDGF 1988; NMDGF 1996). Significant population declines were documented resulting from pesticides, specifically dichloro-diphenyl-trichloroethane (DDT), and the Brown Pelican was listed as federally Endangered in 1970; it was delisted in 2009 (USFWS 2009c; Holmer 2016; NMDGF 2020b). Although Brown Pelicans are not known to breed in New Mexico, they are threatened by nest site disturbance from humans; extreme weather conditions, such as flooding or freezing; and habitat loss and degradation resulting from rising water levels (Anderson and Keith 1980; Anderson and Gress 1983; Jaques and Anderson 1987). The southeastern population is estimated at more than 100,000 birds (Holmer 2016). The Brown Pelican is threatened by illegal killing and chemicals (NMDGF 2020b). Brown Pelicans are expected to experience a 72% breeding and 29% winter range expansion due to climate change (Wilsey et al. 2019a).

Brown-capped Rosy-Finch

The Brown-capped Rosy-Finch (*Leucosticte australis*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Brown-capped Rosy-Finch's climate change vulnerability is impacted by factors related to distribution, movement, evolutionary potential, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Brown-capped Rosy-Finch breeds in alpine tundra habitat above the timberline and migrates downslope to winter on open mountain meadows (Ligon 1961; USFWS 2021b; NABCI 2022). This species is rarely found below 2,100 m (7,000 ft) elevation; they can be found during the summer up to 4,270 m (14,000 ft) elevation and generally winter on open meadows cleared of snow at 2,440 to 3,050 m (8,000 to 10,000 ft) elevation (Ligon 1961; USFWS 2021b). Alpine tundra habitat is dependent on cool temperatures to maintain year-round snowpack and is expected to disappear as montane forests expand to higher elevations as temperatures increase due to climate change (Rosenberg et al. 2016). Breeding habitat in New Mexico is limited to a few small islands of alpine meadow, thus the total Brown-capped Rosy-Finch breeding population within the State is low, with no breeding pairs present in some years (Hendricks 1977). Males outnumbers females on both breeding and wintering grounds (Ryser 1985). Brown-capped Rosy-Finches will migrate downslope 305 m (1,000 ft) daily from winter roost sites to foraging sites (Watson et al. 2024). Winter roost sites include caves, crevices, and rocky outcroppings on cliffs (USFWS 2021b). The Brown-capped Rosy-Finch has experienced a global decline of 95% in the last 50 years, with another 50% population decline anticipated in the next 50 years (Rosenberg et al. 2016; NABCI 2022).

Buff-breasted Flycatcher

The Buff-breasted Flycatcher (*Empidonax fulvifrons pygmaeus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Buff-breasted Flycatcher's climate change vulnerability is impacted by factors related to movement, life history, and evolutionary potential, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Buff-breasted Flycatcher is migratory and is primarily a resident of Mexico but can be found in Arizona and New Mexico during the breeding season (Bowers and Dunning 2020). The Buff-breasted Flycatcher inhabits riparian forests, wetlands, and scrub areas (Hubbard 1978; DeGraaf et al. 1991). The species feeds on insects and other invertebrates, typically while in flight (Bowers and Dunning 2020). The Buff-breasted Flycatcher's range contracted notably southward from the late 1800s through the 1970s. Fire suppression, overgrazing, and logging have likely been the greatest factors in the species' population decline (Sibley 2014; Bowers and Dunning 2020).

Bullock's Oriole

The Bullock's Oriole (*Icterus bullockii*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Bullock's Oriole's climate change vulnerability is impacted by movement factors, which influence its ability to shift in space.

This species is mostly found in riparian and open woodlands but can also be found in forests and urban areas (Flood et al. 2020). The Bullock's Oriole mostly feeds on insects but will also eat fruits, seeds, and other invertebrates (Flood et al. 2020). Partners in Flight indicate a 22% population decline since 1970, and the species showed a significant decline in average detection per kilometer of riparian habitat during the breeding seasons of 1997 to 2016 (Rosenberg et al. 2016; Shook 2017). The North American Breeding Bird Survey shows a population decline of about 27% between 1966 and 2019 (Sauer et al. 2019). The species is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016). Climate-based habitat models suggest that, in future, the summer range of the Bullock's Oriole may undergo little change in New Mexico (Price 2002).

Burrowing Owl

The Burrowing Owl (*Athene cunicularia hypugaea*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Burrowing Owl's climate change vulnerability is impacted by factors related to distribution, movement, and life history, which influence its ability to shift in space and persist in place.

The Burrowing Owl breeds in open grasslands, a landscape particularly threatened by fire suppression, agricultural conversion, urban development, overgrazing, and energy exploration and generation (Wright and Bailey 1982; NMDGF 2006b; NMDGF 2016; Wilsey et al. 2019a). The Burrowing Owl is dependent on burrowing mammals, such as prairie dogs (*Cynomys* spp.) and ground squirrels, for the provision of nesting burrows; these animals are threatened by animal control via trapping and removal efforts and the sylvatic plague (Terres 1980; Ehrlich et al. 1988; Klute et al. 2003; NMDGF 2006b). Burrowing Owls experience high nest and adult predation by a variety of raptor and mammalian predators; their colonial nesting behavior is thought to be an adaptation that helps to reduce predation events (Bent 1938; Klute et al. 2003; Johnson et al. 2016). The mortality rate for juvenile Burrowing Owls is 70%, 19% for adults, and 35% overall (Thomsen 1971). The Burrowing Owl has experienced a population decline of 35% since 1970 (Rosenberg et al. 2016). Climate change vulnerability modeling results project that the Burrowing Owl will lose 12% of its breeding range by 2050 due to climate change (Wilsey et al. 2019a).

Cactus Wren

The Cactus Wren (*Campylorhyncus brunneicapillus couesi*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Cactus Wren's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Cactus Wren primarily resides in desert scrub and shrub habitat dominated by paloverde (*Cercidium microphyllum*), pricklypear (*Opuntia spp*.), and giant saguaro (*Cereus giganteus*); they nest in cactus and other thorny trees (Hubbard 1978; DeGraaf et al. 1991; Barnes 2023). Desert scrub habitat is threatened by increasing wildfire, energy exploration and development, agricultural conversion, and urban development (NMDGF 2016; Wilsey et al. 2019b). The Cactus Wren has experienced a worldwide population decline of 64% since 1970, with another 50% decline expected within the next 20 years (Rosenberg et al. 2016). Despite this population decline, climate-based habitat models project their future summer range may expand within New Mexico (Price 2002).

Canyon Towhee

The Canyon Towhee (*Melozone fusca)* will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Canyon Towhee's climate change vulnerability is impacted by life history factors, which influence its ability to persist in place.

The Canyon Towhee does not migrate and can be found in the southwestern U.S. and Mexico (Johnson and Haight 2020). The species can be found in a variety of landscapes including riparian, forested, scrub, and urban areas (DeGraaf et al. 1991). The Canyon Towhee forages in open areas adjacent to cover in the leaf litter, feeding on seeds, fruits, and insects (Bent 1968). The species is considered stable but has experienced some declines in the central portion of their range between 1966 and 2015 (Sauer et al. 2019). Climate-based habitat models project that the species' future summer range will undergo little change in New Mexico (Price 2002; Wilsey et al. 2019a).

Canyon Wren

The Canyon Wren (*Catherpes mexicanus conspersus*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Canyon Wren's climate change vulnerability is impacted by life history factors, which influence its ability to persist in place.

The Canyon Wren does not migrate and can be found across the western U.S. and Mexico (Jones et al. 2023). They typically require dry, steep, rocky landscapes but can also be found in urban areas (DeGraaf et al. 1991; Jones et al. 2023). The species eats insects and invertebrates that they pull out of rock crevices (Bent 1948; Jones et al. 2023). Populations appear to be stable and may only be slightly declining overall (PIF 2024; Sauer et al. 2017). Habitat alteration and human disturbances appear to be the main threats to this species (Jones et al. 2023).

Cassin's Finch

The Cassin's Finch (*Haemorhous cassinii*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Highly Vulnerable under the RCP 8.5 Scenario. The Cassin's Finch's climate change vulnerability is impacted by factors related to movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Cassin's Finch breeds in open coniferous forests, generally above 1,500 m (5,000 ft) elevation (Bent 1968; Hubbard 1978). This habitat is threatened by degradation and destruction resulting from fire suppression and overgrazing (NMDGF 2016). On their breeding grounds, Cassin's Finches have a five to one sex ratio (Samson 1976). The high air temperatures lead to a failure of this species to breed regularly in the southern portion of its range, and the Cassin's Finch has an upper limiting temperature of 27°C (80.6°F); future (2040-2069) temperatures are projected above this 27°C (80.6°F) threshold for 50% or more of the species' range, increasing the Cassin's Finch's vulnerability to climate change (Salt 1952; Hegewisch et al. 2024). Cassin's Finch could be impacted by grain bait treated with insecticides (Hallman et al. 2014). The Cassin's Finch has experienced a 68% decline in population since 1970 (Rosenberg et al. 2016) and climate-based habitat models project the future summer range will exclude New Mexico (Price 2002; NMDGF 2016).

Cassin's Kingbird

The Cassin's Kingbird (*Tyrannus vociferans vociferans*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Cassin's Kingbird's climate change vulnerability is impacted by life history factors, which influence its ability to persist in place.

The species breeds in the southwestern U.S. and winters in Mexico (Tweit and Tweit 2020). The Cassin's Kingbird inhabits forested and scrubland areas but can also be found in residential areas (Tweit and Tweit 2020; Howe 2021). The species generally eats insects but will also eat small amounts of fruit. Logging and land clearing can have adverse effects on the Cassin's Kingbird (Tweit and Tweit 2020). Populations are considered stable, and the Partners in Flight indicate an 8% population increase since 1970 (Rosenberg et al. 2016; Sauer et al. 2017). Climate-based habitat models project that the summer range for Cassin's Kingbird will undergo little change in New Mexico (Price 2002).

Cassin's Sparrow

The Cassin's Sparrow (*Peucaea cassinii*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Cassin's Sparrow's climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to persist in place and respond to climate change impacts.

This species is a grassland-dependent species, a landscape particularly susceptible to climate change and associated increasing concerns regarding the effects of fire suppression and to increased agricultural, energy, and urban development (Wilsey et al. 2019b). The Cassin's Sparrow is negatively impacted by grazing and experiences some nest parasitism from Brown-headed Cowbirds, although the parasitism rate is not defined within the literature (Kingery and Julian 1971; Bock et al. 1992). Pesticides and insecticides also generally have a negative impact on grassland birds and insectivores (Mineau and Whiteside 2013; Hallman et al. 2014). Despite these concerns, climate-based habitat models project an expanded summer range for the Cassin's Sparrow within New Mexico (Price 2002).

Chestnut-collared Longspur

The Chestnut-collared Longspur (*Calcarius ornatus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Highly Vulnerable under the RCP 8.5 Scenario. The Chestnut-collared Longspur's climate change vulnerability is impacted by factors related to distribution, movement, and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Chestnut-collared Longspur is a winter resident of New Mexico that requires large patches of open grassland and is negatively affected by intensive grazing and pesticide use (Bock et al. 1992; Mineau and Whiteside 2013; Hallman et al. 2014; Somershoe 2018). Habitat degradation and destruction resulting from agricultural conversion, shrubby encroachment, fire exclusion, energy exploration and generation, and urban development threaten this species (Bock et al. 1993; Wilsey et al. 2019b). Chestnut-collared Longspurs experience significant levels of nest failure resulting from nest predation, particularly in the nestling stage, and from Brown-headed Cowbird nest parasitism (Hill and Gould 1997; Somershoe 2018). Prolonged rainstorms of more than one and a half days, triggering cool temperatures, also cause significant nest failure (DuBois 1935, Harris 1944). The Chestnut-collared Longspur has experienced an 85% population decline since 1970 (Sauer et al. 2006; Rosenberg et al. 2016) and is expected to experience a 50% population decline in the next 50 years (NABCI 2022). Climate change distribution modeling results suggest the Chestnut-collared Longspur will lose 85% of its breeding range and 31% of its winter range by 2050, with much of this loss occurring in the northern part of its range (Wilsey et al. 2019a). Within New Mexico, this bird will likely experience a range expansion (Wilsey et al. 2019a).

Chihuahuan Meadowlark

The Chihuahuan Meadowlark (*Sturnella lilianae*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Chihuahuan Meadowlark's climate change vulnerability is impacted by factors related to distribution and movement, which influence its ability to shift in space.

The Chihuahuan Meadowlark was previously listed as a subspecies of the Eastern Meadowlark (*Sturnella magna*) and has only recently been listed as a unique species (Chesser et al. 2022). Thus, much of its available life history data is derived from studies of the Eastern Meadowlark. The Chihuahuan Meadowlark primarily resides in dry grasslands of low to medium height and into desert scrub (Black 1997; AIBAP 2018). This habitat is threatened by degradation and destruction resulting from fire exclusion and shrub encroachment, intensive grazing, agricultural conversion, and energy exploration and generation (AIBAP 2018; Wilsey et al. 2019b). The Chihuahuan Meadowlark experiences high rates of nest mortality in agricultural fields due to direct nest destruction resulting from mowing and indirect mortality triggered by nest desertion

(Ehrlich et al. 1988). It is also likely negatively affected by insecticide use (Mineau and Whiteside 2013; Hallman et al. 2014). Although population trends are not available for the Chihuahuan Meadowlark, the Eastern Meadowlark has experienced a 77% population decline since 1970, with another 50% decline expected in the next 23 years (Rosenberg et al. 2016). Despite this expected decline, climate-based habitat models suggest no likely change in summer range resulting from climate change (Price 2002).

Chihuahuan Raven

The Chihuahuan Raven (*Corvus cryptoleucus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Chihuahuan Raven's climate change vulnerability is impacted by movement factors, which influence its ability to shift in space.

The species can be found in the southcentral portion of the U.S. and in Mexico (Dwyer et al. 2020). The Chihuahuan Raven's northern populations migrate further south during the winter while the southern populations remain at their breeding grounds (Dwyer et al. 2020). Up to half of this bird's diet can be live prey, including insects and small vertebrates, but they will also eat eggs, seeds, berries, and carrion (NMDGF 2007; Dwyer et al. 2020). The species prefers arid landscapes, like deserts and mesquite grasslands, but sometimes utilizes forests and agricultural lands (DeGraaf et al. 1991; NMDGF 2007). Ravens are monogamous, the pairs remaining together outside the breeding season and possibly for life (NMDGF 2007). Overall, populations have been stable since 1968 but are known to be persecuted by humans through trapping, poisoning, and shooting (NMDGF 2007; Dwyer et al. 2020). Climate-based habitat models project that the Chihuahuan Raven's future geographic range might expand in New Mexico (Price 2002).

Chipping Sparrow

The Chipping Sparrow (*Spizella passerina arizonae*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Chipping Sparrow's climate change vulnerability is impacted by movement factors, which influence its ability to shift in space. It is also impacted by barriers, land-use changes, other anthropogenic factors, and other biologic factors, that could increase the effects of climate change.

This subspecies is widespread and is found in the mountains and dry landscapes of the western interior of the U.S. (Middleton 1998). The Chipping Sparrow is migratory, breeding in the U.S. and wintering primarily in Mexico (Williams 1993). The species can be found in forests, wetlands, and agricultural lands (DeGraaf et al. 1991). The Chipping Sparrow feeds off the ground, consuming insects, invertebrates, and small seeds (Gillihan 2006). In years of reduced resource abundance, the species has been observed foraging in fewer habitat types, limiting their searching to patches containing seeds that are optimally sized for their bill type (Niemela 2002). The Chipping Sparrow is a frequent victim of Brown-headed Cowbird parasitism (Gillihan

2006). Additionally, the species seems to be sensitive to noise disturbance, fires, and livestock grazing (Francis et al. 2005; Manville 2000). The Chipping Sparrow experienced an overall decline of about 28% between 1966 and 2019 (Sauer et al. 2019). Climate-based habitat models project that the Chipping Sparrow's future summer range may contract in New Mexico (Price 2002).

Clark's Grebe

The Clark's Grebe (*Aechmorphorus clarkii*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Clark's Grebe's climate change vulnerability is impacted by factors related to distribution, movement, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Clark's Grebe resides in large, secluded marshes and is sensitive to human disturbance (AGFD 1996; NMDGF 2016). This habitat is threatened by destruction and degradation resulting from fluctuating precipitation levels related to climate change and hydrologic changes, including damming, dredging and channelization (Finch 1992; NMDGF 2016). The Clark's Grebe experienced a 21% population decline since 2010 and is likely to experience a population decline of 50% within the next 50 years (Rosenberg et al. 2019; NABCI 2022). Climate change vulnerability models suggest the Clark's Grebe will experience a 21% breeding range contraction by 2050; this contraction is anticipated to impact approximately 50% of the known breeding range in New Mexico (Wilsey et al. 2019a).

Clark's Nutcracker

The Clark's Nutcracker will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Highly Vulnerable under the RCP 8.5 Scenario. The Clark's Nutcracker's climate change vulnerability is impacted by factors related to distribution, movement, life history, and abiotic niche, which influences its ability to shift in space, persist in place, and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Clark's Nutcracker resides in mature, slow-growing, subalpine pine (*Pinus* spp.) forests on dry, rocky slopes at mid to high elevations (DeGraaf et al. 1991). This habitat is threatened by degradation and destruction resulting from changing fire regimes and specific logging practices, including clearcuts and even-aged stand management, and from increasing temperatures driven by climate change (Wilsey et al. 2019; Malcolm et al. 2020). The Clark's Nutcracker is also threatened by insecticides (Johnson and Fagerstone 1994; Hallman et al. 2014). The Clark's Nutcracker has a relatively specific diet, feeding almost exclusively on pine nuts during the winter season (Bailey and Niedrach 1965; VanderWall and Balda 1977; VanderWall 1988). The Clark's Nutcracker has experienced an 8% population decline since 1970 (Rosenberg et al.

2016). It could experience a 57% range decline by 2050 driven by climate change (NMDGF 2016; Rosenberg et al. 2019; Wilsey et al. 2019a).

Cliff Swallow

The Cliff Swallow (*Petrochelidon pyrrhonota*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Cliff Swallow's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Cliff Swallow breeds in Canada and the U.S. and winters in South America (Williams 1993; Brown et al. 2020). The species inhabits forests, wetlands, rangelands, riparian, and urban areas but is more tied to nesting structures (cliffs, buildings, road overpasses, etc.) (DeGraaf et al. 1991). Cliff Swallows have an unusually high degree of intraspecific brood parasitism, seemingly enhanced by the synchronized breeding that occurs within their nesting colonies (Ehrlich et al. 1988). The Cliff Swallow's diet primarily consists of flying insects. They will also eat various other invertebrates (Brown et al. 2020a). Drought, heat waves, and insecticides are known to cause mortality in the species (Friggens et al. 2013; Hallman et al. 2014). Partners in Flight indicate a 37% population increase since 1970 (Rosenberg et al. 2016). Climate-based habitat models project that the Cliff Swallow's future summer range might undergo little change in New Mexico (Price 2002).

Common Black Hawk

The Common Black Hawk (*Buteogallus anthracinus anthracinus*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Common Black Hawk's climate change vulnerability is impacted by factors related to distribution, movement, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Common Black Hawk is a riparian-obligate species, dependent on high quality, mature riparian forests at low elevations for breeding and nesting (Hubbard 1978; NMDGF 1988; Sadoti 2008). This habitat is threatened by degradation and destruction resulting from hydrologic changes, including water diversion and channelization; increasing frequency and severity of floods and droughts; and increasing frequency and severity of wildfire (NMDGF 1994; Smith and Finch 2017). Population declines in Common Black Hawks have been documented in the U.S. that correspond with a 95% loss or degradation of riparian habitat in the southwestern U.S. in the past 100 years (Oberholster 1974; Ohmart 1994). Common Black Hawks may experience higher nest predation from Great-Horned Owls (*Bubo virginianus*) in more open, lower-quality habitat (Sadoti 2008). Although it is a general predator, this subspecies' primary prey includes a wide variety of aquatic species (NMDGF 1996). The New Mexico population of Common Black Hawks is small; estimates appear stable around 60-90 pairs (NMDGF 1996; Skaggs 1996).

Common Ground Dove

The Common Ground Dove (*Columbina passerina pallescens*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Common Ground Dove's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Common Ground Dove resides in native shrublands and riparian corridors (NMDGF 1996; NMDGF 2020b). This habitat isthreatened by destruction and degradation resulting from urban development, water diversion, intensive grazing, and intense agricultural development (NMDGF 2016; NMDGF 2020b). The Common Ground Dove experiences incidental take from hunters misidentifying them as the Mourning Dove (*Zenaida macroura*), a legal game species (NMDGF 1996). Historically this subspecies has been relatively uncommon within New Mexico, and it is more recently restricted to annual reports of one or a few birds within Hidalgo County, with no documented nesting (NMDGF 1991; NMDGF 1996). Climate change vulnerability modeling results suggest a 35% range expansion by 2050, which could result in an expansion of the Common Ground Dove's range within New Mexico (Wilsey et al. 2019a).

Common Nighthawk

The Common Nighthawk (*Chordeiles minor*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Common Nighthawk's climate change vulnerability is impacted by factors related to distribution, movement, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Common Nighthawk is a habitat generalist, nesting in grasslands to open forest and feeding across a variety of habitats (Schmitt 1976; Hubbard 1978). It is a crepuscular aerial insectivore and is threatened by chemicals, specifically insecticides (Baltosser 1991; Hallman et al. 2014; AIBAP 2018). The Common Nighthawk has experienced a 58% decline in population since 1970 (Rosenberg et al. 2019). Climate change vulnerability modeling results suggest it will experience a 15% range expansion by 2050 (Wilsey et al. 2019a).

Costa's Hummingbird

The Costa's Humminbird (*Calypte costae*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Costa's Hummingbird's climate change vulnerability is impacted by factors related to movement, evolutionary potential, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Costa's Hummingbird primarily nests in desert scrub habitat below 1,400 m (4,700 ft) elevation (Hubbard 1978; Kamees and Burkett 1996; USFS 2017). This habitat is threatened by degradation and destruction resulting from wildfire, grazing, and urban development (NMDGF 2016; USFS 2017; NMDGF 2020b). In New Mexico, Costa's Hummingbirds are rare, warm-season migrants and occasional breeders in the far southwestern part of the State (NMDGF 1996). The Costa's Hummingbird is a nectivore and insectivore but feeds primarily on nectar from two shrub species, ocotillo (*Fouquieria splendens*) and chuparosa (***Justicia californica*)** (USFS 2017). It has experienced a 51% population decline since 1970, with another 50% decline expected in the next 37 years (Rosenberg et al. 2016).

Eastern Bluebird

The Eastern Bluebird (*Sialis sialis*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Eastern Bluebird's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Eastern Bluebird is found in meadows and grasslands adjacent to mature pine and pine/oak forests (USFS 2006). In New Mexico, they are an uncommon to fairly-common winter resident in the southern and southeastern part of the State (USFS 2006; Howe 2021). The Eastern Bluebird is a cavity nester, requiring nest boxes, naturally-occurring cavities, or cavities excavated by other bird species; it competes with European Starlings and House Sparrows for cavities (McComb et al. 1987; AIBAP 2018). They tend to follow fire activity and benefit from fires that create nest cavities and maintain an open grassland habitat (Stoddard 1963; Dickson 1981). Eastern Bluebirds are insectivores and are negatively impacted by the use of insecticides (Hallman et al. 2014). They are expected to be resilient to phenology changes anticipated to result from future climate change (Friggens et al. 2013). The Eastern Bluebird has experienced a 178% population expansion since 1970, in large part because of increased bluebird nest box placement and a reduction in pesticide use (Rosenberg et al. 2016). It is expected to experience a 24% winter range expansion by 2050, which would significantly increase its geographic range in New Mexico (Wilsey et al. 2019a).

Elegant Trogon

The Elegant Trogon (*Trogon elegans canescens*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Elegant Trogon's climate change vulnerability is impacted by factors related to distribution, movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Elegant Trogon historically is on the northern edge of its range within New Mexico and is only found in a few counties in the far southwestern portion of the state. Only a handful of breeding pairs exist in New Mexico (NMDGF 1994; NMDGF 1996; Black 1997). Most of its habitat in New Mexico is protected as it is managed by the U.S. Forest Service (USFS) and the

U.S. Department of Defense (Rosenberg et al. 2016). The Elegant Trogon is dependent on high-quality, mature riparian forests for breeding and nesting, generally within montane canyons (NMDGF 1994). This habitat is threatened by destruction and degradation resulting from logging, wildfire, grazing, the de-watering of streams, and groundwater pumping, and they are sensitive to the presence of humans (NMDGF 2007; NMDGF 2016; Rosenberg et al. 2016; NMDGF 2020b). Nests have been abandoned as a result of human activity and presence, particularly the activities of birders (NMDGF 2016; NMDGF 2020b). The Elegant Trogon is a cavity nester and primarily depends on naturally-occurring cavities or cavities excavated by woodpeckers for nest sites (NMDGF 2007). This species has experienced a 15 to 50% population decline in the last 50 years, with an additional 5 to 15% decline anticipated by 2046 (Rosenberg et al. 2016).

Elf Owl

The Elf Owl (*Micrathene whitneyi whitneyi*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Elf Owl's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Elf Owl breeds in desert scrub and desert riparian woodlands at low to mid elevations (Hubbard 1978; DeGraaf et al. 1991). This habitat is threatened by degradation and destruction resulting from the invasion of salt cedar (*Tamarix chinensis*), wildfire, and agricultural and urban development (Haltermann et al. 1989, Henry 1998). The Elf Owl is a cavity nester and primarily depends on naturally-occurring cavities or other birds (e.g., woodpecker species) to excavate their nest sites (Scott et al. 1977; Watson 2017). While Elf Owls will be displaced from their nests by competitors (Western Screech-owl [*Megascops kennicottii*]; Acorn Woodpecker [*Melanerpes formicivorus*]; European Starling), cavities appear to not be a limiting factor within their habitat, so the impact from this competition is likely not significant (Henry et al. 2020).

Evening Grosbeak

The Evening Grosbeak (*Coccothraustes vespertinus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Evening Grosbeak's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Evening Grosbeak is a habitat generalist, generally nesting and foraging in mature coniferous and mixed woodlands, but without any specific tree species preferences (DeGraaf et al. 1991). This habitat is threatened by increased wildfire potential resulting from climate change (NMDGF 2016). They are primarily winter residents in New Mexico, although they do occasionally breed in the northcentral part of the state (Schwarz 1995). The Evening Grosbeak is susceptible to mulyiplr diseases, including lice, tapeworms, and protozoans, with some concern being documented regarding conjunctivitis caused by *Mycoplasma gallisepticum*, salmonellosis, and the West Nile virus (Bent 1968; Bonter and Harvey 2008; WRI. 2010). They are preyed on by native raptors and non-native feral cats and are threatened by insecticides (Bent 1968; Hallman et al. 2014). The Evening Grosbeak has experienced a 92% decline in population since 1970, with a 50% decline expected in the next 38 years (Rosenberg et al. 2016; NABCI 2022). Additionally, climate change vulnerability models indicate the Evening Grosbeak will experience a 55% breeding range contraction and a 35% winter range contraction by 2050 (Wilsey et al. 2019a). Those range contractions will result in New Mexico being almost entirely excluded as habitat (Wilsey et al. 2019a).

Ferruginous Hawk

The Ferruginous Hawk (*Buteo regalis*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Ferruginous Hawk's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Ferruginous Hawk nests in large, isolated trees or rock outcroppings in the transitional area between open grasslands and juniper savannas (DeGraaf et al. 1991; Hawks Aloft 1999; Gillihan 2006). This habitat is threatened by degradation and destruction resulting from agricultural conversion, changing fire intensity and frequency, and energy exploration and generation (Wilsey et al. 2019b). The Ferruginous Hawk feeds on a variety of small mammalian prey species within open grasslands, although their primary prey item is prairie dogs; prairie dog control programs may negatively impact Ferruginous Hawk populations (Finch 1992; AGFD 1996; AIBAP 2018). The Ferruginous Hawk is threatened by nest disturbance and illegal shooting by humans (Snow 1974; Finch 1992). Climate change vulnerability modeling results suggest it will experience a 28% range contraction by 2050, with the Ferruginous Hawk losing approximately half of its breeding range in New Mexico by 2050 (Wilsey et al. 2019a).

Field Sparrow

The Field Sparrow (*Spizella pusilla arenacea*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Field Sparrow's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Field Sparrow is found in scrubby grasslands, shrublands, overgrown fields, and fencerows, generally preferring stands of native grasses, at 850 to 1,680 m (2,800 to 5,500 ft) elevation

(Hubbard 1978; AOU 1983; Meehan et al. 2010). In New Mexico, it is a rare to uncommon but regular transient and is a winter resident in the southeastern part of the State (Hubbard 1978; Howe 2021). The Field Sparrow is threatened by habitat destruction and degradation resulting from intensive agricultural production and by the use of insecticides and herbicides (Meehan et al. 2010). Nest predation is a major source of mortality, with significant avian, mammalian, and reptilian predators causing 36 to 76% nest mortality (Carey et al. 2020). Nest parasitism from Brown-headed Cowbirds is common in some parts of its range, although rates can vary greatly by region (Carey et al. 2020). The Field Sparrow has experienced a 62% population decline since 1970, with another 50% decline expected within the next 36 years (Rosenberg et al. 2016). The Field Sparrow is expected to experience a 47% breeding range contraction and a 3% winter range contraction by 2050, with that small winter range contraction impacting nearly all the New Mexico range (Wilsey et al. 2019a).

Flammulated Owl

The Flammulated Owl (*Psilocops flammeolus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Flammulated Owl's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

This species' habitat is restricted to mid-elevation, dry, open-stand, mature, montane conifer forests (Hubbard 1978; Linkhart and Reynolds 1994; McCallum 1994). This habitat is threatened by degradation and destruction resulting from intensive logging, changing fire frequency and intensity, and removal of dead snags (Johnson and Zwank 1990; McCallum 1994; HawkWatch International 2002). The Flammulated Owl is restricted to semiarid, cool-temperature climates with temperatures below 32°C (90°F); these temperature requirements will likely restrict available habitat as the climate continues to change within its range (McCallum 1994; Hegewisch et al. 2024). The Flammulated Owl is a cavity nester, depending on natural cavities within snags or cavities created by other species, and may compete with other species (e.g., European Starling) for nest cavities (McCallum 1994). Use of insecticides to reduce forest insect pests may affect Flammulated Owl prey abundance (Reynolds and Linkhart 1998). It is expected that the Flammulated Owl will experience a population decline of 8% by 2039 and a 37% loss in breeding range by 2099 (Hatten et al. 2016).

Gila Woodpecker

The Gila Woodpecker (*Melanerpes uropygialis uropygialis*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Gila Woodpecker's climate change vulnerability is impacted by factors related to distribution, movement, life history and evolutionary potential, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

It is on the eastern edge of its range in New Mexico and is only found in a few counties on the far southwestern side of the State (NMDGF 1996). The Gila Woodpecker has relatively specific habitat requirements in New Mexico; it is mostly found in riparian lowlands dominated by cottonwoods (NMDGF 1994; NMDGF 1996). This habitat has experienced degradation and destruction as a result of logging, specific clearing of cottonwoods, water diversion, agricultural and urban development, and invasion of non-native woody species (French tamarisk [*Tamarix gallica*], Russian olive [*Elaeagnus angustifolia]*, Siberian elm [*Ulmus pumila*]) (Szaro 1989; NMDGF 1994; NMDGF 2017b). The Gila Woodpecker nests in cavities in mature snags, primarily cottonwood snags (NMDGF 1988). Breeding European Starlings negatively impact Gila Woodpeckers by competing with it for nest cavities (NMDGF 1994). The Gila Woodpecker has experienced a 44% population decline since 1970 (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest this species will experience a 12% range contraction by 2050 (Wilsey et al. 2019a).

Golden Eagle

The Golden Eagle (*Aquila chrysaetos canadensis*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Golden Eagle's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Golden Eagle uses a variety of fire-dependent habitats, including open grassland, shrub or sagebrush habitat, and piñon-juniper woodland and conifer forests (DeGraaf et al. 1991; FEIS 1996). The Golden Eagle nests on cliffs near open habitat (Hubbard 1978). Fire has been found to improve hunting efficiency for Golden Eagles, and fire suppression has contributed to the loss of Golden Eagle pairs in other parts of the U.S. (Spofford 1971). Golden Eagle mortality has resulted from inappropriate wind turbine design and placement, and large-scale wind and solar developments could reduce prey availability, with construction likely to increase as a result of efforts to curtail climate change (GBBO 2010; LaPré 2011; Koritarov et al. 2013). Golden Eagle's experience a 70% mortality in their first year as a result of starvation, disease, and direct or indirect human causes, including poisoning, trapping, shooting, and nest abandonment (Snow 1973; O'Gara 1994). Bioaccumulation of heavy metals is also of particular concern for Golden Eagles (NMDGF 2015a). There has been a 6% increase in the Golden Eagle population since 1970 (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest the Golden Eagle will experience a 17% range contraction by 2050, with some of that contraction occurring in eastern New Mexico (Wilsey et al. 2019a).

Grace's Warbler

The Grace's warbler (*Setophaga graciae*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Grace's Warbler's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Grace’s Warbler requires mature conifer forests at 1,800 to 2,700 m (6,000 to 8,000 ft) elevation for breeding habitat, with a particular preference for ponderosa pine (*Pinus ponderosa*) mature forests (DeGraaf et al. 1991; Envirological Services 2016). This habitat is threatened by logging, grazing, and insecticide use (Hallman et al. 2014; NMDGF 2016; Rosenberg et al. 2016; Darr and Rustay 2019). While fire plays an important role in the management of ponderosa pine forests, warbler abundance estimates declined in areas previously impacted by a large wildfire, likely because of ladder fuels allowing for increased prevalence of scorched and crown-killed trees (Johnson and Wauer 1996; Moir et al. 1997). Grace’s Warbler has experienced a 52% population decline since 1970 (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest the Grace’s Warbler will experience a 74% range contraction by 2050, with a 90% range contraction projected for New Mexico (Wilsey et al. 2019a).

Grasshopper Sparrow

The Grasshopper Sparrow (*Ammodramus savannarum perpallidus*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Grasshopper Sparrow’s climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Grasshopper Sparrow breeds in the far northeastern part of New Mexico and winters in the far southwestern portion of the State (Hubbard 1978; Howe 2021). The Grasshopper Sparrow is a grassland specialist and has likely experienced habitat degradation and destruction resulting from overgrazing, wildfires, and drought (NMDGF 1990b; NMDGF 2016; NMDGF 2020b). The Grasshopper Sparrow is negatively affected by pesticide and fertilizer use associated with agricultural activities (Meehan et al. 2010; Mineau and Whiteside 2013; Hallman et al. 2014). This species has experienced a 68% population decline across its range since 1970 (Rosenberg et al. 2016). The species is expected to experience a 50% decline within the next 15 years, with over half of the known range in New Mexico protected to be lost (Wilsey et al. 2019a; PIF 2024).

Gray Vireo

The Gray Vireo (*Vireo vicinior*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Gray Vireo’s climate change vulnerability is impacted by factors related to distribution, movement, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by land-use changes and other biologic factors that could increase the effects of climate change.

The Gray Vireo resides on the moderately-steep slopes of open woodlands and shrublands dominated by junipers and piñon pines (Bent 1950; NMDGF 1988). This habitat is slow-growing and threatened by habitat destruction and degradation resulting from wildfire and from uncontrolled logging, grazing, energy exploration and generation, and drought (Gillihan 2006; Rosenberg et al. 2016; Fischer 2020; NMDGF 2020b;). In addition to concerns over breeding habitat, Gray Vireos are also threatened by declining winter habitat, specifically a loss of elephant trees (*Bursera microphylla*), which make up most of their winter diet (Barlow et al. 1999; Gillihan 2006). They experience low nest success, likely because of Brown-headed Cowbird parasitism (Friedman 1963; Fischer 2020). Despite these concerns, the Gray Vireo's breeding range is expected to increase by 11% by 2039 and by 71% by 2099 because of projected suitable future bioclimatic conditions (Hatten et al. 2016).

Gray-crowned Rosy-Finch

The Gray-crowned Rosy-Finch (*Leucosticte tephrocotis*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Highly Vulnerable under the RCP 8.5 Scenario. The Gray-crowned Rosy-Finch's climate change vulnerability is impacted by factors related to distribution, movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Gray-crowned Rosy-Finch winters in arctic climates in montane spruce-fir forests at 2,400 to 3,100 m (8,000 to 10,000 ft) elevation, habitat that is likely to experience significant reductions resulting from climate change (Ligon 1961; Hendricks 1977; USFS 2006). Gray-crowned Rosy-Finches' nest and roost sites include cliffs crevices, ledges, mine shafts, and Cliff Swallow nests (Hendricks 1977; Johnson 1983). Rodent predation likely limits nest site availability and success, and predation from large birds of prey may impact adult survival (Bent 1968). Sex ratios average four males to one female on the breeding ground, which can limit population growth (Bent 1968). Rosy-Finches face high risk of habitat loss resulting from tree and shrub encroachment (Grace et al. 2002). They may experience a reduction in food quality and availability resulting from changes in insect phenology driven by climate change and are threatened by pesticide use (Hallman et al. 2014; Watson et al. 2024). Climate change vulnerability modeling results suggest the Gray-crowned Rosy Finch will experience a 73% winter range contraction by 2050, with 75% of its range projected to be lost in New Mexico (Wilsey et al. 2019a).

Greater Pewee

The Greater Pewee (*Contopus pertinax pallidiventris*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Clark's Grebe's climate change vulnerability is impacted by factors related to distribution, movement and life history, which influence its ability to shift in space and persist in place.

The Greater Pewee is a rare breeder in mature, relatively-open montane pine and fir woodlands with an oak understory at 2,130 to 2,440 m (7,000 to 8,000 ft) elevation in southwestern New Mexico. Migrants have been documented in lowland riparian areas adjacent to these higher-elevation habitats (DeGraaf et al. 1991; Williams 1993; Howe 2021). These habitats are threatened by increased wildfires, intensive logging, and deforestation (NMDGF 2016; Rosenberg et al. 2016). The Greater Pewee, like other flycatchers, is an aerial insectivore and may be threatened by the use of pesticides (Hallman et al. 2014; Cornell Lab 2024). There is an estimated 7,000 Greater Pewee's in the U.S. and Canada, with much of their population residing in Mexico (Rosenberg et al. 2016; PIF 2024). U.S. populations of other birds in the tyrant flycatcher family have experienced a 20% decline since 1970, although Greater Pewee numbers appear stable (Rosenberg et al. 2019; Wilsey et al. 2019a).

Greater Yellowlegs

The Greater Yellowlegs (*Tringa melanoleuca*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Greater Yellowleg's climate change vulnerability is impacted by factors related to distribution, movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Greater Yellowlegs breeds in the northern reaches of North America, using open, flat wetlands with almost no vegetation during the spring and fall migration. They are uncommon but local winter residents in southern New Mexico (Baltosser 1991; Howe 2021). This habitat is threatened by destruction and degradation resulting from the draining of wetlands. The Greater Yellowlegs is expected to experience a 50% population decline in the next 50 years (PIF 2024). Climate change vulnerability modeling results suggest the Greater Yellowlegs will experience a 62% breeding range contraction by 2050 but only a 5% winter range contraction that will only minimally impact the current New Mexico range (Wilsey et al. 2019a).

Green-tailed Towhee

The Green-tailed Towhee (*Pipilo chlorurus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Green-tailed Towhee's climate change vulnerability is impacted by factors related to movement and life history, which influences its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Green-tailed Towhee primarily uses shrub, scrub, and sagebrush habitat at 1,500 to 2,100 m (5,000 to 7,000 ft) elevation and riparian and copse habitat at 2,100 to 4,000 m (7,000 to 13,000 ft) elevation (Hubbard 1978; DeGraaf et al. 1991; Dobbs et al. 2020). These habitats are threatened by degradation and destruction resulting from fire exclusion, agricultural and urban development, and energy exploration and generation (Bock et al. 1978; Wilsey et al. 2019b; Dobbs et al. 2020). The Green-tailed Towhee experiences Brown-headed Cowbird nest parasitism, although impacts are unknown (Bennets et al. 1996). At least some of their diet consists of insects, which means they may be threatened by the use of insecticides (Hallman et al. 2014). The Green-tailed Towhee has experienced a 17% population decline since 1970 (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest the Green-tailed Towhee will experience a 56% breeding range contraction by 2050, with that expansion reducing the New Mexico range by approximately 75% (Wilsey et al. 2019a).

Harris's Hawk

The Harris's Hawk (*Parabuteo unicinctus harrisi*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Harris's Hawk's climate change vulnerability is impacted by factors related to movement and demography, which influence its ability to shift in space and persist in place.

The Harris's Hawk resides in desert scrub and riparian woodland habitat within southern New Mexico (Hubbard 1978; Howe 2021). It experiences population booms and busts in response to jackrabbit (*Lepus* spp.) and cottontail (*Sylvilagus* spp.) populations, its primary prey species (Bednarz 1983; Howe 2021). The Harris's Hawk moves its breeding distribution in response to shifts in rainfall (Palmer 1988). Mortality events have occurred from electrocution on powerlines and transformers, and Harris's Hawks are sensitive to human disturbance (Palmer 1988; Dwyer and Bednarz 2020). Harris's Hawks display polyandry and cooperative breeding, with fledglings from previous years helping to raise nestlings (Bednarz 1983; Dawson and Mannan 1991). Climate change vulnerability modeling results suggest the Harris's Hawk will experience a 26% breeding range expansion by 2050, with that expansion adding to the New Mexico range by more than 50% (Wilsey et al. 2019a).

Horned Lark

The Horned Lark (*Eremophila alpestris*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Horned Lark's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Horned Lark is a habitat generalist at low and middle elevations across New Mexico, residing in open grasslands, deserts, and scrub habitats, provided significant bare-ground or short-grass areas are available (DeGraaf et al. 1991; Clark and Hygnstrom 1994; Howe 2021).

They require open, early-successional habitat associated with prairie dog towns, controlled grazing, and prescribed fire (Clark et al. 1982; Bock et al. 1992; AIBAP 2018). This habitat is threatened by degradation and destruction resulting from shrubby encroachment, fire exclusion, agricultural conversion, and energy exploration and generation (Desmond and Agudelo 2005; Wilsey et al. 2019b). The Horned Lark is an insectivore that may be threatened by, and decline as a result of, insecticide use (Hallman et al. 2014). The Horned Lark has experienced a 75% range-wide population decline since 1970 (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest the Horned Lark will experience a 25% breeding range contraction by 2050, resulting in a range contraction of 15% in New Mexico (Wilsey et al. 2019a).

Juniper Titmouse

The Juniper Titmouse (*Baeolophus ridgwayi*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Juniper Titmouse's climate change vulnerability is impacted by factors related to distribution, movement and life history, which influence its ability to shift in space and persist in place.

The Juniper Titmouse primarily resides in slow-growing, mature juniper woodlands with a high percentage of piñon pine (Gillihan 2006). This habitat is threatened by degradation and destruction resulting from the increased potential for wildfire, energy exploration and generation, and logging (Gillihan 2006; NMDGF 2016). The Juniper Titmouse is a cavity nester and is partially dependent on naturally-occurring cavities or other birds (e.g., woodpecker species) to excavate their nest sites (Gillihan 2006). There are no data available regarding nest parasitism concerns from Brown-headed Cowbirds for the Juniper Titmouse, although some species within piñon-juniper woodlands experience up to 75% parasitism rates (Cicero 2000; Gillihan 2006). The Juniper Titmouse is very territorial, defending its territory year round (Gillihan 2006). The Juniper Titmouse has experienced a 4% population decline since 1970 (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest the Juniper Titmouse will experience a 28% range contraction in the southern portion of its range and a 96% range expansion in the northern portion of its range by 2050 (Wilsey et al. 2019a). This will likely result in a slight range expansion in New Mexico.

Killdeer

The Killdeer (*Charadrius vociferus vociferus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Killdeer's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

Killdeer reside year round in New Mexico, nesting on open ground with almost no vegetation, generally near shallow water, with a strong preference for exposed gravel areas (Baltosser 1991; Shook 2017; Howe 2021). This open habitat is maintained by livestock grazing and prescribed fire, although direct nest mortality resulting from livestock and dogs, cats, and humans can occur (Bock et al. 1992; Reynolds and Krausman 1998). Nests also experience high temperatures as a result of the chosen nest substrate, which can result in nest mortality (Kull 1977). They feed on a variety of aquatic invertebrates and insects and are threatened by insecticides (Eisler 1998). Killdeer populations declined by 26% from 1966 to 2019 (Sauer et al. 2020). Climate change vulnerability modeling results suggest the Killdeer will experience a 23% breeding range expansion by 2050 (Wilsey et al. 2019a).

Lapland Longspur

The Lapland Longspur (*Calcarius lapponicus alascensis*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Lapland Longspur's climate change vulnerability is impacted by factors related to movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Lapland Longspur breeds on the open tundra of northern North America and is a rare winter resident in open grasslands in the northern part of New Mexico (Howe 2021). On their breeding grounds, they are threatened by unseasonally cold weather and predation (Custer and Pitelka 1977). The Lapland Longspur is an insectivore during the breeding season and it is susceptible to insecticides (Hallman et al. 2014). The Lapland Longspur has experienced a 50% population decline since 1970 (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest the Lapland Longspur will experience a 12% winter range contraction in the southern portion of its range by 2050, resulting in a 70 to 80% range contraction in New Mexico (Wilsey et al. 2019a).

Lark Bunting

The Lark Bunting (*Calamospiza melanocorys*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Lark Bunting's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Lark Bunting is found in grasslands, shortgrass prairie, and sagebrush habitat at 850 to 1,680 m (2,800 to 5,500 ft) elevation (Hubbard 1978; Ehrlich et al. 1988; Finch 1992). These habitat types are threatened by degradation and destruction resulting from intensive grazing, fire exclusion, agricultural conversion and fragmentation, and energy exploration and generation (Finch 1992; Wilsey et al. 2019b). Eighty percent of the Lark Bunting's summer diet consists of insects. They have a strong preference for grasshoppers. Lark Bunting local populations levels vary greatly annually, likely in part due to this diet and variation in local insect populations

(Ehrlich et al. 1988; Finch 1992). Insecticide use, particularly as it relates to grasshopper control practices, is a potential threat to Lark Bunting populations (Mineau and Whiteside 2013; Hallman et al. 2014). The Lark Bunting has experienced an 86% population decline since 1970, and another 50% decline is expected within the next 12 years (Rosenberg et al. 2016; PIF 2024). This decline will likely result in a 50% range contraction for Lark Buntings in New Mexico (Wilsey et al. 2019a).

Lark Sparrow

The Lark Sparrow (*Chondestes grammacus strigatus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Lark Sparrow's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

Lark Sparrows breed in open grasslands, savannas, and cultivated fields with scattered trees and shrubs in New Mexico and primarily winter south of the U.S./Mexico border, although winter residents occasionally occur in southern New Mexico (Ehrlich et al. 1988; Williams 1993; Howe 2021). These habitats benefit from regular prescribed burns and could be negatively impacted by woody encroachment and conversion to agriculture (AIBAP 2018; Wilsey et al. 2019b). Lark Sparrows are highly susceptible to brood parasitism by Brown-headed Cowbirds (Newman 1970; Hill 1976). Local declines have been potentially linked to the use of pesticides to control grasshopper populations, a primary breeding season food source for Lark Sparrows (Kaspari and Joern 1993; Paige and Ritter 1999; Hallman et al. 2014). The Lark Sparrow has experienced 32% population decline since 1970 (Rosenberg et al. 2016). Lark Sparrows are expected to experience a 29% breeding range expansion by 2050, with that expansion resulting in a small range expansion within New Mexico (Wilsey et al. 2019a).

Lazuli Bunting

The Lazuli Bunting (*Passerina amoena*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Lazuli Bunting's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Lazuli Bunting breeds in mature riparian woodlands and adjacent shrubland habitat at 850 to 2,290 m (2,800 to 7,500 ft) elevation (Hubbard 1978; DeGraaf et al. 1991). This habitat is threatened by destruction and degradation resulting from wildfires, droughts, agricultural conversion, and water diversion (NMDGF 2016; Rosenberg et al. 2016). Lazuli Buntings are known to hybridize with Indigo Buntings (*Passerina cyanea*) where their ranges overlap, although the impacts to this species are unknown (Fetz 2008). The Lazuli Bunting has experienced a 6% population increase since 1970 (Rosenberg et al. 2016). Climate change vulnerability models project a 61% breeding range expansion for Lazuli Bunting by 2050 (Wilsey et al. 2019a).

Least Tern

The Least Tern (*Sternula antillarum athalassos*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Least Tern's climate change vulnerability is impacted by factors related to distribution and movement, which influence its ability to shift in space. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Least Tern is highly dependent on wetland habitat; it requires bare ground and sandbars for nesting and breeds at only a single location in New Mexico (Martlatt 1984; NMDGF 1994). This habitat is threatened by destruction and degradation resulting from the draining of wetlands, channelization, and significant changes in rainfall that alter hydrologic conditions (NMDGF 2016; NMDGF 2020b). Within New Mexico, this subspecies has generally been found in a single localized population, ranging from a high of 60 adults to a low of 10 birds in 1991 (NMDGF 1991; NMDGF 1994). Extreme heat is major stress factor influencing Least Tern chick survival, and nest predation is high, particularly in colonies with less than 80 birds, such as the single known New Mexico population (Burger 1984; Marlatt 1984). Severe storms can decrease colony size, increase chances of predation, and impact chick survival as a result of the cold temperatures and wet conditions that chicks experience during severe rainstorms or by keeping adults with food away from the nest during these storm events (Haddon and Knight 1983; Martlatt 1984). Human disturbance also negatively impacts nesting colonies (NMDGF 1994). The Least Tern global population has experienced a 50% population decline since 1970 and is expected to experience another 50% decline in the next 20 years (PIF 2024).

Lesser Prairie-Chicken

The Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Lesser Prairie-Chicken's climate change vulnerability is impacted by factors related to distribution, movement, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Lesser Prairie-Chicken resides in shrubby grasslands and adjacent habitat in a few counties on the southeastern side of New Mexico (Hubbard 1978). This habitat is threatened by degradation and destruction resulting from human development, fragmentation, agricultural conversion, fire suppression, intensive grazing, and energy exploration and generation (USFWS 2008a; Rosenberg et al. 2016; Wilsey et al. 2019b; USFWS 2022b). Droughts have resulted in population declines in the past and can reduce food availability, nesting and roosting cover, and hatching success (Sands 1968; Giesen 1998; USFWS 2010b). Lesser Prairie-Chickens experience high nest and adult predation from a variety of mammalian and avian predators and are sensitive to human disturbance (Arritt 1997b; USFWS 1998b; USFWS 2008a). They are threatened by avian malaria (*Plasmodium*) and intestinal parasites (*Eimeria* spp.), both of which can cause mortality at high concentrations (Johnson 2000). New Mexico Lesser Prairie-Chickens exhibit relatively low genetic diversity, raising concerns about the potential for inbreeding depression (Hagen 2003; Bouzat and Johnson 2004). Since the 1800's, the Lesser Prairie-Chicken population has declined by 92% due to the degradation and destruction of habitat, and the population was projected to be 6,000 to 10,000 birds, in 1972, with estimates in 2009 at approximately 5,000 birds in New Mexico (Taylor and Guthery 1980; USFWS 2010b). The Lesser Prairie-Chicken has experienced a 50% decline in the past 44 years, and another 50% decline is expected due to bioclimatic conditions projected to occur in the next 50 years (Rosenberg et al. 2016; NABCI 2022). Climate change vulnerability modeling projects that the Lesser Prairie-Chicken will experience a 46% range contraction by 2050, with a 50% range contraction occurring in New Mexico (Wilsey et al. 2019a).

Lewis's Woodpecker

The Lewis's Woodpecker (*Melanerpes lewisi*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Lewis's Woodpecker's climate change vulnerability is impacted by factors related to distribution, movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Lewis's Woodpecker requires mature open woodlands, preferring riparian woodlands dominated by cottonwoods at lower elevations and old-growth ponderosa pine maintained by fire at upper elevations (Hubbard 1978; Tobalske 1997). This habitat is threatened by degradation and destruction resulting from hydrologically-driven changes in riparian systems, fire exclusion, changing fire frequency, logging, and grazing (UDWR 1997; NMDGF 2016). Their requirement for a fire-dependent habitat means local populations can be transitory, with sporadic movements to areas based on nest site and food availability (Bock 1970; Saab and Dudley 1998). The Lewis's Woodpecker is an insect gleaner, catching aerial insects in flight, rather than probing for wood-boring insects, and stores seeds and nuts, particularly acorns, in cottonwood trees for use over the winter (Bent 1939; Bock 1970). They are cavity nesters that require trees greater than 43 cm (17 in) in diameter for nesting and prefer natural cavities or cavities created by other cavity nesters (e.g., Northern Flicker [*Colaptes auratus*]) to excavating their own cavities (Maser et al. 1988; Tobalske et al. 1997). Breeding European Starlings negatively impact Lewis's Woodpeckers through competition for nest cavities (UDWR 1997). They have experienced a 67% population decline in the past 50 years (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest the Lewis's Woodpecker will experience a 13% breeding range contraction and a 45% winter range contraction by 2050, resulting in a 20% range contraction in New Mexico (Wilsey et al. 2019a).

Loggerhead Shrike

The Loggerhead Shrike (*Lanius ludovicianus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Loggerhead Shrike's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Loggerhead Shrike breeds in open and shrubby grasslands with isolated trees and shrubs used for nesting and as hunting perches (Hubbard 1978; DeGraaf et al. 1991; Yosef and Grubb 1994). This habitat is threatened by changing fire regimes due to fire exclusion, agricultural conversion, urban development, and energy exploration (Kridelbaugh 1982; Cadman 1986; Wilsey et al. 2019b). The Loggerhead Shrike feeds on insects and small mammals, both of which are impacted by pesticide use (Finch 1992; Hallman et al. 2014; Wilsey et al. 2019b). Loggerhead Shrikes' lethal and sub-lethal effects from pesticides have been reported in juvenile Loggerhead Shrikes, and evidence of eggshell thinning resulting from dichlorodiphenyl-dichloroethylene (DDE) has also been documented (Busbee 1977; Anderson and Duzan 1978; Meehan et al. 2010). The Loggerhead Shrike has experienced a 74% population decline in the past 50 years, likely resulting from habitat loss and pesticide use, and will likely see another 50% decline in the next 24 years (Rosenberg et al. 2016). However, climate-based habitat models suggest the Loggerhead Shrike's range may expand in New Mexico in the future due to expansion of favorable bioclimatic conditions (Price 2002).

Long-billed Curlew

The Long-billed Curlew (*Numenius americanus americanus*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the 8.5 Scenario. The Long-billed Curlew's climate change vulnerability is impacted by factors related to distribution, movement, and abiotic niche, which influences its ability to shift in space and respond to climate change impacts. It is also impacted by land-use changes, other anthropogenic factors and biologic factors, which could increase the effects of climate change.

The Long-billed Curlew breeds in northeastern New Mexico and requires undisturbed short-grass prairies and meadows near water and open mudflats for foraging and nesting (King 1977; McCallum et al. 1977; Chase et al. 1982). Their habitat is threatened by degradation and destruction resulting from agricultural conversion; the spread of invasive grasses; over-grazing; fire suppression; energy exploration and expansion, wind farms in particular; wetland draining; and dredging (Finch 1992; Fellows and Jones 2009; Pool et al. 2014; NMDGF 2016; Wilsey et al. 2019b). The Long-billed Curlew is also threatened by pesticides (Ehrlich et al. 1988; Mineau and Whiteside 2013). They experience low nest success rates, likely due to mammalian and avian predators, with success rates ranging between 12 and 40% (Coates et al. 2019). They display a high degree of nest-site fidelity (Page et al. 2014). Climate change vulnerability modeling results suggest the Long-billed Curlew will experience a 45% range loss by 2050, which will impact more than 50% of their breeding habitat in New Mexico (Wilsey et al. 2019a).

Long-billed Dowitcher

The Long-billed Dowitcher (*Lumnodromus scolopaceus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Long-billed Dowitcher's climate change vulnerability is impacted by factors related to distribution and movement, which influence its ability to shift in space.

The Long-billed Dowitcher is a long-distance migrant, breeding along the northern coast of Alaska and the Yukon and Northwest Territories in Canada and wintering along the southern U.S. coast and into Mexico (Cornell Lab 2024). Long-billed Dowitchers are found near shallow water with almost no vegetation below 2,290 m (7,500 ft) elevation and are commonly found along sandbars, shorelines, and mudflats (Hubbard 1978; Baltosser 1991). The Long-billed Dowitcher has experienced a 50% population decline in the past 50 years (NABCI 2022). It is expected to experience a 32% winter range expansion by 2050, with that resulting in a 50% expansion within New Mexico (Wilsey et al. 2019a).

Long-eared Owl

The Long-eared Owl (*Asio otus*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Long-eared Owl's climate change vulnerability is impacted by factors related to distribution, movement and life history, which influence its ability to shift in space and persist in place.

The Long-eared Owl nests in mature forests across a variety of forest types, requiring open areas for hunting small mammals, particularly mice and voles (Marti 1976; Hubbard 1978; Bull et al. 1989; DeGraaf et al. 1991). They generally nest in old bird nests, such as those of jays, magpies, crows (*Corvus* spp.), or hawks, as well as squirrel nests, and will use the same nest for multiple years (Maples et al. 1995). Karalus and Eckert (1974) determined that predation by larger raptors is a limiting factor. Long-eared Owls are sensitive to human disturbance, particularly at the nest site, and they are threatened by rodenticide use (Eisler 1998; Rosenberg et al. 2016). The Long-eared Owl has experienced a 91% population decline since 1970, although the current population trend is unknown (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest the Long-eared Owl will lose 15% of its breeding range, mostly in the southeastern portion of its range, by 2050, although this range contraction will likely impact less than 10% of their New Mexico range (Wilsey et al. 2019a).

Lucifer's Hummingbird

The Lucifer's Hummingbird (*Calothorax lucifer*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Lucifer's Hummingbird's climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Lucifer's Hummingbird occurs in desert scrub habitat on slopes and in adjacent canyons at 1,220 to 2,130 m (4,000 to 7,400 ft) elevation in the Peloncillo Mountains in southwestern New Mexico (NMDGF 1988; USFS 2017). They are particularly dependent on agaves (*Agave* spp.) as a food source, although they will feed from other flowering desert plants such as ocotillo (NMDGF 1988; USFS 2017). This habitat is threatened by degradation and destruction resulting from livestock grazing, fire, and spread of invasive species (NMDGF 2016; McIntyre 2017). The Lucifer's Hummingbird is also threatened by pesticide use (McIntyre 2017). The Lucifer's Hummingbird population in New Mexico appears small but stable, with surveys suggesting no more than 20 females annually (NMDGF 2002; NMDGF 2020b).

Lucy's Warbler

The Lucy's Warbler (*Leiothlypis luciae*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Lucy's Warbler's climate change vulnerability is impacted by movement factors, which influence its ability to shift in space.

The Lucy's Warbler breeds in desert scrub and riparian woodland habitat (DeGraaf et al. 1991). These habitats are at risk of degradation and destruction resulting from burning, excessive grazing, and logging (NMDGF 1994; NMDGF 2016; NMDGF 2020b). The Lucy's Warbler is a cavity nester, nesting in cavities excavated by woodpeckers in snags and in rocky crevices (Scott et al. 1977; AIBAP 2018). They are gleaning insectivores and thus are threatened by pesticide use (Hallman et al. 2014). The Lucy's Warbler has experienced a 24% population increase since 1970 (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest the Lucy's Warbler will experience a 105% breeding range expansion, particularly in the northern portion of its range, by 2050 (Wilsey et al. 2019a).

Mexican Chickadee

The Mexican Chickadee (*Poecile sclateri eidos*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Mexican Chickadee's climate change vulnerability is impacted by factors related to movement, life history, and evolutionary potential, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Mexican Chickadee is a montane forest species on the northern end of its range in the U.S., with less than 500 individuals occurring in the U.S., primarily in southwestern New Mexico and southeastern Arizona (Black 1997; Rosenberg et al. 2016). It generally breeds above 2,130 m (7,000 ft) elevation in pine oak woodlands, nesting in snags and man-made nest boxes, although their habitat requirements are broader within their Mexican range (Scott et al. 1977; Hubbard

1978). This habitat is threatened by destruction and degradation resulting from changing fire conditions (NMDGF 2017a). The Mexican Chickadee has experienced a 15-50% population decline since 1970 (Rosenberg et al. 2016).

Mexican Spotted Owl

The Mexican Spotted Owl (*Strix occidentalis lucida*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Mexican Spotted Owl's climate change vulnerability is impacted by factors related to distribution, movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Mexican Spotted Owl is found in mature, closed canopy forests and piñon-juniper habitat (Grubb et al. 1994; Cassidy et al. 1996; Russell and Harden 2009). This habitat is particularly threatened by habitat destruction and degradation resulting from fire, intensive logging, energy exploration and development, and road and urban development (UDWR 1997; NMDGF 2016). Mexican Spotted Owls are sensitive to human disturbance and display a high degree of nest and territory fidelity (USFWS 1995b; USFS 2020). The Mexican Spotted Owl require large snags or vertical canyon walls for roosting and nesting, with a preferred proximity to riparian habitat at 1,920 to 3,000 m (6,300 to 8,500 ft) elevation (Cassidy et al. 1996; USFS 2020). Predation by other avian predators is a common mortality factor, and Mexican Spotted Owls experience significant competition from Great-Horned Owls and Barred Owls (*Strix varia*) (Gutierrez et al. 2020; USFWS 1995b). Adult annual survival rates are relatively high (80 to 90%), but juvenile survival rates range from six to 29% (USFWS 1995b; White et al. 1995). The Mexican Spotted Owl experiences significant heat stress above 27°C (80.6°F), which could reduce its range by 70% or more in New Mexico in the future (by 2040-2069) (Barrows 1981; Hegewisch et al. 2024).

Mexican Whip-poor-will

The Mexican Whip-poor-will (*Antrostomus arizonae arizonae*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Mexican Whip-poor-will's climate change vulnerability is impacted by factors related to distribution and movement, which influence its ability to shift in space.

The Mexican Whip-poor-will breeds in mature conifer and riparian woodlands and forages in desert scrub habitat (Hubbard 1978; DeGraaf et al. 1991). This habitat is threatened by degradation and destruction resulting from increased wildfires, intensive logging, and deforestation (NMDGF 2016; Rosenberg et al. 2016). The Mexican Whip-poor-will is an aerial insectivore; recent studies have shown that neonicotinoid insecticides have adverse effects on non-target species, including aerial insectivores (Hallman et al. 2014). The Mexican Whip-poor-will is sensitive to disturbance from people and is vulnerable to increased predation resulting from intense logging practices and associated loss of cover (Line 1993). The Mexican Whip-poor-will has experienced a 15 to 50% population decline since 1970 (Rosenberg et al. 2016).

Mountain Bluebird

The Mountain Bluebird (*Sialia currucoides*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Mountain Bluebird's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Mountain Bluebird is found in open woodlands and along forest edges, habitats that benefit from prescribed fire and would be negatively affected by fire exclusion (Westworth and Telfer 1993; Gillihan 2006). Like other bluebirds (*Sialia* spp.), the Mountain Bluebird is a cavity nester, nesting in naturally-occurring cavities, cavities created by woodpecker species, or nesting in nest boxes (Mitchell 1988; Hutto 1995). They do compete with other cavity nesters, such as European Starlings, and wren and swallow species, although the impacts from this competition on their populations are unknown (NMDGF 2016). The Mountain Bluebird is an aerial insectivore; recent studies have shown that neonicotinoid insecticides have adverse effects on non-target species, including aerial insectivores (Hallman et al. 2014). The Mountain Bluebird has experienced a 21% population decline since 1970; their current population trend is unknown (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest Mountain Bluebird will lose 42% of its breeding range by 2050; this range contraction would likely impact approximately 25% of its New Mexico breeding range (Wilsey et al. 2019a).

Mountain Chickadee

The Mountain Chickadee (*Poecile gambeli gambeli*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Mountain Chickadee's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Mountain Chickadee primarily breeds in mixed conifer forests above 1,830 m (6,000 ft) elevation (Hubbard 1978; Stahlecker et al. 1989; DeGraaf et al. 1991). This habitat is threatened by degradation and destruction resulting from intensive logging and increasing fire frequency (Szaro and Balda 1979b; Sallabanks and McIver 1998). The Mountain Chickadee is a cavity nester and dependent on naturally-occurring or woodpecker-excavated cavities within standing snags (Scott et al. 1977). There is documented nest site competition between Mountain Chickadees and Violet-green Swallows (*Tachycineta thalassina*), although the impacts to the Mountain Chickadee from this competition are unknown (Franzreb 1976). The Mountain Chickadee is an insectivore; recent studies have shown that neonicotinoid insecticides have adverse effects on non-target species, including avian insectivores (Hallman et al. 2014). The Mountain Chickadee has experienced a 45% global population decline since 1970 (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest Mountain Chickadee will lose 50% of its breeding range by 2050, with this range contraction potentially impacting approximately 50% of its New Mexico breeding range (Wilsey et al. 2019a).

Mountain Plover

The Mountain Plover (*Charadrius montanus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Mountain Plover's climate change vulnerability is impacted by movement factors, which influence its ability to shift in space. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Mountain Plover breeds primarily in open shortgrass prairies, although this species is also associated with heavily-grazed areas and bare agricultural fields that mimic open shortgrass areas (NMDGF 1994; Knopf and Rupert 1995; UDWR 1997). Shortgrass prairies are threatened by destruction and degradation resulting from conversion to agriculture, fire suppression, and energy exploration (NMDGF 2016; Wilsey et al. 2019b). Mountain Plovers selectively feed in and around prairie dog colonies; pesticide use to reduce insects and chemical control of prairie dogs have a negative impact on Mountain Plovers (Leachman and Osmundson 1990; Mineau and Whiteside 2013). Annual survival of Mountain Plovers was found to increase in drought years, with survival negatively associated with wet conditions, possibly due to nest destruction (USFWS 2010a). The Mountain Plover has experienced a 50% population decline since 1970 and is expected to experience another 50% population decline in the next 13 years (NABCI 2022; PIF 2024). Climate change vulnerability modeling results suggest the Mountain Plover will lose 51% of its breeding range by 2050, with this range contraction potentially impacting approximately 70% of its New Mexico breeding range (Wilsey et al. 2019a).

Neotropic Cormorant

The Neotropic Cormorant (*Nannopterum brasilianus*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Neotropic Cormorant's climate change vulnerability is impacted by factors related to movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Neotropic Cormorant was first documented in New Mexico in 1972, with zero to 50 nests found annually since then (NMDGF 1988; NMDGF 1996). In New Mexico, they are primarily found on large reservoirs, nesting in colonies in snags or trees adjacent to water and consuming a variety of fish species (Hubbard 1978; NMDGF 1996). The Neotropic Cormorant is threatened by loss and degradation of nest sites, disturbance at nest sites, fish population fluctuations, and by direct mortality resulting from the use of pesticides and illegal take and persecution (NMDGF

1996; NMDGF 2016; NMDGF 2020b). Climate change vulnerability modeling results suggest the Neotropic Cormorant will experience a 78% range expansion by 2050, with this potentially adding a significant amount of range in New Mexico (Wilsey et al. 2019a).

Northern Beardless-Tyrannulet

The Northern Beardless-Tyrannulet (*Camptostoma imberbe ridgwayi*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Northern Beardless-Tyrannulet's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Northern Beardless-Tyrannulet is rare in New Mexico, breeding in arid scrub habitat and open riparian woodland in far southwestern New Mexico (NMDGF 1994; NMDGF 1996). This habitat is threatened by destruction and degradation resulting from fire, intensive logging practices, irrigation and water diversion practices, and grazing (NMDGF 2016; NMDGF 2020b). The Northern Beardless-Tyrannulet is an insectivore; recent studies have shown that neonicotinoid insecticides have adverse effects on non-target species, including avian insectivores (Hallman et al. 2014). Although it is locally rare, the Northern Beardless-Tyrannulet is relatively common in Mexico and Central America (Hubbard 1978). Climate change vulnerability modeling results suggest the Northern Beardless-Tyrannulet will experience a 22% range expansion by 2050, with this potentially adding a significant amount of range in New Mexico (Wilsey et al. 2019a).

Northern Harrier

The Northern Harrier (*Circus hudsonius*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Northern Harrier's climate change vulnerability is impacted by factors related to movement and demography, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Northern Harrier is a common winter resident and infrequent summer resident, particularly in wet years, across New Mexico (Hubbard 1978; Howe 2021). It primarily resides in open habitat, including marshes, grasslands, and fallow fields (DeGraaf et al. 1991; Howe 2021). These habitats benefit from regular prescribed fires, but timing must be coordinated to reduce impacts to nests and fledglings (Kruse and Piehl 1986; Finch 1992). These open habitats are threatened by destruction and degradation resulting from conversion to agriculture, energy exploration, intensive livestock grazing, wetland draining, and woody encroachment (Bock et al. 1992; AIBAP 2018; Wilsey et al. 2019b). The Northern Harrier nests on the ground, and nests are threatened by predation, trampling by livestock, human disturbance, agricultural practices, fire and flooding (Kruse and Piehl 1986; Herkert 1991; Finch 1992). They are also threatened by the use of pesticides (Hallman et al. 2014). The Northern Harrier has experienced a 37%

population decrease since 1970 (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest the Northern Harrier will experience a 27% breeding range contraction by 2050, potentially reducing its New Mexico breeding range by at least 50% (Wilsey et al. 2019a).

Northern Rough-winged Swallow

The Northern Rough-winged Swallow (*Stelgidopteryx serripennis*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Northern Rough-winged Swallow's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

Northern-Rough-winged Swallows nest in burrows, preferring to nest in cliffs and riverbanks near water, although they can also be found under bridges and in old buildings (Ehrlich et al. 1988; Howe 2021). They will dig their own burrow for a nest, although they will also use old burrows created by bank swallows, kingfishers, or ground squirrels, and are often limited in distribution by the availability of dry, sandy soil for suitable for nests (Harrison 1975; Terres 1980). They are aerial insectivores, primarily feeding on aerial insects over waterways, open fields, and savannahs, and are threatened by the use of insecticides (Ehrlich et al. 1988; Hallman et al. 2014). The Northern Rough-winged Swallow is expected to experience a 4% breeding range loss by 2050 due to climate change, with that potentially resulting in a 5% range loss in New Mexico (Wilsey et al. 2019a). It will likely be relatively resilient to phenology changes anticipated under future climatic conditions (Friggens et al. 2013).

Olive Warbler

The Olive Warbler (*Peucedramus taeniatus arizonae*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Olive Warbler's climate change vulnerability is impacted by factors related to distribution, movement and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Olive Warbler breeds in New Mexico above 2,100 m (6,890 ft) elevation in fir and pine forests (Hubbard 1978; Terres 1980). The occasional transient will winter in New Mexico (Howe 2021). They are gleaning insectivores and are threatened by the use of insecticides (Hallman et al. 2014). The Olive Warbler is expected to experience a 51% breeding range contraction by 2050 due to climate change, potentially reducing New Mexico habitat by 50% (Wilsey et al. 2019a).

Olive-sided Flycatcher

The Olive-sided Flycatcher (*Contopus cooperi*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Olive-sided Flycatcher's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Olive-sided Flycatcher breeds in upland coniferous forests near bogs and rivers and migrates through much of New Mexico (Hubbard 1965; Tatschl 1967; Howe 2021). Specifically, it prefers to nest in large, mature trees and perch in tall snags in edge areas between mature conifer and grasslands, with low canopy cover at 2,730 to 3,050 m (9,000 to 10,000 ft) elevation (Bailey and Niedrach 1965; Verner and Boss 1980; Finch 1992). The Olive-sided Flycatcher prefers recently-burned landscapes and stand-replacing wildfires that create snags and open areas for foraging, although an increase in wildfire frequency and intensity may reduce the availability of mature conifer forests they require for nesting (Altman and Sallabanks 2000; NMDGF 2016). This habitat is also threatened by destruction and degradation resulting from forest succession and logging (Finch 1992; NMDGF 2016; Rosenberg et al. 2016). The Olive-sided Flycatcher is an insectivore and is threatened by pesticide use (Finch 1992; Hallman et al. 2014). The Olive-sided Flycatcher displays relatively-high site fidelity on breeding and wintering grounds (Altman 1997). The Olive-sided Flycatcher has experienced a 78% population decline since 1970 (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest the Olive-sided Flycatcher will experience a 34% breeding range contraction by 2050, potentially reducing its New Mexico breeding range by at least 50% (Wilsey et al. 2019a).

Peregrine Falcon

The Peregrine Falcon (*Falco peregrinus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Peregrine Falcon's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Peregrine Falcon inhabits various landscapes including forests, woodlands, desert scrub, and grasslands (Bailey 1965; DeGraaf et al. 1991). The species feeds almost entirely on other bird species, including pigeons, doves, shorebirds, and waterfowl, but also feeds on bats, fish, and rodents (NMDGF 1988; Haynes and Shuetze 1997). The Peregrine Falcon is migratory and winters south of the Mexican border and into northern South America. The species is known to be monogamous and mate for life. Nest failure and juvenile mortality are high, and a mated pair typically only successfully raises one young per brood (ODWC 1993; Johnson 2018). The Peregrine Falcon is present in low numbers and is in decline as a result of direct mortality; poisoning; and habitat loss, degradation, and fragmentation (Haynes and Schuetze 1997; NMDGF 2016; Johnson 2018). The Peregrine Falcon experienced a bottleneck in the 1970s, primarily as a result of DDT poisoning, with only 324 known pairs being recorded at the time (NPS, 2024). The Peregrine Falcon population in northern New Mexico is declining, but the species overall has experienced a 105% population increase since the bottleneck in the 1970's (Rosenberg et al. 2016). However, there are still threats to the species including pesticides, illegal hunting, and avian influenza (NMDGF 2016; USGS 2020b) Peregrine Falcons can be sensitive to human activity and, in New Mexico, disturbance of nesting pairs is considered a primary threat to the species (NMDGF 1995; USFS 2020). Additionally, the Peregrine Falcon is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Phainopepla

The Phainopepla (*Phainopepla nitens lepida*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Phainopepla's climate change vulnerability is impacted by factors related to life history and abiotic niche, which influence its ability to persist in place and respond to climate change impacts.

The Phainopepla resides in oak and riparian woodlands and into arid shrub habitat (Hubbard 1978; DeGraaf et al. 1991). It rarely drinks water and instead gets water from a variety of berries (Howe 2021, Cornell Lab 2024). It is also an insectivore and is susceptible to pesticide use (Hallman et al. 2014). Phainopepla mortality resulting from drought has been documented; climate change will likely exacerbate climatic extremes and increase the intensity, frequency, and severity of droughts (Friggens et al. 2013). The Phainopepla has experienced an 8% population decline since 1970 (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest the Phainopepla will experience an 31% range expansion by 2050, which could expand its New Mexico range by approximately 50% (Wilsey et al. 2019a).

Pine Grosbeak

The Pine Grosbeak (*Pinicola enucleator montana*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Pine Grosbeak's climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

In New Mexico, the Pine Grosbeak primarily breeds in the spruce and spruce-fir forests in the Jemez, San Juan, and Sangre de Cristo Mountains above 2,440 m (8,000 ft) elevation, although it will migrate to 850 to 1,680 m (2,800 to 5,500 ft) during the winter (Hubbard 1978; DeGraaf et al. 1991; Howe 2021). The Pine Grosbeak is a boreal resident, and this habitat is threatened by changing temperature extremes due to climate change (Rosenberg et al. 2016). The Pine Grosbeak has experienced a 49% population decline since 1970 (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest the Pine Grosbeak will experience a 59% range loss by 2050, which would result in a complete loss of habitat in New Mexico (Wilsey et al. 2019a).

Pine Siskin

The Pine Siskin (*Spinus pinus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Pine Siskin's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

Pine Siskins are common summer residents and uncommon winter residents in New Mexico, found in mixed oak/conifer forests with an oak understory, occasionally foraging in adjacent weedy fields, at 850 to 2,290 m (2,800 to 7,500 ft) elevation (Hubbard 1978; USFS 2006). They are insectivores and are susceptible to the use of pesticides (Hallman et al. 2014). The Pine Siskin has experienced an 80% population decline since 1970 and is anticipated to experience another 50% decline within the next 23 years (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest the Pine Siskin will experience a 47% breeding range contraction by 2050, which would result in a 75% loss of habitat in New Mexico (Wilsey et al. 2019a).

Pinyon Jay

The Pinyon Jay (*Gymnorhinus cyanocephalus*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Highly Vulnerable under the RCP 8.5 Scenario. The Pinyon Jay's climate change vulnerability is impacted by factors related to life history, ecological role, and abiotic niche, which influence its ability to persist in place and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Pinyon Jay prefer piñon/juniper woodlands, with mature piñon pine (*Pinus edulis*) stands, generally breeding at higher elevations and wintering at lower elevations (Tatschl 1967; Gillihan 2006; Malcolm et al. 2020). They will also breed in sagebrush habitats and mixed-conifer forests (DeGraaf et al. 1991; Malcolm et al. 2020). These habitats are threatened by destruction and degradation resulting from fire, logging, livestock grazing, and energy exploration and associated resource excavation (NMDGF 2016; Johnson et al. 2020; Malcolm et al. 2020). Pinyon Jays feed primarily on piñon seeds and cache them, although they will also forage for Jefferson pine (*Pinus jeffreyi*) and ponderosa pine seeds (Gillihan 2006; van Riper et al. 2014). The primary reasons for nest failure are avian predation and cold and snowy spring weather; climate change will likely exacerbate climatic extremes and increase the intensity, frequency, and severity of unseasonably cold weather (Johnson and Sadoti 2019). The Pinyon Jay is susceptible to West Nile Virus (Defenders of Wildlife 2022). Nestlings eat insects and are threatened by the use of pesticides (Hallman et al. 2014). They are sensitive to noise and human activity (Johnson et al. 2020). The Pinyon Jay has experienced an 84% population decline in the past 50 years and is expected to experience a 50% population decline within the next 19 years (Rosenberg et al. 2016). The Pinyon Jay's breeding range is projected to decrease by 25 to 31% between 2010 and 2099 due to changes in mean winter precipitation and maximum summer temperatures and changes in the range of piñon pine, single-leaf piñon (*Pinus monophylla*), and Jeffrey pine (van Riper et al. 2014).

Piping Plover

The Piping Plover (*Charadrius melodus circumcinctus*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Piping Plover's climate change vulnerability is impacted by factors related to distribution and movement, which influence its ability to shift in space. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Piping Plover was considered common in the U.S. in the 1930s but experienced significant population declines, almost vanishing from nesting areas in some parts of its range. Population declines are primarily due to the loss or alteration of nesting and wintering areas resulting from development; vehicular traffic; human disturbance; and the flooding of nests triggered by impoundments, irregular water, and natural flood events (NMDGF 1988; Burger 1993; Boyne 2000). The U.S. population has increased by 300% since 1985 to approximately 6,500 birds. This increase is the result of intensive management efforts, including restrictions on beach access during sensitive nesting periods and predator control activities (Holmer 2016). In New Mexico, the Piping Plover is a rare transient on the mudflats and shorelines of lakes in eastern New Mexico in the Canadian and Pecos River drainages, with only nine records in the state (Howe 2021). Piping Plovers experience significant nest predation by and chick mortality resulting from a variety of mammalian and avian predators (Patterson et al. 1990; Patterson et al. 1992). The Piping Plover is expected to experience a 74% breeding range loss and a 21% winter range loss by 2050 due to climate change (Wilsey et al. 2019a).

Plumbeous Vireo

The Plumbeous Vireo (*Vireo plumbeus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Plumbeous Vireo's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Plumbeous Vireo breeds in open mixed-conifer and oak woodlands, piñon-juniper forests, and mixed-oak woodlands (Stahlecker et al. 1989; DeGraaf et al. 1991). These habitats are threatened by destruction and degradation resulting from intensive logging (Szaro and Balda 1979a). They are sensitive to human disturbance and experience nest parasitism from Brown-headed Cowbirds, particularly near urban areas, that results in reduced nest productivity (Friedmann 1963; Marvil and Cruz 1989). The Plumbeous Vireo has experienced a 39% population decline since 1970 (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest the Plumbeous Vireo will experience an 81% breeding range expansion and a

11% range contraction by 2050; these potential changes will likely result in no significant breeding range change in New Mexico (Wilsey et al. 2019a).

Prairie Falcon

The Prairie Falcon (*Falco mexicanus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Prairie Falcon's climate change vulnerability is impacted by factors related to demography and life history, which influence its ability to persist in place.

The Prairie Falcon migrates locally and can be found across the western U.S. (Steenhof 2020). The species inhabits various landscapes including riparian, prairies, wetlands, forests, and scrub (DeGraaf et al. 1991; USFS 2006). In general, the species exhibits a strong negative relationship with shrub encroachment, primarily by mesquite, in winter and spring, indicating the Prairie Falcon requires open grassland patches with little to no shrub encroachment (Desmond and Agudelo 2005). The Prairie Falcon feeds on small mammals, particularly ground squirrels (Steenhof 2020). The Prairie Falcon has experienced a 41% population increase since 1970, however, many factors, such as pesticide and heavy metal contamination, habitat destruction, and persecution, still threaten raptor populations (Hoffman and James 1987; Rosenberg et al. 2016). Additionally, the mortality rate is high for this species, up to 75% for juveniles (Hawks and Mika 2013).

Purple Martin

The Purple Martin (*Progne subis*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Purple Martin's climate change vulnerability is impacted by factors related to movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

Purple Martins breed in a variety of woodland and open habitat, generally near water (Ehrlich et al. 1988; DeGraaf et al. 1991). Purple Martins are cavity nesters that are dependent on natural cavities, and those constructed by other species, and will be outcompeted by House Sparrows and European Starlings for these cavities (Finch 1992). They are exclusively an aerial insectivore and are threatened by pesticide use (Hallman et al. 2014). Cold, stormy weather, particularly in spring and summer, can reduce food availability and result in mortality of adults and juveniles; climate change will likely exacerbate climatic extremes (Brown et al. 2021). The Purple Martin has experienced a 23% population decline since 1970 (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest the Purple Martin will experience a 51% breeding range expansion by 2050, which would result in a significant breeding range expansion in New Mexico (Wilsey et al. 2019a).

Pygmy Nuthatch

The Pygmy Nuthatch (*Sitta pygmaea melanotis*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Pygmy Nuthatch's climate change vulnerability is impacted by factors related to life history and abiotic niche, which influence its ability to persist in place and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Pygmy Nuthatch is found primarily in conifer and mixed hardwood forests at mid to upper elevations (DeGraaf et al. 1991; Howe 2021). They are cavity nesters and winter roosters and select for cavity location and species that provide thermal insulation and ventilation from The Pygmy Nuthatch is found primarily in conifer and mixed-hardwood forests at mid to upper elevations (DeGraaf et al. 1991; Howe 2021). They are cavity nesters and winter roosters and select for cavity locations and tree species that provide thermal insulation from outdoor ambient temperatures (van Riper et al. 2014). This species' habitats are threatened by destruction and degradation resulting from logging, particularly removal of snags and intensive thinning (Franzreb 1977; Scott et al. 1977; Szaro and Balda 1979b). Pygmy Nuthatches have a male-skewed sex ratio, although unmated offspring, particularly males, will assist with nest construction and brood rearing, which can result in increased productivity (Norris 1958; Sydeman et al. 1988). Their summer diet consists primarily of insects and they are threatened by pesticide use (Norris 1958; Hallman et al. 2014). The Pygmy Nuthatch has experienced a 21% population decline since 1970 (Rosenberg et al. 2016). Climate change vulnerability modeling results suggest the Pygmy Nuthatch will experience a 60% breeding range loss by 2050, which would result in a 90% loss of range in New Mexico (Wilsey et al. 2019a).

Pyrrhuloxia

The Pyrrhuloxia (*Cardinalis sinuatus sinuatus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Pyrrhuloxia's climate change vulnerability is impacted by life history factors, which influence its ability to persist in place. It is also impacted by anthropogenic or topographic barriers and biologic factors, which could increase the effects of climate change.

The species is nonmigratory or migrates locally and can be found in various landscapes including riparian, forests, grasslands, and urban areas in the southern U.S. and Mexico (DeGraaf et al. 1991; Tweit and Thompson 2020; USFS 2006). The species is omnivorous and can feed on nectar, pollen, seeds, fruits, and insects (Tweit and Thompson 2020). The Pyrrhuloxia is decreasing in numbers, with a likely 48% population decline since 1970 (Rosenberg et al. 2016). Climate-based habitat models project that the Pyrrhuloxia's future summer range may expand in New Mexico (Price 2002).

Red-faced Warbler

The Red-faced Warbler (*Cardellina rubrifrons*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Red-faced Warbler's climate change vulnerability is impacted by factors related to distribution, movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Red-faced Warbler is found in New Mexico and Arizona during its breeding season and is otherwise found throughout Mexico (Williams 1993; Martin and Barber 2020). The species typically inhabits mature ponderosa forests in undisturbed or lightly-disturbed areas and places nests at the base of fir or maple (*Acer* spp.) trees (NMDGF 2016). The Red-faced Warbler feeds on a variety of insects and invertebrates, primarily from trees and branches (Martin and Barber 2020). The Red-faced Warbler is low in numbers and limited in its distribution, making it highly threatened by disturbances (Envirological Services 2018). Habitat loss and degradation resulting from severe wildfire has been identified as the greatest conservation concern for breeding populations of this species (Envirological Services 2018). Additionally, the Red-faced Warbler is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Red-headed Woodpecker

The Red-headed Woodpecker (*Melanerpes erythrocephalus caurinus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Red-headed Woodpecker's climate change vulnerability is impacted by movement factors, which influence its ability to shift in space.

The Red-headed Woodpecker is an irregular, short-distance or partial migrant with most populations residing on their breeding ground year round, generally within the central to eastern U.S. (Frei et al. 2020). The species can be found in forests, grasslands, wetlands, riparian areas, and some urban areas (Rosenberg et al. 2016; Howe 2021). The Red-headed Woodpecker is omnivorous and eats invertebrates, seeds, and fruits (Sibley 2014; Frei et al. 2020). The Red-headed Woodpecker has experienced a 67% population decrease since 1970 (Rosenberg et al. 2016). Forestry, logging, farming, and chemicals can have adverse effects on the species (NMDGF 2016). The Red-headed Woodpecker's greatest threats include habitat loss and fragmentation resulting from urbanization and changing forest conditions (NMDGF 2016; Rosenberg et al. 2016). Additionally, the Red-headed Woodpecker is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Red-naped Sapsucker

The Red-naped Sapsucker (*Sphyrapicus nuchalis*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Moderately

Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Red-naped Sapsucker's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Red-naped Sapsucker breeds and winters extensively in the U.S. with some populations wintering south of the Mexican border (Williams 1993; Walters 2020). The species primarily inhabits riparian and forested landscapes (DeGraaf et al. 1991; USFS 2006). The Red-naped Sapsucker feeds on tree sap, insects, and fruits (Sibley 2014). The Red-naped Sapsucker is considered a "double keystone" species for its role excavating nest cavities and drilling sap wells, both of which are subsequently used by other species (Ehrlich and Daily 1988; Daily 1993). The Red-naped Sapsucker does experience predation by species like the American Goshawk (*Accipiter atricapillus*), which can threaten some populations (Reynolds et al. 1992; WRI 2010). The Red-naped Sapsucker has experienced an 80% population increase since 1970 (Rosenberg et al. 2016). However, climate-based habitat models project the species' range to decrease by 49% by 2039 and 78% by 2099 (Hatten et al. 2016). Additionally, the Red-naped Sapsucker is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Rock Wren

The Rock Wren (*Salpinctes obsoletus obsoletus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Rock Wren's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Rock Wren is found in the western U.S. and in Mexico (Benedict et al. 2021). The species is a short-distance migrant, with many populations remaining at their breeding sites year round (Hubbard 1978; Benedict et al. 2021). The Rock Wren is found in various landscapes but is typically found in desert scrub and on rocky slopes and cliffs where they can create their nests in rocky crevices or gopher burrows (Terres 1980; USFS 2006). The species is possibly limited locally by the availability of rock outcrops, which the species uses as nesting and feeding habitat (Wauer 1964). The Rock Wren primarily feeds on ground-dwelling insects such as grasshoppers, beetles, and ants (Lowther 2000; Wilsey et al. 2019b). The Rock Wren has experienced a population decrease of 39% since 1970 (Rosenberg et al. 2016). Forestry, chemicals, mining, and vegetation change can have adverse effects on the Rock Wren (Price 2002; Hallman et al. 2014; Wilsey et al. 2019b). The Rock Wren is sometimes the victim of brood parasitism by the Brown-headed Cowbird (Bent 1948). Climate-based habitat models project that the Rock Wren's future summer range may contract in New Mexico (Price 2002). Additionally, the Rock Wren is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Sage Thrasher

The Sage Thrasher (*Oreoscoptes montanus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Sage Thrasher's climate change vulnerability is impacted by factors related to movement, life history, and evolutionary potential, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Sage Thrasher primarily breeds and winters in the U.S. but some populations winter south of the Mexican border and some populations breed north of the Canadian border (Ehrlich et al. 1988; Reynolds et al. 2020). The species primarily inhabits areas dominated by big sagebrush (*Artemisia tridentate*) and is considered an obligate of sagebrush habitats (Braun et al. 1976; van Riper et al. 2014). The Sage Thrasher primarily feeds on insects but will also eat berries and seeds (Reynolds et al. 2020; Wilsey et al. 2019b). The Sage Thrasher has experienced a 44% population decline since 1970 (Rosenberg et al. 2016). Vegetation change, chemicals, mining, and towers can have adverse effects on the Sage Thrasher (Wilsey et al. 2019b). Climate-based habitat models project that the Sage Thrasher's range will decrease 25% by 2039 and 78% by 2099 and that, by 2099, there will be no suitable habitat in New Mexico for the species (van Riper 2014; Hatten et al. 2016). Additionally, the Sage Thrasher is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Sagebrush Sparrow

The Sagebrush Sparrow (*Artemisiospiza nevadensis = Amphispiza belli nevadensis*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Sagebrush Sparrow's climate change vulnerability is impacted by factors related to movement, life history, and ecological role, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

Sagebrush Sparrows breed and winter exclusively in North America, with some populations wintering south of the U.S.-Mexican border (Williams 1993). The species prefer sagebrush grasslands but are also found in other shrub and brush rangelands, desert scrub, and evergreen forests (DeGraaf et al. 1991; Stahlecker et al. 1989; USFS 2006). Additionally, they are often associated with prairie dog towns (Clark et al. 1982). The Sagebrush Sparrow primarily feeds on insects and other invertebrates but will also eat seeds, fruits, and succulent vegetation (Sibley 2014). Sagebrush Sparrow populations are decreasing in numbers with the main causes being habitat loss, degradation, and fragmentation and pollutants and contaminants (NMDGF 2016). Habitat fragmentation can expose Sagebrush Sparrows to Brown-headed Cowbird parasitism (Sibley 2014; Rosenberg et al. 2016). Fire, heavy livestock grazing, chemicals, and towers can also have adverse effects on the Sagebrush Sparrow (Hallman et al. 2014; Hayes 2014; NMDGF 2016). Climate-based habitat models project the Sagebrush Sparrow's future summer range may exclude New Mexico, but the species' entire range is expected to increase by 74% by 2039

(Price 2002; Hatten et al. 2016). The Sagebrush Sparrow is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Savannah Sparrow

The Savannah Sparrow (*Passerculus sandwichensis*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Savannah Sparrow's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Savannah Sparrow resides in meadows, grasslands, tundra, and cultivated fields at 850 to 1,680 m (2,800 to 7,500 ft) elevation (Hubbard 1978; Ehrlich et al. 1988). These habitats are threatened by destruction and degradation resulting from livestock grazing, energy exploration and generation, and habitat succession (Wilsey et al. 2019b). The Savannah Sparrow is an insectivore and is threatened by the use of pesticides (Mineau and Whiteside 2013; Hallman et al. 2014). The Savannah Sparrow has experienced a 40% population decline since 1970 and will likely experience another 50% decline in the next 19 years (Rosenberg et al. 2016; PIF 2024). Climate change vulnerability modeling results suggest the Savannah Sparrow will experience a 31% breeding range loss by 2050, which would result in a complete loss of breeding range in New Mexico (Wilsey et al. 2019a).

Scott's Oriole

The Scott's Oriole (*Icterus parisorum*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Scott's Oriole's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Scott's Oriole breeds in the southern U.S. and winters south of the Mexican border (Williams 1993). The Scott's Oriole is found in various landscapes including riparian, woodland, and shrubland areas and, in New Mexico, are detected significantly more in uplands (DeGraaf et al. 1991; Kozma 1995). The species uses fibers from yucca leaves, grass, and cacti to build its hanging cup nests in juniper trees (Gillihan 2006). The Scott's Oriole primarily feeds on insects but will occasionally consume berries, cactus fruits, and nectar (Gillihan 2006). Some populations of the Scott's Oriole are significantly impacted by brood parasitism of the Bronzed Cowbird (*Molothrus aeneus*) (Gillihan 2006). Additionally, mining, oil and gas industrial development, and insecticides can adversely affect this species (Gillihan 2006; Hallman et al. 2014). Climate-based habitat models project that the future summer range of the Scott's Oriole may expand in New Mexico (Price 2002). However, the Scott's Oriole is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Short-eared Owl

The Short-eared Owl (*Asio flammeus flammeus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Short-eared Owl's climate change vulnerability is impacted by factors related to movement, evolutionary potential, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Short-eared Owl is found throughout the U.S. but can winter south of the Mexican border (Williams 1993). The species is a grassland-obligate species and can occupy riparian and marsh areas (Cowardin et al. 1979; Wilsey et al. 2019). The Short-eared Owl mainly feeds on rodents while the juveniles seem to feed on some insects to supplement their diet (Clark 1975). The Short-eared Owl is decreasing in numbers and is experiencing habitat loss, degradation, and fragmentation (UDWR 1997). Farming, livestock grazing, plowing and mowing, vegetation change, and wetland draining can have adverse effects on the Short-eared Owl (Bock et al. 1992; Mineau and Whiteside 2013; Wilsey et al. 2019b). Avian influenza is highly pathogenic and is known to affect this species (USGS 2020b). There has been a 65% population decline of the Short-eared Owl since 1970 (Rosenberg et al. 2016). Additionally, the Short-eared Owl is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Snowy Plover

The Snowy Plover (*Charadrius nivosus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Snowy Plover's climate change vulnerability is impacted by factors related to movement, evolutionary potential, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by anthropogenic or topographic barriers, land-use changes, and other anthropogenic factors, which could increase the effects of climate change.

The Snowy Plover inhabits areas near water with a preference for sandy alkaline beaches, flats, and shores (Hubbard 1978; Finch 1992). The species has a large but discontinuous range extending from North America to South America, primarily along the western coastline (Peterson 1990; Page et al. 1991). The Snowy Plover feeds on insects and crustaceans (Page et al. 2009; Sibley 2014). The Snowy Plover's primary threat are habitat loss, degradation, and fragmentation (USFWS 1991; NMDGF 2016). The species is sensitive to human activity and is especially sensitive to disturbances while nesting (Page et al. 2009; Holmer 2016). Predation by gulls, Common Ravens (*Corvus corax*), Red Foxes (*Vulpes vulpes*), skunks, Raccoons (*Procyon lotor*), and Coyotes (*Canis latrans*) may result in a high rate of clutch loss in some areas (Page et al. 1985). Additionally, the Snowy Plover is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Southwestern Willow Flycatcher

The Southwestern Willow Flycatcher (*Empidonax traillii extimus*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Southwestern Willow Flycatcher's climate change vulnerability is impacted by factors related to movement, evolutionary potential, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by anthropogenic or topographic barriers and biologic factors, which could increase the effects of climate change.

The Southwestern Willow Flycatcher is primarily found in riparia, areas and is closely associated with willows (*Salix* spp.) and open water (Hubbard 1978; USFWS 1995a). The Southwestern Willow Flycatcher almost exclusively feeds on insects but will occasionally eat berries (Knopf 1988; NMDGF 1988). The Southwestern Willow Flycatcher breeds throughout the western portion of the U.S. and southern Canada and winters primarily south of the U.S.-Mexico border (Williams 1993). The Southwestern Willow Flycatcher is present in low numbers and its populations are decreasing with the main causes being habitat loss and degradation, introduced species, predation, and brood parasitism (AFGD 1996; Brodhead et al. 2007). Intense fires, dams in large rivers, livestock grazing, and irrigation can have adverse effects on the species (NMDGF 2016; NMDGF 2020b). In 2016, the total breeding population for Southwestern Willow Flycatchers was estimated at 2,000 birds. This species declined in part due to large-scale loss of riparian forest resulting from cattle grazing, water extraction, and habitat destruction (Holmer 2016). Future climate projections indicate that the species' range will shift north with more extreme projections showing a pronounced shift north into Nevada, Utah, and Colorado (Coulson et al. 2016). The species is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016). The Southwestern Willow Flycatcher is expected to be vulnerable to climate change due to associated exacerbation of habitat threats (fire, exotic plants, water management, and floods), increased brood parasitism, and reduction in food resources and nest failure in times of drought. The flycatcher is expected to show some resilience due to its mobility, habitat use plasticity, and re-nesting behavior (Friggens 2015).

Spotted Sandpiper

The Spotted Sandpiper (*Actitis macularius*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Spotted Sandpiper's climate change vulnerability is impacted by abiotic niche factors, which influence its ability to respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Spotted Sandpiper is found along the shores of lakes, ponds, and streams with shallow water, preferring shores with rocks, wood, or debris (Harrison 1978; DeGraaf et al. 1991). These habitats are threatened by destruction and degradation resulting from water level manipulation, wetland draining, dredging, and channelization (Sanderson 1977). The Spotted Sandpiper is a year-round resident in New Mexico, with some individuals migrating to southern wintering populations (Howe 2021). They display skewed sex ratios in favor of the males, and they exhibit polyandry (Oring and Maxson 1978). Climate change vulnerability modeling results suggest the Spotted Sandpiper will experience a 27% breeding range loss by 2050, which would result in a 50% loss of breeding range in New Mexico (Wilsey et al. 2019a).

Spotted Towhee

The Spotted Towhee (*Pipilo maculatus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Spotted Towhee's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Spotted Towhee is found in various landscapes including forests, rangelands, wetlands, and some urban areas (DeGraaf et al. 1991). The species feeds on seeds, insects, and other invertebrates (Puckett and van Riper 2014). The Spotted Towhee breeds in the northwestern U.S. and Canada and winters in the southcentral U.S. and Mexico (Williams 1993). The species is sensitive to vegetation change and is the best indicator in terms of the health of understory vegetation for resident birds (Hawks Aloft 2011). Noise disturbances, fires, towers, and insecticides can have adverse effects on the Spotted Towhee (Hawks Aloft 2011; Francis et al. 2005). The Spotted Towhee's predators include Scrub Jays, snakes, ground squirrels, weasels, raptors, and Cats. Spotted Towhee's are also common victims of nest parasitism by the Brown-headed Cowbird (WRI 2010). The Spotted Towhee has experienced an estimated 6% population increase since 1970, and recent assessments show that this species is likely to be resilient to changes in habitat caused by climate change (Friggens et al. 2013; Rosenberg et al. 2016). However, climate-based habitat models project that the Spotted Towhee's range may contract in New Mexico (Price 2002). Additionally, the Spotted Towhee is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Sprague's Pipit

The Sprague's Pipit (*Anthus spragueii*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Sprague's Pipit's climate change vulnerability is impacted by factors related to movement, evolutionary potential, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts

The Sprague's Pipit is found in grasslands and is closely associated with native mixed-grass prairies, rarely breeding in other vegetation types (Somershoe 2018). The species' breeding range is primarily north of the Canadian border, and its wintering range is primarily south of the Mexican border (Williams 1993). The Sprague's Pipit feeds mostly on insects and invertebrates but will also collect seeds in the winter (Somershoe 2018). The Sprague's Pipit is decreasing in numbers, limited in distribution, and restricted in range (Rosenberg et al. 2016; Somershoe 2018). Habitat loss, degradation, and fragmentation are the main threats to the species (Somershoe 2018). The Sprague's Pipit is known to be nest parasitized by the Brown-headed

Cowbird (Somershoe 2018). The Sprague's Pipit has experienced an estimated 73% population decline since 1970 (Rosenberg et al. 2016). The species has lost half its population in the last 50 years and is likely to lose another 50% if nothing is done for the species and its habitat (NABCI 2022). Agriculture, heavy livestock grazing, insecticides, mining, oil and gas industrial development, and species invasions caused by climate change are known to have adverse effects on the species (Hallman et al. 2014; NMDGF 2016). The species is projected to lose more than 95% of their modeled, current distribution in the future due to climate change (Wilsey et al. 2019a).

Steller's Jay

The Steller's Jay (*Cyanocitta stelleri macrolopha*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Stellar's Jay's climate change vulnerability is impacted by factors related to life history and ecological role, which influence its ability to persist in place and respond to climate change impacts.

Steller's Jays are non-migratory, however, they will move down in elevation during the colder months (Bent 1946) and are found in a variety of landscapes but seem to be more abundant in fir forests (Hubbard 1965). The species feeds on seeds, berries, and invertebrates and is dependent on the food supplied annually by mast production, including acorns (Graces 1980; Gillihan 2006). The American Goshawk is a known predator of the Steller's Jay (Reynolds et al. 1992). Forestry, herbicides, insecticides, and grain bait have known adverse effects on the Steller's Jay (Hallman et al. 2014; Malcolm et al. 2020). The Steller's Jay has experienced a population decline of about 5% since 1970 (Rosenberg et al. 2016).

Thick-billed Kingbird

The Thick-billed Kingbird (*Tyrannus crassirostris*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Thick-billed Kingbird's climate change vulnerability is impacted by factors related to movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Thick-billed Kingbird is restricted to riparian habitats in the U.S. and typically breeds near running water (Ehrlich et al. 1988; NMDGF 1988). The species is typical of other kingbirds (*Tyrannus* spp.), perching high in trees and feeding on various insects (NMDGF 1988). The Thick-billed Kingbird is migratory and moves south to Mexico and Guatemala in its nonbreeding season (NMDGF 1988). The Thick-billed Kingbird is considered rare in New Mexico but is listed as globally stable overall (AGFD 1995; Rosenberg et al. 2016). The primary threat to the species in New Mexico is loss of its riparian woodland habitat (NMDGF 1994). Fire, logging, agriculture, and livestock grazing can have adverse effects on the Thick-billed Kingbird (NMDGF 2016). Additionally, the species is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Thick-billed Longspur (McCown's Longspur)

The Thick-billed Longspur (*Rhynchophanes mccownii*), formerly known as the McCown's Longspur, will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Thick-billed Longspur's climate change vulnerability is impacted by factors related to movement, life history, and evolutionary potential, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Thick-billed Longspur inhabits grasslands and desert scrub habitats, like those found in the Chihuahuan Desert (Ehrlich et al. 1988; DeGraaf et al. 1991). The species' adult diet is typically grasses, seeds, and forbs while juveniles feed mostly on insects (Willams 1993; Somershoe 2018). The Thick-billed Longspur occurs throughout New Mexico during its migration season and winters in the extreme southern counties and in Mexico (Willams 1993). Human activity can cause nest desertion, pesticides can cause direct poisoning of nestlings, and nest predation is believed to limit productivity (With 1994). The Thick-billed Longspur is considered declining in numbers and has a limited distribution and restricted range (Somershoe 2018). Habitat loss, degradation, and fragmentation are the leading causes of the bird's decline (Somershoe 2018). In 2021, the Thick-billed Longspur was identified as a bird of conservation concern by the U.S. Fish and Wildlife Service (USFWS). This designation encompasses birds, beyond those that are federally Threatened or Endangered, that represent the highest conservation priorities for the USFWS (USFWS 2021b). The Partners in Flight indicated an 86% population decline since the 1970s, while the North American Bird Conservation Initiative suggests an even higher decline of 94% (Rosenberg et al. 2016; NABCI 2022). The short-term population trend is estimated to have declined by 10 to 50% (Sauer et al. 2003) Based on a climate model projecting a 3°C (5.4°F) by 2090, the species is projected to lose more than 95% of its current distribution by that year (Wilsey et al. 2019b). Additionally, the Thick-billed Longspur is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Varied Bunting

The Varied Bunting (*Passerina versicolor*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Varied Bunting's climate change vulnerability is impacted by factors related to distribution and movement, which influence its ability to shift in space.

In New Mexico, the Varied Bunting prefers dense areas of mesquite (*Prosopis* spp.) in canyon bottoms but is also found in desert riparian deciduous woodlands and marshes (NMDGF 1988; DeGraaf et al. 1991). This species feeds on a variety of seeds and insects (NMDGF 1988). The Varied Bunting is only found in the extreme southern counties of New Mexico during the breeding season and migrates to Mexico and Guatemala in the winter (NMDGF 1988). This species is a bird of conservation concern for the USFWS. This designation encompasses birds, beyond those that are federally Threatened or Endangered, that represent the highest conservation priorities by the USFWS (USFWS 2021b). Loss of habitat, particularly the loss of dense shrubby riparian habitat, is the main threat to these birds in New Mexico (NMDGF 1994; NMDGF 1996). Fire, livestock grazing, logging, and the use of insecticides are known to adversely affect the Varied Bunting, and the species is sensitive to human presence and activity (NMDGF 2016; NMDGF 2020b). Brown-headed Cowbird nest parasitism may also threaten New Mexico's small breeding populations (NMDGF 1996). The Varied Bunting is known to hybridize with its sister species, the Painted Bunting (*Passerina ciris*) (Storer 1961). Additionally, the Varied Bunting is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Verdin

The Verdin (*Auriparus flaviceps ornatus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Verdin's climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Verdin is a year-round resident in New Mexico, breeding in desert and arid shrub habitat with minimal trees (Baltosser 1991; DeGraaf et al. 1991). The Verdin has experienced a 60% population decline since 1970, likely because of habitat loss, and will likely experience another 50% decline within the next 21 years if the current trend continues (Rosenberg et al. 2016). Despite this anticipated decline, climate change vulnerability modeling results suggest the Verdin will experience a 27% breeding range expansion by 2050, which would result in a 50% expansion in New Mexico (Wilsey et al. 2019a). Climate change will likely exacerbate climatic extremes in aridland habitats, which will push the Verdin's limits for heat tolerance and dehydration as precipitation becomes more variable and heat waves increase in intensity, frequency, and duration (Rosenberg et al. 2016).

Vesper Sparrow

The Vesper Sparrow (*Pooecetes gramineus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Vesper Sparrow's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Vesper Sparrow is found in the northern U.S. during summer for breeding and migrates to the southern U.S. and Mexico during the winter (Ehrlich et al. 1988). The Vesper Sparrow is found throughout New Mexico and breeds in a wide variety of habitats, including grasslands and prairies, savannas, fallow fields and croplands, arid scrub, and woodland clearings (Ehrlich et al. 1988). The sparrow feeds primarily on insects in the summer and grasses and forbs in the winter (Ehrlich et al. 1988; AIBAP 2018). In New Mexico, it is found in the northern portion of the State during the summer and in the southern portion during the winter (Hubbard 1978). Climate-based habitat models project that the Vesper Sparrow's future summer range may contract in New Mexico (Price 2002). The Vesper Sparrow is decreasing in numbers with the primary causes being habitat loss, degradation, and fragmentation (NMDGF 2016; Rosenberg et al. 2016). The species has experienced a 30% population decline since the 1970s (Rosenberg et al. 2016). Additionally, the Vesper Sparrow is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Violet-crowned Hummingbird

The Violet-crowned Hummingbird (*Leucolia violiceps elliot*i) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Violet-crowned Hummingbird's climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Violet-crowned Hummingbird can be found in various landscapes but is primarily found in riparian woodlands at low to moderate elevation (NMDGF 1988; NMDGF 1994). The species feeds on nectar and a variety of small arthropods and is considered an important pollinator (NMDGF 1988; McIntyre 2010). Fires, logging, and livestock grazing have adverse effects on the Violet-crowned Hummingbird. The species is also sensitive to introduced species, habitat fragmentation, and climate change-related variables, especially extreme weather events and the spread of diseases (McIntyre 2010; Hayes 2014; NMDGF 2020b). Avian nest predation has been identified as an important cause of reproductive failure for the Violet-crowned Hummingbird (NMDGF 1996). Additionally, the Violet-crowned Hummingbird is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Violet-green Swallow

The Violet-green Swallow (*Tachycineta thalassina lepida*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Violet-green Swallow's climate change vulnerability is impacted by factors related to movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Violet-green Swallow is typically found in forested landscapes but is also found near bodies of water and sometimes utilizes agricultural land (Stahlecker et al. 1989; DeGraaf et al. 1991). The species feeds on insects, arthropods, and other invertebrates (Williams 1993). The Violet-green Swallow winters primarily south of the Mexican border and is typically in New Mexico during its breeding season (Williams 1993). Forestry, draining of bogs and lakes, use of insecticides, and tall man-made structures can have adverse effects on the Violet-green Swallow (Manville 2000; Hallman et al. 2014). Partners in Flight state the species has experienced a population decline of 19% since 1970 (Rosenberg et al. 2016) while the North American Breeding Bird Survey estimates populations have experienced a decline of about 28% between

1966 and 2015 (Sauer et al. 2017). Climate-based habitat models project that the Violet-green Swallow's future summer range may contract in New Mexico (Price 2002). Additionally, the Violet-green Swallow is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Virginia's Warbler

The Virginia's Warbler (*Leiothlypis virginiae*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Virginia's Warbler's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Virginia's Warbler is typically found in ponderosa pine, chaparral, and piñon-juniper forest types with a dense, tall shrub layer that is critical for foraging and nesting but is also found in urban and agricultural areas (DeGraaf et al. 1991). The species feeds on various insects either from the ground or while flying (Gillihan 2006). The Virginia's Warbler breeds in the southwestern U.S. and migrates to southern Mexico for the winter (Williams 1993). There is documentation the Virginia's Warbler is parasitized by the Brown-headed Cowbird and that livestock grazing near nests significantly increases the chance of brood parasitism occuring (Terres 1980; Gillihan 2006). The Virginia's Warbler is decreasing in numbers and has a limited distribution and restricted range. The species is experiencing habitat loss, degradation, and fragmentation and is easily impacted and disturbed (NMDGF 2015b; NMDGF 2016). The Virginia's Warbler has experienced a 46% decline from 1968 to 2019, with the species' main threats being tropical deforestation, changing forest conditions, and urbanization (Sauer et al. 1997; Rosenberg et al. 2016). The Virginia's Warbler is expected to experience a high degree of climate exposure within its migratory range, and climate change vulnerability modeling results suggest a 38% breeding range decline by 2050 (Rosenberg et al. 2016; Wilsey et al. 2019a).

Western Bluebird

The Western Bluebird (*Sialia mexicana bairdi*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Western Bluebird's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Western Bluebird nests in open ponderosa pine and pine-oak woodlands (DeGraaf et al. 1991; Gillihan 2006; AIBAP 2018). These habitats are threatened by destruction and degradation resulting from stand-replacing fire (although fire can improve foraging and nesting opportunities), intensive logging, and energy exploration and associated resource excavation (NMDGF 2016; AIBAP 2018). Like other bluebirds, the Western Bluebird is a cavity nester, nesting in naturally-occurring cavities, cavities created by woodpecker species, or nesting in nest boxes (Mitchell 1988; Gillihan 2006). They do compete with other cavity nesters such as

European Starlings and House Sparrows, although the impacts of this competition on Western Bluebird populations are unknown (Gillihan 2006; NMDGF 2016). The Western Bluebird is an aerial insectivore; recent studies have shown that neonicotinoid insecticides have adverse effects on non-target species, including aerial insectivores (Hallman et al. 2014). Climate change vulnerability modeling results suggest the Western Bluebird will experience a 29% breeding range loss by 2050, with a 30% loss in New Mexico (Wilsey et al. 2019a).

Western Grebe

The Western Grebe (*Aechmophorus occidentalis*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Western Grebe's climate change vulnerability is impacted by factors related to movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

Western Grebes are aquatic diving birds found in fresh and salt water along western North America (Bent 1919). Within New Mexico, they are found in middle elevations near large bodies of water (Hubbard 1978). The species breeds in the western U.S. and Canada, then migrates to the southwestern U.S. and the western Mexico coastlines (Cornell Lab 2024). The Western Grebe feeds primarily on fish but is opportunistic and will eat insects, mollusks, crabs, aquatic plants, and other aquatic species (Terres 1980; Johnsgard 1987). This species was also identified as a bird of conservation concern by the USFWS. This designation encompasses birds, beyond those that are federally Threatened or Endangered, that represent the highest conservation priorities for the USFWS (2021b). According to the 2022 State of the Birds Report, this species has lost half of its population in the past 50 years. The species' gregarious behavior makes it highly susceptible to mortality because of being coated in oil in wintering areas, and it is vulnerable to disturbances of nesting colonies. Additionally, the Western Grebe is expected to experience a high degree of climate exposure within its migratory range, and climate change vulnerability modeling results suggest a 23% breeding range contraction and 24% winter range contraction by 2050 (Rosenberg et al. 2016; Wilsey et al. 2019a).

Western Kingbird

The Western Kingbird (*Tyrannus verticalus*), also known as the Arkansas Kingbird, will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Western Kingbird's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The species is found throughout New Mexico during its breeding season and inhabits prairie riparian areas, lowland shrublands and woodlands up locally into evergreen woodlands, and urban residential areas with shade trees (Bailey 1928; Hubbard 1978; Williams 1993). The species primarily feeds on insects, with the occasional taking of fruits, seeds, and treefrogs (Bailey 1928; Bent 1942; Ohlendorf 1974). The Western Kingbird is migratory and flies to southern Mexico and into Guatemala in the nonbreeding season (Williams 1993). Western Kingbirds frequently use nest sites with high exposure to the sun, indicating that adults, eggs, and nestlings have physiological adaptations to heat (Smith and Finch 2017). The Western Kingbird can be parasitized by feather lice (*Degeeriella* spp.) and can be the victim of nest parasitism by the Brown-headed Cowbird (Peters 1936; Bent 1942; Terres 1980). The Western Kingbird can hybridize with the Scissor-tailed Flycatcher (*Tyrannus forficatus*) (Terres 1980). Breeding Bird Survey data indicate a significant population increase in central North America in recent decades (Sauer and Droege 1992). The Partners in Flight indicate a 20% population increase but a decrease in population distribution since 1970 (Rosenberg et al. 2016). Overall, the species is common throughout the western portion of the U.S. and is apparently tolerant of ecological changes but can be adversely affected by vegetation changes, such as mechanical thinning (USFS 1982; Wilsey et al. 2019b). Additionally, the Western Kingbird is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Western Meadowlark

The Western Meadowlark (*Sturnella neglecta*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Western Meadowlark's climate change vulnerability is impacted by factors related to movement and evolutionary potential, which influence its ability to shift in space and respond to climate change impacts.

The Western Meadowlark does not occupy forests or wetlands and is found exclusively in open areas such as grasslands, savannas, pastures, and cultivated fields (Ehrlich et al. 1988; AIBAP 2018). Mowing and other agricultural practices are known to destroy nests or cause nest desertion (Wilsey et al. 2019b). The Western Meadowlark feeds on insects in the warmer months and grains and seeds in the colder months (Schmidt 1989; AIBAP 2018). The species is migratory and winters in northern and central Mexico. Partners in Flight indicate a 77% population decline since 1970 (Rosenberg et al. 2016). Climate-based habitat models project that the Western Meadowlark's future summer range will undergo little change in New Mexico (Price 2002). However, the Western Meadowlark is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Western Sandpiper

The Western Sandpiper (*Calidris mauri*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Western Sandpiper's climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

Western Sandpipers breed along the coast of Alaska, migrate regularly through New Mexico, and winter irregularly in the State (Hubbard 1978; Howe 2021). They are found along shorelines, mudflats, sandbars, and playas at 900 to 1,500 m (2,800 to 5,500 ft) elevation (Baltosser 1991; Howe 2021). The Western Sandpiper has a restricted breeding range across a specific habitat type, with large aggregations during migration and wintering periods such that a single catastrophic event can impact a large percentage of the global population (Franks et al. 2014). Climate change vulnerability modeling results suggest the Western Sandpiper will experience a 77% breeding range loss by 2050 (Wilsey et al. 2019a).

Western Wood-Pewee

The Western Wood-Pewee (*Contopus sordidulus)* will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Western Wood-Pewee's climate change vulnerability is impacted by factors related to movement, life history, and evolutionary potential, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The species is found throughout New Mexico during its breeding season in warmer months (Hubbard 1987; Williams 1993). They occur in riparian woodlands, wooded lowlands, and riparian prairies (Hubbard 1978; Chase et al. 1982). The Western Wood-Pewee primarily feeds on invertebrates but is also known to occasionally eat berries and seeds (Bent 1942; Shook 2017). The Western Wood-Pewee is considered to be declining in numbers in New Mexico (Rosenberg et al. 2016). Partners in Flight indicate a 47% population decline since 1970 (Rosenberg et al. 2016). The Western Wood-Pewee is occasionally a Brown-headed Cowbird brood parasitism victim (Bent 1942; Terres 1980). This species is known to shun disturbances but seems to have neither a positive nor a negative response to fire (Elrich et al. 1988; Sallabanks and McIver 1998). Additionally, the Western Wood-Pewee is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Whiskered Screech-Owl

The Whiskered Screech-Owl (*Megascops trichopsis asperus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Whiskered Screech-Owl's climate change vulnerability is impacted by factors related to life history and abiotic niche, which influence its ability to persist in place and respond to climate change impacts.

The Whiskered Screech-Owl prefers pine-oak woodlands but can also be found in desert scrub and marsh areas (DeGraaf et al. 1991; NMDGF 1994). The owl nests in natural cavities and will mostly utilize abandoned woodpecker holes (Scott et al. 1977). The Whiskered Screech-Owl is decreasing in numbers; has a limited range and restricted distribution; and is easily disturbed and impacted, especially by human activity (NMDGF 1996; NMDGF 2016; Rosenberg et al. 2016). Vegetation removal and wildfires can cause a loss of habitat and are the principal threats to the Whiskered Screech-Owl in New Mexico (NMDGF 1996). The global population of the Whiskered Screech-Owl is estimated to have decreased 15 to 50% in the past 44 years (Rosenberg et al. 2016).

White-eared Hummingbird

The White-eared Hummingbird (*Basilinna leucotis borealis*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The White-eared Hummingbird's climate change vulnerability is impacted by abiotic niche factors, which influence its ability to respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The White-eared Hummingbird is found in moist pine and pine-oak zones in New Mexico, typically in the summer, and winters in Mexico and Central America in similar areas (NMDGF 1988; NMDGF 1996). As is typical with other hummingbirds, the White-eared Hummingbird feeds on flower nectar and insects (NMDGF 1988). The White-eared Hummingbird is experiencing habitat loss, fragmentation, and degradation and is affected by pollutants and contaminants (NMDGF 2020b). The species is sensitive to introduced species, roads, logging, livestock grazing, and mining (NMDGF 2020b). Climate change will have adverse effects on the White-eared Hummingbird through associated extreme weather events and spread of diseases (McIntyre 2017). Additionally, the White-eared Hummingbird is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

White-tailed Ptarmigan

The White-tailed Ptarmigan (*Lagopus leucura altipetens*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The White-tailed Ptarmigan's climate change vulnerability is impacted by factors related to distribution, evolutionary potential and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is impacted by anthropogenic or topographic barriers and biologic factors, which could increase the effects of climate change. It also has documented or modeled responses to climate change that impact its vulnerability score.

The species is found mostly in major alpine landscapes, mainly above 3,200 m (10,500 ft) in elevation, where their habitat complexes allow for year-round occupancy. They occasionally forage and roost in riparian areas, meadows, or burned areas at lower elevations during the winter (Braun et al. 2015; NMDGF 2017c). The White-tailed Ptarmigan feeds on buds, leaves, flowers, insects, and other arthropods (NMDGF 1988). Hatchlings are precocial, leaving the nest within 12 hours of hatching, and born covered in dense down with their eyes open (NMDGF

2017c). The White-tailed Ptarmigan is experiencing habitat loss, degradation, and fragmentation and is easily impacted and disturbed (NMDGF 2016). Use of the ptarmigan's habitat by livestock and humans that results in disturbance is a principal threat to the species in New Mexico. Additionally, the White-tailed Ptarmigan is preyed upon by numerous species including skunks (*Mustela* spp.), Prairie Falcons, Coyotes, and Golden Eagles, among others (NMDGF 2017c). A bioclimatic modeling study indicated that through 2070, for multiple climate change Scenarios, that suitable bioclimatic conditions for the White-tailed Ptarmigan are likely to decline throughout its range and only about 17% of its current range is likely to remain stable by 2070 (Salas et al. 2017b).

White-throated Swift

The White-throated Swift (*Aeronautes saxatalis saxatalis*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The White-throated Swift's climate change vulnerability is impacted by movement factors, which influence its ability to shift in space.

In New Mexico, the White-throated Swift occurs in various landscapes such as mountains, canyons, cliffs, and riparian areas, but this species prefers areas where flying insects are most abundant (DeGraaf et al. 1991). They use cliffs for nesting and are generally found at mid elevations (1,520 to 2,300 m [5,000 to 7,500 ft]) (DeGraaf et al. 1991). While the White-throated Swift is migratory, it is found in New Mexico year round. The species feeds primarily on insects, typically over water or in mud flats, making this species highly associated with water (Thomas 1979; Baltosser 1991). Swifts are apparently tolerant of ecological disturbances if their nesting habitat is maintained (USFS 1981). However, as of 2016, there has been a 48% decline in total numbers of White-throated Swift since 1970 (Rosenberg et al. 2016). The White-throated Swift is expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Williamson's Sapsucker

The Williamson's Sapsucker (*Sphyrapicus thyroideus nataliae*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Williamson's Sapsucker's climate change vulnerability is impacted by factors related to distribution and movement, which influence its ability to shift in space. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Williamson's Sapsucker resides in old-growth coniferous and mixed forests above 2,400 m (8,000 ft) elevation (van Riper et al. 2014; Howe 2021). It uses snags, stumps, and trunks for nesting sites, preferring aspen (*Populus* spp.) over conifer trees for nesting (Bent 1939; van Riper et al. 2014). It primarily feeds in pines (Crockett and Hadow 1975). These habitats are threatened by destruction and degradation resulting from intensive logging and fire, which could increase in intensity, frequency, and severity due to climate change (NMDGF 2016). The Williamson's Sapsucker is a year-round resident in some portions of New Mexico and the State represents winter habitat for birds that breed in the northern portion of their range (Hubbard 1978). They exhibit high site fidelity (Ingold 1991). While adults are diet generalists, nestlings primarily feed on ants (Gyug et al. 2023). Climate change vulnerability modeling results suggest the Williamson's Sapsucker will experience a 51% breeding range loss by 2050; that decline would result in a 50% breeding range loss in New Mexico (Wilsey et al. 2019a).

Wilson's Warbler

The Wilson's Warbler (*Cardellina pusilla*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Wilson's Warbler's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Wilson's Warbler is found in a variety of landscapes including various forest types, desert scrub, agricultural lands, and riparian areas (DeGraaf et al. 1991; USFS 2020). The species' diet is primarily invertebrates such as insects, spiders, beetles, and caterpillars (Stewart et al. 1978). The Wilson's Warbler is migratory and spends its breeding season mostly north of the Canadian border and its nonbreeding season mostly south of the Mexican border (AOU 1998). The species' nesting behaviors are incompatible with heavy livestock use of streams and the species is sensitive to human presence and activity while nesting (USFS 1982). The Wilson's Warbler is considered a common Brown-headed Cowbird brood parasitism victim (Terres 1980). Insecticides, forestry, and tall buildings can have an adverse effect on the Wilson's Warbler (Hawks Aloft 2011; USFS 2020). There has been a 57% population decline of the Wilson's Warbler since 1970 (Rosenberg et al. 2016). Habitat degradation, sedimentation resulting from post-wildfire erosion, grazing, recreation, motorized travel, and changes in hydrology can negatively affect this species (USFS 2020). Additionally, the Wilson's Warbler is also expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Woodhouse's Scrub Jay

The Woodhouse's Scrub Jay (*Aphelocoma woodhouseii*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Woodhouse's Scrub Jay's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

This species is found in various landscapes including woodlands, grasslands, desert scrub, and riparian areas (DeGraaf et al. 1991). The Woodhouse's Scrub Jay is omnivorous and feeds on invertebrates, small vertebrates, small fruits, acorns, and pine nuts (Gillihan 2006). The Woodhouse's Scrub Jay is non-migratory and is a relatively sedentary species with territories averaging 1.5 to 3 ha (3.7 to 7.4 ac) (Chesser et al. 2016). The species is sensitive to noise disturbances and can have adverse effects (Francis and Cruz 2005). Fire is essential to maintenance of the scrub jay's habitat but it can destroy their nests during the breeding season (FEIS 1996). *Aphelocoma woodhouseii* is treated as a species separate from *Aphelocoma californica* due to differences in ecology, morphology, genetics, and vocalizations. Although the two species do interbreed, the hybrid zone is narrow, and there is evidence for selection against hybrids (Chesser et al. 2016). Climate-based habitat models project that the Woodhouse's Scrub Jay's future summer range may exclude New Mexico (Price 2002).

Yellow-billed Cuckoo (Eastern Population)

The eastern population of the Yellow-billed Cuckoo (*Coccyzus americanus americanus*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Extremely Vulnerable under the RCP 8.5 Scenario. The Yellow-billed Cuckoo's climate change vulnerability is impacted by factors related to movement, ecological role and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The eastern population of the Yellow-billed Cuckoo is a federal species of concern but is not federally listed. This species breeds north of the Mexican border and winters south of the Mexican border (Williams 1993). The Yellow-billed Cuckoo is primarily found in riparian areas but can also be found utilizing agricultural lands and residential areas (Chase et al. 1982; Rosenberg et al. 2016). Declines in population numbers are consistently reported due to the loss or disturbance of riparian habitat (Finch 1992). The Yellow-billed Cuckoo primarily feeds on caterpillars but will, if only rarely, eat various other insects and small fruits (Howe 1986). Because the Yellow-billed Cuckoo relies heavily on caterpillars for their diet, population numbers fluctuate with changes in caterpillar abundance (Finch 1992). The greatest factor influencing Yellow-billed Cuckoos has been the invasion of exotic woody plants into southwestern riparian systems and the destruction of riparian systems for agricultural use, development, and other anthropogenic activities (Howe 1986). Partners in Flight indicate a 54% decrease in population of Yellow-billed Cuckoos since 1970 (Rosenberg et al. 2016). Additionally, the Yellow-billed Cuckoo is also expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016).

Yellow-billed Cuckoo (Western Population)

The western population of the Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Extremely Vulnerable under the RCP 8.5 Scenario. The Yellow-billed Cuckoo's climate change vulnerability is impacted by factors related to movement, ecological role, evolutionary potential, and abiotic niche, which influence its ability to shift in space respond to climate change impacts.

The Yellow-billed Cuckoo is migratory and generally winters south of the Mexican border (MNMB 1992). The species is a riparian-obligate species, with tamarisk (*Tamarix* spp.)-dominated riparian woodlands being designated as critical habitat for the species (AGFD 1988; Hathcock et al. 2017; NMDGF 2017b). Because the Yellow-billed Cuckoo's habitat is rare and populations are small and isolated, the species is increasingly susceptible to further declines resulting from lack of immigration, extreme weather events, fluctuating availability of prey, pesticides, livestock grazing, changes in water flow and water table levels, tall structure strikes, invasive species (tamarisk leaf beetle [*Diorhabda* spp.], exotic woody plants, etc.), and other factors related to climate change (i.e., besides extreme weather events and changes in hydrology) (USFWS 2013e). Caterpillars form a primary component of the Yellow-billed Cuckoo's diet but they also, if only rarely, feed on small fruit and other invertebrates (Howe 1986). Because the Yellow-billed Cuckoo relies heavily on caterpillars for their diet, population numbers fluctuate with changes in caterpillar abundance (Finch 1992). Additionally, the cuckoo tightly synchronizes nest timing with the local summer peak in cicada abundance (Stanek et al. 2021). The species prefers temperatures from 18 to 32°C (65 to 90°F) (Stanek et al. 2021). The greatest factor influencing Yellow-billed Cuckoos has been the invasion of exotic woody plants into southwestern riparian systems and the destruction of riparian systems for agricultural use, development, and other anthropogenic activities (Howe 1986). Partners in Flight indicate a 54% decrease in the population of Yellow-billed Cuckoos since 1970 (Rosenberg et al. 2016). The Yellow-billed Cuckoo is also expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016). Climate change will likely have adverse effects on the species through phenology changes expected under future climatic conditions and reduce the quantity of available habitat, further exacerbating the vulnerability of the species' sensitive, isolated populations (USFWS 2009d). The western population of the Yellow-billed Cuckoo has experienced more population decline and reduction in habitat than the eastern population.

Yellow-eyed Junco (Arizona Yellow-eyed Junco)

The Yellow-eyed Junco (*Junco phaeonotus palliatus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Yellow-eyed Junco's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The Yellow-eyed Junco is a non-migratory passerine that occurs in the far southwestern corner of New Mexico, within Grant, Hildalgo, and Otero Counties (NMDGF 2016). The species is typically found in forested areas but can also occupy desert scrub and marshes during the winter (NMDGF 1988; DeGraaf et al. 1991). The bird's diet consists largely of seeds while insects are fed to their young (NMDGF 1988). The Yellow-eyed Junco is known to hybridize with other *Junco* species (*Junco hyemalis hyemalis; aikeni; cismontanus; mont*) (NMDGF 1988; Williams 1997). The species is in low numbers within New Mexico and is threatened by habitat loss, degradation, and fragmentation (NMDGF 2016). In one study, predation was the main cause of nestling and fledgling mortality (Sullivan 1989; Sullivan 2020). Because of the limited numbers and range of the New Mexico population, the Yellow-eyed Junco could be threatened by habitat loss or destruction including that resulting from fires, disease, logging, or pollution (NMDGF 2016).

Yellow-headed Blackbird

The Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Yellow-headed Blackbird’s climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Yellow-headed Blackbird’s habitat is typically riparian or marsh areas, and the species prefers tall, permanently-flooded, emergent wetlands (Baltosser 1991; DeGraaf et al. 1991). Limiting factors include water levels, food supply, and potentially presence of pesticides in the environment (Baltosser 1991; Hallman et al. 2014). The diet of these birds includes plants, invertebrates, and animals (Fischer and Bolen 1981). The Yellow-headed Blackbird is highly migratory and is found throughout New Mexico. The species is found in the northern portion of New Mexico during its breeding season and in the southern portion of New Mexico during its nonbreeding season (Twedt and Crawford 2020). In New Mexico, Yellow-headed Blackbirds are decreasing in numbers, and the species has declined by 9% since 1970 (Rosenberg et al. 2016). The Yellow-headed Blackbird is also expected to experience a high degree of climate exposure within its migratory range (Rosenberg et al. 2016). Climate-based habitat models project that, in the future, the bird’s summer range may exclude New Mexico (Price 2002).

APPENDIX 3. Assessment summaries for all fish Species of Greatest Conservation Need.

Arkansas River Shiner (Native Population)

The Arkansas River Shiner (*Notropis girardi*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a Climate Change Vulnerability Index (CCVI) ranking of Highly Vulnerable under both Representative Concentration Pathway (RCP) 8.5 Scenarios. The Arkansas River Shiner's climate change vulnerability is impacted by factors related to distribution, movement, evolutionary potential and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by anthropogenic or topographic barriers, land-use changes, other anthropogenic factors, and biologic factors that could increase the effects of climate change on this species.

This shiner species was once widespread throughout the western portions of the Arkansas River basin in Arkansas, Kansas, New Mexico, Oklahoma, and Texas, but has been extirpated from 80% of its historical range (USFWS 1998c). It is currently restricted to two separate, geographically isolated populations within the South Canadian River (USFWS 2023f) in New Mexico, Oklahoma, and Texas, with the native population likely occupying less than 1,000 km^2 (621 mi^2) (USFWS 2005a). A non-native introduced population occurs in the Pecos River in New Mexico, which is outside of the species' historical range (Bestgen et al. 1989). Designated critical habitat consists of 856 km (532 mi) of linear distance of rivers and 91.4 m (300 ft) of adjacent riparian areas within Kansas and Oklahoma; no critical habitat was designated in New Mexico or Texas (USFWS 2005a). The species inhabits wide, shallow, sandy-bottomed rivers and larger streams in the western portion of the Arkansas River basin (USFWS 2023f). Occupied waters are generally meandering with little shade, highly variable flows and water temperature, and high evaporation rates and concentrations of dissolved solids (NMDGF 1988; Sublette et al. 1990). The species is a generalized forager, feeding on invertebrates suspended in the water column and decaying organic material lying on the streambed (USFWS 2018b). While the species may be tolerant of adverse conditions associated with drought, elevated water temperatures, and low dissolved oxygen concentrations, it does require adequate water flow and quality for successful reproduction, recruitment, and maintenance of viable populations (USFWS 2018b). Relative abundance has fluctuated over time under various environmental conditions, including recurring drought, yet the South Canadian River continues to support genetically-diverse populations (highest in the introduced Pecos River population, which may indicate that this region has served as a climate change refugia for this species) (Osborne et al. 2010; Osborne et al. 2021). The most significant threats to the shiner include habitat destruction and modification from stream dewatering or depletion resulting from the diversion of surface water and groundwater pumping, construction of impoundments and diversions, and water quality degradation, all of which have fragmented habitats and altered stream flows (USFWS 2018b). Under the RCP 8.5 Scenario, increased annual maximum temperatures and evapotranspiration are the climate variables that will have the most significant effects on this species. Additionally, prolonged drought (addressed as effects from storms in the index) will increase the vulnerability of this species to climate change (USFWS 2018b).

Bigscale Logperch

The Bigscale Logperch (*Percina macrolepida*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Bigscale Logperch's climate change vulnerability is primarily impacted by anthropogenic or topographic barriers and other biologic factors that could increase the effects of climate change on this species.

There are significant data gaps regarding the species' genetic diversity, life history, population structure, and the extent and magnitude of threats it currently faces. The index score could change as these gaps are filled. The native range of the species extends from Louisiana, Oklahoma, and Arkansas to Texas, New Mexico, and Mexico; however, its status as native/non-native within the Arkansas River basin is unclear (Buchanan and Stevenson 2003). The species was introduced in the Arkansas River basin in southeastern Colorado and northeastern New Mexico, and records from western Oklahoma also likely represent introductions (Cashner and Matthews 1988; Sublette et al. 1990; Fuller et al. 1999). It was also introduced in the Sacramento-San Joaquin river drainage in central California (Moyle 2002). In New Mexico, its native range encompass the Pecos and Black Rivers; the introduced range is within the Ute Reservoir on the South Canadian River (Sublette et al. 1990). It still occupies its historical range within the State, but localized abundance in this historical range is in decline (NMDGF 2020b). Abundance in the Arkansas River basin, within its introduced range, has likely increased due to the construction of the McClellan-Kerr Arkansas River Navigation System (Buchanan and Stevenson 2003). While the adult population of the species throughout its range is thought to be relatively large, the exact population size is unknown (Buchanan and Stevenson 2003). Habitat is generally unshaded, broad, moderately-deep rivers with rubble and gravel substrates (Sublette et al. 1990), or silty, shifting sand bottoms (Lee et al. 1980; Page and Burr 2011). Food items consist primarily of small invertebrates that are released from shifting substrates or drift downstream on the current (Cross and Collins 1995; Sublette et al. 1990). The species has limited available habitat within the State and is threatened by predation by non-native species and fluctuating water levels and desiccation of habitats driven by man-made barriers and climate change (NMDGF 2016). Based on projections of the impacts of increased temperatures and altered precipitation regimes on aquatic ecosystems, the Bigscale Logperch will likely experience negative climate-related impacts on its geographic range and abundance (Sievert et al. 2022).

Blue Sucker

The Blue Sucker (*Cycleptus elongatus*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Blue Sucker's climate change vulnerability is impacted by factors related to movement, demography, and life history, which influence its ability to shift in space and persist in place.

New Mexico is at the edge of the species' range. The historical range of the species includes large rivers throughout most of the eastern half of the United States (U.S) and into Mexico (USFWS 1994a), including the Mississippi-Missouri River system and western Gulf Coast drainages. The historical range in New Mexico included the Pecos River from Carlsbad downstream to the Texas border and the lower reaches of the Black River (Sublette et al. 1990). There is some evidence to suggest that the species also occurred in the Rio Grande in New Mexico, but its presence there has never been verified (NMDGF 2020b). Genetic research shows that the form of *Cycleptus* sp. in the Rio Grande drainage, including the Pecos River, may warrant recognition as a separate species; however, it has yet to be described in the literature (Burr and Mayden 1999; Bessert 2006). Populations in New Mexico have declined significantly since 2002 due to recurring outbreaks of toxic golden algae (*Prymnesium parvum*) in some reaches of the Pecos River, where the sucker is now thought to be extirpated. Additionally, it is unknown if the Black River supports a self-sustaining population as sampling efforts in 2012 and 2013 recorded extremely-low densities (Caldwell 2013; NMDGF 2020b). Overall, abundance is reduced on the edges of the species' range due to dam construction and impacts to water quality from siltation and pollution (NMDGF 1988). The long-term, projected population trend shows a 50 to 70% decline throughout the sucker's range (NatureServe 2024). The Blue Sucker is most common in rivers with hard-bottom substrates, deep channels, pools with moderately fast-flowing water, and deep lakes (NMDGF 1988). The species are bottom feeders whose prey consists of aquatic insects, insect larvae, crustaceans, plant material, and algae (NMDGF 1988; USFWS 1993). Primary threats to the species include habitat fragmentation by dams and other barriers, loss of high-velocity habitats, contaminants, stranding in canals, and toxic conditions caused by golden algae. Oil and gas development poses an increasing threat to water quality and quantity in the Black River drainage (NMDGF 2020b). Water quality impacts from sewage effluent and agricultural runoff have also affected this species. It appears to tolerate high turbidity provided the current is sufficient to prevent silt deposition (Pflieger 1997). Based on projections of the impacts of increased temperatures and altered precipitation regimes on aquatic ecosystems, the Blue Sucker will likely experience negative climate-related impacts on its geographic range and abundance (Sievert et al. 2022).

Central Stoneroller

The Central Stoneroller (*Campostoma anomalum*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Central Stoneroller's climate change vulnerability is impacted by barriers, land-use changes, other anthropogenic impacts and biologic factors that could increase the effects of climate change. It also has documented or modeled responses to climate change that impact its vulnerability score.

New Mexico is at the edge of the species' range. The range of the Central Stoneroller includes much of the central and eastern U.S., southeastern Canada, and the Rio Grande and Rio San Juan basin in Mexico (Page and Burr 2011). In New Mexico, the historical native distribution includes the Arkansas, Canadian, and Pecos Rivers and some of their tributaries. Introductions occurred in the Rio Grande near Albuquerque, the Rio San Jose, and the Gila River drainage where it is thought to be extirpated (Sublette et al. 1990). Holm and Crossman (2001) suggest the Central Stoneroller is either secure or apparently secure in all but two states throughout its geographic range. In North Dakota they are listed as vulnerable and in Louisiana they are listed as imperiled. They are not listed as Threatened or Endangered under the federal Endangered Species Act (ESA). The status of the species appears to be relatively stable, as there are greater than 300 element occurrences that constitute numerous subpopulations. No range-wide threats are currently known, and the current population seems relatively stable; the species has also expanded its geographic range and abundance in Ontario, Canada as a result of introductions and naturalization (Holm and Crossman 2001). In New Mexico, the species' distribution has been altered by human activities (NMDGF 2024). Food availability, excessive siltation and pollutants and impoundment and channelization of streams have affected the species in some regions (McAllister 1987; Jenkins and Burkhead 1994). The black spot parasite (*Uvulifer* sp.) and predation by piscivorous fishes and avian species may also affect the stoneroller (McKee and Parker 1982; Holm and Crossman 2001). Development, deforestation, and loss of riparian vegetation have also been identified as potentially having a negative influence on the species, although the extent and magnitude of these threats have not been quantified (NMDGF 2024). Based on projections of the impacts of increased temperatures and altered precipitation regimes on aquatic ecosystems, the Central Stoneroller will likely experience negative climate-related impacts to its geographic range and abundance (Sievert et al. 2022).

Chihuahua Chub

The Chihuahua Chub (*Gila nigrescens*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Extremely Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Chihuahua Chub's climate change vulnerability is impacted by factors related to distribution, evolutionary potential and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is impacted by barriers, land-use changes, other anthropogenic factors and biologic factors that could increase the effects of climate change. It also has documented or modeled responses to climate change that impact its climate change vulnerability score.

This species is restricted to tributaries of the endorheic Guzmán basin, including the Mimbres River in New Mexico and the Guzmán and Laguna Bustillos basins in Chihuahua, Mexico (Sublette et al. 1990; Propst and Stefferud 1994; Page and Burr 2011). The species has declined dramatically in both range and abundance (Propst and Stefferud 1994), and Miller et al. (2005) reported that "this species has been eliminated over the past 35 years from at least half its original range." There are approximately 345 km (215 mi) of potentially-occupied habitat in Chihuahua where it has only been observed in remote stream reaches that are largely unaffected by human activities and where non-native predatory fishes are absent (NMDGF 2020b; USFWS 2023a). However, most of the potentially-occupied habitat in Chihuahua has not been surveyed (Propst and Stefferud 1994). In New Mexico, the Mimbres River and its tributaries Relatively recent surveys of the Mimbres River population revealed upstream dispersal had occurred in the system, since the last status review, to Monument and Cooney Canyons (USFWS 2023a). Surveys and genetic analysis suggest the range has increased by 43 km (27 mi), for a total of 58 km (36 mi) of potentially-occupied river. Stocking efforts using hatchery fish augmented the range expansion, but the species continues to disperse upstream from the limited stocking locations (USFWS 2023a). The short-term population projection is a decline of 10 to 30%, with the long-term trend being 50 to 70% (Miller and Chernoff 1979; Propst and Stefferud 1994; Miller et al. 2005). While there are ongoing efforts to recover the species within protected habitats in New Mexico, the U.S. Fish and Wildlife Service (USFWS) has determined the species should be upgraded to Endangered under the federal ESA (currently listed as Threatened; NMDGF 2020b; USFWS 2023a). The species is typically observed in pools with tree root masses used for cover in permanently-watered stream reaches; it was rare or absent where non-native fishes (i.e., predators) were common (Propst and Stefferud 1994). The chub feeds primarily on aquatic invertebrates, and spawns in spring, and possibly into the fall, in pools with beds of aquatic vegetation (USFWS 1983; Propst et al. 1999). At the time of listing, threats to the species included habitat loss and modification from channelization, development of flood levees, diversion of surface water for irrigation, dam construction, pollution, deforestation, and excessive groundwater pumping, most of which result in desiccation of stream habitats. Modification of the Mimbres River resulting from agricultural development and construction of flood control infrastructure eliminated much of the natural deep pools and undercut bank habitats utilized by the chub. Subsequent to these modifications, the species was limited to one small section of the river (USFWS 1983). In Chihuahua, water quality degradation, surface water diversion, groundwater pumping, stream channelization, and introduction of non-native fishes have contributed to its decline (Miller and Chernoff 1979). Wildfire in New Mexico has also impacted the species and its habitats through substantial inputs of ash following post-fire rain events (NMDGF 2020b). While there is a lack of data specific to the physiological and behavioral tolerances of the species, its extremely restricted range and small population sizes make it susceptible to any environmental changes. The local and regional effects of the anthropogenic activities that threaten the chub are expected to increase as the human population grows and development increases. Climate change is expected to cause increases in air and water temperatures, which have already been documented on the Mimbres River. Warmer water temperatures may have a variety of impacts on the Chihuahua Chub, including increased susceptibility to disease, changes in prey base, increased exposure to ash flows following forest fires and rain events, decreased water quality, and increased competition and/or predation from non-native species (USFWS 2023a).

Colorado Pikeminnow

The Colorado Pikeminnow (*Ptychocheilus lucius*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Colorado Pikeminnow's climate change vulnerability is impacted by factors related to movement and demography which influence its ability to shift in space and persist in place. It is also impacted by barriers, land-use changes, other anthropogenic factors, and biologic factors that could increase the effects of climate change. It also has documented or modeled responses to climate change that impact its climate change vulnerability score.

Historically, the species occupied warm waters of the Colorado River system, which includes the mainstem and major tributaries (Animas, Dolores, Green, Gunnison, San Juan, Uncompahgre, White, and Yampa Rivers) from Mexico and Arizona to Wyoming. It was extirpated from most of its historical range by the early 1970s, including the entirety of the lower Colorado River basin; it now occupies roughly 25% of its former range (Sublette et al. 1990). These declines were largely due to human activities, such as construction of large dams and water use that altered river flows and restricted the fish's movement. The species was included on the 1967 federal List of Endangered Species (USFWS 1967). A total of 1,848 river km (1,148 mi) were designated as critical habitat for this and three other Colorado River species in 1994 in Colorado (583 km; 583 mi), Utah (1,168 km; 726 mi), and New Mexico (97 km; 60 mi) (USFWS 1994b). This represents approximately 29% of the historical range of the Colorado Pikeminnow, which now occurs in three populations in the Green River, upper Colorado River, and San Juan River subbasins within approximately 1,740 km (1,081 mi) of riverine habitat (USFWS 2011d). As part of the recovery effort for this species, reintroduction programs were implemented, including one within the San Juan River subbasin; these efforts are ongoing. An experimental, non-essential population of Colorado Pikeminnow was also designated in the Salt and Verde Rivers of the Gila River subbasin, but individuals stocked into these two tributaries since the 1980s do not appear to have established a population (USFWS 2022e). The trend over the past 10 years appears to have been relatively stable; the Green River adult population declined then increased in the early 2000s, and recruitment increased during this period as well (USFWS 2011d). The Colorado River adult population size and recruitment rates were relatively stable in the 1990s and 2000s, but the projected long-term population trend shows a continued decline and low population resiliency (USFWS 2011d; USFWS 2022e). The species utilizes a variety of environments that change over the course of its life cycle within larger rivers in the Colorado River basin. Larvae and juveniles inhabit calm, warm backwaters and low-velocity areas. As they mature, larger juveniles and adults establish home ranges that include pools, deep runs, and eddies where they can forage (USFWS 2023g). While the species can migrate long distances to find suitable spawning bars comprised of loose, clean cobbles and gravel, they may spawn closer to their home range if suitable sites are available, and does depend upon environmental cues, such as declining spring flows and increasing water temperatures, to determine spawning timing (Dibble et al. 2023). Young feed primarily on insects and crustaceans, and adults are obligate piscivores (NMDGF 1988). Colorado Pikeminnow continues to endure threats from habitat fragmentation, entrainment through diversions and entrapment in impoundments, reduction in habitat-regulating flows, contamination of water, and predation of young by and competition with non-native predatory fishes (USFWS 2022e). There is uncertainty regarding the effects of climate change on the Colorado Pikeminnow. It will likely have large impacts on the Colorado River basin's aquatic ecosystems, such as changes in the timing of peak flows due to earlier snowmelt; changes in the volume of peak flows because of altered snowpacks; higher water temperatures resulting from increased air temperature; greater evaporation rates, which will lead to drier conditions; and changes in water management of the reservoir system, all of which will affect the environmental cues the species relies upon throughout its life cycle (USFWS 2011d).

Desert Sucker

The Desert Sucker (*Catostomus clarkii*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under the RCP 4.5 Scenario and Extremely Vulnerable under the RCP 8.5 Scenario. The Desert Sucker's climate change vulnerability is impacted by factors related to distribution and abiotic niche, which influence its ability to shift in space and respond to climate change. It is impacted by barriers, land-use changes, other anthropogenic factors and biologic factors that could increase the effects of climate change. It also has documented or modeled responses to climate change that impact its climate change vulnerability score.

The range of the species includes the Colorado River basin below the Grand Canyon in Arizona, Nevada, New Mexico, Utah, and northern Sonora, Mexico. Different subspecies occur in the White River system (subspecies *intermedius*), in the Meadow Valley Wash and Clover Creek (undescribed subspecies) in Nevada, and in the Virgin River basin in Utah, Arizona, and Nevada (subspecies *utahensis*) (Sublette et al. 1990; Page and Burr 2011). It has been extirpated in the Pahranagat Valley and is very rare in the upper White River valley except in Lund town Spring in Nevada (Deacon and Williams 1984). Miller et al. (2005) mapped two sites where this species occurs in northern Sonora (Rios Santa Cruz and San Pedro). Changes in distribution, abundance, and habitat quality are not well documented, but the species appears to be relatively stable or slowly declining, based on an estimated 13.5% decline in the lower Colorado River basin (Olden and Poff 2005), where it appears to persist in much of its historical habitat (Minckley and Marsh 2009). While the total adult population size is unknown, it likely exceeds 10,000 individuals (Sigler and Sigler 1996; Page and Burr 2011). Mapping efforts in the 1990s identified over 130 collection sites within the species range (Sublette et al. 1990; Texas Natural History Collections 1997). Habitat consists of small to medium rivers with pools and riffles over gravel-rubble bottoms with sandy silt in interstices, and the species appears to avoid or is unable to persist in reservoirs and lakes (Sublette et al. 1990; Minckley and Marsh 2009). Young tend to gather in quiet water among aquatic plants or algae and move into swifter water (i.e., 5 - 50 cubic feet per second mean annual flow) as they increase in size (Sublette et al. 1990; Sigler and Sigler 1996; Minckley and Marsh 2009). This sucker tolerates a wide range of temperatures but is relatively intolerant of low dissolved oxygen levels (Lowe et al. 1967; Sublette et al. 1990). Spawning occurs on gravel-and-cobble bottoms of riffles and rapids, generally in July and August in New Mexico (Sublette et al. 1990; Miller et al. 2005; Minckley and Marsh 2009). This species has morphologically-specialized, tough-sheathed jaws that are used to scrape food from stones and other surfaces. Diet generally includes algae and associated invertebrates, such as midges and mayflies, and detritus (Clarkson and Minckley 1988; Sigler and Sigler 1996). This species is considered to be in imminent danger of becoming threatened throughout all or a significant portion of its range. Threats such as habitat dewatering, dams, pollution, introductions of exotic turtles and fishes (e.g., red shiner [*Cyprinella lutrensis*]), and hybridization with other species of suckers continue to influence its status throughout its range, including the status of populations in Mexico (Jelks et al. 2008; NMDGF 2016). Based on projections of the impacts of increased temperatures and altered precipitation regimes on aquatic ecosystems, the Desert Sucker will likely experience negative climate-related impacts on its geographic range and abundance (Sievert et al. 2022).

Gila Chub

The Gila Chub (*Gila intermedia*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Gila Chub's climate change vulnerability is impacted by factors related to distribution and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is impacted by barriers, land-use changes, other anthropogenic effects, and biologic factors that could increase the effects of climate change. It also has documented or modeled responses to climate change that impact its climate change vulnerability score.

Note on taxonomy: In 2016, the American Fisheries Society and the American Society of Ichthyologists and Herpetologists Joint Committee on the Names of Fishes determined that the Gila Chub and the Headwater Chub (*G. nigra*) are part of a single taxon—the Roundtail Chub (*G. robusta*) (USFWS 2017a). In 2017, the USFWS withdrew a proposal to list as separate entities the Headwater Chub and the Roundtail Chub (USFWS 2017c); however, the entity, *G. intermedia* (invalid taxon per ITIS 2024) currently remains listed under the federal ESAt but may be proposed for delisting in the future (USFWS 2022c). Due to this accepted taxonomic revision, *G. intermedia* is no longer considered a separate taxonomic entity by NMDGF and is no longer state-listed as Endangered (NMDGF 2018b).

Historically, this species occurred in the upper Gila River basin in southern Arizona, southwestern New Mexico, and northeastern Sonora, Mexico (USFWS 2005b; Miller and Lowe 1964; Minckley 1973; Page and Burr 2011). The majority of the range is in Arizona, where small remnant populations remain in six of the eight historical drainages where it has been documented. The current known distribution in Mexico has been reduced to two small spring areas near the Arizona-Mexico border, and no individuals remain in the Mexican portion of the Santa Cruz River basin (Varela-Romero et al. 1992; Weedman et al. 1996). Today, the species has been extirpated or much reduced in numbers and distribution throughout most of its historical range (Minckley 1973; Weedman et al. 1996; USFWS 2005b). In New Mexico, it occurs as a single population in about 2 river km (1.24 river mi) of Turkey Creek above the waterfalls, which act as barriers to movement (Paroz and Propst 2007). Historically, 47 populations were recorded in 43 rivers, streams, and spring-fed tributaries; currently the area of occupancy appears to be less than 500 km^2 (193 mi^2) (USFWS 2005b). Recent literature indicates that approximately 25 of these localities are considered extant, but most are small and isolated and face one or more threats. It was also estimated that 90% of the currently-occupied habitat is degraded, due to the presence of non-native fishes and conflicting land management practices (USFWS 2015). About 50% of the land where extant populations occur is managed by the U.S. Forest Service (USFS) or U.S. Bureau of Land Management (BLM). The two populations in Mexico occur on private lands and are not protected (NatureServe 2024). The species typically inhabits pools and cienegas in headwaters and smaller (higher-order) streams throughout its range in the Gila River basin at elevations between 609 and 1,676 m (2,000 and 5,500 ft) (Miller 1946; Minckley 1973; Rinne 1976; Weedman et al. 1996). It is highly secretive, seeking cover of undercut banks, terrestrial vegetation, boulders, root wads, fallen logs, and thick overhanging or aquatic vegetation in deeper waters (Nelson 1993; Weedman et al. 1996; NMDGF 2006a; USFWS 2015). Habitat use is known to vary by age and likely both seasonally and geographically (Griffith and Tiersch 1989; Minckley 1981). The Gila Chub feeds mainly on aquatic and terrestrial insects and filamentous and diatomaceous algae. Larger individuals feed during evening and early morning hours, whereas young chubs feed during daylight hours (Minckley 1973; Griffith and Tiersch 1989). There may also be a prey shift as fish mature, with smaller fish feeding on organic debris and aquatic plants, and larger, adult fish feeding on invertebrates and small fish (Rinne and Minckley 1991). The species exists as a few, small isolated, populations; the small size of these populations, and their degree of fragmentation and isolation, cause them to be highly susceptible to threats from random environmental conditions such as drought, flood events, and wildfire. The species exists in a few, small, isolated, populations; the small size of these populations, and their degree of fragmentation and isolation, cause them to be highly susceptible to threats from randomly occurring events such as droughts, floods, and wildfires. The species is also vulnerable to predation by, and competition with, non-native organisms, including fish in the family Centrarchidae (bass [*Micropterus* spp.] and sunfish [*Lepomis* spp.]), other fish species, American Bullfrogs (*Rana [Aquarana] catesbeiana*), and crayfish (*Orconectes virilis*) and habitat degradation from surface water diversions and ground water withdrawals (USFWS 2005b). Parasites of Gila Chub have not been documented, but they are likely susceptible to the same parasites as the Roundtail Chub, most commonly the cestode, *Isoglaridacris bulboocirrus*, and protozoan and copepod parasites (Mopame 1981; NMDGF 2006a). Various regional modeling efforts indicate that the Southwest is highly likely to experience a prolonged drying trend in response to projected changing climatic patterns. These changes have severe implications for the integrity of the aquatic habitats that support aquatic species in this region (Seager et al. 2007). Additionally, altered stream flow events, an increased demand for water storage and conveyance systems, and warming water temperatures that favor non-native species are likely to impact native species (Rahel and Olden 2008). Warmer water temperatures may expand the distribution of aquatic non-native species by approximately 30% (Mohseni et al. 2003). Despite the lack of quantitative data regarding specific impacts to the Gila Chub from climate change, regional modeling projections suggest it is likely to have profound effects on the amount, permanency, and quality of habitat for this species.

Gila Topminnow

The Gila Topminnow (*Poeciliopsis occidentalis occidentalis*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Extremely Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Gila Topminnow’s climate change vulnerability is impacted by factors related to distribution, movement, and evolutionary potential, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by barriers, land-use changes, other anthropogenic effects and biologic factors that could increase the effects of climate change.

Note on taxonomy: The full species is the currently recognized taxonomic entity, rendering the subspecies, *P. o. ssp. occidentalis*, invalid under the Integrated Taxonomic Information System (ITIS 2024). The subspecies remains listed under the federal ESA as Endangered, however, the USFWS has been petitioned to reclassify the species to Threatened (USFWS 2019; USFWS 1967).

Historically, the Gila Topminnow occurred naturally in the Gila River system in Arizona and extreme western New Mexico, and extended into Sonora, Mexico. Weedman (1998) reported that it is restricted to 14 natural localities in Arizona and is stable at various localities in Mexico; however, both naturally-occurring and reintroduced populations are likely to continue to decline. Hedrick et al. (2001) reported that the Gila Topminnow existed naturally in the U.S. in only four isolated Arizona watersheds in eight populations. The species was extirpated in New Mexico but reintroduced at the Red Rock Wildlife Area in 1989 (Sublette et al. 1990). Over time, more than 200 reintroductions or dispersals from reintroductions have occurred at 175 wild locations with highly variable results and few reintroduced populations likely to persist into the future. Additionally, 12 captive populations persist and are used for propagation and/or conservation purposes; reintroductions will continue to be a key component of the recovery efforts for this speices well into the future (Weedman 1998). Extensive reintroduction efforts are underway in Arizona, where roughly 65% of the reintroductions have persisted for more than five years Species abundance has not been quantified but is thought to have declined significantly over time (Minckley 1969; Minckley 1973). Gila Topminnows prefer shallow warm water with permanent or sometimes intermittent flows in small streams or marginal areas of larger streams. They are often associated with dense aquatic vegetation and algae mats. They can tolerate varying temperatures, chemistries, and salinities ranging from tap water to sea water (Haynes and Schuetze 1997; Minckley et al. 1977; Weedman 1998). They are considered generalist feeders, feeding on detritus and algae and opportunistically on aquatic invertebrates (Lee et al. 1980). The species is threatened by continued habitat loss driven by water development, habitat degradation associated with erosion from roads and damaged watersheds, and the introduction of non-native, aquatic species, such as American Bullfrogs, crayfish, and the western mosquitofish (*Gambusia affinis*), that prey on juvenile topminnows and compete with adult topminnows (Weedman 1998). Based on projections of the impacts of increased temperatures and altered precipitation regimes on aquatic ecosystems, the Gila Topminnow will likely experience negative climate-related impacts on its geographic range and abundance (Sievert et al. 2022).

Gila Trout

The Gila Trout (*Oncorhynchus gilae*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Gila Trout's climate change vulnerability is impacted by factors related to distribution and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is impacted by barriers and biologic factors that could increase the effects of climate change. It also has documented or modeled responses to climate change that impact its climate change vulnerability score.

The exact extent of the historical range of the Gila Trout is unknown; however, the species was known to occur in multiple streams and tributaries within the Gila and San Francisco River basins in New Mexico and Arizona, where it still occurs. Fragmentation of the species' distribution has resulted in 23 smaller, isolated populations within just over 210 stream km (130 stream mi), constituting less than 20% of its former range (USFWS 2022g). These remnant populations, comprised of relict, reestablished, and replicate populations, characteristically occur in high densities during relatively stable flow periods (USFWS 2003b; WNTI 2016; Moffat 2017; USFWS 2022g). As part of the significant restoration and recovery efforts that have been implemented over time, hatchery facilities were established for propagation of the species to support reintroduction and augmentation projects and to maintain the different genetic lineages across its range (USFWS 2020a; USFWS 2022g). Facilitated by reintroductions, numbers of Gila Trout increased and remained stable through the 1990s and 2000s but experienced dramatic declines following severe wildfires in 2012 and 2013 (WNTI 2016). However, recovery efforts succeeded in restoring multiple Gila Trout populations to pre-fire conditions (Moffat 2017). The total number of individuals is unknown and fluctuates under varying environmental conditions, specifically with changes in the volume of stream discharge, but current population abundance is estimated at 37,000 (Brown et al. 2001; Moffat 2017; USFWS 2022g). Gila Trout occurs in cold-water rivers and streams where temperatures typically do not exceed 26ºC (78ºF) at elevations from 1,660 m (5,400 ft) to over 2,800 m (9,200 ft) within coniferous and mixed-conifer woodlands, montane coniferous forests, and subalpine coniferous forests (Dick-Peddie 1993; Propst and Stefferud 1997). Unimpaired water quality is important to the health of this species and characterized by high dissolved oxygen concentration, low turbidity and conductivity, low levels of total dissolved solids, near-neutral pH, and low conductivity (Propst et al. 1999; USFWS 2022g). Gila Trout feeds opportunistically on insects and insect larvae, but because the species coevolved with several other fishes, piscivory does occur, including on speckled dace (*Rhinichthys osculus*) and smaller Gila Trout (Propst and Stefferud 1997; Van Eimeren 1988). The diet will also shift on a seasonal basis as the relative abundance of various prey taxa changes (USFWS 2022g). The species declined mainly due to hybridization and competitive/predatory interactions with introduced trout species (rainbow [*Oncorhynchus mykiss*], cutthroat [*O. clarki*], and brown (*Salmo trutta*)) and habitat degradation caused by overgrazing, wildfire, forestry practices, and mining (Sublette et al. 1990). Today, the primary habitat-based threats facing the species include large-scale, high-severity wildfires; effects of climate change; and grazing. Predation by and competition with no-native trout remain significant sources of concern as well as disease and illegal harvesting of the species. Additionally, human-mediated introgressive hybridization and small, isolated populations are important considerations in the recovery of the species (USFWS 2022g). Based on a statewide assessment using existing climate change models and reports, Gila Trout is projected to be negatively affected by climate change (Friggens 2015). The direct effects of climate change are unknown; however, projected increases in water temperatures, reduced flows, increased sediment input, shifts in precipitation patterns, earlier snowmelt, and shifts in storm intensity are likely to cause imminent and future reductions in available Gila Trout habitat. These changes will result in reduced population sizes, contraction of the species' geographic distribution, and further population isolation (Friggens 2015; USFWS 2022g).

Gray Redhorse

The Gray Redhorse (*Moxostoma congestum*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Extremely Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Gray Redhorse's climate change vulnerability is impacted by factors related to distribution and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

Among the references used, there are considerable data gaps related to the species' genetic diversity, life history and population size and structure, and the extent and magnitude of threats it currently faces. The index score may change as these gaps are filled. The historical range of the Gray Redhorse included the Gulf Coastal drainages of central and west Texas, the Pecos River of New Mexico and Texas, the Rio Grande in New Mexico, and Mexican tributaries to the Rio Grande downstream of the Big Bend region (Jenkins 1980). In Texas, it is restricted to the streams within the Edwards Plateau including the Brazos, Colorado, Guadalupe, Nueces, Rio Grande, and San Antonio drainages (Jenkins 1980; Hubbs et al. 1991). In New Mexico, the species has experienced significant mortalities due to outbreaks of golden algae since the early 2000s, resulting in a nearly 90% contraction of the species' range within the state (NMDGF 2022). Some translocation efforts were implemented beginning in 2012, with evidence of reproduction documented in 2016 and 2018; however, subsequent periods of long-term dry downs occurred, and those translocated populations are now thought to be extirpated (NMDGF 2022). Neither the global abundance nor that in New Mexico are known, but it is thought to fluctuate over time depending upon environmental conditions (Jenkins 1980). The Gray Redhorse is considered a warm-water species that occurs in clear to moderately-turbid, low-gradient, low-velocity, small to medium rivers over rock, gravel, sand, and silt, often in riffles and deep runs. It spawns in pool tails just above riffles over clean cobble-gravel-pebble bottoms in shallow water (Sublette et al. 1990). This species mostly feeds on insects and mollusks, but unlike most suckers, the Gray Redhorse ingests relatively little vegetation (NMDGF 1988). Feeding is opportunistic, with individuals consuming seasonally available food items within their environment (Cowley and Sublette 1987). There is some evidence that suggests this species can alter its feeding strategy in response to impacts to its habitat, potentially leading to re-establishment of historically-occupied sites (NatureServe 2024). In New Mexico, the primary threats to the species, which have resulted in and are anticipated to continue to cause habitat fragmentation and range contraction, include dams, habitat desiccation, modified flow regimes, impaired water quality from contaminants, stranding in canals, and toxic conditions caused by golden algae. Additionally, intensified oil and gas development poses an increasing threat to water quality and quantity in the Black and Delaware River drainages (NMDGF 2022). The introduction of grass carp (*Ctenopharyngodon idella)* to control aquatic vegetation within habitats occupied by Gray Redhorse may pose another threat to this species (Propst et al. 1999). Based on projections of the impacts of increased temperatures and altered precipitation regimes on aquatic ecosystems, the Gray Redhorse will likely experience negative climate-related impacts on its geographic range and abundance (Sievert et al. 2022).

Greenthroat Darter

The Greenthroat Darter (*Etheostoma lepidum*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Extremely Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Greenthroat Darter climate change vulnerability is impacted by factors related to distribution and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

Among the references used, there are considerable data gaps related to the species' within-population genetic diversity, life history and population sizes and structure, and the extent and magnitude of threats it currently faces. The index score may change as these gaps are filled. The historical range of the Greenthroat Darter includes tributaries of the Colorado, Guadalupe, and Nueces Rivers of the Edwards Plateau in Texas and the Pecos River system in southeastern New Mexico (Sublette et al. 1990). In 1997, it was recorded at 22 sites in Texas and eight sites in New Mexico (Texas Natural History Collections 1997). The drainages where the species occurs are generally disjunct, and the population status within each drainage is unknown; however, despite this uncertainty, the species is thought to persist throughout much of its historical range in Texas, but its distribution is significantly reduced in New Mexico (NMDGF 1996). Translocation efforts were carried out in the Carlsbad Caverns National Park in 1999, and the species also occurred on the Bitter Lake National Wildlife Refuge (NWR) (Sublette et al. 1990; Davenport and Archdeacon 2008; Page and Burr 2011). Davenport and Archdeacon (2008) observed the species at all previously-sampled sites except on the Bitter Lake NWR, where the encroachment of common reed (*Phragmites sp.*) into the riparian area of Bitter Creek likely caused the local extirpation of the species on the NWR. Total adult population size is unknown, but it is thought to be common on the Edwards Plateau in Texas and uncommon in New Mexico (Page and Burr 2011). Habitat for this species includes swift-flowing, spring-fed headwaters, creeks, and small rivers, particularly vegetated riffle areas with gravel and rubble substrates. It also utilizes clear ponded-water habitats, such as sinkholes and littoral areas of other lentic habitats that are subject to significant wave action. Eggs are laid on vegetation or on any solid substrate including the undersides of rocks (Page 1983; Sublette et al. 1990; Page and Burr 2011). While considered a diet generalist, this species generally consumes small crustaceans, aquatic insects, algae on solid substates in riffles, and aquatic vegetation (Sublette et al. 1990). The primary threats to the species in New Mexico both historically and currently are habitat alteration from groundwater mining, flow diversion, excessive sedimentation, modification of stream morphology, and pollution from industrial, agricultural, and domestic sources (NMDGF 1996). Many of the spring-fed tributaries within the Pecos River drainage have experienced decreased flows, or ceased to flow, following increases in anthropogenic withdrawals from the artesian and shallow aquifers; loss of these habitats has relegated the Greenthroat Darters to the few remaining springs with flow (Davenport and Archdeacon 2008). Based on projections of the impacts of increased temperatures and altered precipitation regimes on aquatic ecosystems, the Greenthroat Darter will likely experience negative climate-related impacts on its geographic range and abundance (Sievert et al. 2022).

Headwater Catfish

The Headwater Catfish (*Ictalurus lupus*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Extremely Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Headwater Catfish's climate change vulnerability is impacted by factors related to distribution and evolutionary potential, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by barriers, land-use changes, other anthropogenic threats and biologic factors that could increase the effects of climate change.

Among the references used, there are considerable data gaps relative to the species' within-population genetic diversity, life history and population sizes and structure, and the extent and magnitude of threats it currently faces. The index score may change as these gaps are filled. Additionally, life history and demography traits are based on similar species, the Channel Catfish (*I. punctatus*) and Blue Catfish (*I. furcatus).* The native range of the Headwater Catfish includes the headwater and upstream sections of the Rio Grande and Pecos River basins in the U.S. and the Rio San Fernando, Rio Soto la Marina, and the isolated Cuatro Cienegas basin in Mexico (Kelsch and Hendricks 1986; Hubbs et al. 2008). Historically this species was also documented in the upper Nueces, San Antonio, Guadalupe, and Colorado (introduced) basins in Texas, but it now appears to be extirpated from these systems (Kelsch and Hendricks 1990; Hubbs et al. 2008). Research into propagation techniques has been undertaken, and the species was translocated from the Delaware River to Sitting Bull Canyon Creek (Eddy County, New Mexico); however, the status of that effort was unknown as of 1990 (Sublette et al. 1990). Despite the species' persistence, the status of its populations has declined and its range has contracted (Kelsch and Hendricks 1990; Sublette et al. 1990). Total adult population size is unknown, and there are conflicting accounts of its abundance, from being regarded as locally or moderately common (Kelsch and Hendricks 1990; Page and Burr 2011) to relatively uncommon in New Mexico and Texas (Harrell 1978; Platania 1990; Edwards et al. 2002; Bonner et al. 2005). It inhabits headwater streams and fluctuating tailwaters of dams with sandy and rocky riffles, runs, and deep pools of creeks and small rivers with clear temperate waters, generally with a moderate gradient (Sublette et al. 1990; Page and Burr 2011). The Headwater Catfish is an omnivorous bottom-feeder, like other members of the Ictaluridae; diet items include aquatic insects, crustaceans, other aquatic and terrestrial organisms, algae, and detritus (Littrell et al. 2003). A major threat that has and continues to face the species is competition and hybridization with the Channel Catfish. In New Mexico, interactions with this species have eliminated the Headwater Catfish from most of its native range (Sublette et al. 1990). The species has also been adversely affected by reservoir construction, especially by dams that lack suitable fishways, and spring desiccation (Hubbs and Garrett 1990). Based on projections of the impacts of increased temperatures and altered precipitation regimes on aquatic ecosystems, the Headwater Catfish will likely experience negative climate-related impacts on its geographic range and abundance (Sievert et al. 2022).

Headwater Chub

The Headwater Chub (*Gila nigra*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Extremely Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Headwater Chub's climate change vulnerability is impacted by factors related to distribution and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by barriers, land-use changes, other anthropogenic effects, and biologic factors that could increase the effects of climate change.

Note on taxonomy: In 2016, members of the genus *Gila* in the Lower Colorado River (*G. intermedia*, *G. nigra*, and *G. robusta*) were determined to belong to a single species, *G. robusta* (Roundtail Chub; Page et al. 2016), which is consistent with the Integrated Taxonomic Information System report (ITIS 2024). The American Fisheries Society checklists (Nelson et al. 2004; Page et al. 2013) maintain *G. robusta* and *G. nigra* as distinct species. Taxonomic revisions that propose to reinstate *G. nigra* as separate from *G. intermedia* and *G. robusta* are anticipated, hence, NMDGF continues to recognize this species as valid (NMDGF 2024).

The Headwater Chub is endemic to the Gila River basin of Arizona and New Mexico where it occurs in the middle and headwater reaches of middle-sized streams (Bestgen and Propst 1989; Minckley and DeMarais 2000; Page and Burr 2011). In Arizona, Voeltz (2002) determined that this species likely occurred in several tributaries to the Salt River, including the Verde River and most of the Tonto Creek drainage; the San Carlos River drainage (a tributary to the Gila in Arizona); and parts of the upper Gila River in New Mexico (USFWS 2012b). The USFWS (2012b) performed a review of the species' status and determined that the extent of the historical distribution of the Headwater Chub is unclear; however, the area of occupancy, number of subpopulations, and population size are believed to have declined significantly over time. The is species now estimated to occur in 40 to 50% of its historical range within approximately 200 stream-km (125 mi). At the time of the assessment, the total population size was unknown, but based on the available data, of the 23 extant populations, one was considered stable-secure, seven were stable-threatened, seven were unstable-threatened, and eight had unknown status (USFWS 2012b). Land ownership along inhabited streams is largely U.S. Forest Service (80%), 10% tribal, 5% state, and 5% private (USFWS 2012b). The species occurs in deep, near shore pools adjacent to swift riffles and runs, often where cover such as rocks, root wads, undercut banks, or deep water is available at elevations between 1,325 and 2,000 m (4,347 and 6,562 ft) (Bestgen and Propst 1989; Minckley and DeMarais 2000; Page and Burr 2011). The species is associated with substrates including sand, gravel, small boulders, and large in-stream objects in waters that range in temperature between 20 and 27°C (68 and 80.6°F) with a minimum around 7°C (44.6°F) (Bestgen and Propst 1989; Voeltz 2002). The Headwater Chub is omnivorous, ingesting mostly aquatic and terrestrial invertebrates that are supplemented with plant material, detritus, and fishes (Neve 1976; Bestgen 1985; Rinne and Minckley 1991). The species exists in small, isolated, highly-fragmented populations, making it susceptible to threats from stochastic environmental conditions such as drought, flood events, and wildfire (USFWS 2012b). Throughout its range, declines are attributed largely to the introduction of non-native fishes (predators, competitors); dams, water diversions, impoundments, groundwater pumping, channelization, and channel changes caused by alteration of riparian vegetation, and watershed degradation from mining, grazing, roads, water pollution, urban and suburban development, and other human actions, such as recreation (Bestgen and Propst 1989; AGFD 2003; NMDGF 2006a; USFWS 2012b). The two most significant threats facing Headwater Chubs are predation and competition by non-native aquatic species and wildfire (USFWS 2012b). In the Southwest, wildfires often occur during the summer monsoon season, and when followed by rain, toxic, ash-laden debris can be washed into streams, which adversely affects the local fish populations (Rinne 2004; Carter and Rinne 2005). Various regional modeling efforts indicate that the Southwest is highly likely to experience a prolonged drying trend in response to projected changes in climatic patterns. These changes have severe implications for the integrity of the aquatic habitats that support the Headwater Chub (Seageret al. 2007). Additionally, altered stream flow events, an increased demand for water storage and conveyance systems, and warming water temperatures that favor non-native species are likely to impact the Headwater Chub (Rahel and Olden 2008). Warmer water temperatures may expand the distribution of aquatic non-native species by some 30% (Mohseni et al. 2003). These warm-water, non-native species, such as Red Shiner (*Cyprinella lutrensis*), Common Carp (*Cyprinus carpio*), Mosquito Fish, and Largemouth Bass (*Micropterus salmoides*), are also expected to benefit from prolonged periods of low flow (Rahel and Olden 2008). Despite the lack of quantitative data regarding specific impacts to the Headwater Chub from climate change, regional modeling projections suggest it is likely to have profound effects on the amount, permanency, and quality of habitat for the species.

Loach Minnow

The Loach Minnow (*Rhinichthys cobitis*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Extremely Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Loach Minnow's climate change vulnerability is impacted by factors related to distribution, life history and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It is also impacted by barriers, land-use changes, other anthropogenic effects, and biologic factors that could increase the effects of climate change.

Historically, the Loach Minnow was locally common throughout much of the Verde, Salt, San Pedro, San Francisco, and Gila (upstream from Phoenix) River systems in Arizona and New Mexico and the San Pedro River in Sonora, Mexico. It is now extirpated throughout much of its former range in Arizona, its distribution has been significantly reduced in New Mexico, and much of its habitat in Mexico has been destroyed by water diversions for agriculture (USFWS 2012a). The species is represented by perhaps 10 distinct occurrences (subpopulations) within an area of about 1,000 km^2 (386 mi^2s), which is a reduction of approximately 85% of the historical distribution (USFWS 1986b; USFWS 2012a). Despite long-term monitoring that has been ongoing at some sites for nearly 60 years, the range-wide population size remains unknown. Population numbers may fluctuate between monitoring years, but generally, they are very low, with maximum detections being fewer than 600 individuals at any one site and as low as 1 at others. Translocation efforts have been implemented, and evidence of successful reproduction has been observed at some locations. Efforts remain ongoing at three sites with varied results, but translocations were discontinued at four other sites due to failure of the species to establish or declines in habitat suitability due to drought or other drivers (USFWS 2023c). The Loach Minnow is an obligate riffle-dweller that lives on the bottom of shallow, unpolluted swift waters flowing over gravel, cobble, and rubble substrates in mainstem rivers and tributaries with low to moderate gradients at 1,220 to 2,440 m (4,000 to 8,000 ft) elevation (USFWS 2012a; Propst and Bestgen 1991; Propst et al. 1988; Rinne 1989;). Low amounts of fine sediment and substrate embeddedness, abundant aquatic insects, sometimes with filamentous algae, and a healthy, adjacent riparian community with bank stability are also characteristic of the species' habitat (Lee et al. 1980). Water velocity and depth are driving variables for species' presence; adults inhabit moderate to swift (15-100 cm/sec [0.5-3.28 ft/sec]), shallow (3-40 cm [1.18-15.75 in]) water with gravel, cobble, and rubble substrates; juvenile habitat is similar but also includes sand substrates (USFWS 2012a). Recurrent flooding is important in flushing the system of fine sediments and in controlling establishment of non-native fishes (Propst and Bestgen 1991). This species may be able to tolerate changing water conditions and competition with non-native species better than most cyprinids native to the Gila, possibly due to its behavior of seeking the interstices of rubble-gravel for feeding and oviposition (Sublette et al. 1990). The Loach Minnow has a somewhat restricted diet, feeding opportunistically on riffle-inhabiting insect larvae (*e.g.*, simuliid dipterans and mayflies). Juveniles feed primarily on chironomids, and adults eat various benthic insects (dipterans, mayflies, stoneflies, caddisflies) (Propst and Bestgen 1991; Sublette et al. 1990). Only small, isolated populations of this species remain, with limited to no opportunities for interchange between populations or expansion of existing areas due non-native species' distributions; barriers, such as dams and reservoirs; and dewatering and sedimentation of habitats. These primary threats, together with ongoing drought and a changing climate, exacerbate the loss of water in some areas, and future water development projects are likely to occur. Competition with, or predation by, non-native species, such as Channel Catfish and Flathead Catfish (*Pylodictis olivaris*), Green Sunfish (*Lepomis cyanellus*), and Red Shiner, also pose a significant, ongoing threat to the species (USFWS 2012a). Various regional modeling efforts indicate that the Southwest is highly likely to experience a prolonged drying trend in response to projected changing climatic patterns, which could impact this species. These changes have severe implications for the integrity of the aquatic habitats that support the Loach Minnow (Seageret al. 2007). Additionally, altered stream flow events, an increased demand for water storage and conveyance systems, and warming water temperatures that favor non-native species are likely to impact the Loach Minnow (Rahel and Olden 2008). Warmer water temperatures may expand the distribution of aquatic non-native species by some 30% (Mohseni et al. 2003). Despite the lack of quantitative data regarding specific impacts on the Loach Minnow from climate change, regional modeling projections suggest it is likely to have profound effects on the amount, permanency, and quality of habitat for this species.

Longnose Gar

The Longnose Gar (*Lepisosteus osseus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP

4.5 and RCP 8.5 Scenarios. The Longnose Gar's climate change vulnerability is impacted by factors related to life history and evolutionary potential, which influence its ability to persist in place and respond to climate change impacts.

The Longnose Gar is a wide-ranging species whose historical and extant distribution includes the North American Atlantic slope from the Delaware River in New Jersey, to central Florida; the St. Lawrence River in Quebec, Canada, through the Great Lakes (except Lake Superior); the Mississippi River basin to the Red River (Hudson Bay basin) in North Dakota, and south to Louisiana; and the Gulf Slope drainages from central Florida to the Rio Grande drainage in Texas and Mexico (Page and Burr 2011). In New Mexico, it is thought to be native to the Rio Grande and Pecos Rivers (Cope and Yarrow 1875; Sublette et al. 1990). It has been documented on the Bosque Del Apache and Bitter Lake NWRs but is believed to have become rare or extirpated within the New Mexico portion of the range (Brooks 1990; Sublette et al. 1990; Calamusso et al. 2005). While the total population size is currently unknown, the species is thought to be locally common, with an estimated range-wide, stable population of over 100,000 fish (Page and Burr 2011 The species inhabits warm, weedy lakes and reservoirs; backwaters and quiet pools of medium to large rivers; stagnant ponds; sloughs; canals; brackish waters of coastal inlets; and, occasionally, coastal marine waters. It is often near the cover of vegetation or submerged or overhanging objects. Juveniles frequently occur in shallower waters with larger individuals in deeper waters. Individuals are often near the surface in pelagic areas of lakes and reservoirs and in the quieter regions of rivers and streams (Sublette et al. 1990). Longnose Gar feed most actively at night at or near the surface on a diet comprised mainly of fishes, but the young eat small crustaceans or larvae of aquatic insects. If in brackish waters, they may also feed on crab (Becker 1983; Sublette et al. 1990). This species is considered a very adaptable generalist that can tolerate a variety of habitats and conditions. They have a lung-like swim bladder that allows them to breathe air at the surface in low oxygen environments, and they can withstand high-water temperatures (Sublette et al. 1990; McGrath 2010). No significant threats have been identified for this species; however, in New Mexico, various regional modeling efforts indicate that the Southwest is highly likely to experience a prolonged drying trend in response to projected changing climatic patterns. These changes may have severe implications for the integrity of the aquatic habitats that support the Longnose Gar (Seageret al. 2007). Additionally, altered stream flow events and an increased demand for water storage and conveyance systems may impact the species, whereas warming water temperatures that favor non-native species may also favor the Longnose Gar (Rahel and Olden 2008). Despite the lack of quantitative data regarding specific impacts to the Longnose Gar from climate change, regional modeling projections suggest it is likely to have profound effects on the amount, permanency, and quality of habitat for this species.

Mexican Tetra

The Mexican Tetra (*Astyanax mexicanus*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Mexican Tetra's climate change vulnerability is impacted by factors related to movement, life history, and evolutionary potential, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

Note on taxonomy: This species includes the surface form with eyes and relatively high genetic variability and eyeless cave forms with relatively low genetic variability (Nelson 1984). The two forms interbreed, which may be a factor in its evolution (Panaram and Borowsky 2005). The cave populations are sometimes recognized as a separate species, *Astyanax jordani*, but Page et al. (2013) follow Romero (2008) in not recognizing these populations as distinct.

The Mexican Tetra is the only naturally-occurring characid in the U.S. with a historical distribution from eastern New Mexico and southern Texas southward to the Atlantic-slope drainages of Mexico. It was restricted to the Rio Grande and Pecos drainages and the Nueces drainage in Texas, but its use as a bait fish resulted in range expansion to the north and west in the southwestern U.S. (Sublette et al. 1990). In New Mexico, the species is thought to be extirpated from the Rio Grande drainage because of human activities but remains extant in the Pecos River and associated flood plain habitats from the Bitter Lake NWR downstream to the Texas/New Mexico border (Propst et al. 1999; Sublette et al. 1990). Total adult population size is unknown, but it is likely stable and may exceed 1,000,000 individuals (NatureServe 2024). Locally, this species is thought to be quite common (Miller et al. 2005). This warm-water species inhabits various stream and river systems and is commonly found in low-velocity pools with rock- and sand-bottoms; it also occurs in caves in Mexico (Propst et al. 1999; Miller et al. 2005). Habitats in Arizona include swift rapids, eddies, and pools. In New Mexico, it occurs primarily in spring habitats, and young have been observed in shallow water near overhanging bank vegetation (Sublette et al. 1990). The Mexican Tetra is highly piscivorous, but in northeastern Mexico, it is reported as omnivorous, eating plant matter, filamentous algae, and aquatic insects (Sublette et al. 1990). Historically, the degradation of stream habitats caused by overgrazing in riparian areas, sedimentation and siltation, channelization, and water diversions have resulted in the decline of the species (Sublette et al. 1990). These impacts are likely to continue, and in New Mexico, various regional modeling efforts indicate that the Southwest is highly likely to experience a prolonged drying trend in response to projected changing climatic patterns. These changes may have severe implications for the integrity of the aquatic habitats that support the Mexican Tetra (Seageret al. 2007). Additionally, altered stream flow events and an increased demand for water storage and conveyance systems may impact the species, whereas warming water temperatures that favor non-native species may also favor the Mexican Tetra (Rahel and Olden 2008). Despite the lack of quantitative data regarding specific impacts to the Mexican Tetra from climate change, regional modeling projections suggest it is likely to have profound effects on the amount, permanency, and quality of habitat for this species.

Mottled Sculpin

The Mottled Sculpin (*Cottus bairdii*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Extremely Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Mottled Sculpin's climate change vulnerability is impacted by factors related to demography, life history, evolutionary potential and abiotic niche, which influence its ability to persist in place and respond to climate change impacts. It is also impacted by barriers, land-use changes, other anthropogenic effects, and biologic factors that could increase the effects of climate change.

The Mottled Sculpin exhibits a highly-disjunct eastern and western range in North America, with major areas of occurrence scattered in Canada east from Saskatchewan; along the Rocky Mountains (including the Columbia and Colorado basins); along the Appalachian Mountains; the Ozark Plateau region of Missouri and Arkansas; and areas surrounding the Great Lakes. In New Mexico, it is native to the San Juan River basin including Pine, Navajo, Animas, and San Juan rivers upstream from Shiprock (Sublette et al. 1990); however, long-term monitoring of small-bodied fishes in the San Juan River has documented only two individuals of the species between 2007 and 2019 (Zeigler and Ruhl 2016; Barkalow et al. 2020). Exact numbers of individuals are unknown among the discontinuous populations throughout the species' range, but overall abundance is thought to be high (>100,000; NatureServe 2024). This sculpin inhabits clear, cold to warm headwaters, creeks, springs, small rivers, and lakes, with sand and gravel or rocky substrates. Habitat preference varies geographically, but it often seeks cover under rocks or vegetative cover (Scott and Crossman 1973; Lee et al. 1980; Peden and Hughes 1984; Page and Burr 2011). The Mottled Sculpin is a benthic feeder, feeding mostly at night among rocks. Its diet consists mainly of immature aquatic insect larvae, especially mayflies, chironomid midges, and stoneflies. Larger individuals also eat caddisflies, crayfish, annelids, other fishes (including fish eggs), and plant material (Scott and Crossman 1973; Becker 1983). The species may seasonally shift its prey base depending on availability (Platis et al. 2024). Sculpins are also cannibalistic, and large males may eat small females (Downhower et al. 1983; Sublette et al. 1990). Walker et al. (2019) determined that sculpin abundance and persistence rates declined with increasing land-use change, likely due to decreased water quality and availability of refuge habitat, especially when coupled with changes in precipitation and water-flow conditions. Despite the estimated range-wide abundance, the species is considered vulnerable, imperiled, or critically imperiled in eight of the 35 states and provinces where it occurs due to the various threats it faces (IDNR 2022). Some of the threats in some portions of its range include heavy metals (e.g., copper, cadmium, and zinc) that contaminate local waterways as a result of mining, coal burning, steel production, and metal smelting activities; habitat conversion for urban development and agricultural production, which can lead to water quality and quantity degradation from sedimentation, eutrophication, and increases in chemical pollutant concentrations; cannibalism and predation by Brook Trout (*Salvelinus fontinalis*), Brown Trout (*Salmo trutta*), Northern Pike (*Esox lucius*), Common Mergansers (*Mergus merganser*), Water Snakes (*Nerodia sipedon*), and herons (Ardeidae); and competition with other species for prey and habitat (Metzke 2023). The direct effects of climate change on the Mottled Sculpin are unknown; however, projected increases in water temperatures, reduced flows, increased sediment input, shifts in precipitation patterns, earlier snowmelt, and shifts in storm intensity are likely to cause imminent and future reductions in available Mottled Sculpin habitat in New Mexico should the species be present in the state (Friggens 2015).

Pecos Bluntnose Shiner

The Pecos Bluntnose Shiner (*Notropis simus pecosensis*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Extremely Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Pecos Bluntnose Shiner's climate change vulnerability is impacted by factors related to distribution, movement, life history, evolutionary potential and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It is also impacted by barriers, land-use changes, other anthropogenic effects, and biologic factors that could increase the effects of climate change.

The historical range of the Pecos Bluntnose Shiner included a 530 km (329 mi) reach of the Pecos River from the Gallinas River confluence north of Santa Rosa to slightly north of Carlsbad, New Mexico (Chernoff et al. 1982; Sublette et al. 1990). There are two historical records of this subspecies from the Pecos River system in Texas from 1853 and 1976 (GBIF 2021). Based on recent monitoring data, the current range has been reduced to a 305 km (190 mi) section of the Pecos River from the Taiban Creek confluence to the Brantley Reservoir delta, which is a 42% decrease from the historical range (USFWS 2020b). At the time of federal listing, critical habitat was designated as two separate reaches along the Pecos River (USFWS 1987). The upper critical habitat section is the Rangelands reach, a 103 km (64 mi) reach extending from 1 km (0.6 mi) upstream from the confluence of Taiban Creek downstream to the Crockett Draw confluence. This reach is considered the Pecos Bluntnose Shiner's stronghold. The lower critical habitat section is the Farmlands reach, a 60 km (37 mi) reach extending from Hagerman to Artesia (USFWS 1987). Because of the declines of and continued threats to this species, as well as projections of future reductions in flow on the Pecos River, a refugial population was established at Dexter National Fish Hatchery and Technology to provide some level of protection from the possibility of species' extinction (Osborne and Turner 2006). While the exact population densities are unknown, it is understood that the mean density can vary greatly based on river flow and river intermittency from year to year. Between 2011 and 2020, the mean density ranged from 25 fish per 100 m^2 (1,076 ft^2) in 2011 to a low of about 3 fish per 100 m^2 (1,076 ft^2) in 2013, then increasing to 33 fish per 100 m^2 (1,076 ft^2) in 2018 before declining to 15 fish per 100 m^2 (1,076 ft^2) in 2020 (USBR 2021; USFWS 2017b). Estimates of contemporary effective population size ranged from 75 to 569 Pecos Bluntnose Shiner individuals based on microsatellite DNA (Osborne and Turner 2009). Frankham et al. (2014) submit that an effective population size (N_e) of at least 1000 individuals is necessary to maintain adaptive evolutionary potential in perpetuity. While populations with $N_e < 1000$ are not at immediate risk of extinction, their ability to adapt to environmental changes is impaired, thereby reducing their long-term viability (Frankham et al. 2014). Based on these data, the observed effective population sizes for the Pecos Bluntnose Shiner may limit this species' ability to adapt to future climatic conditions. The Pecos Bluntnose Shiner is classified as a warm-water taxa. In the Pecos River, it occupies most of the available habitats in streams (Hatch et al. 1985); however, it is most common in main channel areas, with low-velocity water, depths between 17 and 31 centimeters (7 and 12 inches), with substrates comprised of shifting sand and small gravel (Sublette et al. 1990). Young shiners primarily consume zooplankton, while adults feed on terrestrial insects (ants and wasps), aquatic invertebrates (mainly fly larvae and pupae), larval fish, and plant seeds (salt cedar [*Tamarix* spp.]); ingested vegetation may incidentally capture prey (Platania 1993; USFWS 2010c). Major threats to the species include habitat fragmentation from dam construction, water management resulting in restricted flow from reservoirs, water diversions for irrigation, groundwater pumping, siltation, and water quality degradation caused by agricultural activities along the Pecos River (Archdeacon et al. 2015; USFWS 2020b). Direct impacts to the Pecos Bluntnose Shiner have not been modeled; however, based on a statewide assessment using existing climate change models and reports, projected increases in water temperatures, reduced flows, increased sediment input, shifts in precipitation patterns, earlier snowmelt, and shifts in storm intensity are likely to cause imminent and future reductions in available Pecos Bluntnose Shiner habitat (Friggens 2015). In particular, the biggest threat to the species is river drying and intermittent flows, and it is anticipated that climate change will exacerbate the currently experienced difficulty in maintaining flow throughout occupied habitat (USFWS 2020b). These changes may result in reduced population sizes, further contraction of geographic distribution, and further population isolation for this species (Friggens 2015).

Pecos Gambusia

The Pecos Gambusia (*Gambusia nobilis*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Extremely Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Pecos Gambusia's climate change vulnerability is impacted by factors related to distribution, life history, evolutionary potential and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It is also impacted by barriers, land-use changes, other anthropogenic threats, and biologic factors that could increase the effects of climate change.

The historical range of the Pecos Gambusia includes the Pecos River basin in western Texas and southeastern New Mexico (Page and Burr 2011; USFWS 2018a). The species originally extended from near Fort Sumner, New Mexico, to the area around Fort Stockton, Texas. Currently, the species probably occupies less than 20 km^2 (seven mi^2) in four widely disjunct localities in the Pecos River drainage of western Texas and southeastern New Mexico: Diamond Y Spring and Solomon Spring systems in Texas and on the Bitter Lake NWR and at Blue Spring in New Mexico (USFWS 2018a). Some attempts were made to establish introduced populations in New Mexico; efforts at Geyser Spring, Living Desert State Park, Southwestern Native Aquatic Resources and Recovery Center, and in Carlsbad, New Mexico, failed or have been abandoned (USFWS 2018a). Although the global abundance of the species is unknown, it is likely large, with estimates in portions of its range exceeding one million (Bendarz 1979; Echelle and Echelle 1980). The populations in Texas were described as "large and healthy" (Hubbs and Karges 1999), but current information is lacking on the status of the species in these localities. On the Bitter Lake NWR, the locations and abundance of the species change over time for a variety of reasons, such as local extirpations or the discovery of new sites, but abundance estimates are not available where the species is known to occur. While there are no data on species' abundance, the populations appear to be stable (USFWS 2018a). At Blue Spring, Bednarz (1979) estimated

900,000 Pecos Gambusia within the spring system; however, that estimate is now quite dated. Habitat includes shallow margins of clear, warm, vegetated spring waters, such as pools and outflows, that are high in calcium carbonate, and gypsum sinkhole habitats (Lee et al. 1980; Page and Burr 2011). Feeding occurs at the surface and in mid-water, and diet consists primarily of insects (e.g., corixids and culicids), amphipods, and some filamentous algae. Feeding occurs throughout the day but correlates most with insect activity at night (Swaim and Boeing 2008). The greatest threats to the species, both historically and at present, are drying of spring habitats due to lowering water tables from groundwater pumping, predation by introduced fishes (especially where aquatic vegetation or shallow water are lacking), and competition and possibly hybridization with other *Gambusia* species (Echelle et al. 1989; Hubbs et al. 2002). Land management activities and alterations in the natural flow and physical conditions of the Pecos River have interfered with or eliminated, the accessibility of now isolated suitable habitats, which precludes natural recolonization when local extinctions occur during drought years (USFWS 2018a). Direct impacts to the Pecos Gambusia from climate change have not been modeled; however, based on a statewide assessment using existing climate change models and reports, projected increases in water temperatures, reduced flows, increased sediment input, shifts in precipitation patterns, earlier snowmelt, and shifts in storm intensity are likely to cause imminent and future reductions in available Pecos Gambusia habitat (Friggens 2015). The spring habitats are dependent on groundwater levels that are directly affected by precipitation, which could be altered by climate change. The changes in precipitation and drought frequency associated with climate change could result in decreased availability of the groundwater that is necessary to recharge aquifers that support the species in western Texas and eastern New Mexico. Increased groundwater pumping for human consumption will also impact the likelihood and frequency of drying of Pecos Gambusia habitats. Other indirect climate change impacts on water quality, non-native species, disease susceptibility, and other factors are likely but have not been quantified (USFWS 2018a).

Pecos Pupfish

The Pecos Pupfish (*Cyprinodon pecosensis*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Extremely Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Pecos Pupfish's climate change vulnerability is impacted by factors related to distribution, life history, evolutionary potential, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It is also impacted by barriers, land-use changes, other anthropogenic threats, and biologic factors that could increase the effects of climate change.

The historical range of the Pecos Pupfish includes the Pecos River from the Bitter Lake NWR and Bottomless Lakes State Park near Roswell, New Mexico, downstream approximately 650 km (404 mi) to the mouth of Independence Creek, Texas (USFWS 2000). By 2000, the range of the species had been reduced by nearly two-thirds, relegating the species only to the upper reach of the Salt Creek in Texas and in the Pecos River from north of Malaga upstream to Bitter Lake NWR, Bottomless Lakes State Park, and the BLM Overflow Wetlands Wildlife Habitat Area/Area of Critical Environmental Concern (USFWS 2000). The range-wide abundance of the species is unknown but may exceed 10,000 individuals (NatureServe 2024). However, few genetically pure populations of this species remain, as it has been replaced by *C. pecosensis* x *C. variegatus* hybrids Pecos Pupfish habitat includes saline springs, gypsum sinkholes, and low-velocity, desert streams with moderately deep runs, pools, and backwaters. The species is tolerant of, and often abundant in, highly-saline habitats that support relatively few species (Sublette et al. 1990; NMDGF 1995). This species forages along the bottom, feeding mainly on a diatom-detritus mixture, but is considered an omnivore (Sublette et al. 1990). The primary threats to the Pecos Pupfish include habitat loss caused by the damming and dewatering of the Pecos River, pumping of groundwater, and hybridization with the Sheepshead Minnow (*Cyprinodon variegatus*) (USFWS 1998d). Lowered water tables can eliminate water flow between sinkholes, isolating populations and limiting the species' ability to naturally recolonize previously-occupied habitats. The species may, however, be able to burrow into wetted bottom substrates, which enables them to persist in otherwise isolated, drying habitats (Sublette et al. 1990). River flooding, on the other hand, may allow access of non-native fishes to isolated sinkhole habitats, subjecting Pecos Pupfish to competition and predation (USFWS 1998d). To address these threats and the decline of the species, the USFWS, BLM, New Mexico Department of Game and Fish, New Mexico Department of Agriculture, New Mexico State Parks, and Texas Parks and Wildlife Department developed and implemented a conservation agreement wherein the agencies committed to protect known extant populations, establish new populations, and prohibit the use of Sheepshead Minnow as bait. The agreement was signed in 1999 but expired in 2004 and has not been revisited (USFWS 1998d; USFWS 2000; USFWS 2009b). Direct impacts to the Pecos Pupfish from climate change are unclear; however, based on a statewide assessment using existing climate change models and reports, projected increases in air and water temperatures, reduced flows, increased sediment input, shifts in precipitation patterns, earlier snowmelt, and shifts in storm intensity are likely to cause imminent and future reductions in available Pecos Pupfish habitat (Friggens 2015). Within the Chihuahuan Desert, the Bottomless Lakes State Park, Lost River, Pecos River, Bitter Lake NWR, Rio Felix, and Lower Hondo experienced significant increases in mean maximum and minimum temperatures between 1970–2005 (Enquist and Gori 2008). Spring habitats are dependent on groundwater levels that are directly affected by precipitation, which could be altered by climate change. The changes in precipitation and drought frequency could result in decreased availability of the groundwater necessary to recharge aquifers that support this species. Increased groundwater pumping for human consumption will also impact the likelihood and frequency of drying of Pecos River habitats (USFWS 2018d). Other indirect impacts of climate change on water quality, non-native species, disease susceptibility, and other factors are likely but have not been quantified (USFWS 2018f).

Peppered Chub

The Peppered Chub (*Macrhybopsis tetranema*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Extremely Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Peppered Chub's climate change vulnerability is impacted by factors related to distribution, life history, evolutionary potential, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Peppered Chub is native to the upper Arkansas River drainage in Oklahoma, Kansas, Texas, New Mexico, and Colorado. As of 1999, it was extant in about 100 river-km (62 river-mi) in Kansas and about 200 river The Peppered Chub is native to the upper Arkansas River drainage in Oklahoma, Kansas, Texas, New Mexico, and Colorado. As of 1999, it was extant in about 100 river-km (62 river-mi) in Kansas and about 200 river-km (124 river-mi) in New Mexico and Texas (Luttrell et al. 1999). These locations are widely disjunct: the Ninnescah River and an associated portion of the Arkansas River in Kansas and the South Canadian River between Ute and Meredith reservoirs in New Mexico and Texas (Eisenhour 1999; Luttrell et al. 1999). By 2022, the species had been extirpated from 94% of its historical range and was subsequently listed as Endangered by the USFWS and critical habitat was designated along 1,404 river-km (872 river-mi) in three units in New Mexico, Oklahoma, and Texas (USFWS 2022a). While the range-wide population size is unknown, surveys over time have documented a significant decline in the relative abundance of the species; efforts between 2013 and 2017 yielded over 1,800 collections with only 2% containing Peppered Chubs (USFWS 2018b). The species often occurs with the Arkansas River Shiner in shallow channels of large, permanently-flowing streams, where currents run over clean, fine sandy substrates; it also tends to avoid calm water and silty substrates (Collins et al. 1995; USFWS 2018b). Peppered Chubs appear more adapted to headwater portions of streams. Both species can tolerate adverse conditions that occur in the drought-prone prairie streams they inhabit, such as elevated water temperatures and low dissolved oxygen concentrations. Peppered Chubs may be associated with turbid water more so than the Arkansas River Shiner (USFWS 2018b). The Peppered Chub feeds primarily on larval insects, small crustaceans, immature aquatic insects, and plant material. Young begin to forage among sediments on the river bottom within days of hatching (USFWS 2018b). Peppered Chubs can tolerate a range of habitat conditions; however, to persist under a changing climate, the species must have the ability to respond through genetic adaptation, range shifts that require dispersal capability, and behavioral adjustments (USFWS 2018b). The adaptive capacity of the Peppered Chub is compromised by the small number of populations (and lack of genetic diversity as a species); limited dispersal ability, which is further hampered by discontinuous available habitats; and the inability to change the behaviors that support their specialized life cycle and associated reproductive phenology (USFWS 2018d). Threats to the species include altered flow regimes from construction of dams and impoundments, groundwater extraction, and climate change effects on precipitation; stream fragmentation, modified geomorphology, and poor water quality; and the introduction and spread of invasive species. Because of the short lifespan of the Peppered Chub (approximately two years), the risk of extinction from successive years of low flows or drought conditions is high. These threats continue to act on the species and may worsen in the future (USFWS 2022a). Within the Great Plains, average temperatures have increased, and projections indicate this trend will continue (USFWS 2018b). Cook et al. (2015) described the history of repeated drought in the absence of global climate change and projected significant increases in droughts in the southwest and central plain regions under both moderate and high future emissions Scenarios used for climate change modeling, exceeding droughts observed during the last millennium. Should either of these Scenarios be realized, the Peppered Chub will likely experience significant negative impacts (USFWS 2018b).

Plains Minnow

The Plains Minnow (*Hybognathus placitus*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Extremely Vulnerable under the RCP 8.5 Scenario. The Plains Minnow's climate change vulnerability is impacted by factors related to life history and abiotic niche, which influence its ability to persist in place and respond to climate change impacts. It is also impacted by barriers, land-use changes, other anthropogenic effects and biologic factors that could increase the effects of climate change.

The historical range of the Plains Minnow includes the Arkansas, Brazos, Colorado, Missouri, and Red River drainages from Montana and North Dakota south through Colorado and Kansas (Scheurer et al. 2003) to New Mexico and Texas and the Mississippi River from the mouth of the Missouri River to Tennessee (Page and Burr 2011). The species was introduced in Utah (Lehtinen and Layzer 1988), and introduced populations in the Pecos River in New Mexico could serve as genetic reservoirs should the species continue to decline and conservation measures become necessary (Worthington et al. 2018). While the species has undergone declines in distribution and abundance in some portions of its range (Rees et al. 2005a), it remains broadly distributed across the Great Plains, occupying main tributaries of the Mississippi River; the Arkansas, Missouri, and Platte Rivers, and the Gulf Coast drainages including the Brazos, Colorado, and South Canadian Rivers (Osborne et al. 2021). In New Mexico, the species was thought to be extirpated from the Dry Cimarron River and the Canadian River above the Ute Reservoir, but populations in the Canadian River below Ute Reservoir were possibly stable. In the Pecos River, the introduced Plains Minnow may have displaced the native Rio Grande Silvery Minnow (*Hybognathus amarus*) (NatureServe 2024). The total adult population size is unknown, but it is likely very large. This species has been described as one of the most common fishes of the Great Plains. However, it is thought to be extirpated from the Ninnescah and Arkansas Rivers due to drought (Page and Burr 2011; Osborne et al. 2021). Habitat for the Plains Minnow, which it shares with the Arkansas River Shiner and Peppered Chub in some portions of its range, includes shallow runs and pools of creeks and small to medium rivers with sandy, silt substrates and relatively slow to moderate currents (Lehtinen and Layzer 1988; Page and Burr 2011). Waters are clear to highly-turbid and have high levels of dissolved solids. Eggs probably are scattered over silt-bottomed backwaters. In New Mexico, it occurs along main channels of major streams and a short distance up tributaries (Sublette et al. 1990). Feeding involves scraping algae, diatoms, and other microflora from rocks, snags, and plant roots from the stream bottom or along stream margins (Sublette et al. 1990). Osborne et al. (2021) noted that fishes occupying streams of the Great Plains possess adaptations that enable them to survive changing, sometimes harsh, environmental conditions, such as small body size (<100 mm [4 in] total length), short generation time (1–3 years), fractional spawning in some species, and release of semi-buoyant eggs into the water column. The species' short lifespans, however, make them extremely vulnerable to stochastic environmental events. The most significant threats to the species include diversions for water management that result in changes in flow regime in both mainstem rivers and tributary streams and artificial structures that cause degradation and fragmentation of habitats by eliminating naturally-variable water levels, dynamic streambeds, and fluctuating water temperatures (Cross et al. 1985). The elimination of flood events has removed the environmental cues for spawning and reduced the quality and quantity of available spawning habitat (Wilde and Ostrand 1999). The introduction of non-native species, such as Blackstripe Topminnow (*Fundulus notatus*), Bluegill (*Lepomis macrochirus*), and Largemouth Bass, has resulted in competition with, and predation of, the Plains Minnow and other native fish populations in the Missouri River (Winston 2002) and other river systems. Other threats include hybridization, disturbance of riparian zones, and landscape-scale changes that degrade the proper function of stream ecosystems (Rees et al. 2005a). Despite being wide-ranging, the species is particularly sensitive to extreme low-flow events and highly susceptible to stochastic environmental events that could reduce reproduction and recruitment (Osborne et al. 2021). Within the Great Plains, average temperatures have increased, and projections indicate this trend will continue (USFWS 2018b). Cook et al. (2015) described the history of repeated drought in the absence of global climate change and projects significant increases in droughts in the southwest and central plain regions under both moderate and high future emissions Scenarios used for climate change modeling, exceeding droughts observed during the last millennium. Should either of these Scenarios be realized, the species that occupy aquatic habitats within this region will likely experience significant negative impacts (USFWS 2018b).

Razorback Sucker

The Razorback Sucker (*Xyrauchen texanus*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Razorback Sucker's climate change vulnerability is impacted by factors related to movement, demography, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The historical range of the Razorback Sucker included most of the Colorado River basin, from Wyoming and Colorado to Sonora and Baja California (Page and Burr 2011). After its listing by the USFWS and the recovery goals were published, wild populations of the species were considered threatened due to low numbers within its contracted range. Critical habitat was designated on 2,776 river-km (1,725 river-mi) within the Colorado River basin, including portions of the Colorado, Duchesne, Gila, Green, Gunnison, Salt, San Juan, Verde, White, and Yampa Rivers, and several Colorado River mainstem reservoirs including Lake Mead and Lake Mohave (USFWS 1990; USFWS 1994b; USFWS 2002b). When the recovery plan was published in 2002, a minimum viable population was estimated to be approximately 5,800 adults; this number was subsequently exceeded by the number of adults, whether stocked or wild-produced, present in the Green and Colorado Rivers (USFWS 2021d). Four populations of Razorback Sucker occur in the upper Colorado River basin; these populations have been actively conserved and managed for over 20 years. Increases in abundance and expansion of populations into available habitats are facilitated by fish passage facilities. Successful reproduction has been documented in all populations, and evidence of survival into later life stages has increased; however, populations in the upper basin rely on management actions to maintain long-term resiliency (USFWS 2021d). On the lower Colorado River, dams delineate the boundaries of the Razorback Sucker populations, where habitat and water quality are generally high, and water temperatures and food supply are adequate to sustain the species within three of the four populations. Few natural barriers to movement occur within these populations, yet connectivity across the dams depends on management actions. Water management eliminates variable flows in the lower basin, which are essential to connect off-channel floodplains in the upper basin. The reservoirs provide suitable nursery habitat for juvenile Razorback Suckers, which is essential for recruitment in Lake Mead (USFWS 2021d). River habitats typically utilized by the species include deep runs, eddies, backwaters, and flooded off-channel environments in spring; runs and pools often in shallow water associated with submerged sandbars in summer; and low-velocity runs, pools, and eddies in winter. Spawning in rivers occurs over bars of cobble, gravel, and sand substrates during spring runoff at variable flow rates and water temperatures. Spawning also occurs in reservoirs over rocky shoals and shorelines. Young prefer nursery environments with quiet, warm, shallow water such as tributary mouths, backwaters, or inundated floodplain habitats in rivers and coves or shorelines in reservoirs (USFWS 2002b). The species demonstrates a high degree of plasticity in its ability to utilize both lotic and lentic habitats and survive a wide range of environmental conditions (USFWS 2018f). Razorback Suckers have a wide diet breadth that includes algae, planktonic crustaceans, aquatic insect larvae, plants, and detritus (Marsh 1987). The greatest threats to Razorback Sucker populations are reductions in, and alterations of, flow regimes that cause declines in available habitat and connectivity and may increase predation, particularly of larvae, by non-native fishes. The effects of global climate change are not expected to affect the species in the immediate future but may result in impacts over the long term. Direct negative impacts to Razorback Suckers from climate change may occur from reduced runoff or temporal changes in peak flows, while indirect negative impacts are associated with increased abundance of non-native fishes. Potential positive impacts from climate change include warming of certain river reaches currently cooled by reservoir releases and potential increased growth rates (NatureServe 2024; USFWS 2018f).

Rio Grande Chub

The Rio Grande Chub (*Gila pandora*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Rio Grande Chub's climate change vulnerability is impacted by factors related to life history, evolutionary potential, and abiotic niche, which influence its ability to persist in place and respond to climate change impacts. It is also impacted by barriers, other anthropogenic effects, and biologic factors that could increase the effects of climate change.

Note on taxonomy: Based on a phylogenetic analysis of *Gila* species that occur in the western U.S. and Mexico, Schönhuth et al. (2014) observed that *Gila modesta*, a species with a small range in Mexico, clustered within the same clade as, and showed no genetic differentiation from, *Gila pandora* despite its range being disjunct from the Rio Grande Basin. Based on this analysis, the USFWS included *Gila modesta* in its Species Status Assessment (SSA) of *Gila pandora* (USFWS 2024c).

The Rio Grande Chub is known from the upper Rio Grande basin in north-central New Mexico and south-central Colorado and portions of the Canadian River basin in New Mexico and the Pecos River basin in New Mexico and Texas. There has been uncertainty regarding whether the species is native or introduced to the Canadian River in New Mexico, but there is no evidence supporting introductions. Hence, due to the lack of data, the presumption is that the Rio Grande Chub was historically native to the Canadian River basin in New Mexico. Another population may exist in the State of Coahuila, Mexico, which is currently classified as *G. modesta* (USFWS 2024a). Currently, the species occurs in 53 disjunct populations within 844 stream-km (524.4 stream-mi) of its historical range (USFWS 2024c). Its distribution has contracted by as much as 75% in the Rio Grande basin, where it is mostly restricted to tributary streams and infrequently occurs in the mainstem in northern New Mexico and southern Colorado, although it can still be found in the Pecos and Canadian River basins in New Mexico (Rees et al. 2005b; USFWS 2024c). The Rio Grande Chub generally occurs in cool- to cold-water streams between 1,717 and 2,810 m (5,633 and 9,219 ft) with low gradients. Habitat heterogeneity is important for the species, which utilizes moderately-sized pools and runs with instream structure, such as large woody debris, boulders, undercut banks, and aquatic vegetation over sand, gravel, and cobble substrates (Calamusso and Rinne 1996; Bestgen et al. 2003; Platania 1991; Rees et al. 2005b). The Rio Grande Chub often co-occurs with the Rio Grande Sucker (*Pantosteus plebeius*) in the Rio Grande basin (USFWS 2024c). The species is considered an omnivorous mid-water column feeder that consumes drifting invertebrates, fish, and occasional vegetation (USFWS 2024d). The total adult population size of the Rio Grande Chub is unknown but likely exceeds 10,000 individuals (NatureServe 2024). Based on the USFWS's SSA, 34% of the 53 populations are at high risk of extirpation over the next 10 years, 57% are at a medium risk, and 9% are at low extirpation risk (USFWS 2024d). The primary threat to the species both historically and at present is predation by, and competition with, non-native species, such as non-native trout, Northern Pike, and Smallmouth Bass (*Micropterus dolomieu*). Rio Grande Chub populations are distributed across a relatively wide geographic area, providing redundancy that can help protect the species from negative effects of catastrophic events. They also occur across a range of environmental gradients, suggesting the species possesses some adaptive capacity that will facilitate its survival through changing environmental conditions (USFWS 2024d). Overall, habitat suitability is likely to decline across the range of the Rio Grande Chub over this century, but this decline will be variable. Reduced water flows, higher water temperatures, and changes in water quality resulting from more frequent and severe droughts may negatively affect the persistence of native fishes. Additionally, increased upstream water temperatures at higher elevations may make these habitats more suitable for some non-native species (Rahel et al. 2008; Bell et al. 2021; USFWS 2024c). The Rio Grande Chub occupies mid- to upper-elevation streams, lakes, and ponds, which under different climate Scenarios, anthropogenic barriers and steep stream gradients may limit the Rio Grande Chub's ability to move into more suitable habitats (USFWS 2024c). Despite these apparent risks, the USFWS concluded that the species is not likely to become Endangered within the foreseeable future throughout all of its range (USFWS 2024a).

Rio Grande Cutthroat Trout

The Rio Grande Cutthroat Trout (*Oncorhnchus clarkii virginalis*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Extremely Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Rio Grande Cutthroat Trout's climate change vulnerability is impacted by factors related to distribution, life history, evolutionary potential, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It is impacted by barriers, other anthropogenic effects and biologic factors that could increase the effects of climate change. It also has documented or modeled responses to climate change that impact its climate change vulnerability score.

The historical range of the Rio Grande Cutthroat Trout is not definitely known, but it likely encompassed all suitable habitats in the Canadian, Pecos, and Rio Grande River basins (Sublette et al. 1990; Behnke 1992). There is speculation that the species may have occurred in Texas and Mexico, but there is no evidence that supports its presence there (Behnke 1967; Garrett and Matlock 1991; USFWS 2022d). Although once widely distributed across connected stream networks, Rio Grande Cutthroat Trout populations now occupy approximately 11% of its historical habitat in highly-fragmented populations that are isolated from one another (USFWS 2023b). Alves et al. (2008) documented approximately 120 self-sustaining populations of Rio Grande Cutthroat Trout throughout the Rio Grande, Pecos, and Canadian watersheds, representing less than 12% of its presumed historic range. The USFWS's SSA (2014a) identified 122 "conservation populations" (populations with less than 10% introgression [gene mixing] with non-native species and subspecies), of which 20 were categorized as in the "Best" condition, i.e., they have a long, occupied stream reach (>9.65 km [6 mi]), effective population sizes of >500, and no non-native trout presence. Fifteen populations were considered in "Poor" condition, i.e., either hybridizing non-native trout were present or the effective population size was less than 50 individuals. The remaining 35 and 52 populations were categorized as "Good" and "Fair," respectively (USFWS 2014d). The Rio Grande Cutthroat Trout utilizes different types of habitats for different life stages. Spawning habitat typically consists of clean gravel with little or no fine sediment (NMDGF 2002). Nursery habitats are usually at stream margins where water velocity is low and water temperature is slightly warmer, as water temperature may play a critical role in the development of young and recruitment into the reproductive population (Harig and Fausch 2002). The Rio Grande Cutthroat Trout can tolerate up to 25ºC (77ºF); however, juvenile trout could experience mortality due to higher daily temperatures, and declining growth rates and malformations have been observed when average temperatures exceed 18ºC (64ºF) for more than a month (Zeigler et al. 2013). Adult habitat consists of pools with some cover and riffles that promote food production and foraging. Refugia may be sought in, but not limited to, deep pools that are not subject to freezing in the winter or desiccating during summer or periods of drought. Refugia are critical for survival and may be a limiting factor in headwater streams (Harig and Fausch 2002). Rio Grande Cutthroat Trout, like other cutthroat trout species, are opportunistic feeders ingesting mostly aquatic invertebrates and terrestrial insects the fall into the water (Sublette et al. 1990; Rinne 1995). As they mature, Rio Grande Cutthroat Trout will also feed on other fish species (Rinne 1995). Rio Grande Cutthroat Trout habitats have been lost and/or degraded by wildfires, dewatering and diversion of streams, and loss of streambank cover from overgrazing by livestock and timber harvest. Populations have been impacted by hybridization or introgression with non-native trout species and competition with introduced salmonids (Sublette et al. 1990; Rinne 1995; USFWS 2002a). Importantly, most populations are isolated in headwater habitats and gene flow among populations is extremely limited (Rinne 1995), putting them at risk from catastrophic events. The Rio Grande Cutthroat Trout occupies cold water habitats that are projected to be affected by increased water temperatures, decreased streamflow, changes in the seasonal distribution of water discharge and/or runoff, and an increased occurrence of extreme environmental events, such as wildfire, drought, and floods (USFWS 2022d). Many of the remaining populations are at risk of extirpation due to climate warming (Zeigler et al. 2012).

Rio Grande Shiner

The Rio Grande Shiner (*Notropis jemezanus*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Extremely Vulnerable under the RCP 8.5 Scenario. The Rio Grande Shiner's climate change vulnerability is impacted by factors related to distribution, life history and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It is also impacted by barriers, land-use changes, other anthropogenic effects, and biologic factors that could increase the effects of climate change.

The Rio Grande Shiner historically occupied the Rio Grande drainage in New Mexico, Texas, and Mexico, including the Rio Grande and Pecos Rivers from their headwaters in northern New Mexico to the Rio Grande delta on the Texas coast. It also occurred in major tributaries to the Rio Grande in Mexico including the Rio Conchos, Rio Salado, and Rio San Juan (Hendrickson and Cohen 2015; NatureServe 2024). Much of its historical range has contracted, and in New Mexico, it has been extirpated from the Rio Grande mainstem and may only occur in the Pecos River between the Fort Sumner Irrigation District Dam and Brantley Reservoir (Hoagstrom and Brooks 2005). In Texas, the species occupies the main stem river from Presidio, Texas, to the Amistad Reservoir (Hendrickson and Cohen 2015). As of the early 2000s, the species was thought to be extant in Mexico, but its status was unknown (Hoagstrom and Brooks 2005). The total adult population size of the Rio Grande Shiner is unknown but presumably exceeds 10,000; however, its distribution and abundance are declining (NatureServe 2024). Effective population size estimates for the species suggest a decreasing population and if the population rebounds, relatively few (i.e., several hundred) individuals may be responsible. Genetic research also suggested that the populations are spatially panmictic (Osborne 2013), and populations are small and isolated within fragmented habitats (Wild Earth Guardians 2020). The Rio Grande Shiner occupies warm-water habitats that include runs and flowing pools in large, open, relatively vegetation-free rivers and large creeks with rubble, gravel, and sand substrates often overlain with silt (Lee et al. 1980; Sublette et al. 1990; Page and Burr 2011). The species has a carnivorous-omnivorous diet, like most *Notropis* species (Sublette et al. 1990). Dams, reservoirs, and other water diversion structures have resulted in significant habitat fragmentation within the range of the Rio Grande Shiner. The Rio Grande was once a large expanse of free-flowing waters (2,651 river-km [1650 river-mi]), but only five free-flowing reaches exceeding 100 km (62 mi) in length remain. Similarly, the Pecos River, from its confluence with Tecolote Creek at Tecolotito, New Mexico, to its confluence with the Rio Grande in Texas (1,378 km [856 mi]), is fragmented by numerous water-control structures. There are two free-flowing reaches along the Pecos greater than 300 km (186 mi), all other reaches in this section are less than 65 km (40 mi) long (Dudley and Platania 2007). Because of the extensive network of dams and reservoirs within the species' range, flow regimes have been altered, resulting in changes in channel morphology, habitat homogeneity, and contributed to low flows and drying of stream reaches

(Larson and Propst 2000; Dudley and Platania 2007). These conditions can cause water quality degradation through increased salinity and golden algae blooms, which have caused population declines from which the species has never fully recovered (Cheek and Taylor 2015). Another threat to the Rio Grande Shiner, and other native shiners, is predation of larval fish by non-native species. If normal food sources are limited and/or changes in flow regimes occur, non-natives are likely to concentrate and prey on larval fish that are already impacted by reservoir operations (Larson and Propst 2000). The Rio Grande basin faces considerable threats from climate change. Warming in the absence of precipitation in the region is expected to result in increased watershed evapotranspiration, decreased spring snowpack and snowmelt, and reduced water supplies. The average temperatures in the Upper Rio Grande Basin have already increased over the course of the 20th century (USBR 2011). Synergistic effects of climate change combined with changes in water management necessitated by human population growth coupled with the unique life history traits of the species makes the Rio Grande Shiner more susceptible to significant impacts from existing and future threats (USFWS 2021a).

Rio Grande Silvery Minnow

The Rio Grande Silvery Minnow (*Hybognathus amarus*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Rio Grande Silvery Minnow's climate change vulnerability is impacted by factors related to distribution, life history, evolutionary potential, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It is also impacted by barriers, land-use changes, other anthropogenic effects, and biologic factors that could increase the effects of climate change.

The Rio Grande Silvery Minnow is one of seven species in the genus *Hybognathus* known to occur in the U.S. (Pflieger 1980). At one time, this was one of the most widespread and abundant species in the Rio Grande basin of New Mexico, Texas, and Mexico, although it has not been observed in any Mexican tributaries to the Rio Grande despite extensive survey efforts (Edwards et al. 2003; USFWS 2010d). The extent of occurrence, area of occupancy, and population size have declined greatly; its range has been reduced from about 3,862 river- km (2,400 river- mi) to 280 river-km (174 river-mi) within the middle Rio Grande or about 7% of its historical range (Bestgen and Platania 1991; USFWS 2010d; NMDGF 2020b). The majority of the population is thought to occur within a 96-km (60-mi) reach downstream of the San Acacia Dam (Ikenson 2002). A nonessential, experimental population of the Rio Grande Silvery Minnow was designated in 2008, and individuals were introduced into the Rio Grande near Big Bend, Texas (USFWS 2008b). The status of this population will continue to be monitored (USFWS 2010d). Critical habitat for the species was designated along 252 km (157 mi) of the middle Rio Grande in New Mexico in 2003 (USFWS 2003a). The total adult population size of the Rio Grande Silvery Minnow is unknown but thought to be over 10,000; however, the overall abundance of the species continues to decline (USFWS 2010d; NatureServe 2024). Importantly, species abundance can fluctuate by orders of magnitude from year to year depending on environmental conditions (Alò and Turner 2005). For example, one monitoring effort showed that the species' density in October 2018 experienced a massive decline (> 99%) when compared to October 2017 due to reduced spring runoff in 2018 (Osborne et al. 2021). Species such as the Rio Grande Silvery Minnow that have short lifespans and occur in fragmented habitats in a limited geographic range are at higher risk of significant impacts to population numbers and possibly extinction from even brief periods of unfavorable environmental conditions. Impacts from these conditions can erode genetic diversity through reductions in the effective population size (Osborne et al. 2021). A recovery augmentation program has proven to be a relevant and necessary tool in the maintenance of Rio Grande Silvery Minnow populations (USFWS 2023h). Archdeacon et al. (2023) surmised that augmentation of hatchery-reared fish increased the number of reproductive individuals in the population, which has been critical following a genetic bottleneck within the wild population. The Rio Grande Silvery Minnow occupies a variety of habitats in shallow, low-gradient, large streams with shifting sand or silty bottoms in areas of low- or moderate-velocity water, such as eddies, pools, and backwaters, and is rarely found in deep main channel runs that have high water velocities (NMDGF 1988; USFWS 2010d). Like other species of *Hybognathus*, the Rio Grande Silvery Minnow feeds on diatoms, algae, larval insects, and plant material scraped from bottom sediment (Sublette et al. 1990). Organic detritus has also been identified as a food item (NMDGF 2024). The species has and continues to be threatened by habitat and water quality degradation and modified water flows from dewatering; river channelization; water management operations and diversion of river flow to provide water for agricultural, municipal, and industrial uses; and lack of suitable refugia during periods of low or no flow (Bestgen and Platania 1991; USFWS 2003a; USFWS 2007b; USFWS 2010d). More frequent and prolonged drought is likely to impact the species into the future as there is a general downward trend in spring runoff volume and changes in timing of spring runoff; spring runoff volume and timing are key to the successful spawning and recruitment of individuals of this species (USFWS 2010d). Climate change is projected to cause increases in temperature and alter precipitation and run-off patterns in the Rio Grande basin (Lehner et al. 2017; Overpeck and Udall 2020). Decreased water volume is likely to complicate the distribution of water for human uses and maintenance of habitat for the Rio Grande Silvery Minnow (USFWS 2023h). The average temperatures in the upper Rio Grande basin have already increased over the course of the 20th century (USBR 2011). The effects of climate change, coupled with changes in water management necessitated by human uses, will challenge the implementation of conservation actions necessary for this species, which occurs in fragmented and isolated populations and is vulnerable to natural and human-caused changes (USFWS 2023h). The Minnow Action Team within the middle Rio Grande Endangered Species Collaborative Program has been working, and continues to work, towards the recovery of the species through the captive propagation program, habitat restoration activities, modifying seasonal river operations, and focusing on maintaining refugial habitats for the Rio Grande Silvery Minnow (NMDGF 2020b; NMDGF 2024).

Rio Grande Sucker

The Rio Grande Sucker (*Catostomus plebeius*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Rio Grande Sucker's climate change vulnerability is impacted by factors related to distribution, life history, ecological role, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It is also impacted by barriers, other anthropogenic effects, and biologic factors that could increase the effects of climate change.

Note on taxonomy: Within Catostomidae, there are 13 recognized genera, which includes *Pantosteus*. At various times, *Pantosteus* has been considered a subgenus within the genus *Catostomus* (Smith 1966), but molecular genetic studies have confirmed that the genus *Pantosteus* is a monophyletic lineage (Unmack et al. 2014; Bangs et al. 2018). Both morphological and genetic studies have shown that the Rio Grande Sucker is a distinct taxonomic entity compared to other species within the genus (Smith 1966; Crabtree and Buth 1987; Unmack et al. 2014; Bangs et al. 2018). Currently, according to the Integrated Taxonomic Information System, the accepted nomenclature for the Rio Grande Sucker is *Panosteus plebeius* (ITIS 2024).

In the U.S., the Rio Grande Sucker is restricted to the higher elevation portions of its historical range in Arizona, Colorado, and New Mexico. The species occurs in first, second, and third order streams of the upper Gila, Mimbres, Pecos, and middle Rio Grande River basins, but its range has become highly fragmented and disjunct. In New Mexico, it occupies streams in, and adjacent to the Carson, Santa Fe, Cibola, Lincoln, and Gila National Forests in the upper Rio Grande basin (USFWS 2024d). The area of occupancy and population size in the U.S. appear to have declined substantially (Rees and Miller et al. 2005; USFWS 2024d). Data on the status of populations in Mexico are lacking, including information on extirpations that may have occurred in any of the major drainages where the species has been documented (USFWS 2024d). Habitats in New Mexico generally occur within diverse ecosystems ranging from desert scrub up to subalpine zones at elevations between 1,000 and 3,000 m (3,280 and 9,842 ft) with low stream gradients (<3.2%) (Calamusso et al. 2002; USFWS 2024d). The species occupies rocky pools, runs, and riffles of small to medium rivers (Lee et al. 1980; Page and Burr 2011), as well as backwaters and pools below riffles with gravel and/or cobble substrates; it is rarely observed in waters with heavy silt and organic detritus (Sublette et al. 1990). The Rio Grande Sucker often co-occurs with the Rio Grande Chub in the Rio Grande basin (USFWS 2024d). The Rio Grande

Sucker ingests filamentous algae and other microscopic and macroscopic organisms, including diatoms, benthic invertebrates, and sometimes detritus scraped from rocks or from gravel between cobble and boulders (Sublette et al. 1990; NatureServe 2024). Total adult population size is unknown but presumably exceeds 10,000 (NatureServe 2024). Historically, the species was more widely and continuously distributed throughout the mainstem and tributaries of the Rio Grande, but dams, diversions, alteration of flows, non-native species, wildfire, and climate change have resulted in species' declines and continue to impact the species (USFWS 2024d). The USFWS determined that there are 32 Rio Grande Sucker populations in the U.S. that occupy a combined 605.7 river-km (376.4 river-mi). While the distribution of the species has contracted, multiple populations remain in all the major drainages that make up the species' historical range, except for the Pecos River basin, which supports a single population (USFWS 2024a; USFWS 2024d). Based on an extirpation risk score developed in the USFWS's SSA, most populations (18 out of 32) were at medium risk of extirpation over the next 10 years, 12 at high risk, and two at low risk. These scores were determined based on the presence of non-native species; 20 populations are invaded by non-native trout and/or white sucker (*Catostomus commersonii*), and 12 of those are at high risk of extirpation. Eight of the 18 medium-risk populations co-occur with non-native trout, but severe population declines are not expected, and these medium-risk populations are likely to persist over the next 10 years, largely because they possess characteristics of a resilient population (e.g., occupied stream length, adult abundance). No populations were at risk of extirpation from stream dewatering or wildfire over the next 10 years (USFWS 2024b; USFWS 2024d). Projected changes in temperature, precipitation, and snowpack due to climate change are expected to modify both the magnitude and timing of runoff. These conditions increase the risk of drought into the future (Ault et al. 2016), which reduces water flows, increases water temperatures, and degrades water quality and may affect the survival and reproduction of native fishes. However, no specific data documenting these effects on the Rio Grande Sucker are currently available (USFWS 2024d). Yet, the Rio Grande Sucker displays phenotypic plasticity, can move into more suitable habitats as conditions change, and/or evolve in place, despite having limited ability to disperse long distances. Additionally, stable populations have been documented in manipulated, novel environments, such as agricultural ditches (USFWS 2024b). Several agencies are party to a conservation agreement designed to promote the conservation of the Rio Grande Sucker and Rio Grande Chub through monitoring, data compilation and management, restoration of populations, habitat restoration, management of non-native species, salvage operations, and public outreach (RGC and RGS 2018). Despite these apparent risks, and considering the current conservation efforts, the USFWS concluded that the species is not likely to become Endangered within the foreseeable future throughout all of its range (USFWS 2024a).

Roundnose Minnow

The Roundnose Minnow (*Dionda episcopa*) will experience a high degree of climate change exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Roundnose Minnow's climate change vulnerability is impacted by factors related to distribution and life history, which influence its ability to shift in space and persist in place.

The Roundnose Minnow is found in the Rio Grande and its tributaries, particularly in the Pecos River system, upstream of the Devil's River in Texas, in New Mexico, and in Coahuila, Mexico (Sublette et al. 1990; Page and Burr 2011). Within New Mexico, this species was previously more abundant and widespread but now is limited to springs and low-gradient streams in the middle (Eddy and Chavez Counties) and upper (DeBaca and Guadalupe Counties) Pecos River valley (Schönhuth et al. 2012; Platania and Farrington 2015). Additionally, there is significant genetic divergence between individuals in the middle and upper Pecos River, suggesting some impacts to genetic diversity (Schönhuth et al. 2012). The Roundnose Minnow is herbivorous, feeding almost exclusively on aquatic vegetation, and lives in shallow, rocky, clear pools of low-gradient rivers and streams with an abundance of aquatic vegetation (Sublette et al. 1990; Page and Burr 2011). It spawns in seep springs when water temperatures reach 17-18°C (62-64°F) and may spawn year round in some streams, such as El Rito Creek, due to elevated minimum winter water temperatures (Platania and Farrington 2015). Their sex ratio skews towards more females, with females becoming sexually mature at a smaller size than other *Dionda* spp., generally around age one (Platania and Farrington 2015). During sampling in the middle Pecos River valley, no minnows were sampled that were older than age three (Platania and Farrington 2015). The Roundnose Minnow is primarily threatened by habitat destruction and degradation from habitat fragmentation due to dams and barriers to fish movement and dewatering due to over-allocation of water resources to humans, which could be exacerbated by the increasing intensity, frequency, and severity of droughts due to climate change (Platania and Farrington 2015).

Roundtail Chub (lower Colorado River populations and upper basin populations)

The Roundtail Chub (*Gila robusta*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Roundtail Chub's climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

Note on taxonomy: The *Gila robusta* complex has a complicated taxonomic history. The USFWS follows the taxonomic revision that determined available evidence did not support species-level status for the Headwater Chub (*G. nigra*) and the Gila Chub (*G. intermedia*), collapsing them into Roundtail Chub (*G. robusta*) (Page et al. 2017). This nomenclature is consistent with the Integrated Taxonomic Information System report (ITIS 2024). Results of research conducted by Chafin et al. (2021), however, supported the resurrection of the three species as distinct entities. Taxonomic revisions that propose to reinstate *G. nigra* as separate from *G. intermedia* and *G. robusta* are anticipated, hence, NMDGF continues to recognize *G. nigra* as a separate taxon from *G. robusta* (NMDGF 2024).

The historical range of the Roundtail Chub encompasses the Colorado River basin across five states (Arizona, Colorado, New Mexico, Utah, Wyoming). Hydrological, geographical, ecological, and genetic factors provide the rationale for dividing the species into an upper Colorado River basin and a lower Colorado River basin section, delineated by the Glen Canyon Dam (Voeltz 2002). The lower Colorado River basin includes the Bill Williams, Gila, and Little Colorado River populations in Arizona and New Mexico (USFWS 2022f). Throughout the entire range, the species occupies about 45% of its historical range (Bezzerides and Bestgen 2002). In the lower Colorado River basin, the calculated occupied stream length represents a 66% reduction in the species' distribution. The species is extirpated from the middle and lower Gila watersheds where it historically occurred and has experienced reductions greater than 80% in the lower Gila-Agua Fria, San Pedro-Wilcox, and Santa Cruz watersheds. The Bill Williams River watershed has experienced the smallest reduction in occupied range compared to the historical distribution (12%) (USFWS 2022f). The total adult population size of the Roundtail Chub is unknown but likely exceeds 10,000 (NatureServe 2024). There is a lack of detailed information on factors such as changes in abundance, number of populations, genetic diversity, and temporal changes in stressors; therefore, occupied stream length across the lower Colorado River was used as a surrogate to ascertain species status, as discussed above (USFWS 2022f). Roundtail Chub occupy cool to warm waters of rivers, streams, and cienegas, often in deep pools and eddies. Adults favor slow-moving, deep pools with cover such as large rocks or boulders, root wads, undercut banks, overhead bank cover, and woody debris. Spawning occurs in pools, runs, and riffle habitats with slow- to moderate-velocity water and is cued by water temperatures of 14 to 24˚C (57 to 75˚F) with most at 18 to 20˚C (64 to 68˚F). Young of the year occupy shallow (less than 50 cm [19.7 in] in depth) and low-velocity waters with vegetated shorelines. Water temperatures within occupied habitat vary seasonally between 0 and 32˚C (32 and 90˚F). Lethal water temperature limits are around 34˚C (93˚F) (USFWS 2022f). The Roundtail Chub is opportunistic in its feeding habitats, ingesting available aquatic and terrestrial insects, gastropods, crustaceans, fishes, and sometimes filamentous algae (Sublette et al. 1990). Historical threats to the species included the construction of dams, impoundments, and diversions; flow regulation; river and channel modifications; sedimentation resulting from adjacent land uses, such as livestock grazing, timber harvest, road construction, and removal of riparian vegetation; and, importantly, the introduction and expansion of non-native predatory and competitive fish species (Hubbs 1954; Miller 1961; Minckley and Deacon 1968; Meffe 1985). Water quality degradation from contaminants, nutrient inputs, and pathogens may have also contributed to declines in populations and/or poor habitat conditions (Carman 2006). Various regional modeling efforts indicate that the Southwest is highly likely to experience a prolonged drying trend in response to projected changing climatic patterns. Altered stream flow, an increased demand for water storage and conveyance systems, and warming water temperatures that favor non-native species are likely to impact the Roundtail Chub (Seageret al. 2007; Rahel and Olden 2008). Factors such as these can reduce the ecological integrity of stream habitats and result in small, isolated populations that lose the ability to recolonize following disturbance and may ultimately become extirpated (Fagan et al. 2002; USFWS 2022f). Despite the lack of quantitative data regarding specific impacts to the Roundtail Chub from climate change, regional modeling projections suggest it is likely to have profound effects on the amount, permanency, and quality of habitat for species in this region (Seager et al. 2007). The ongoing active management currently in place remains critically important to the conservation and persistence of Roundtail Chub given its status and potential future climatic Scenarios facing the species (USFWS 2022f).

Smallmouth Buffalo

The Smallmouth Buffalo (*Ictiobus bubalus*) will experience a high degree of climate change exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Smallmouth Buffalo's climate change vulnerability is impacted by factors related to demography and life history, which influence its ability to persist in place.

The Smallmouth Buffalo is found across much of the U.S. and is found in New Mexico in the Rio Grande in Dona Ana and Sierra Counties and the Pecos River in and downstream of Sumner Reservoir, although it is likely extirpated from the Pecos basin (Sublette et al. 1990; Page and Burr 2011; Wick 2023). In New Mexico, they reside in larger pools of higher-order rivers with low-velocity currents and lower-elevation impoundments, preferring clean to moderately-turbid, deep, warm waters (Sublette et al. 1990). The most productive habitat appears to include abundant aquatic vegetation and a silt bottom (Dalquest and Peters 1966). Smallmouth Buffalo spawn April through September, generally in flooded terrestrial vegetation during higher water levels when water temperatures are between 19 and 27.5 °C (66 and 81°F), and they will sometimes migrate up small streams to spawn (Jester 1973; Becker 1983). A very recent study from the northern stretch of the Mississippi River found Smallmouth Buffalo became sexually mature when they weigh more than 540 g (19 oz) and 289 mm (11.4 in) in length, generally at three to 11 years, and generally have a life span of up to 30 years or more (Maxson et al. 2024). However, it is common for southern populations to become sexually mature sooner than northern populations, so New Mexico populations may mature sooner (Sublette et al. 1990). Hybridization has been documented with the Bigmouth Buffalo (*Ictiobus cyprinellus)*, although impacts to fitness are not known (Lee et al. 1980). This species was relatively common prior in the 1960s but has subsequently become more rare as a result of fish toxicants and commercial fishing (Sublette et al. 1990). The New Mexico populations specifically have experienced a decline in numbers across all populations (Sublette et al. 1990).

Sonora Sucker

The Sonora Sucker (*Catostomus insignis*) will experience a high degree of climate change exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Sonora Sucker's climate change vulnerability is impacted by factors related to distribution and life history, which influence its ability to shift in space and persist in place.

The Sonora Sucker's range includes the upper Gila River and Bill Williams River systems (Colorado River basin) in Arizona, the Gila and San Francisco drainages (except along the extreme headwaters) in New Mexico (Sublette et al. 1990; AGFD 2002b), and headwaters of the Santa Cruz and San Pedro Rivers (Gila basin) in northern Sonora, Mexico, although it is extirpated in the southern half of its range (Lee et al. 1980; Miller et al. 2005). This species is found in pools of still water with sand and gravel substrates, in habitats ranging from warm-water rivers to cold-water trout streams, feeding on bottom-dwelling invertebrates in lentic habitats (Sublette et al. 1990; Rinne 1992). The Sonora Sucker spawns in gravel riffles, starting in late winter through midsummer (Sublette et al. 1990; Gibson et al. 2015). The Sonora Sucker has a lifespan of eight to 10 years (Lateral Lines 2012). Hybrids have been reported between the Sonora Sucker and the Desert Sucker, although impacts to fitness are not known (Sublette et al. 1990). High lead levels that could negatively impact reproduction have been found in the Sonora Sucker population in Aravaipa Creek (USFWS 2012b). It is threatened by habitat destruction and degradation from channelization, siltation, and the use of prescribed fire (Rinne and Carter 2008; NMDGF 2016).

Southern Redbelly Dace

The Southern Redbelly Dace (*Chrosomus erythrogaster*) will experience a high degree of climate change exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Southern Red-belly Dace's climate change vulnerability is impacted by factors related to distribution, movement, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Southern Redbelly Dace has a large range across the U.S.; it is on the edge of its range in New Mexico (Page and Burr 2011). In New Mexico, it is found in a few small, disjunct populations in Mora and Colfax Counties in northern New Mexico, in the upper Mora River drainage in Coyote Creek and in the tributaries of Black Lake (Sublette et al. 1990). The Southern Redbelly Dace is found in permanent spring and spring-run habitats that are clear, cool, and shaded with gravel substrate, but are rare in stream habitats within New Mexico (NMDGF 1988; Propst et al. 1999). They spawn in schools from April to June in shallow water at 10 to 16°C (50 to 61°F) near riffles among gravel (NMDGF 1988; Sublette et al. 1990). They are herbivores, primarily feeding on microscopic plants and algae, although small invertebrates are likely also consumed (Lee et al. 1980). Individuals are sexually mature at year two, and the average life span is three years (Sublette et al. 1990). The Southern Redbelly Dace will hybridize with the Central Stoneroller (C*ampostoma anomalum*) and the Creek Chub (*Semotilus atromaculatus*); fitness costs are unknown but, if sufficiently negative, could impact population abundance and trends (Grady and Cashner 1988; ASIR 2008). This species has a critical thermal maximum that is seasonally related to an ambient temperature ranging from 0 to 21.5°C (32 to 71°F); temperature increases due to climate change could result in lethal ambient temperatures for the Southern Redbelly Dace (Sublette et al. 1990; Hegewisch et al. 2024). Non-native predators, such as the brown trout and rainbow trout, could also be a threat to this species as they occupy similar elevations and habitats (ASIR 2008). They are also threatened by habitat destruction and degradation from wetland draining and dredging, siltation, pollution, bank destabilization, and agricultural practices such as irrigation and livestock grazing (ASIR 2008; NMDGF 2016; NMDGF 2020b).

Speckled Chub

The Speckled Chub (*Macrhybopsis aestivallis*) will experience a high degree of climate change exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Speckled Chub's climate change vulnerability is impacted by factors related to demography, life history, and abiotic niche, which influence its ability to persist in place and respond to climate change impacts.

The Speckled Chub has a relatively wide range across multiple river systems in New Mexico, Texas and Mexico (Eisenhour 1999). In New Mexico, it was historically found in the Rio Grande and the Canadian and Pecos River basins and has experienced a 73% range contraction in recent years, including extirpation from the Rio Grande and much of the lower Pecos River (NMDGF 1988; Osborne 2013). The Speckled Chub is found in low-gradient, swift, main channel streams with fine gravel or sand substrates and high levels of turbidity and dissolved solids (Cross et al. 1985; NMDGF 1988; Sublette et al. 1990). Spawning starts in late spring when water temperatures exceed 21°C (70°F) and continues through August (Sublette et al. 1990). The Speckled Chub spawns in sandy areas and depends on moving water to carry developing eggs (Pflieger 1997). They have a single brood annually and rarely survive past one and a half years (Starrett 1951; Sublette et al. 1990; Pflieger 1997). The Speckled Chub is a ground feeder, feeding on insect larvae, organic detritus, and plant material (Sublette et al. 1990). Water withdrawal for irrigation and dams alter natural discharge patterns and reduce fish populations, and drought conditions combined with increased water withdrawal likely resulted in extirpation of this species from the Rio Grande system (Bestgen and Platania 1990). Continued dissection of riverine habitat resulting from human activity is likely to negatively affect this species, particularly as droughts and floods increase in intensity, frequency, and severity due to climate change (Bestgen and Platania 1990; Osborne 2013). Other activities, such as proposed desalinization projects, could also reduce surface flows and threaten Speckled Chub populations (Osborne 2013). This species has likely already experienced a severe genetic bottleneck in the past, although current genetic diversity is relatively high (Osborne 2013).

Spikedace

The Spikedace (*Meda fulgida*) will experience a high degree of climate change exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Spikedace's climate change vulnerability is impacted by factors related to distribution, movement, life history, evolutionary potential, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

Historically, the Spikedace was found throughout much of the Agua Fria, Gila, Salt, San Francisco, San Pedro, and Verde River systems up to 1,800 to 1,900 m (5,900 to 6,230 ft) elevation (USFWS 2012b). Currently, they occupy less than 10% of their historic range; they are only present in the Aravaipa Creek in Arizona and a portion of the Gila River south of Cliff, New Mexico (USFWS 2012ab). Much of their current range is protected on state or federal lands and some is designated as critical habitat (USFWS 1986a; USFWS 2012b). Each Spikedace population is genetically distinct, suggesting they have been historically isolated (USFWS 2012b). Spikedace are typically associated with shallow runs with loose sand-gravel substrate and clear water (Sublette et al. 1990; Propst et al. 1999). Habitat preferences vary; juveniles prefer very shallow (less than five cm [2 in]) and slower (less than five cm/sec [two in/sec]) stream margin habitats while adults prefer main channel habitats with two to 20 cm/sec (0.8 to eight in/sec) water velocities and four to 12 cm (1.5 to five in) water depths. In the winter, this species tends to congregate along cobble-bottomed stream margins (Propst et al. 1986). Spikedace spawn from mid-March to May in shallow riffles with gravel and sand substrates, where fine sediments smaller than sand do not impact oxygenation of the eggs; thus, clean, silt-free substrates are essential for reproduction (Propst et al. 1986; USFWS 2012b). The Spikedace generally is sexually mature in its second year, and its life span is normally one to two years with few individuals surviving past year four (Barber et al. 1970; Minckley 1973). Females generally spawn at least twice every year (Propst et al. 1986). Population numbers are unknown but have declined in recent years (USFWS 2012b; Paroz and Propst 2006). Populations appear to spike during years of high flow (Minckley 1981). The Asian taperworm (*Taenia asiatica*) and the Ich parasite (*Ichthyophthirius multifiliis*) could pose a threat to the Spikedace, although no impacts have been documented (USFWS 2012b). The Spikedace is threatened by habitat destruction and degradation from stream flow depletion, water diversion, livestock grazing, road construction, and habitat alteration (USFWS 2012b). However, this species seems most threatened by competition and predation resulting from the introduction of non-native and invasive fish species, particularly the Red Shiner but also including the Channel catfish, Flathead Catfish, Black Bullhead (*Ameiurus melas*), Yellow Bullhead (*A. natalis)*, and Western Mosquitofish, and are generally rare or absent where non-native fish species are common (USFWS 2012b; Minckley 1973; Propst et al. 1986). Increasing droughts due to climate change and water withdrawals may decrease the amount of habitat available for all species within a given stream, forcing natives and non-natives into closer proximity to one another, increasing the potential for competition and predation, and ultimately resulting in the loss of Spikedace populations (USFWS 2008c).

Suckermouth Minnow

The Suckermouth Minnow (*Phenacobius mirabilis*) will experience a high degree of climate change exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Suckermouth Minnow's climate change vulnerability is impacted by life history factors, which influence its ability to persist in place.

The Suckermouth Minnow is common across much of its range in the Mississippi River Basin (Page and Burr 2011). In New Mexico, it is found in the South Canadian and Dry Cimarron Rivers and is on the edge of its range so it has likely never been common in this State (NMDGF 1994; NMDGF 1996). The Suckermouth Minnow occupies small to medium sized streams with sand, gravel and rubble-bottomed riffles with generally clear waters, although they do tolerate high levels of turbidity in some areas (NMDGF 1988). It is a bottom-feeding omnivore, feeding on insect larvae, other invertebrates, and detritus (Sublette et al. 1990). The Suckermouth Minnow spawns in water temperatures at 14 to 25°C (57 to 77°F) from April through August (NMDGF 1988; Sublette et al. 1990). They reach sexual maturity at age two and rarely survive past age three (NMDGF 1988). The Suckermouth Minnow has experienced recent population declines along the edge of its range and was not documented in recent surveys in the Dry Cimarron River, suggesting it may be locally extirpated (NMDGF 1996; NMDGF 2018b). It is most threatened by habitat fragmentation, excessive sedimentation of run habitat, and habitat desiccation due to increasing water use for irrigation and grazing and increasing temperatures resulting from climate change (Sublette et al. 1990; NMDGF 2018b).

White Sands Pupfish

The White Sands Pupfish (*Cyprinodon tularosa*) will experience a high degree of climate change exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Highly Vulnerable under the RCP 8.5 Scenario. The White Sands Pupfish's climate change vulnerability is impacted by factors related to distribution and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The White Sands Pupfish is found in four distinct populations, two natural populations on White Sands Missile Range and two introduced populations on Holloman Air Force Base, in the lower area of the Tularosa basin in southern New Mexico across an area totaling less than 100 km^2 (38.6 mi^2) (Jester and Suminski 1982; Pittenger and Springer 1999; Carman 2010; Page and Burr 2011; Pittenger 2015). Despite this very limited range, the White Sands Pupfish is relatively abundant where it occurs; the total adult populations likely exceeds 100,000 (Pittenger and Springer 1999). It lives in shallow pools and calm spring runs with fine mud-silt and sand-gravel bottoms with very saline water. This habitat is characterized by high fluctuation in daily temperatures and very little aquatic vegetation (Miller and Echelle 1975; Suminski 1977). It is also naturally devoid of other aquatic vertebrates and large, predatory aquatic invertebrates, which reduces predation concerns, although experimental studies indicate introductions of non-native species such as mosquitofish and crayfish would be detrimental to pupfish populations (Miller and Echelle 1975; Suminski 1977; Rogowski and Stockwell 2006a). Pupfish (*Cyprinodon* spp.) can also be negatively impacted by trematode parasites and high salinity, both of which are features of pupfish habitat (Rogowski and Stockwell 2006b). Spawning occurs in the shallow reaches of their habitat when water temperatures reach 18°C (64°F) and on through September (Suminski 1977). Pupfish have been documented to move in response to changes in water temperature, with some species avoiding water temperatures above 36°C (97°F), although dissolved oxygen levels and salinity did not seem to influence movement (Barlow 1958). Lower allelic diversity has been documented in sections of the Salt Creek population where a perched culvert prevented upstream pupfish movement, and new water diversions or barriers to fish movement could result in future loss of gene flow (Stockwell and Mulvey 1996; Martin 2010). The White Sands Pupfish experiences very high mortality as it develops from egg to adult, sometimes reaching 98% mortality, and very few adults survive beyond age three (Jester and Suminski 1982). The White Sands Pupfish is found entirely on the federally-protected White

Sands Missile Range and thus receives considerable protection and support through habitat and invasive species management activities (Pittenger 2015). It is threatened by use of pesticides and herbicides, weapons testing and other military activities, destruction of habitat by feral horses, introduction of invasive fish species, and dewatering or alteration of existing habitat (NMDGF 1994; NMDGF 1996). Increases in air temperature due to climate change will likely result in increasing water temperatures and evaporation rates that could result in accelerated water loss and diminished spring flow, which could reduce available habitat for the White Sands Pupfish (Pittenger 2015).

Zuni Bluehead Sucker

The Zuni Bluehead Sucker (*Catostomus discobolus yarrowi*) will experience a high degree of climate change exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Extremely Vulnerable under the RCP 8.5 Scenario. The Zuni Bluehead Sucker's climate change vulnerability is impacted by factors related to distribution, movement, life history, evolutionary potential, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

This subspecies was originally written *C.d. jarrovii*, although some more recent literature uses *C.d. yarrowi* (Sublette et al. 1990; Starnes 1995). These names are synonymous with each other. The Zuni Bluehead Sucker is likely the result of introgressive hybridization between *C. discobolus* and *C. plebeius*, and some research suggests it could be recognized as distinct at the species level (Starnes 1995; Propst et al. 2001).

This sucker has a very limited range within the headwater streams of the Little Colorado River in west-central New Mexico and east-central Arizona at 610 to 2,060 m (2,000 to 6,760 ft) elevation (Propst et al. 2001; AGFD 2002a). The Zuni Bluehead Sucker is endemic to springs and perennial and intermittent streams in an arid landscape, and the potential for range or population expansion is limited (USFWS 2020d). Migration to spawning areas appears to occur in spring, although migration distances are generally unknown. Adult suckers are generally found in moderate- to fast-flowing water above a rubble-rock substrate while young fish prefer quiet, shallow waters near the shoreline (Sublette et al. 1990). They have a life span of at least 20 years (Ptacek et al. 2005). Genetic analyses indicated low genetic diversity and extensive population isolation (Turner and Wilson 2009). There have been dramatic declines in the Zuni Bluehead Sucker's abundance and distribution in New Mexico since 1989; the total adult population is likely only several hundred, all occurring in three isolated populations in the upper Rio Nutria drainage in the Zuni River watershed (NMDGF 1994; Jelks et al. 2008; USFWS 2011b; USFWS 2013c; USFWS 2013d). They are preyed on, and outcompeted by, invasive green sunfish and fathead minnows (*Pimephales promelas*) (Gilbert and Carman 2011; USFWS 2020d). Spawning occurs at 10 to 15°C (50 to 59°F) on gravel beds with a cobble substrate within pool and pool-run habitat (Propst et al. 1999). Sexual maturity is usually at 90 to 200 mm (3.5 to 7.9 in) length, although females are generally larger, or at around one to two years of age. This species displays female-skewed sex ratios on spawning grounds (Sublette et al. 1990; Propst et al. 1999). Black spot, caused by the fish parasitic fluke *Uvulifer* spp., has been documented on the Zule Bluehead

Sucker in one population, although no physical deformities resulting from the disease have been detected in subsequent sampling efforts (Gilbert and Carman 2011). The Zuni Bluehead Sucker is threatened by habitat destruction and degradation from beaver activity, land development, invasive species, overgrazing, and water diversion (NMDGF 1988; USFWS 2008c). It is also threatened by increasing drought, fire, and reduced stream flow resulting from warmer air temperatures triggered by climate change (USFWS 2008c; USFWS 2020d).

APPENDIX 4. Assessment summaries for all mammal Species of Greatest Conservation Need.

Allen's Big-eared Bat

The Allen's Big-eared Bat (*Idionycteris phyllotis*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a Climate Change Vulnerability Index (CCVI) ranking of Highly Vulnerable under the Representative Concentration Pathway (RCP) 4.5 Scenario and Extremely Vulnerable under the RCP 8.5 Scenario. The Allen's Big-eared Bat's climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Allen's Big-eared Bat is primarily found in wooded areas in mountains and canyons, although they are also found in riparian woodlands and desert scrub and shrub habitat (Hoffmeister 1986; Adams 2003). Nursery roost sites are found primarily in mature ponderosa pine (*Pinus ponderosa*) snags, although they also use mines, caves, bridges, and culverts (Adams 2003; Holroyd et al. 2023). Available water sources are very important for insectivorous bats, and studies have found a loss of 50% of the water in an individual bat's body in a single day (Taylor and Tuttle 2007). Allen's Big-eared Bats are likely limited by roost sites and water sources, and most nursery colonies are within 1.6 km (1 mi) of a water source (Chung-MacCoubrey 1995; Taylor and Tuttle 2007). Allen's Big-eared Bats display high roost site fidelity and are known to move nightly 70 to 100 km (43 to 62 mi) between nursery roosts and foraging areas (Brown and Berry 2004). The Allen's Big-eared Bat is sensitive to outdoor cats and noise and light pollution (Holroyd et al. 2023). They are threatened by roost site disturbance and logging, particularly logging practices that reduce standing snags (Chung-MacCoubrey 1995; Holroyd et al. 2023). Climate change is of particular concern for bat species because bats are sensitive to changes in environmental conditions (Jones et al. 2009). Bats will exit hibernation prematurely, ovulate, and become pregnant if there are warm conditions and a food supply during the second half of winter (Racey 1972; Jones et al. 2009). If bats experience periods of inclement weather associated with food shortages during pregnancy, they will become torpid and extend their gestation period (Racey 1973; Racey and Swift 1981; Jones et al. 2009).

American Beaver

The American Beaver (*Castor canadensis*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The American Beaver's climate change vulnerability is impacted by factors related to movement, evolutionary potential, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The American Beaver requires permanent water in close proximity to native tree and shrub species such as cottonwood and aspen (*Populus* spp.), willow (*Salix* spp.), and dogwood (*Cornus* spp.) (Findley et al. 1975; Kelleyhouse 1979; Wright and Bailey 1982). Forage species generally are early successional, so fire may improve American Beaver habitat (Kelleyhouse 1979). They depend on a hydrologic system with enough stream flow to maintain deep water year-round, while also a low enough water level such that dams are not frequently breached; changes in the hydrologic system including increased intensity, frequency, and severity of droughts and floods could negatively impact the American Beaver (Small et al. 2016; MacFarlane et al. 2017). They generally do not forage on non-native species; their foraging activities do remove native plant species, thus potentially facilitating invasion by non-native plants (Kimball and Perry 2008; NMDGF 2017b). They also experience population declines because of both legal harvest and illegal take (Pollock et al. 2017). The American Beaver is also threatened by logging, road construction and human development, wetland draining and stream channelization, and pesticide use and associated chemical bioaccumulation (Johnson and Fagerstone 1994; NMDGF 2015a; Small et al. 2016; Pollock et al. 2017). The American Beaver population was estimated at 5,500 to 6,000 in New Mexico in 1967, and the current population is estimated to be a sixth of the historic population (Findley et al. 1975; Small et al. 2016).

American Mink

The American Mink (*Neogale vison*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The American Mink's climate change vulnerability is impacted by factors related evolutionary potential and abiotic niche, which influence its ability to respond to climate change impacts.

The American Mink is at the southern end of its range in New Mexico and was historically found in the San Juan, Pecos, Canadian, and upper Rio Grande River drainages (Hubbard et al. 1979). Two road-killed American Mink were found in Cimarron County in 1988, although it is unknown if they were naturally-occurring or farm-raised individuals, and this species is presumed extirpated in New Mexico (NMDGF 1991). American Mink are riparian obligates, generally found near permanent rivers or wetlands systems, often within a forested landscape (Hubbard et al. 1979; Fitzgerald et al. 1994). They depend on abandoned beaver lodges or muskrat dens and are carnivorous generalists, although fish make up most of their diet (Hubbard et al. 1979; Fitzgerald et al. 1994). They are threatened by increasing floods and droughts resulting from climate change, human water diversions, and general habitat loss due to extreme wildfires and logging (Peale et al. 2022). However, fire may improve habitats that have higher vegetation density along streams and many downed snags (FEIS 1996).

American Pika

The American Pika (*Ochotona princeps*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Highly Vulnerable under the RCP 8.5 Scenario. The American Pika's climate change vulnerability is impacted by factors related to distribution, movement, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by barriers and has documented or modeled responses to climate change that impact its climate change vulnerability score.

The species' habitat in New Mexico is narrowly restricted to mountainous areas above 2,950 m (8,500 ft) in elevation, typically talus slides and boulder fields that provide suitable cover (Armstrong 1987; Fitzgerald et al. 1994). While individuals may disperse longer distances, juveniles generally remain within their natal home range or move to an adjacent home range (Peacock 1997). The American Pika experiences high annual mortality rates, particularly in juveniles, and low annual reproductive rates (Johnson 1967; Millar and Zwickel 1972; Millar 1973). Natural barriers that restrict dispersal and correlate with decreasing gene flow for the American Pika include topographic complexity; streams; and hot, west-facing slopes (Castillo et al. 2014). Additionally, the American Pika cannot tolerate ambient air temperatures above 28℃ (82.4°F) for more than two hours; this thermal limit will likely restrict their available habitat as temperatures rise because of climate change (MacArthur and Wang 1973; Smith 1974; Hegewisch et al. 2024). A 2003 study revisited historical locations of pikas in the Great Basin and found that seven of 25 populations (28%) reported earlier in the 20th century appeared to have experienced recent extirpations (Beever et al. 2003).

Arizona Gray Squirrel

The Arizona Gray Squirrel (*Sciurus arizonensis arizonensis*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Arizona Gray Squirrel's climate change vulnerability is impacted by factors related to distribution and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by barriers, land-use changes, other anthropogenic effects and biologic factors that could increase the effects of climate change.

The Arizona Gray Squirrel is endemic to deciduous riparian forests, particularly cottonwood habitat, at elevations of 1,300 to 2,200 m (4,260 to 7,220 ft) in just a few counties in southwestern New Mexico and southeastern Arizona (Hoffmeister 1986; Frey et al. 2008). This squirrel feeds primarily on mast-producing trees such as walnuts (*Juglans* spp.), pine (*Pinus* spp.) and Douglas-fir (*Pseudotsuga menziesii*) seeds (Hoffmeister 1986; Cudworth and Koprowski 2013). Precipitation is known to heavily influence mast production, and the Arizona Gray Squirrel may be negatively impacted by an increasing frequency, intensity, and severity of droughts associated with climate change, although some research suggests they may increase consumption of insect galls during drought years (Cudworth and Koprowski 2013). The Arizona Gray Squirrel is secretive, remaining motionless for more than an hour when disturbed by humans (Frey et al. 2008). They are threatened by rodenticides, particularly when used to control pest populations (Johnson and Fagerstone 1994). Predation by both mammalian and avian species is known to occur (Cudworth and Koprowski 2014). The Arizona Gray Squirrel is further threatened by habitat loss and the introduction of the Abert's Squirrel (*Sciurus aberti*), which is known to outcompete the Arizona Gray Squirrel for resources (Frey et al. 2008).

Arizona Montane Vole

The Arizona Montane Vole (*Microtus montanus arizonensis)* will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both an RCP 4.5 Scenario and RCP 8.5 Scenario. The Arizona Montane Vole's climate change vulnerability is impacted by factors related to distribution and evolutionary potential, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by barriers, land-use changes, other anthropogenic effects and biologic factors that could increase the effects of climate change.

The Arizona Montane Vole is restricted to riparian areas and areas with water-saturated soils (Frey 2021). The vole consumes mainly grasses and sedges and occasionally insects (NMDGF 1988). The species has low population levels and a limited geographic distribution (NMDGF 2016; Frey 2021), primarily because of habitat loss, degradation, and fragmentation (NMDGF 2016). In New Mexico, the population has declined 80% in the last 16 years, and the four known remaining populations are likely at imminent risk of extinction due to the lack of suitable habitat (Frey 2021). Wide roads, especially divided highways, are anthropogenic barriers for the species, and while most of the species' range is within the Gila National Forest, there are still some large roadways within its range (NatureServe 2024). Voles construct their living tunnels through thick and often matted grasses and avoid areas with livestock grazing, as ungulate movements disturb these tunnels and runways (NMDGF 1988; Frey 2021). Data show that the most significant influence of livestock grazing on riparian habitat was the reduction of vertical cover; presence of grazing and vertical cover were the two most significant factors at sites where the Arizona Montane Vole was not captured (Frey 2021). Vole populations are prone to large fluctuations in population size in unstable environments (Frey 2021). Spring precipitation can influence vole reproduction and population cycles, directly impacting their vulnerability to climate change (Frey 2021). Fire, prescribed or natural, can have adverse effects on this species (NMDGF 2020b).

Arizona Shrew

The Arizona Shrew (*Sorex arizonae*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Arizona Shrew's climate change vulnerability is impacted by factors related to distribution and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by barriers, land-use changes, and other anthropogenic effects that could increase the effects of climate change.

The Arizona Shrew has a small geographic range and its populations are small and isolated. In New Mexico, the Arizona Shrew is only known to occur in the Animas Mountains (NMDGF 1988). The shrews have very narrow habitat requirements and are found primarily in riparian edges or mesic forests (AGFD 1988; NMDGF 1988). The Arizona Shrew forages in and under forest leaf litter for insects, spiders, and sometimes small animals that it can overpower

(NMDGF 1988; NMDGF 1996). Habitat loss, degradation, and fragmentation drive both low population numbers and the restricted range of the Arizona Shrew (Schmitt 1997; AGFD 1996) and it may be especially vulnerable to disturbances within its habitat (NMDGF 1988), including livestock grazing, fire, and habitat alteration and conversion (AGFD 1988; AGFD 1996). Furthermore, it is likely that Euliptyphla will be one of the mammalian orders least able to keep pace with climate change (Schloss et al. 2012).

Banner-tailed Kangaroo Rat

The Banner-tailed Kangaroo Rat (*Dipodomys spectabilis*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Highly Vulnerable under the RCP 8.5 Scenario. The Banner-tailed Kangaroo Rat's climate change vulnerability is impacted by factors related to distribution, movement, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its climate change vulnerability score.

The Banner-tailed Kangaroo Rat is a large kangaroo rat that prefers heavy soils in well-developed grasslands; their presence declines sharply when shrub canopy cover exceeds 15% (NMDGF 2007; Cosentino et al. 2014). The Banner-tailed Kangaroo Rat is associated with prairie dog (*Cynomys* spp.) colonies and is threatened by rodenticide use, particularly their use in controlling pest populations (Clark et al. 1982; Johnson and Fagerstone 1994). Dispersal distances are short, with most individuals staying within one home range diameter of their natal site (Jones et al. 1988). Despite this short dispersal distance, gene flow has been documented (Busch et al. 2007). Some populations have experienced significant declines in southeastern Arizona (Waser and Ayers 2003). Heavy rains associated with tropical storms can negatively impact food stores and result in population declines; such storms could increase in frequency, severity, and intensity due to climate change (Valone et al. 1995). The Banner-tailed Kangaroo Rat is endemic to the Chihuahuan Desert and, like other arid-adapted endotherms, likely currently experiences conditions at its physiological limits. Climate change modeling suggests that under a worst-case scenario of a 6.5°C (11.7°F) land temperature increase by 2099, apparent survival of adult Banner-tailed Kangaroo Rats may decline to by more than 60% (Moses et al. 2012).

Big Free-tailed Bat

The Big Free-tailed Bat (*Nyctinomops macrotis*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Big Free-tailed Bat's climate change vulnerability is impacted by factors related to distribution, movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Big Free-tailed Bat is found in a variety of conifer and mixed woodlands and depends on rocky cliffs for roosts (Hoffmeister 1986; Frey 1995b). Available water sources are very important for insectivorous bats and studies have found a loss of 50% of the water in an individual bat's body in a single day (Taylor and Tuttle 2007). Big Free-tailed Bats are likely limited by water sources, which could be negatively impacted by an increase in drought frequency, severity, and intensity due to climate change (Taylor and Tuttle 2007). Big Free-tailed Bats are likely limited by maternity roost sites, which they may use multiple years in a row, and are threatened by roost site disturbance (Taylor and Tuttle 2007; Corbett et al. 2008; Holroyd et al. 2023). The Big Free-tailed Bat is sensitive to outdoor cats and noise and light pollution (Holroyd et al. 2023). Climate change is of particular concern for bat species because bats are sensitive to changes in environmental conditions (Jones et al. 2009). Bats will exit hibernation prematurely, ovulate, and become pregnant if there are warm conditions and a food supply during the second half of winter (Racey 1972; Jones et al. 2009). If bats experience periods of inclement weather associated with food shortages during pregnancy, they will become torpid and extend their gestation period (Racey 1973; Racey and Swift 1981; Jones et al. 2009).

Black-footed Ferret

The Black-footed Ferret (*Mustela nigripes*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Extremely Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Black-footed Ferret's climate change vulnerability is impacted by factors related to distribution, ecological role, evolutionary potential, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The last confirmed Black-footed Ferret observation in New Mexico was in 1934 (Frey and Yates 1996). There have been attempts at reintroduction into New Mexico since the 2000's and as recently as 2019, with signs of successful reproduction in the wild (NMDGF 2019; NMDGF 2020a). At present, there are likely 300 to 400 Black-footed Ferrets in the wild across its former range (NMDGF 2019). The Black-footed Ferret almost exclusively feeds on prairie dogs and is found in Black-tailed and Gunnison Prairie Dog (*Cynomys ludovicianus; Cynomys gunnisoni*) towns; in New Mexico, most reports of Black-footed Ferrets are from Gunnison Prairie Dog towns (Findley et al. 1975; Hubbard et al. 1979; Frey 1998). The Black-footed Ferret and prairie dogs are susceptible to the sylvatic plague caused by the bacteria *Yersinia pestis*; this is the primary threat to both animals (NMDGF 2019). They are also threatened by prairie dog population control efforts, such as shooting and poisoning (Johnson and Fagerstone 1994; Jones and Schmitt 1997).

Black-tailed Prairie Dog

The Black-Tailed Prairie Dog (*Cynomys ludovicianus*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both an RCP 4.5 and RCP 8.5 Scenario. The Black-tailed Prairie Dog's climate change vulnerability is impacted by factors related to movement, evolutionary potential, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by barriers, and other biologic factors that could increase the effects of climate change.

The Black-Tailed Prairie Dog inhabits shortgrass plains and avoids areas with tall grasses, heavy sagebrush (*Artemisia* spp.), and other thick vegetation cover (Finch 1992; Findley 1987). The Black-tailed Prairie Dog is herbivorous and prefers various species of grasses over other available vegetation (Hubbard et al. 1979). The Black-tailed Prairie Dog is a keystone species upon which many other prairie species depend. (Miller and Cully 2001). The Black-footed Ferret is almost completely dependent on prairie dogs for food and is their main predator. The Black-tailed Prairie Dog has low population numbers and is decreasing in both numbers and geographic distribution (Schmitt 1997; NMDGF 2016). Additionally, it has a limited geographic distribution and is easily impacted or disturbed (Schmitt 1997; NMDGF 2016). The main causes of the species' declining status are poisoning, hunting, and disease (Findley et al. 1975; Hoffmeister 1986). The sylvatic plague caused by the bacteria *Yersinia pestis* is a significant threat (Finch 1992). Dispersal rates for the Black-tailed Prairie Dog are low and populations are widely separated across its range (Chesser 1983). The area of occupancy and the populations of the Black-tailed Prairie Dog have declined by about 98% in recent times; however, many large populations still remain (USFWS 2004).

Canada Lynx

The Canada Lynx (*Lynx canadensis*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Canada Lynx's climate change vulnerability is impacted by factors related to distribution, evolutionary potential, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by barriers, and other biologic factors that could increase the effects of climate change. It also has documented or modeled responses to climate change that impact its climate change vulnerability score.

Canada Lynx were likely historic residents of New Mexico, although their presence in the state was never verified (Frey and Yates 1996). In 1999, the Colorado Division of Wildlife released 22 Canada Lynx from Canada and Alaska into southwestern Colorado and they dispersed into New Mexico, Utah, and Wyoming. Canada Lynx have been documented year-round in New Mexico, although no reproduction has been documented. One den was found within 9 km (5.6 mi) of the Colorado-New Mexico state boundary (Shenk 2007; USFWS 2009a). Canada Lynx reside in subalpine and coniferous forests, often selecting for abundant large live trees and medium, large, and very large dead trees (USFWS 1998a; Squires et al. 2017). In New Mexico, the Canada Lynx is a habitat specialist found primarily in boreal and subalpine spruce (*Picea* spp.)-fir (*Abies* spp.) forests at elevations of 2,980 to 3,660 m (9,800 to 12,000 feet); and this habitat likely cannot support a self-sustaining population Canada Lynx (USFWS 2014a; USFS 2020). Their primary food source is snowshoe hares (*Lepus americanus*), although they also prey on other small mammals and birds (USFWS 1998a). Canada Lynx select for areas 20 to 30 years post fire, in part because of the snowshoe hare's preference for this habitat. However, immediately following a fire, Canada Lynx numbers are low (Koehler and Brittell 1990; Fisher and Wilkinson 2005). Changes in fire intensity, frequency, and severity because of climate change could reduce available habitat for the Canada Lynx and their primary prey species (Citron and Frey 2024). Canada Lynx are also threatened by intensive logging, bioaccumulation of rodenticide, and human-caused mortality (NMDGF 1990a; Johnson and Fagerstone 1994; USFWS 1998a). They experience a wide variety of diseases, although the impacts at the population level are not well known (TWS 2023a; Citron and Frey 2024). Climate vulnerability modeling results suggest the Canada Lynx's range will contract under all emission scenarios by 2050 and 2070 and there will potentially be no suitable habitat within New Mexico in future (Pandey and Papes 2017).

Cave Myotis

The Cave Myotis (*Myotis velifer*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Cave Myotis's climate change vulnerability is impacted by factors related to movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Cave Myotis is primarily found in desert and grassland habitat, although it is also found in riparian and juniper (*Juniperus* spp.)-piñon (*Pinus* spp.) woodlands (Findley et al. 1975; Hoffmeister 1986). It forages over open water along waterways and in dense riparian vegetation and is a cave rooster, although some roosts are found in mines and buildings (Findley et al. 1975; Fitzgerald et al. 1994). Because the Cave Myotis feeds along open water, they could be negatively impacted by wetland draining, aquatic habitat dredging, or water diversion (Taylor 2011). The fungus *Pseudogymnoascus destructans* (*Pd*) that causes white-nose syndrome (WNS) has been reported in the Cave Myotis, although preliminary research suggests the Cave Myotis has naturally-occurring actinobacteria that can control and even completely suppress WNS (Knudsen et al. 2013). The Cave Myotis is very sensitive to human disturbance, particularly at nursery sites (Mann et al. 2002; Angelo 2009). The Cave Myotis is also sensitive to feral cats and noise and light pollution (Holroyd et al. 2023). Climate change is of particular concern for bat species because bats are sensitive to changes in environmental conditions (Jones et al. 2009). Bats will exit hibernation prematurely, ovulate, and become pregnant if there are warm conditions and a food supply during the second half of winter (Racey 1972; Jones et al. 2009). If bats experience periods of inclement weather associated with food shortages during pregnancy, they will become torpid and extend their gestation period (Racey 1973; Racey and Swift 1981; Jones et al. 2009).

Common Porcupine

The Common Porcupine (*Erethizon dorsatum*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Common Porcupine's climate change vulnerability is impacted by life history factors, which influence its ability to persist in place.

The Common Porcupine is found across a variety of forested habitats including conifers in montane and subalpine forests, pinon-juniper woodlands, riparian woodlands and semidesert shrublands (Findley et al. 1975; Fitzgerald et al. 1994). The Common Porcupine is threatened by human-related mortality, predation, intensive logging and overgrazing (Sweitzer et al. 1997; List et al. 1999; Appel et al. 2017). A climate change vulnerability assessment found that the Common Porcupine would likely be relatively resilient to climate change based on their habitat, food, and dispersal characteristics (Friggens et al. 2013).

Desert Pocket Gopher

The Desert Pocket Gopher (*Geomys arenarius*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Desert Pocket Gopher's climate change vulnerability is impacted by factors related to distribution, movement, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Desert Pocket Gopher has a very restricted range; it is only found in a few counties in New Mexico and Texas (Williams and Genoways 1978). They are found in open grasslands and sand scrub habitats in loose sandy and loamy soils (Findley et al. 1975). This habitat is threatened with degradation and destruction resulting from agricultural discing and plowing, fire suppression, and overgrazing (Downhower and Hall 1966; Hafner 1998b). They are not found in clay or gravel soils (Davis and Schmidly 1994). Other Pocket Gopher species have a small home range of less 0.015 ha (0.04 ac) and rarely disperse more than 1 km (0.62 mi) (Banfield 1974; Nowak 1999). As of 1998, the total adult population size was estimated at more than 10,000 individuals, found across only 2,000 ha (50,000 ac) (Hafner, pers. comm., 1998a). Narrow roads and water bodies further restrict movement (Oxley et al. 1974). The parasitic louse *Geomydoecus quadridentatos* is found only on a few *Geomys* species, including the Desert Pocket Gopher, although impacts to the species are not known (Williams and Genoways 1978). The Desert Pocket Gopher is also threatened by rodent control through rodenticide use (Johnson and Fagerstone 1994). The Desert Pocket Gopher's current distribution is in an arid climate with a moisture deficiency index of -40% to -60% (Williams and Genoways 1978). It is endemic to the Chihuahuan Desert and, like other arid-adapted endotherms, likely currently experiences conditions at its physiological limits. The Desert Pocket Gopher exhibits population contractions during dry periods and population expansions during wet periods; increasing intensity, frequency, and severity of droughts and floods will likely amplify these demographic swings and could result in some populations being lost due to climate change (Hafner, pers. comm. 1998a).

Eastern Red Bat

The Eastern Red Bat (*Lasiurus borealis*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Eastern Red Bat's climate change vulnerability is impacted by factors related to movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Eastern Red Bat is a habitat generalist, using a variety of forested and semi-forested landscapes, including within urban areas, and roosting in trees, shrubs, and caves (Elmore et al. 2004; O'Keefe et al. 2009; Holroyd et al. 2023). The Eastern Red Bat generally forages over open water, and bats generally roost within 1.6 km (1 mi) of a water source and can experience the loss of 50% of the water in an individual bat's body in a single day. Wetland draining, aquatic habitat dredging, or water diversions could negatively impact this bat (Taylor and Tuttle 2007; Taylor 2011). Pd is the fungus that causes WNS, and it has not been documented in the Eastern Red Bat. Mortality from WNS is unknown in bats that enter torpor during the winter but do not roost in caves or mines (USFWS 2011a). The Eastern Red Bat experiences high mortality at wind turbine facilities, and expansion of wind energy facilities in an effort to reduce greenhouse gas emissions is likely to result in population declines (Winhold et al. 2008; Arnet and Baerwald 2013; Koritarov et al. 2013). Climate change is of particular concern for bat species because bats are sensitive to changes in environmental conditions (Jones et al. 2009). Bats will exit hibernation prematurely, ovulate, and become pregnant if there are warm conditions and an available food supply during the second half of winter (Racey 1972; Jones et al. 2009). If bats experience periods of inclement weather associated with food shortages during pregnancy, they will become torpid and extend their gestation period (Racey 1973; Racey and Swift 1981; Jones et al. 2009).

Ermine Weasel

The Ermine Weasel (*Mustela richardsonii*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Ermine Weasel's climate change vulnerability is impacted by abiotic niche factors, which influence its ability to respond to climate change impacts.

The Ermine Weasel prefers wooded habitat with thick understory, generally near waterways, although they rarely occur in heavily-forested areas (Simms 1979). In New Mexico, the Ermine Weasel is found at elevations of 2,380 to 3,660 m (7,800 to 11,000 ft) in meadows and along riparian corridors in the Jemez, San Juan, and Sangre de Cristo mountain ranges in the northern part of the state (Findley 1987; Frey 2004). This habitat may be threatened with degradation and destruction resulting from dredging, channelization, and overgrazing (Frey and Calkins 2014). The Ermine Weasel preys on voles (*Microtus* spp.) and other small rodents; populations are known to fluctuate with changes in these rodent prey populations (Fagerstone 1987; Frey and Calkins 2010). The Ermine Weasel could also be threatened by bioaccumulation of rodenticides (Johnson and Fagerstone 1994). This weasel experiences relatively high predation rates and has a wide variety of avian and mammalian predators (Frey and Calkins 2010). Temperature increases are likely to cause an upward displacement of climate and vegetation zones resulting in decreased habitat area and increased fragmentation. The Ermine Weasel may be especially vulnerable to climate change because adequate snow cover appears to be a key habitat requirement; snow increases winter survival of prey and foraging efficiency and inhibits competitors (Frey and Calkins 2014).

Fringed Myotis

The Fringed Myotis (*Myotis thysanodes thysanodes*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Big Free-tailed Bat's climate change vulnerability is impacted by factors related to movement, demography, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

This bat is found across a variety of grassland, shrubland, and woodland habitats (Cook 1986; Finch 1992). Nursery roost sites include mines, caves, and under bark on mature ponderosa snags (Tuttle 1996). The Fringed Myotis is threatened by human disturbance and destruction at roost sites and is sensitive to feral cats and noise and light pollution (Finch 1992; Holroyd et al. 2023). WNS has been documented in New Mexico in the *thysanodes* subspecies, although potential impacts are unknown (Hathaway and Northup 2019; NMDGF 2023). The Fringed Myotis commonly forages over waterways, catching flying insects (Finch 1992; USFS 1995). Insectivorous bats experience high rates of evaporative water loss due to the high proportion of protein in their diet; thus, available surface water near roost sites is important (Chung-MacCoubrey 1995). Climate change is of particular concern for bat species because bats are sensitive to changes in environmental conditions (Jones et al. 2009). Bats will exit hibernation prematurely, ovulate, and become pregnant if there are warm conditions and an available food supply during the second half of winter (Racey 1972; Jones et al. 2009). If bats experience periods of inclement weather associated with food shortages during pregnancy, they will become torpid and extend their gestation period (Racey 1973; Racey and Swift 1981; Jones et al. 2009).

Gray-collared Chipmunk

The Gray-collared Chipmunk (*Neotamias cinereicollis cinereicollis*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Gray-collared Chipmunk's climate change vulnerability is impacted by factors related to distribution and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Gray-collared Chipmunk is found in montane coniferous forest and coniferous mixed forest from 2,440 to 2,740 m (8,000 to 9,000 ft) in elevation in western New Mexico and eastern Arizona (Hall 1981; Hilton and Best 1993; Frey 2004). This subspecies appears to avoid areas that have been recently burned, particularly areas impacted by high intensity fires, which could increase in frequency, intensity, and severity due to climate change (Kyle and Block 2000; Jones et al. 2021). The Gray-collared Chipmunk hibernates during winter in response to environmental cues, which could change temporally as climatic conditions change (Braga and Buck 2021).

Gray-footed Chipmunk

The Gray-footed Chipmunk (*Neotamias canipes*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Gray-footed Chipmunk's climate change vulnerability is impacted by factors related to distribution and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Gray-footed Chipmunk is found at upper elevations in conifer forests and mixed woodlands at 1,800 to 3,600 m (5,900 to 11,800 ft) in elevation in southwestern Texas and southeastern New Mexico (Best et al. 1992; Frey 2004; Schmidly and Bradley 2016). They seem to prefer recently-burned forests with downed trees, although they are vulnerable to large, stand-replacing fires (Frey and Boykin 2007; Schmidly and Bradley 2016).

Gunnison's Prairie Dog

The Gunnison's Prairie Dog (*Cynomys gunnisoni*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Extremely Vulnerable under the RCP 8.5 Scenario. The Gunnison's Prairie Dog's climate change vulnerability is impacted by factors related to distribution, movement, evolutionary potential, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by barriers and other biologic factors that could increase the effects of climate change.

The species inhabits grasslands from low valleys to montane meadows and requires soils of proper texture, depth, and drainage to allow for burrow construction (Pizzimenti and Hoffman 1973; Frey 1995b). The prairie dogs use their burrows for protection, especially from extreme weather and temperatures (Clark 1982). They also usually hibernate in their burrows during the winter months but have even been seen above ground during winter months in lower elevations (Rayor et al. 1987). The Gunnison's Prairie Dog feeds primarily on grasses and forbs but will occasionally eat invertebrates (Lechleitner et al. 1962). The Gunnison's Prairie Dog has low population numbers and a limited geographic distribution. The population numbers and geographic distribution of this species are also in decline; it is easily impacted and disturbed (Schmitt, pers. comm., 1997). A significant threat to the Gunnison's Prairie Dog is the sylvatic plague caused by the bacteria *Yersinia pestis* and spread through fleas (Pizzimenti and Hoffman 1973; Finch 1992). Outbreaks often cause >90% mortality in affected colonies (Cully and Williams 2001; Sackett et al. 2013; Russell et al. 2019). The Gunnison's Prairie Dog is the most susceptible of the five living species of *Cynomys*, sometimes experiencing greater than 99% mortality from plague (Cully et al. 1997) or complete loss of colonies (Lechleitner et al. 1962; Rayner 1985). The Gunnison's Prairie Dog is also affected by tularemia, or rabbit fever, which is caused by the bacterium *Francisella tularensis* (Hoffmeister 1986). Predation and low winter/spring precipitation also impact prairie dog survival (40-50% survival rate) and recruitment (Friggens and Martin 2006). Offspring recruitment is a primary factor limiting population growth for the Gunnison's Prairie Dog (Davidson et al. 2014). Furthermore, human poisoning, hunting, and persecution have caused widespread extirpations of this species (Findley et al. 1975; Hoffmeister 1986). Additionally, long-term research in the southern portion of their range, in New Mexico and Mexico, shows that both established and restored prairie dog colonies in more xeric environments are highly vulnerable to drought (Davidson et al. 2014).

Heather Vole

The Heather Vole (*Phenacomys intermedius intermedius*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Heather Vole's climate change vulnerability is impacted by factors related to distribution and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

In New Mexico, the Heather Vole is found in montane conifer forest habitats at high elevations in the Sangre de Cristo and San Juan Mountain ranges (Findley et al. 1975; Frey 2004). They are preyed on by a variety of natural avian and mammalian predators (Frey 2004). The Heather Vole is threatened by stand-replacing fires, livestock grazing, and phenological changes due to climate change (Frey 2004; NMDGF 2015b).

Hoary Bat

The Hoary Bat (*Aeorestes cinereus cinereus*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Hoary Bat's climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its climate change vulnerability score.

In New Mexico, the Hoary Bat is found in a variety of montane woodland and riparian habitats in the summer (Schmidly 1977). They primarily roost in the foliage or under the bark of large trees, generally adjacent to a clearing (Bailey 1932; Fitzgerald et al. 1994). The Hoary Bat is sensitive to feral cats and noise and light pollution (Holroyd et al. 2023). Insectivorous bats experience high rates of evaporative water loss due to the high proportion of protein in their diet; thus, available surface water near roost sites is important (Chung-MacCoubrey 1995). The Hoary Bat is threatened by fire, particularly large, stand-replacing wildfires; wetland habitat destruction and degradation; livestock grazing; and logging (Taylor 2011). Climate change is of particular concern for bat species because bats are sensitive to changes in environmental conditions (Jones et al. 2009). Bats will exit hibernation prematurely, ovulate, and become pregnant if there are warm conditions and an available food supply during the second half of winter (Racey 1972; Jones et al. 2009). If bats experience periods of inclement weather associated with food shortages during pregnancy, they will become torpid and extend their gestation period (Racey 1973; Racey and Swift 1981; Jones et al. 2009). The Hoary Bat is the most commonly-killed bat at wind turbine facilities and has experienced a 90% population decline in the past 50 years (Arnett and Baerwald 2013; NatureServe 2024). This decline is likely to continue as wind energy facilities are likely to expand significantly in New Mexico and across the United States (U.S.) as efforts to mitigate climate change and reduce greenhouse gas emissions increase (Koritarov et al. 2013).

Holzner's Cottontail Rabbit

The Holzner's Cottontail Rabbit (*Sylvilagus holzneri*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Holzner's Cottontail Rabbit's climate change vulnerability is impacted by distribution factors, which influence its ability to shift in space.

The Holzner's Cottontail Rabbit is found in New Mexico and Arizona in brushy habitat on benches and mesa tops above 2,040 m (6,700 ft) in elevation (Findley et al. 1975; USFWS 1980a; Frey 1995b). Low severity fires are likely to improve habitat and forage potential, while high severity fires may reduce habitat quality (FEIS 1996). The Holzner's Cottontail Rabbit is threatened by habitat destruction and degradation resulting from livestock grazing and logging (NMDGF 2015b). *Sylvilagus* species are known to be susceptible to plague, caused by the introduced bacterium *Yersinia pestis*, and rabbit hemorrhagic disease, both of which can be fatal (USGS 2020a; NMDGF 2024). They are also threatened by pesticides, with neonicotinoids having embryotoxic effects on species in the genus *Sylvilagus* (Gibbons et al. 2015).

Hooded Skunk

The Hooded Skunk (*Mephitis macroura milleri*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Hooded Skunk's climate change vulnerability is impacted by life history factors, which influence its ability to persist in place.

The Hooded Skunk is found in the southwest corner of New Mexico, in scrubby desert, riparian woodland and shrubland, and conifer and deciduous woodlands, from 1,240 to 2,740 m (4,000 to 9,000 ft) in elevation (Findley et al. 1975; Cook 1986). Skunks are considered by some as a pest, a source of human property damage, and as a carrier of rabies. Thus, they are often targets of human-caused mortality from shooting, trapping, and poisoning (Eisler 1991; Johnson and Fagerstone 1994; Citron and Frey 2024). They are also threatened by extreme storm events due to climate change (Citron and Frey 2024).

Jaguar

The Jaguar (*Panthera onca arizonensis*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Jaguar's climate change vulnerability is impacted by factors related to distribution, movement, and evolutionary potential, which influence its ability to shift in space and respond to climate change impacts.

While Jaguars were historically found in New Mexico, they were extirpated in the early 1900's (NMDGF 1991), though they are federally-listed in the U.S. A single observation was recorded in 1996 in Hidalgo County, with occasional transient animals occurring in Arizona; there has been no confirmed breeding in the U.S. (Glenn 1996; USFWS 1997). Within its current range in Central and South America, the Jaguar occurs across a variety of habitats ranging from swampy savannahs to arid woodlands, tropical rainforests, and desert riparian habitat (Arritt 1997a). Historically in the U.S. and currently within its existing range in South and Central America, the Jaguar is threatened by human persecution triggered by livestock and grazing expansions and associated increased potential for human-wildlife conflict and by illegal poaching (USFWS 1980b; Brown 1983; NMDGF 2016; Quigley et al. 2017). It is also threatened by habitat destruction, degradation, and fragmentation resulting from agricultural conversion, road and urban development, and the potential construction of a continuous border wall between the U.S. and Mexico (Koblinsky 2017; Quigley et al. 2017; Peters et al. 2018;). Effects from climate change could reduce the amount of available Jaguar habitat (Citron and Frey 2024).

Least Shrew

The Least Shrew (*Cryptotis parvus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Least Shrew's climate change vulnerability is impacted by factors related to demography and abiotic niche, which influence its ability to persist in place and respond to climate change impacts. It is also impacted by barriers, land-use changes, other anthropogenic factors, and biologic factors that could increase the effects of climate change.

While the Least Shrew is common over much of its range, it is generally locally distributed and uncommon in New Mexico (NMDGF 1988). The species was previously more widely distributed in the southern portion of the state. However, desiccation of the region has led to the extirpation of most populations (NMDGF 1988; NMDGF 1996). Within New Mexico, the species is confined to mesic habitats and populations are centered around natural playas (NMDGF 1988; Shuster 1990; NMDGF 1996). The shrew's diet includes earthworms, insects, and other arthropods (NMDGF 1996). The Least Shrew has a limited geographic distribution mostly because of habitat loss, degradation, and fragmentation (Shuster 1990; Schmitt 1997). Additionally, there is evidence that the Least Shrew has either experienced a genetic bottleneck, ongoing inbreeding, or both (Shuster 1990). This evidence, combined with fossil and distribution data, suggests the New Mexico populations represent relictual populations isolated during climatic changes that occurred more than 11,000 years ago (Shuster 1990). Additionally, the Euliptyphla order (i.e., shrews, moles, and others) will be one of the mammalian taxa least able to keep pace with climate change (Schloss et al. 2012).

Lesser Long-nosed Bat

The Lesser Long-nosed Bat (*Leptonycteris yerbabuenae*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Lesser Long-nosed Bat's climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Lesser Long-nosed Bat is on the northern edge of its breeding range in New Mexico and Arizona, with a few known nursery roost sites in southwestern New Mexico (USFWS 2016). They are found in desert grasslands and scrublands and roost in caves and abandoned mines and buildings (Hoffmeister 1986; Snow et al. 1993; USFWS 2016). This bat feeds extensively on the nectar, pollen, and soft fruit of agaves (*Agave* spp.), although their diet can include cactus, including saguaro species (*Carnegiea* spp.), and insects are likely consumed incidentally (NMDGF 1996; USFWS 2016; Laws et al. 2023). The Lesser Long-nosed Bat is threatened by human disturbance and destruction at roost sites, particularly resulting from illegal border crossings and vandalism, and is sensitive to feral cats and noise and light pollution (Finch 1992; USFWS 2018c; Holroyd et al. 2023). They also experience relatively high mortality from wind turbines, and expansion of wind energy facilities to reduce greenhouse gas emissions and mitigate climate change could result in population declines (Koritarov et al. 2013; O'Shea et al. 2016; USFWS 2016). Lesser Long-nosed Bat habitat is threatened by destruction and degradation resulting from urban development, livestock grazing, catastrophic fire, drought, and the tequila industry, although commercial producers are actively working to reduce industry-driven threats (USFWS 2016). Climate change is of particular concern for bat species because bats are sensitive to changes in environmental conditions (Jones et al. 2009). Bats will exit hibernation prematurely, ovulate, and become pregnant if there are warm conditions and an available food supply during the second half of winter (Racey 1972; Jones et al. 2009). If bats experience periods of inclement weather associated with food shortages during pregnancy, they will become torpid and extend their gestation period (Racey 1973; Racey and Swift 1981; Jones et al. 2009). Changes in phenology due to climate change, specifically changes in plant distribution and flowering time, are expected to impact Lesser Long-nosed Bats, although the extent of those impacts are unknown (Bagne and Finch 2013; USFWS 2016).

Mexican Gray Wolf

The Mexican Gray Wolf (*Canis lupus baileyi*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Extremely Vulnerable under the RCP 8.5 Scenario. The Mexican Gray Wolf's climate change vulnerability is impacted by factors related to distribution and evolutionary potential, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by barriers, land-use changes and other anthropogenic factors that could increase the effects of climate change.

The Mexican Gray Wolf is currently federally-listed as Endangered. The wolf does not require specific landscapes, and its diet can include a wide variety of mammals (ungulates, lagomorphs, rodents, and carrion) (Merkle et al. 2009). The Mexican Gray Wolf was functionally extirpated by humans in 1970, primarily because of conflicts with the livestock industry and perceived threats to humans (AGFD 1988). All Mexican Gray Wolves alive today descend from three captive lineages founded between 1960 and 1980 from a total of seven wolves (Hedrick 2010).

Captive breeding programs and reintroductions have reestablished growing populations spanning Arizona and New Mexico (USFWS 2013a). Surveys completed in late 2022 and early 2023 indicated that there was a minimum of 136 wolves, 40 packs, and 20 breeding pairs in New Mexico (USFWS 2023d). However, none of the 17 populations of the Mexican Gray Wolf in New Mexico were considered resilient by the USFWS in 2013 (USFWS 2013a). The most significant threat to the Mexican Gray Wolf is human activity and urbanization (Watson and Gruber 2006; NMDGF 2016). Illegal shooting, trapping, and poisoning cause wolf deaths every year and several other deaths are attributed to vehicular strikes (Hedrick 2010; USFWS 2013a).

Mexican Long-nosed Bat

The Mexican Long-tongued Bat (*Leptonycteris nivalis*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Mexican Long-nosed Bat's climate change vulnerability is impacted by factors related to distribution, movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Mexican Long-nosed Bat is on the northern edge of its range in New Mexico, with much of its range extending into Mexico (Wilson and Reeder 2005). It has been confirmed in the Pelonocillo, Animas, and Big Hatchet Mountains, and is generally found at elevations of 1,000 to 2,200 m (3,280 to 7,220 ft) (NMDGF 1990b; Arita 1991; Ammerman et al. 2012). This bat is generally found in upland pine-oak (*Quercus* spp.) or tropical deciduous forests, roosting primarily in caves but also found in mines and culverts. It migrates to Mexico in the winter (Schmidly 1977; NMDGF 1996; Cole and Wilson 2006). The Mexican Long-nosed Bat feeds primarily on the nectar, pollen, and fruit of agaves with cactus species making up a small portion of their diet (NMDGF 1996; USFWS 2018d). While population estimates are difficult to obtain, it seems likely the New Mexico roost site has less than 2,000 individuals (USFWS 2018d). It is threatened by human disturbance and destruction at roost sites, and it is sensitive to feral cats and noise and light pollution (USFWS 2018d; Holroyd et al. 2023). It is also threatened by habitat destruction and degradation resulting from wildfire and habitat fragmentation (NMDGF 2016). Climate change is of particular concern for bat species because bats are sensitive to changes in environmental conditions (Jones et al. 2009). Bats will exit hibernation prematurely, ovulate, and become pregnant if there are warm conditions and an available food supply during the second half of winter (Racey 1972; Jones et al. 2009). If bats experience periods of inclement weather associated with food shortages during pregnancy, they will become torpid and extend their gestation period (Racey 1973; Racey and Swift 1981; Jones et al. 2009). Climate change is expected to result in a contraction by 59% by 2050 of the current range of the Mexican Long-nosed Bat (USFWS 2018d). In particular, climate change is expected to negatively impact the relationship between the Mexican Long-nosed Bat and agaves, with distribution overlap being reduced by 75% and negative impacts to flowering phenology (i.e., timing) likely but not fully understood (USFWS 2018d).

Mexican Long-tongued Bat

The Mexican Long-tongued Bat (*Choeroncycteris mexicana*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Mexican Long-tongued Bat's climate change vulnerability is impacted by factors related to distribution, movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its climate change vulnerability score.

The Mexican Long-tongued Bat is on the northern edge of its breeding range in the U.S. and is found at only a few roost sites in southeastern Arizona and southwestern New Mexico (Cryan and Bogan 2003). They roost in caves and mines in grasslands, riparian woodlands, and pine oak forests at 975 to 1,850 m (3,200 to 6,070 ft) elevation (Cryan and Bogan 2003). The Mexican Long-tongued Bat feeds primarily on agave, and overharvest or destruction of agaves could result in population declines (Monday 1993; Tuttle 1996). It is also threatened by human disturbance and destruction at roost sites and is sensitive to feral cats and noise and light pollution (Holroyd et al. 2023). It is further threatened by habitat destruction and degradation resulting from wildfire and drought (NMDGF 2016). Climate change is of particular concern for bat species because bats are sensitive to changes in environmental conditions (Jones et al. 2009). Bats will exit hibernation prematurely, ovulate, and become pregnant if there are warm conditions and an available food supply during the second half of winter (Racey 1972; Jones et al. 2009). If bats experience periods of inclement weather associated with food shortages during pregnancy, they will become torpid and extend their gestation period (Racey 1973; Racey and Swift 1981; Jones et al. 2009).

New Mexico Jumping Mouse

The New Mexico Jumping Mouse (*Zapus hudsonius luteus = Z. luteus luteus*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Extremely Vulnerable under the RCP 8.5 Scenario. The New Mexico Jumping Mouse's climate change vulnerability is impacted by factors related to distribution, evolutionary potential, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by barriers, land-use changes, other anthropogenic factors, and biologic factors that could increase the effects of climate change.

The New Mexico Jumping Mouse is listed by the U.S. Fish and Wildlife Service (USFWS) as Endangered due to degradation of riparian habitat and extirpation from multiple historical locations (USFWS 2014c; USFWS 2020c). The New Mexico Jumping Mouse is a habitat specialist and requires tall (≥ 61 cm [≥ 24 in]), dense riparian herbaceous vegetation primarily composed of sedges and forbs (Frey 2008; USFWS 2020c). Because the mouse requires dense vegetation, livestock overgrazing in streamside habitats could threaten this species, as could periodic severe flooding (Finch 1992). Additionally, the New Mexico Jumping Mouse relies on

American Beavers to create a complex network of microhabitats that are ideal for the mice while also limiting human use of the area (Frey 2006). As such, the decline in American Beaver populations is considered a driver of the decline in suitable habitat for the New Mexico Jumping Mouse (USFWS 2020c). The New Mexico Jumping Mouse is present in low numbers, has a limited geographic distribution, and is easily impacted and disturbed (Wright and Frey 2010; USFWS 2013a). The continued loss of the mouse's habitat is the primary factor driver of the ongoing decline of the 17 populations in New Mexico; none of these populations are considered resilient (USFWS 2014c). Dams, water diversions, livestock grazing, severe fires, highways, and other anthropogenic and natural activities threaten this species (USFWS 2020c). The New Mexico Jumping Mouse has relatively low yearly fecundity and a life span of likely one to two years, resulting in low population growth potential (USFWS 2020c). Furthermore, the species hibernates between October and May and is only active during the grass and forb growing season (Whitaker 1972; Frey 2005; Hathcock et al. 2017). However, it is suggested that the mouse exits hibernation when the soil temperature warms 12 to 13°C (8.5 to 9°F) (Hoffmeister 1986); thus, the length and occurrence of hibernation might decline as temperatures warm under climate change. Additionally, dispersal distances are considered low for the New Mexico Jumping Mouse (Friggens 2015). Other threats to the mouse will be compounded as climatic conditions change (USFWS 2020c).

North American River Otter

The North American River Otter (*Lontra canadensis*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The North American River Otter's climate change vulnerability is impacted by factors related to movement, life history, evolutionary potential, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The North American River Otter resides in permanent water systems with an abundance of fish, crayfish, and other small prey items (Dronkert-Egnew 1991; Cox et al. 2018). After extirpation of the North American River Otter from New Mexico in the 1950's, 33 otters were reintroduced in 2008 and four otters, one adult and three juveniles, were observed in 2013, confirming reproduction (Frey and Yates 1996; Converse et al. 2014; Cox and Murphy 2019). The sex ratio in the otter population in New Mexico favors females, which is indicative of range expansion (Cox and Murphy 2019). In 2019, the New Mexico otter population was estimated at 83 to 100 individuals, with concerns regarding genetic drift and reduced genetic diversity, and in 2021, nine otters were reintroduced to New Mexico to improve genetic diversity (Cox and Murphy 2019; Morgan 2021). The North American River Otter is threatened by bioaccumulation of heavy metals in prey species (NMDGF 2016). It is also threatened by overexploitation, water pollution, and habitat degradation (NMDGF 2016; Cox and Murphy 2019).

Northern Pygmy Mouse

The Northern Pygmy Mouse (*Baiomys taylori ater*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Northern Pygmy Mouse's climate change vulnerability is impacted by factors related to distribution and movement, which influence its ability to shift in space.

The Northern Pygmy Mouse is at the northern edge of its range in New Mexico and resides in well-developed grasslands with dense grass cover above 1,675 m (5,500 ft) in elevation (Findley et al. 1975; Geluso et al. 2017). They are very small and thus are threatened by interspecific competition (Findley et al. 1975; Hoffmeister 1986). Based on their preference towards dense grass and the threat of interspecific competition, the Northern Pygmy Mouse likely does best in areas with an above-average amount of water runoff. It could be negatively impacted by frequent droughts (Hoffmeister 1986). They average three to five litters in a breeding season, although individuals have been documented with up to nine litters (Hoffmeister 1986). The Northern Pygmy Mouse has a small home range of 45 to 729 m^2 (484 to 7,846 ft^2) but is likely a good disperser based on other closely-related *Peromyscus* spp. (Eshelman and Cameron 1987; Maier 2002). They are known to be good swimmers and can cross rivers (Geluso et al. 2017). Grazing and fire negatively impact habitat, and they are threatened by high densities of imported fire ants (*Solenopsis* spp.) (Killion et al. 1995; Hayward et al. 1997; Jones et al. 2003). A recent north and westward expansion of the Northern Pygmy Mouse range into previously unoccupied areas may be associated with a shift in climate (Choate 1990; Geluso et al. 2017).

Organ Mountains Colorado Chipmunk

The Organ Mountains Colorado Chipmunk (*Neotamias quadrivittatus australis*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Organ Mountains Colorado Chipmunk's climate change vulnerability is impacted by factors related to distribution, movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Organ Mountains Colorado Chipmunk is found across less than 100 km^2 (40 mi^2) in the Organ Mountains chain, in scattered piñon-juniper woodlands above 1,845 to 2,225 m (6,050 to 7,300 ft) in elevation (Sullivan 1996; Schwieger et al. 2021). The population is estimated at 1,000 to 2,000 individuals (NMDGF 1988). The overwinter survival rate for the Colorado Chipmunk (*Neotamias quadrivittatis*) is less than 33%, and local extirpation or near-extirpation is common (Best et al. 1992). Timing of hibernation and breeding for the Organ Mountains Colorado Chipmunk are temperature and precipitation dependent (Frey and Kopp 2013; Schweiger and Frey 2021). This chipmunk selects for cool microclimate refugia on montane habitat islands; thus, it will be impossible for this subspecies to shift its range in response to climate change (Schweiger and Frey 2021; Jacobson and Frey 2024). Additionally, climate change modeling projected intensity of daily chipmunk activity would increase by 89% in winter and by 51% in early summer by 2050 because of elevated temperatures. These changes in daily activity may negatively affect fitness by reducing hibernation time and reproductive output and could have severe consequences for the overall fitness of the Organ Mountain Colorado Chipmunk (Schweiger and Frey 2021).

Oscura Mountains Colorado Chipmunk

The Oscura Mountains Colorado Chipmunk (*Neotamias quadrivittatus oscuraensis*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Highly Vulnerable under the RCP 8.5 Scenario. The Oscura Mountains Colorado Chipmunk's climate change vulnerability is impacted by factors related to distribution, movement, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Oscura Mountains Colorado Chipmunk is found across less than 100 km^2 (40 mi^2) in the Oscura Mountains chain, in scattered old-growth piñon-juniper woodlands above 2,370 to 2,500 m (7,800 to 8,200 ft) in elevation, selecting rocky escarpments and large diameter juniper trees (NMDGF 1996; Sullivan 1996; Schweiger et al. 2021;). The Organ Mountains Colorado Chipmunk population is estimated at 1,000 to 2,000 individuals, and there is no population estimate for the Oscura Mountains Colorado Chipmunk, although their population is likely also limited (NMDGF 1988). The overwinter survival rate for the Colorado Chipmunk (*Neotamias quadrivittatis*) is less than 33%, and local extirpation or near-extirpation is common (Best et al. 1992). The Oscura Mountains are encompassed within the White Sands Missile Range, thus there is potential for habitat loss and disturbance resulting from military testing and associated activities (Perkins-Taylor and Frey 2018). Habitat loss driven by drought, wildfire, logging, bark beetle outbreaks, and other diseases that impact mature conifer woodlands is of significant concern for the Oscura Mountains Colorado Chipmunk; these drivers will likely be exacerbated by climate change (Perkins-Taylor and Frey 2018). Climate change models project range size stability for this subspecies, although this information should be tempered by the likely negative impacts of climate change on the woodland habitat for this species (Puckett et al. 2019).

Pacific Marten

The Pacific Marten (*Martes caurina*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Pacific Marten's climate change vulnerability is impacted by factors related to distribution, evolutionary potential, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Pacific Marten reaches its southern limit in New Mexico and is considered an infrequent resident within the San Juan and Sangre de Cristo mountains in northern New Mexico (Findley et al. 1975; NMDGF 2020b). The marten is a habitat specialist that is found in structurally-complex montane spruce-fir forests and alpine habitat with seasonal snow cover (Findley et al. 1975; Linnell et al. 2018). Marten abundance is generally related to food availability, Voles and mice are preferred prey items but a variety of insects and small animals also contribute to their diet (Strickland et al. 1982; NMDGF 1996). Martens require deep snow for denning, the availability of which could be negatively impacted by climate change (Strickland et al. 1982; Wasserman et al. 2012). The Pacific Marten is at risk of direct and indirect mortality from trapping, shooting, and road kills (Linnell et al. 2018; NMDGF 2020b). Their habitat is also threatened by destruction and degradation resulting from stand-replacing wildfire, logging, road construction, and grazing (Fitzgerald et al. 1994; NMDGF 2020b). Climate change is expected to significantly fragment habitat for the American Marten (*Martes americana*), which could potentially reduce genetic diversity; Pacific Marten's may see a similar response to climate change (Wasserman et al. 2012).

Peñasco Least Chipmunk

The Peñasco Least Chipmunk (*Neotamias minimus atristriatus*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Extremely Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Peñasco Least Chipmunk's climate change vulnerability is impacted by factors related to distribution and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by barriers, land-use changes, and other biologic factors that could increase the effects of climate change. It also has documented or modeled responses to climate change that impact its climate change vulnerability score.

The Peñasco Least Chipmunk is found across less than 100 km^2 (40 mi^2) in three disjunct populations within the Lincoln National Forest in the White Mountains of Lincoln County, New Mexico (Frey and Hays 2017; Frey and McKibben 2018). Historically, this subspecies was found in the Sacramento Mountains in Otero County, New Mexico, although that population is thought to be extirpated (Frey and Hays 2017). The Peñasco Least Chipmunk is a habitat specialist, residing in open grassland and forb habitats with large diameter, mature ponderosa pine and Engelmann spruce (*Picea engelmannii*) scattered across a flat, rocky area at 3,100 to 3,600 m (10,200 to 11,800 ft) in elevation (USFWS 2018e; McKibben and Frey 2020). This habitat is threatened by destruction and degradation resulting from increased intensity, frequency, and severity of drought and wildfire, vegetation shifts, agricultural development, and intensive logging (NMDGF 2016; USFWS 2018e; USFWS 2021c). Understory vegetation is a key resource for the Peñasco Least Chipmunk, providing protection from predators and diverse grasses and forbs for food (Jacobson et al. 2021). This chipmunk is sensitive to human presence and noise, particularly recreational activities including hiking, biking, and the use of motorized vehicles (USFWS 2018e). It is potentially negatively impacted by competition with the Gray-footed Chipmunk and could be impacted by outbreaks of diseases such as hantavirus, plague, and tularemia (McKibben and Frey 2020; McKibben 2022). The Peñasco Least Chipmunk is limited by higher temperatures and lower humidity during the summer months; shifts in temperature and precipitation could limit the active period for individual chipmunks, which could ultimately influence individual fitness and species persistence (McKibben et al. 2021). Climate change modeling also suggests the Peñasco Least Chipmunk's habitat will become unsuitable under future climate change scenarios; this decline in habitat will be further exacerbated by the limited dispersal capabilities of this species and the elevational restrictions of the existing range (Puckett et al. 2019).

Pocketed Free-tailed Bat

The Pocketed Free-tailed Bat (*Nyctinomops femorosaccus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Pocket Free-tailed Bat's climate change vulnerability is impacted by factors related to demography and abiotic niche, which influence its ability to persist in place and respond to climate change impacts.

While relatively common across its range in the southeastern U.S. and into Mexico, the Pocketed Free-tailed Bat is found in only two populations in Eddy and Hidalgo Counties in New Mexico (Frey 2004). They roost on rocky cliffs and slopes and in caves and sometimes in man-made roosts across a variety of semiarid habitats (Hoffmeister 1986; Holroyd et al. 2023). Pocketed Free-tailed Bats are not able to maneuver quickly and require large areas of open water to drink (Tuttle 1996). They are threatened by human disturbance and destruction at roost sites and are sensitive to feral cats and noise and light pollution (Holroyd et al. 2023). Climate change is of particular concern for bat species because bats are sensitive to changes in environmental conditions (Jones et al. 2009). Bats will exit hibernation prematurely, ovulate, and become pregnant if there are warm conditions and an available food supply during the second half of winter (Racey 1972; Jones et al. 2009). If bats experience periods of inclement weather associated with food shortages during pregnancy, they will become torpid and extend their gestation period (Racey 1973; Racey and Swift 1981; Jones et al. 2009).

Prairie Vole

The Prairie Vole (*Microtus ochrogaster haydenii*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Prairie Vole's climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Prairie Vole is relatively widespread across its range, although it is found in only a few specific localities in New Mexico (Frey 2004). They are found in upland grasslands and fallow fields that provide enough ground cover to create runways (Davis and Kalisz 1992). This ground cover is negatively influenced by large, frequent fires, which could increase in intensity, frequency, and severity due to climate change, and by cattle grazing (Frey 1995a; Stockrahm et al. 1995). Average life span of the Prairie Vole is a year or less, although individuals are sexually mature by five to six weeks and have multiple litters through the year (Getz et al. 1993; Ozgul et al. 2004). Reproduction peaks are dependent on availability of moisture, and shortened photoperiods reduced fertility in juvenile males (Stalling 1990; Getz et al. 1993). Site fidelity is high in Prairie Voles and natal dispersal is rare; when it occurs, dispersal distances are less than 33 m (108 ft) (McGuire et al. 1993; Getz 1997). Prairie Voles experience fatality because of exposure to rodenticides (Johnson and Fagerstone 1994). Climate change is expected to negatively impact Prairie Voles (Hayes 2014).

Snowshoe Hare

The Snowshoe Hare (*Lepus americanus bairdii*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Snowshoe Hare's climate change vulnerability is impacted by factors related to distribution, movement, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Snowshoe Hare is on the extreme southern edge of its range in New Mexico and is found in the Sangre de Cristo and San Juan Mountain ranges in subalpine coniferous forest at 3,000 to 3,340 m (9,840 to 10,960 ft) in elevation (Frey and Malaney 2006). They are prey for a wide variety of avian and mammalian predators (Kumar et al. 2020). In New Mexico, Snowshoe Hares prefer forests with a dense understory of shrubs and small trees that provide cover from predators and for nesting burrows (Sievert and Keith 1985; Findley 1987). Increased intensity, frequency, and severity of wildfires due to climate change and increased logging could result in habitat loss and degradation for this species (Malaney and Frey 2006). Snowshoe Hares change coat color seasonally in response to shortening and lengthening photoperiod, and they experience reduced survival when their coat color is mismatched with the landscape (Findley 1987; Zimova et al. 2016). This reduced survival has resulted in range contractions associated with reduced snow duration and color mismatch-related mortality and could result in severe population declines in the future, as snow cover continues to decline (Zimova et al. 2016; Burt et al. 2017). This color mismatch will likely be exacerbated by climate change, particularly considering the lack of behavioral plasticity that Snowshoe Hares have demonstrated with this mismatch (Kumar et al. 2020).

Southern Pocket Gopher

The Southern Pocket Gopher (*Thomomys umbrinus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Southern Pocket Gopher's climate change vulnerability is impacted by factors related to distribution, movement, and life history, which influence its ability to shift in space and persist in place.

The Southern Pocket Gopher is on the northern edge of its range in the U.S. and is generally found in southern New Mexico and Arizona and into southcentral Mexico (Mathis et al. 2014). Within New Mexico, they are found in woody and shrubby habitats on open, rocky slopes at 1,770 to 2,440 m (5,800 to 8,000 ft) elevation (Bailey 1932; Cook 1986; Hoffmeister 1986). Pocket Gophers generally display low dispersal distances and small home ranges (Howard and Childs 1959; Nowak 1999). The Southern Pocket Gopher spends much of its time underground and rarely travels from its burrow when above ground (Findley et al. 1975). They generally have two to three litters per year, with two to three young per litter (NMDGF 1988). They are threatened by pesticide and rodenticide use and by increasing intensity, frequency and severity of wildfires (Johnson and Fagerstone 1994; NMDGF 2020b).

Southern Red-backed Vole

The Southern Red-backed Vole (*Myodes gapperi*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Southern Red-backed Vole's climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

Red-backed Voles were recently moved to the *Clethrionomys* genus from the previous genus *Myodes* genus (Kryštufek et al. 2020). *Myodes* is used here for consistency with BISON-M (NMDGF 2024). The Southern Red-backed Vole is found in forested stands with more overstory canopy cover, more uniformly-distributed coarse woody debris, and in proximity to water (Keinath and Hayward 2003). This habitat is threatened by destruction and degradation resulting from logging and grazing (Frey 1995a; Keinath and Hayward 2003). Fire can result in direct vole mortality, habitat loss, and increased exposure to predation, although low severity fires can result in longer-term habitat improvement (Bendell 1974; Jones 1990). Negative impacts from fire could result from the increasing intensity, frequency, and severity of wildfires anticipated due to climate change. Southern Red-backed Voles are threatened by pesticides and rodenticides (Johnson and Fagerstone 1994). Southern Red-backed Voles have small home ranges and display high site fidelity (Merritt and Merritt 1978; Gillis and Nams 1998). They are also preyed on by a variety of mammalian and avian species (Merritt 1981; Frey 1995a). Based on historic behavior, it is likely the Southern Red-backed Voles will shift their ranges higher in elevation in response to climate change and their range may shift to the north. These responses could impact their range in New Mexico, although the extent of the impact is unknown and likely dependent on the degree of warming that occurs (Guralnick 2007).

Southwestern Little Brown Myotis

The Southwestern Little Brown Myotis (*Myotis occultus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Southwestern Little Brown Myotis's climate change vulnerability is impacted by factors related to distribution and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

It is found in a variety of shrub and woodland habitat types, provided they are near water (Ramsey and Jennings 1998; Chung-MacCoubrey 2005). The Southwestern Little Brown Myotis generally feeds over streams and other bodies of water and is only found as a transient in areas without large water bodies. Draining and filling wetlands and increasing droughts could impact their access to food (Chung-MacCoubrey 2005). They generally roost in snags, tree cavities and foliage, and under bark (Taylor 2011). They have also been found roosting in man-made buildings, and human disturbance to roost sites can result in direct and indirect mortality (Findley et al. 1975; Castner et al. 1993). The Southwestern Little Brown Myotis is sensitive to outdoor cats and noise and light pollution (Holroyd et al. 2023). *Pd* is the fungus that causes WNS and it has not been documented in the Southwestern Little Brown Myotis, although WNS has resulted in significant mortality to the closely-related Little Brown Bat (*Myotis lucifugus*) (Holroyd et al. 2023). Climate change is of particular concern for bat species because bats are sensitive to changes in environmental conditions (Jones et al. 2009). Bats will exit hibernation prematurely, ovulate, and become pregnant if there are warm conditions and a food supply during the second half of winter (Racey 1972; Jones et al. 2009). If bats experience periods of inclement weather associated with food shortages during pregnancy, they will become torpid and extend their gestation period (Racey 1973; Racey and Swift 1981; Jones et al. 2009).

Spotted Bat

The Spotted Bat (*Euderma maculatum*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Spotted Bat's climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Spotted Bat will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Spotted Bat is found in piñon juniper woodlands and forages in open meadows and over streams within these woodlands and roosts in crevices of rocks, caves, and cliffs (Findley et al. 1975; Frey 1995b). It appears to breed at upper elevations, moving to lower elevations during winter (Geluso 2000). Wildfires can threaten this species' habitat, and increasing intensity, frequency, and severity of wildfires due to climate change could further impact the Spotted Bat (USFS 2020). They are diet specialists, feeding almost exclusively on nocturnal moth species (Geluso 2006; USFS 2020). The Spotted Bat is sensitive to outdoor cats and noise and light pollution (Holroyd et al. 2023). Climate change is of particular concern for bat species because bats are sensitive to changes in environmental conditions (Jones et al. 2009). Bats will exit hibernation prematurely, ovulate, and become pregnant if there are warm conditions and a food supply during the second half of winter (Racey 1972; Jones et al. 2009). If bats experience periods of inclement weather associated with food shortages during pregnancy, they will become torpid and extend their gestation period (Racey 1973; Racey and Swift 1981; Jones et al. 2009).

Thirteen-lined Ground Squirrel

The Thirteen-lined Ground Squirrel (*Ictidomys tridecemlineatus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Thirteen-lined Ground Squirrel's climate change vulnerability is impacted by factors related to life history and abiotic niche, which influence its ability to persist in place and respond to climate change impacts.

The Thirteen-lined Ground Squirrel requires dry, open, sandy areas such as short grass prairies, montane meadows, agricultural fields, roadsides, and prairie dog towns (Fitzgerald et al. 1994). This habitat requires frequent disturbance from grazing, mowing, or fire to maintain an open landscape, although increased presence of livestock can also reduce food and trample squirrel burrows (Horncastle et al. 2019). Juvenile male mortality average 89-96% and juvenile female mortality averaged 74-88%, likely the result of males dispersing into more marginal habitat than females. This higher male mortality rate also results in a female-skewed sex ratio (Rongstad 1965; McCarley 1966; Streubel and Fitzgerald 1978). Thirteen-lined Ground Squirrels experience high rates of mortality from floods and predation (Jones et al. 2003).

Tricolored Bat

The Tricolored Bat (*Perimyotis subflavus*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Tricolored Bat's climate change vulnerability is impacted by factors related to evolutionary potential and abiotic niche, which influence its ability to respond to climate change impacts. It is also impacted by land-use changes, other anthropogenic factors, and biologic factors that could increase the effects of climate change. It also has documented or modeled responses to climate change that impact its climate change vulnerability score.

The Tricolored Bat is found across a variety of forested habitats, generally near water (Fujita and Kunz 1984). It is generally considered a tree-roosting bat in the summer and hibernates in caves and mines during the winter (Geluso et al. 2005). It generally forages over water (White et al. 2006). The Tricolored Bat has experienced a northward and westward range expansion in the past few decades (Geluso et al. 2005; Kurta et al. 2007). Its abundance in New Mexico is unknown, but likely low, although it has been documented year-round (Valdez et al. 2009). The Tricolored Bat is sensitive to outdoor cats and noise and light pollution (Holroyd et al. 2023). Climate change is of particular concern for bat species because bats are sensitive to changes in environmental conditions (Jones et al. 2009). Bats will exit hibernation prematurely, ovulate, and become pregnant if there are warm conditions and a food supply during the second half of winter (Racey 1972; Jones et al. 2009). If bats experience periods of inclement weather associated with food shortages during pregnancy, they will become torpid and extend their gestation period (Racey 1973; Racey and Swift 1981; Jones et al. 2009). *Pd* is the fungus that causes WNS and has been found in Tricolored Bat populations in the eastern U.S. (USFWS 2011a; Ballmann et al. 2017). Based on data from winter counts of hibernating bats from other 200 sites across 27 states, the Tricolored Bat has declined by more than 90%. Bat colonies in the eastern U.S. affected by WNS have experiences losses reaching 95% within two to three years of initial WNS detection (USFWS 2011a; Cheng et al. 2021). The Tricolored Bat is also threatened by wind turbines, with an estimated 45,000-94,000 bats killed by wind turbines in the U.S. and Canada from 2000-2011 (Arnett and Baerwald 2013). This threat will likely increase as wind turbine development expands in New Mexico and across the U.S. (Koritarov et al. 2013).

Western Jumping Mouse

The Western Jumping Mouse (*Zapus princeps princeps*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Western Jumping Mouse's climate change vulnerability is impacted by factors related to distribution and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

In New Mexico, the Western Jumping Mouse is found primarily in mesic meadows within montane and subalpine coniferous forests above 2,440 m (8,000 ft) in elevation. (Findley et al. 1975; Frey 2006). They have small home ranges less than 0.3 ha (0.74 ac) and must reside within 50 m (164 ft) of a water source (Clark 1971; Stinson 1977). They hibernate, and the length of the hibernation period increases as elevation increases (Brown 1967). Western Jumping Mice are susceptible to rodenticides (Johnson and Fagerstone 1994).

Western Red Bat

The Western Red Bat (*Lasiurus blossevillii*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Western Red Bat's climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Western Red Bat resides in riparian habitats consisting of cottonwood, sycamore (*Platanus occidentalis*), and rabbitbrush (*Chrysothamnus* spp.) (Cook 1986; Findley et al. 1975). In New Mexico, nearly all roost trees were live cottonwood, velvet ash (*Fraxinus velutina*), or box elder (*Acer negundo*) (Geluso 2016). Available water sources are very important for insectivorous bats, with most nursery colonies found within 1.6 km (1 mi) of a water source, and studies have found a loss of 50% of the water in an individual bat's body in a single day (Taylor and Tuttle 2007). The Western Red Bat is sensitive to outdoor cats and noise and light pollution (Holroyd et al. 2023). Climate change is of particular concern for bat species because bats are sensitive to changes in environmental conditions (Jones et al. 2009). Bats will exit hibernation prematurely, ovulate, and become pregnant if there are warm conditions and a food supply during the second half of winter (Racey 1972; Jones et al. 2009). If bats experience periods of inclement weather associated with food shortages during pregnancy, they will become torpid and extend their gestation period (Racey 1973; Racey and Swift 1981; Jones et al. 2009).

Western Water Shrew

The Western Water Shrew (*Sorex navigator*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Western Water Shrew's climate change vulnerability is impacted by factors related to distribution, movement, life history, and abiotic niche, which influence its ability to shift in space, persist in place and respond to climate change impacts.

The Western Water Shrew is limited to the Sangre de Cristo, San Juan, and Jemez Mountain ranges in New Mexico (Findley et al. 1975). They are generally found within 3 m (10 ft) of permanent streams in coniferous forests and are rarely below the timberline at 2,440 m (8,000 ft) in elevation (Conaway 1952; Findley et al. 1975). Habitat generally includes significant cover (e.g., dense vegetation) near streams, as well as boulders, downed logs, and tree roots. Preferred vegetation cover consists of sedges, grasses, and forbs; they are rarely found under trees and shrubs (Conaway 1952; Frey and Calkins 2020). This habitat is threatened by destruction and degradation resulting from heavy grazing, recreation, motorized activities, and changes in hydrology (Hoffmeister 1986; USFS 2020). The average life span of the Western Water Shrew is approximately 18 months, so most individuals in a population are likely immature first-year animals (Conaway 1952). Shrews and primates are expected to be least able of the mammalian taxa to adapt to climate change (Schloss et al. 2012).

Western Yellow Bat

The Western Yellow Bat (*Dasypterus xanthinus*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Western Yellow Bat's climate change vulnerability is impacted by factors related to movement, evolutionary potential, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

Within New Mexico, the Western Yellow Bat is relatively uncommon, primarily restricted to Hidalgo and Dona Ana Counties in the southwestern part of the state (NMDGF 1996; Frey 2004; Zabriskie et al. 2019). The Western Yellow Bat resides in riparian habitats consisting of cottonwood, sycamore, and rabbitbrush (Findley et al. 1975; Cook 1986). It appears to prefer the California fan palm (*Washingtonia filifera*) (Hoffmeister 1986; AGFD 1996). In New Mexico, the bat's migration movements may coincide with the blooming of agave and perhaps yucca (*Yucca* spp.) (Findley et al. 1975). This habitat is threatened by destruction and degradation resulting from livestock grazing, intensive logging, and hydrologic alterations (NMDGF 2020b). Available water sources are very important for insectivorous bats, with most nursery colonies found within 1.6 km (1 mi) of a water source, and studies have found a loss of 50% of the water in an individual bat's body in a single day (Taylor and Tuttle 2007). The Western Yellow Bat is sensitive to outdoor cats and noise and light pollution (Holroyd et al. 2023). Climate change is of particular concern for bat species because bats are sensitive to changes in environmental conditions (Jones et al. 2009). Bats will exit hibernation prematurely, ovulate, and become pregnant if there are warm conditions and a food supply during the second half of winter (Racey 1972; Jones et al. 2009). If bats experience periods of inclement weather associated with food shortages during pregnancy, they will become torpid and extend their gestation period (Racey 1973; Racey and Swift 1981; Jones et al. 2009). The Western Yellow Bat is at low risk from wind turbines, with only an estimated 600-1,300 bats killed by wind turbines in the U.S. and Canada from 2000-2011 (Arnett and Baerwald 2013). However, this risk will likely increase as wind turbine development expands in New Mexico and across the U.S. (Koritarov et al. 2013).

White-nosed Coati

The White-nosed Coati (*Nasua narica*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The White-nosed Coati's climate change vulnerability is impacted by factors related to movement and life history, which influence its ability to shift in space and persist in place.

The White-nosed Coati is found in the southwestern portion of New Mexico, primarily in oak woodland riparian forests at 1,600 to 2,100 m (5,250 to 6,900 ft) elevation (Hass 1997; Frey et al. 2013; NMDGF 2018a). They are preyed on extensively by Mountain Lions (*Puma concolor*), Golden Eagles (*Aquila chrysaetos*), and Red-tailed Hawks (*Buteo jamaicensis*) (Hass 1997). They are also affected by rabies and canine distemper (Kaufmann et al. 1976). Coatis are threatened by direct mortality resulting from shooting, trapping and poisoning (Hubbard et al. 1979).

White-sided Jackrabbit

The White-sided Jackrabbit (*Lepus callotis gaillardi*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The White-sided Jackrabbit's climate change vulnerability is impacted by factors related to distribution and life history, which influence its ability to shift in space and persist in place.

The White-sided Jackrabbit is on the northern edge of its range in the U.S. and is limited to Hidalgo County in New Mexico (NMDGF 1988). They are found in shortgrass plains with almost no shrub component and feed almost exclusively on native grasses (Bednarz 1977; Bednarz and Cook 1984; NMDGF 1996). They are outcompeted and excluded by the Black-tailed Jackrabbit (*Lepus californicus*) in areas that experience shrub and forb invasion (Bednarz 1977; NMDGF 1988). This species' habitat is threatened by destruction and degradation resulting from livestock grazing and shrubby invasion (Traphagen 2011; NMDGF 2016). The White-sided Jackrabbit has experienced declines within New Mexico since 1976, likely due to shrub and forb encroachment and increased road mortality, although the level of decline is unknown (NMDGF 1996; Traphagen 2011; Brown et al. 2018). The White-sided Jackrabbit is threatened by direct mortality from trapping, hunting, and poaching (NMDGF 2016; NMDGF 2020b). Documented declines in density suggest increasing traffic from Department of Homeland Security Border Patrol may be negatively impacting the White-sided Jackrabbit (Traphagen 2011). The White-sided Jackrabbit is expected to show a neutral response to climate change, although it could be vulnerable due to anticipated future reduced food resources and increased drought (Friggens 2015).

White-tailed Jackrabbit

The White-tailed Jackrabbit (*Lepus townsendii campanius*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The White-tailed Jackrabbit's climate change vulnerability is impacted by factors related to distribution and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The White-tailed Jackrabbit is found within the sage plains of the upper Rio Grande Valley, which occurs throughout much of Colorado. This species is on the southern end of its range in New Mexico (Findley et al. 1975). It prefers shortgrass and desert scrub habitats with areas of disturbance, to allow for easier detection of predators (Frey and Yates 1996; USFS 2020). This habitat is threatened by destruction and degradation resulting from livestock grazing, vegetation succession, and agriculture (Brown et al. 2020b). This species experiences negative effects from competition with the Black-tailed Jackrabbit (Dunn et al. 1982). The White-tailed Jackrabbit experiences reduced reproductive output during late-summer droughts (Rogowitz 1992). At the species level, the White-tailed Jackrabbit has experienced state-level extirpations and local extinctions across much of its range. These population declines have been documented since 1950, likely due to altered predator communities, habitat loss, and climate change (Brown et al. 2020b). White-tailed Jackrabbit predators, such as the Coyote (*Canis latrans*), Bobcat (*Lynx rufus*), and Ferruginous Hawks (*Buteo reglais*), have increased throughout their range, and jackrabbits make up a significant portion of the diets of Ferruginous Hawks and Golden Eagles (Brown et al. 2018; Brown et al. 2020b). The White-tailed Jackrabbit is threatened by direct mortality resulting from hunting, trapping, and poisoning. It is also threatened by herbicides and pesticides and the recent emergence of rabbit hemorrhagic disease (Brown et al. 2020b; Ferreira et al. 2023). The White-tailed Jackrabbit is adapted to cold temperatures and experiences seasonal coat color variation; both aspects of their biology could negatively impact their ability to adapt to a changing climate (Brown et al. 2020b; Ferreira et al. 2023).

Yellow-bellied Marmot

The Yellow-bellied Marmot (*Marmota flaviventris*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Yellow-bellied Marmot's climate change vulnerability is impacted by factors related to life history and abiotic niche, which influence its ability to persist in place and respond to climate change impacts.

In New Mexico, the Yellow-bellied Marmot is generally found above 3,350 m (11,000 ft) in elevation within the Sangre de Cristo Mountains in meadows within the spruce-fir subalpine forests above the timberline (Findley et al. 1975). Mountaintop isolation has led to low levels of genetic variation, which can be further eroded by climate change-driven declines in available habitat (Frey et al. 2019). They require large rocks for protection from predators and hibernate near green succulent vegetation, such as deciduous shrubs (Frey et al. 2019). Yellow-bellied

Marmots are also known to burrow in human-made culverts, buildings, and walls, but can experience direct mortality because of hunting and trapping (Frase and Hoffmann 1980; Armstrong 2011). Nearly all males and less than half of all females disperse from their natal territory (Armitage 1991). New Mexico represents the southern limit of the Yellow-bellied Marmot's range, and they may be existing closer to ecological thresholds that limit its distribution and impacts from climate change may be compounded as a result (Hampe and Petit 2005; Frey et al. 2019). Yellow-bellied Marmots experienced earlier hibernation emergence and decreased survivorship during periods of drought, both responses could affect their ability to adapt to climate change given anticipated increases in the occurrence and severity of drought (Guralnick 2007; Armitage 2013).

Yellow-nosed Cotton Rat

The Yellow-nosed Cotton Rat (*Sigmodon ochrognathus*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Yellow-nosed Cotton Rat's climate change vulnerability is impacted by movement factors, which influence its ability to shift in space.

The Yellow-nosed Cotton Rat is found in cottonwood and rabbitbrush riparian habitats, oak woodlands and savannas, and coniferous forests at 1,160 to 2,560 m (3,800 to 8,400 ft) in elevation, generally on rocky slopes with scattered bunches of grass (Cook 1986; Davis and Schmidly 1994; Geluso and Geluso 2020). Female Yellow-nosed Cotton Rats can breed at less than two months of age, and a similar species, the Hispid Cotton Rat (*Sigmidon hispidus*), rarely survives past six months in the wild (Hoffmeister 1986; Cameron and McClure 1988). This habitat is threatened by destruction and degradation resulting from wildfire, which could increase in intensity, frequency, and severity due to climate change, and by grazing and agricultural conversion (Jones et al. 2003; Geluso 2009).

Yuma Myotis

The Yuma Myotis (*Myotis yumanensis yumanensis*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Yuma Myotis's climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Yuma Myotis is found in low elevation deserts, grasslands, and woodlands, roosting near water in a variety of human-made structures, rock crevices, cliff swallow nests, and large snags (Braun et al. 2015; Tye and Geluso 2019). They are dependent on water for foraging and are more closely associated with water than most other bat species (Findley et al. 1975; Holroyd et al. 2023). They are threatened by roost site disturbance and logging, particularly logging practices that reduce standing snags (Chung-MacCoubrey 1995; Holroyd et al. 2023). The Yuma Myotis is sensitive to outdoor cats and noise and light pollution (Holroyd et al. 2023). Climate change is of particular concern for bat species because bats are sensitive to changes in environmental conditions (Jones et al. 2009). Bats will exit hibernation prematurely, ovulate, and become pregnant if there are warm conditions and a food supply during the second half of winter (Racey 1972; Jones et al. 2009). If bats experience periods of inclement weather associated with food shortages during pregnancy, they will become torpid and extend their gestation period (Racey 1973; Racey and Swift 1981; Jones et al. 2009). *Pd* is the fungus that causes WNS, and it has been detected in the Yuma Myotis in southeastern Colorado in 2023, although impacts on the species are not yet known (Ballmann et al. 2017; TWS 2023b).

APPENDIX 5. Assessment summaries for all reptile Species of Greatest Conservation Need.

Arid Land Ribbonsnake

The Arid Land Ribbonsnake (*Thamnophis proximus diabolicus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a Climate Change Vulnerability Index (CCVI) ranking of Less Vulnerable under both Representative Concentration Pathway (RCP) 4.5 and RCP 8.5 Scenarios. The Arid Land Ribbonsnake's climate change vulnerability is impacted by factors related to distribution and abiotic niche, which influence its ability to shift in space and respond to climate change impacts. It is also impacted by barriers, land-use changes, other anthropogenic factors, and biologic factors that could increase the effects of climate change.

The Western Ribbonsnake (*Thamnophis proximus)* is found across a variety of semiaquatic habitats throughout its range, stretching from the Great Lakes to New Mexico (Ernst and Ernst 2003). The Arid Land Ribbonsnake subspecies resides near streams, ponds, marshes, and (sometimes) stock tanks that support some aquatic shrubby vegetation including willows (*Salix* spp.), cattails (*Typha* spp.), and bulrushes (*Scirpus* spp.) at 900 to 1,500 m (2,950 to 4,920 ft) elevation within New Mexico. This species is primarily limited to eastern New Mexico, western Texas, and northeastern Mexico (NMDGF 1988; Rossman et al. 1996). It is considered relatively common in Texas, although it is uncommon in New Mexico, located in only two disjunct populations, and likely has a low population density (NMDGF 1988; NMDGF 1994; Bartlett and Bartlett 1999). The Arid Land Ribbonsnake can alter its activity levels based on daily temperatures and can be diurnal or nocturnal; it will also hibernate during cooler winter temperatures from October to March (NMDGF 1988). It has likely seen a population reduction due to the introduction of non-native species such as American Bullfrogs (*Rana* [*Aquarana*] *catesbeiana*) or predatory fish (*Micropterus* spp.) (NMDGF 1988). It is also threatened by habitat alteration, including draining of wetlands; illegal take and overcollection; and road mortality (Graeter et al. 2013; NMDGF 2016).

Arizona Black Rattlesnake

The Arizona Black Rattlesnake (*Crotalus cerberus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Arizona Black Rattlesnake's climate change vulnerability is impacted by factors related to distribution, demography and abiotic niche, which influence its ability shift in space, persist in place, and respond to climate change impacts. It is impacted by barriers, land-use changes, other anthropogenic factors, and biologic factors that could increase the effects of climate change. It also has documented or modeled responses to climate change that impact its climate change vulnerability score.

It can be found in a variety of habitats at 1,860 to 2,447 m (6,100 to 8,130 ft) elevation, including desert scrub, grasslands, chaparral, woodlands, and forests, provided south- or southwest-facing rock outcroppings are available for over-winter sites and they are near a spring or stream

(Christman et al. 2020; Nowak et al. 2020; Christman et al. 2021). Arizona Black Rattlesnakes tend to be more diurnal than most other rattlesnakes but are still nocturnally active on hot summer nights (Nowak et al. 2020). They hibernate from November to April and are known for gathering in large social groups in hibernacula (van Riper et al. 2014). Prey items are varied and include lizards, small mammals, and birds (Nowak et al. 2020). Females will give birth in small social groups, possibly due to limited hibernation and rookery sites, and young will stay in these groups for up to two weeks, with females cooperatively parenting (van Riper et al. 2014; Nowak et al. 2020). The Arizona Black Rattlesnake has four distinct subpopulations that do not interbreed; this could result in declining genetic diversity and could impact their ability to respond to climate change (Douglas et al. 2016; Christman et al. 2020). Arizona Black Rattlesnakes are threatened by illegal take and overcollection; proximity to people increases chances of mortality, similar to other rattlesnakes (Nowak et al. 2020). They also experience significant road mortality and are threatened by fire, particularly large, stand-replacing fires (Graeter et al. 2013; Douglas et al. 2016; Christman et al. 2020). While the snake fungal disease (*Ophidiomyces ohpiodiicola*) has not been detected in New Mexico, it has been detected in Arizona and could be of significant concern for this species (Christman et al. 2021). The greatest threat facing Arizona Black Rattlesnake is range contraction driven by climate change; the range of the species is projected to shift northward and decrease by 40% by 2039 and 46% by 2099 (Hatten et al. 2016; Christman et al. 2021). Rattlsnakes will have limited ability to disperse northward in response to this range shift and will likely be limited to elevational shifts (Christman et al. 2020).

Banded Rock Rattlesnake

The Banded Rock Rattlesnake (*Crotalus lepidus klauberi*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Banded Rock Rattlesnake's climate change vulnerability is impacted by demography factors, which influence its ability to persist in place. It is also impacted by barriers, land-use changes, and biologic factors that could increase the effects of climate change.

The Banded Rock Rattlesnake typically inhabits rocky, mountainous areas but can also be found in the desert transition zone in pine (*Pinus* spp.)-oak (*Quercus* spp.) forests, mesquite grasslands, and desert scrub (Campbells and Lamar 1989; Christman et al. 2021). They are diurnal during the cooler parts of the year and more nocturnal during the heat of the summer, and they hibernate in underground burrows or under rocks during winter (Holycross and Jones 2020). Young are born alive, from August to October, and remain with their mother for up to two weeks; they are sexually mature at three years of age and can live for 20 years or longer (NMDGF 2007; Holycross and Jones 2020). The Banded Rock Rattlesnake appears to include multiple distinct subpopulations that do not interbreed; this could negatively impact genetic diversity and reduce this species' ability to adapt to climate change (Holycross and Jones 2020). The Banded Rock Rattlesnake is threatened by road mortality, illegal take and overcollection, mining, grazing, and recreational development (NMDGF 2007; Holycross and Jones 2020). Climate change models project this species will experience a range contraction of 4% by 2039 and 8% by 2099 (Hatten et al. 2016).

Big Bend Slider

The Big Bend Slider (*Trachemys gaigeae*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Big Bend Slider's climate change vulnerability is impacted by factors related to distribution, demography, evolutionary potential, and abiotic niche, which influence its ability shift in space, persist in place, and respond to climate change impacts. It is also impacted by barriers, land-use changes, other anthropogenic factors, and biologic factors that could increase the effects of climate change.

The Big Bend Slider is restricted to a small portion of the Rio Grande River at 1,280 to 1,410 m (4,200 to 4,625 ft) elevation and can be found in a variety of aquatic habitats including rivers, canals, ditches, and stock tanks, provided they are at least 1 to 2 m (3 to 6 ft) in depth (Garrett and Barker 1987; Stuart 1998). Permanent water bodies are preferred but vegetation and bottom substrate are variable (Garrett and Barker 1987; Stuart 1998). They will bask in the mornings or afternoons during cooler parts of the year but are inactive from October to February (Stuart 1998). Big Bend Sliders are omnivorous and will feed on insects, dead fish or crayfish, algae, and other aquatic vegetation (Stuart and Ward 2009; Forstner et al. 2014). Females can produce up to three clutches of four to 29 eggs from May through July that are incubated at 28 to 30 °C (82.4 to 86.0 °F); sex determination is temperature dependent (Stuart 1998). Young hatch beginning in August and overwinter in the nest to emerge in the following spring (Stuart and Ward 2009). Genetic diversity is low in some populations, accompanied by a small effective population size, although there is no evidence of a recent loss of genetic diversity (Osborne 2017). The threats to the Big Bend Slider include collection and consumption by humans and habitat degradation resulting from river channelization, damming, water diversion, groundwater pumping, and pollution (Stuart and Ward 2009). Hybridization between the Big Bend Slider and the Red-eared Slider (*Trachemys scripta elegans*) has been documented and is a concern to managers (Stuart 1998; Forstner et al. 2014). Mortality due to drought has been documented (Friggens et al. 2013).

Bleached Earless Lizard

The Bleached Earless Lizard (*Holbrookia maculate ruthveni*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Bleached Earless Lizards's climate change vulnerability is impacted by factors related to distribution, demography evolutionary potential, and abiotic niche, which influence its ability shift in space, persist in place, and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its climate change vulnerability score.

The Bleached Earless Lizard is endemic to New Mexico and is found only in sand dunes with very sparse vegetation at White Sands National Monument in Dona Ana and Otero Counties (Mangineli 1993). They are primarily diurnal but may be more active in the evening or at night on hot days (Hammerson 1982). Bleached Earless Lizards take shelter either in burrows or by burying themselves in loose soil and are mostly active from March to October; they hibernate during the winter (Hammerson 1982). Prey items consist of a variety of small invertebrates including insects and spiders (Behler and King 1979; Hammerson 1982). Breeding requires temperatures at 27 to 39 °C (80 to 102°F) (Sena 1978). Females will lay a clutch of three to 11 eggs in June or July; first year females will have a single clutch while second year females will have two (Gennard 1974; Hammerson 1982). In New Mexico, approximately 20% of individuals will survive to their second year, but less than 1% survive to their third year (Gennard 1974). Female home ranges average 0.04 to 0.06 ha (0.1 to 0.15 ac) and males average 0.1 ha (0.25 ac) and likely have small dispersal distances (Gennard 1972). Climate change modeling suggests local extinction rates for species in the Phrynosomatidae family average 4% worldwide and that these averages will increase to 16% by 2050 and to 30% by 2080. (Sinervo et al. 2010). Bleached Earless Lizards are threatened by livestock grazing and pesticide use (Hall 1980).

Bolson's Tortoise

The Bolson's Tortoise (*Gopherus flavomarginatus*) will experience a high degree of climate exposure and has a low adaptive capacity. Overall, it has a CCVI ranking of Extremely Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Bolson's Tortoise's climate change vulnerability is impacted by factors related to distribution, movement, demography, life history, evolutionary potential, and abiotic niche, which influence its ability shift in space, persist in place, and respond to climate change impacts. It is also impacted by barriers, land-use changes, other anthropogenic factors, and biologic factors that could increase the effects of climate change.

The Bolson's Tortoise's current natural population is found in a small area totaling 6,090 km^2 (2,351 mi^2) in the Chihuahuan desert in Mexico (Bury et al. 1988; Ureña-Aranda et al. 2015). It was historically found in New Mexico, although it was extirpated from the state (USFWS 2023e). In 2006, a restoration project was started at a research facility in New Mexico using captive tortoises from a similar project in Arizona. An estimated 900 individuals are part of the restoration efforts on the 146,900 ha (363,000 ac) Armendaris Ranch in southwestern New Mexico (Truett and Phillips 2009; Barrus 2023; TWS 2024). In 2023, a safe harbor agreement was signed that initiated a reintroduction program that entails releasing a total of 250 Bolson's Tortoises into the wild at Armendaris Ranch; this reintroduction has started with 26 tortoises in the wild (USFWS 2023e; TWS 2024). The Bolson's Tortoise prefers habitat with gentle slopes, moderately-hard, compacted soils with high silt and sand content (Morafka 1982; USFWS 2023e). This habitat is generally vegetated by creosote bush (*Larrea tridenata*), mesquite (*Prosopis juliflora*), tobosagrass (*Pleuraphis mutica*), or other desert plants (Truett and Phillips 2009; USFWS 2023e). Bolson's Tortoises occur at higher elevations than other *Gopherus* spp., generally at 1,00 to 1,400 m (3,280 to 4,590 ft) elevation and tend to avoid lowland areas due to their risk of flooding (Morafka 1982; USFWS 2023e). They spend more than 95% of their lives inside burrows that they dig themselves and can exhibit high site fidelity for a particular burrow (USFWS 2023e). These burrows are used as hibernacula during the winter and as a refuge from weather extremes or predators (Truett and Phillips 2009). The Bolson's Tortoise prefers to feed on tobosagrass but they are opportunistic and will also eat other grasses or herbaceous annuals (Morafka 1982; Morafka et al. 1989). Their mating season coincides with the monsoon season in the late summer and early fall, and females lay eggs the following May and June (Truett and Phillips 2009). Females generally produce two clutches of five to six eggs which then hatch from July to October (Morafka 1982; USFWS 2023e). Nest and hatchling predation rates are very high, resulting in survival rates of only 1-3% (Morafka 1982; USFWS 2023e). Juveniles mature at 15-20 years of age; lifespan is unknown but over 50 years, with some individuals reaching 80 years (Truett and Phillips 2009; Barrus 2023b; USFWS 2023e). Low genetic diversity (only two distinct haplotypes) has been documented, and this species has significant genetic homogeneity, likely due to a previous population bottleneck (Ureña-Aranda and de los Monteros 2012). Bolson's Tortoises are threatened by human predation, habitat modification, overgrazing, and illegal collection (Bury et al. 1988; Truett and Phillips 2009; USFWS 2023e). Climate change is projected to lead to hotter and drier conditions in this species' range, which is likely to further stress the remaining population (USFWS 2023e).

Dunes Sagebrush Lizard

The Dunes Sagebrush Lizard (*Sceloporus arenicolus*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Highly Vulnerable under the RCP 8.5 Scenario. The Dune Sagebrush Lizard's climate change vulnerability is impacted by factors related to distribution, life history, ecological role, and abiotic niche, which influence its ability shift in space, persist in place, and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its climate change vulnerability score.

The Dune Sagebrush Lizard is found across a 2,312 km^2 (892 mi^2) area in localized populations in the Mescalero Sands in southeastern New Mexico and Monahan Sandhills in Texas; in New Mexico, potential and occupied habitat consists of 1,697 km^2 (655 mi^2) (Degenhardt et al. 1996; Painter 2004). The Dunes Sagebrush Lizard is restricted to habitat with sand dune blowouts within shinnery oak (*Quercus havardii*); the presence of shinnery oak seems to be of significant importance for ensuring reduced predation, burrow creation, basking sites, and prey availability (Sena 1984; NMDGF 2007; USFWS 2010a). They specifically prefer larger, cooler blowouts and need sand with a median grain size of 0.201 mm (0.008 in) to allow adequate gas diffusion for subsurface hibernation and the incubation of eggs (Sena 1984; Ferguson et al. 2014). They are mostly diurnal and lie in wait to ambush their prey, which includes a variety of insects and other arthropods (NMDGF 1988; Sias, pers. comm., 1996). Hibernation begins in October or November and lasts until March or April (Sena 1984; NMDGF 2007). While dispersal is not well understood, limited research suggests gravid females will move several hundred meters from their home range to nest, while juveniles and males primarily stayed within their home ranges (Fitzgerald and Painter 2004). The Dunes Sagebrush Lizard begins breeding in late April (NMDGF 2007), and females can produce up to two clutches of three to six eggs from June to

August (Sabath 1960; Degenhardt and Jones 1972). Hatchlings emerge from July to early September and are sexually mature by the following spring or summer (Sena 1984). Juvenile survival rates averaged 19-35% (Ryberg et al. 2014). The Dunes Sagebrush Lizard is preyed on a by a variety of reptilian and avian species; predation rates are highest near nesting time, as gravid females tend to bask in more visible locations to assist with egg development (Hill and Fitzgerald 2007). The Dunes Sagebrush Lizard is threatened by the elimination of shinnery oak as a result of chemical brush control programs on Bureau of Land Management (BLM) lands and private land (Snell and Landwer 1991; NMDGF 1995; USFWS 2010a). Oil and gas exploration, drill pads, roads, and pipelines also present potential threats, resulting in habitat fragmentation, seismic impacts, and poisoning from toxins (USFWS 2010a; NMDGF 1995; Walkup et al. 2018). The overall warming from climate change is also likely to reduce the availability of thermal microclimates suitable for the lizard, forcing individuals to further limit their surface activity and limiting the lizard's ability to meet its nutritional requirements (Ferguson et al. 2014). Climate change modeling suggests local extinction rates for species in the Phrynosomatidae family average 4% worldwide and that these averages will increase to 16% by 2050 and 30% by 2080. (Sinervo et al. 2010).

Giant Spotted Whiptail

The Giant Spotted Whiptail (*Aspidoscelis stictogramma*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Highly Vulnerable under the RCP 8.5 Scenario. The Giant Spotted Whiptail's climate change vulnerability is impacted by factors related to distribution, evolutionary potential and abiotic niche, which influence its ability shift in space and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its climate change vulnerability score.

In New Mexico, the Giant Spotted Whiptail is only found in Guadalupe Canyon in Hidalgo County at 1,321 to 1,387 m (4,330 to 4,550 ft) elevation (Degenhardt et al. 1996). It is also found in a few distinct populations in Arizona and in at least 100 distinct locations in Sonora, Mexico (Brennan and Holycross 2006; Rorabaugh and Lemos Espinal 2016). The Giant Spotted Whiptail is found in dense shrubby vegetation along the banks of stream courses in rocky areas of arroyos or canyons (NMDGF 1988; Stebbins 2003). Giant Spotted Whiptails are primarily diurnal, foraging for prey in leaf litter or dense vegetation, sheltering in piles of rocks or debris, and hibernating within their burrows (NMDGF 1988). Dispersal is not well known, but they can likely travel a few hundred meters from their home territory; home range size is likely much less than 1 ha (2.5 ac) (Eifler and Eifler 1998). Mating likely occurs in the spring, and females lay one to four eggs in June or July (NMDGF 1988). The Giant Spotted Whiptail is fairly secure in New Mexico, although it is on the northern edge of its range with a small population; past surveys recorded maximum counts of only eight individuals (Baltosser 1980; Painter et al. 2017). The Giant Spotted Whiptail is threatened by fires that can remove the thick shrubby vegetation it relies on and impacts from overgrazing and overcollection (NMDGF 1996; NMDGF 2016). Climate change modeling suggests local extinction rates for species in the Phrynosomatidae family average 4% worldwide, and that these averages will increase to 16% by 2050 and to 30% by 2080. (Sinervo et al. 2010).

Gray-banded Kingsnake

The Gray-banded Kingsnake (*Lampropeltis alterna*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Gray-banded Kingsnake's climate change vulnerability is impacted by factors related to distribution, demography and abiotic niche, which influence its ability shift in space, persist in place, and respond to climate change impacts.

The Gray-banded Kingsnake ranges from southeastern New Mexico to southwestern Texas and into northeastern Durango and extreme western Nuevo Leon in central Mexico (Degenhardt et al. 1996; Stebbins 2003; Werler and Dixon 2000). It is found in dry, rocky desert terrain with scrubby desert vegetation at 670 to 2,286 m (1,200 to 7,500 ft) elevation (Degenhardt et al. 1996; Werler and Dixon 2000). Areas with limestone outcroppings are favored for their abundance of rock cover (NMDGF 1994). These snakes are nocturnal and are known for their secretive nature, sheltering in crevices or under rocks during the day and burrowing underground to hibernate during the winter (Hakkila 1994; Degenhardt et al. 1996). Higher humidity reduces the probability of significant desiccation in nocturnal reptiles, such as the Gray-banded Kingsnake, and allows these animals to be active for longer periods; humidity may decline as temperatures increase due to climate change (Hakkila 1994). Breeding likely occurs in the spring, with females laying three to 13 eggs from late May to early July (Tennant 1984). Although the population status is unknown in New Mexico, in part due to this species' secretive nature, very few specimens have been documented in New Mexico, and populations are likely small and unevenly distributed (Painter et al. 2002). The Gray-banded Kingsnake is threatened by habitat degradation resulting from overgrazing and by road mortality (Hakkila 1994; Graeter et al. 2013). They are also one of the most sought-after snakes in the pet trade, and overcollection and illegal take are a leading threat for this species (Hakkila 1994; Painter et al. 2002; NMDGF 2016).

Gray-checkered Whiptail

The Gray-checkered Whiptail (*Aspidoscelis dixoni*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Highly Vulnerable under the RCP 8.5 Scenario. The Gray-checkered Whiptail's climate change vulnerability is impacted by factors related to distribution, demography, life history, evolutionary potential, and abiotic niche, which influence its ability shift in space, persist in place, and respond to climate change impacts. It is impacted by barriers, land-use changes, other anthropogenic factors, and biologic factors that could increase the effects of climate change. It also has documented or modeled responses to climate change that impact its climate change vulnerability score.

The Gray-checkered Whiptail inhabits woodland, shrubland, or grassland slopes or flats with sparse vegetation in a few small populations and is endemic to Hidalgo County in New Mexico (Degenhardt et al. 1996). Preferred areas are often near streams or other watercourses (Degenhardt et al. 1996). It was previously lumped with the Common Checkered Whiptail (*A. tesselatus*) but was regarded as a distinct species by Walker et al. (1994) and others (Degenhardt et al. 1996; Cordes and Walker 2006; Crother 2008). As such, it has an extremely limited distribution that is likely no more than just a few square kilometers (Cole et al. 2007). Like many other lizards, they are mostly diurnal, taking shelter in burrows or under rocks when conditions are not favorable, and hibernate during the winter (NMDGF 1988; Painter 1991). Gray-checkered Whiptails are nearly all female, are parthenogenetic, and are thought to be the result of hybridization between two bisexual species, the Marbled Whiptail (*A. marmoratus*) and the Texas Spotted Whiptail (*A. septemvittatus*) (Painter 1991; Painter 1995). Individuals lay one to eight eggs in May to July and may produce two clutches in the same year (Stebbins 1985; Degenhardt et al. 1996). Juveniles are sexually mature at two years of age (Stebbins 1985; Degenhardt et al. 1996). The Gray-checkered Whiptail is threatened by overcollection and road mortality and habitat loss and degradation resulting from overgrazing, mining, chemical brush control, and habitat alteration (Walker et al. 1994; NMDGF 2016, NMDGF 2020b). It is also threatened by hybrdization and competition with the Western Whiptail (*A. tigris*) (NMDGF 2016; NMDGF 2020b). Climate change modeling suggests local extinction rates for species in the Phrynosomatidae family average 4% worldwide and that these averages will increase to 16% by 2050 and 30% by 2080. (Sinervo et al. 2010).

Green Rat Snake

The Green Rat Snake (*Senticolis triaspis intermedia*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Green Rat Snake's climate change vulnerability is impacted by factors related to demography, evolutionary potential, and abiotic niche, which influence its ability to persist in place and respond to climate change impacts.

The Green Rat Snake is a montane species found at 1,225 to 2,140 m (4,000 to 7,000 ft) elevation in forested and rocky canyons near streams (Stebbins 1985; Stebbins 2003). It is primarily crepuscular and will take shelter in trees and bushes during the day or in burrows and rock crevices at night (Stebbins 1985). Green Rat Snakes likely hibernate during the winter or aestivate during periods of extreme heat (Degenhardt et al. 1996). Mating likely occurs in the spring, and five or more eggs are laid in the late summer or early fall (Behler and King 1979). The Green Rat Snake is threatened by overcollection, intentional killing, road mortality, and habitat degradation resulting from fire and overgrazing (Watson and Fruber 2006; NMDGF 2016; NMDGF 2020b).

Knobloch's Mountain Kingsnake

Knobloch's Mountain Kingsnake (*Lampropeltis knoblochi*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less

Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Knobloch's Mountain Kingsnake's climate change vulnerability is impacted by factors related to demography and abiotic niche, which influence its ability to persist in place and respond to climate change impacts.

The Knobloch's Mountain Kingsnake is found in the Sierra Madre Occidental in Mexico into the Madrean Sky Islands in southern Arizona and southwestern New Mexico (Burbrink et al. 2011). It is found in found in rocky, montane habitat at 1,380 to 2,500 m (4,525 to 8,200 ft) elevation near streams or in riparian canyons that are forested with abundant leaf litter (Stebbins 2003; Holycross et al. 2020a). They are primarily diurnal and are most active from late afternoon to dusk (Ingrasci et al. 2004). The Knobloch's Mountain Kingsnakes hibernate during the winter and are active in the spring, summer, and fall, especially following rain events (Holycross et al. 2020a). Prey items are mainly lizards but can also include small mammals and birds (Holycross et al. 2020a). Based on the activity of captive individuals, mating occurs from March to May (Holycross et al. 2020a). Females can lay multiple clutches of one to three eggs from April to July that then hatch from July to September (Holycross et al. 2020). The Knobloch's Mountain Kingsnake is threatened by overcollection, road mortality, and stand-replacing wildfires (Graeter et al. 2013; Holycross et al. 2020a).

Little White Whiptail

The Little White Whiptail (*Aspidoscelis inornata gypsi*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Little White Whiptail's climate change vulnerability is impacted by factors related to distribution, demography and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Little White Whiptail is found only on White Sands National Monument and White Sands Missile Range and is restricted to white sand dunes with little vegetation (Mangineli 1993; Wright and Lowe 1993; Burkett 1996; Degenhardt et al. 1996). They have also been found up to 50 m (165 ft) from dunes on "adobe soil" (Dixon 1967). Other species in the Teiidae family limit dispersal movement to a few hundred meters and have very small home ranges, generally much smaller than 1 ha (2.5 ac) (Eifler and Eifler 1998). They are diurnal and hibernate during the winter, being most active from early spring to late fall when the ambient air temperature is more favorable (Stebbins 1985). Little White Whiptails prey on spiders, moth larvae, butterflies, and beetles (Stebbins 1985). Little White Whiptails are known to naturally hybridize with the New Mexico Whiptail (*A. neomexicanus*), Chihuahuan Spotted Whiptail, (*A. exsanguis*), and Desert Grassland Whiptail (*A. uniparens*), all of which are uniparental; no negative impacts from this hybridization have been documented (Wright and Lowe 1993). The Little White Whiptail is threatened by agricultural and other human activity, although both are relatively limited within its range (Hammerson et al. 2019).

Mexican Gartersnake

The Mexican Gartersnake (*Thamnophis eques megalops*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Extremely Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Mexican Gartersnake's climate change vulnerability is impacted by factors related to distribution, demography, evolutionary potential and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It is also impacted by barriers, land-use changes, other anthropogenic factors, and biologic threats, which could increase the effects of climate change.

The Mexican Gartersnake is found in central and southeastern Arizona and southwestern New Mexico, with a larger range southward into the Mexican states of Chihauhua, Durango, Guanajuato, Hidalgo, San Luis Potosi, and Sonora (Rosen and Schwalbe 1988; Tipton 2005; USFWS 2009d). In New Mexico, it is currently limited to a single population along the Gila River in Grant County (NMDGF 2020b). The Mexican Gartersnake is found near relatively shallow, slow-moving water that are at least partially vegetated (NMDGF 1988). Mexican Gartersnakes are typically active from March to November and will become inactive to avoid cold temperatures or extreme heat (Manjarrez 1998). Prey can include fish, amphibians, worms, leeches, and sometimes mice (Macias Garcia and Drummond 1988; Manjarrez 1998). Mating occurs in the spring, and females give birth to as many as 25 young from late April to early November (Manjarrez 1998). Mexican Gartersnake juvenile survival and recruitment is depressed in areas with an abundance of non-native species (Rosen and Schwalbe 1988; USFWS 2014b). The Mexican Gartersnake's habitat is threatened by degradation or destruction resulting from water diversion, impoundment, or groundwater pumping (USFWS 2013f). Predation, particularly from non-native species including American Bullfrogs, sportfishes (*Micropterus* spp.), and crayfish (AGFD 1995; NMDGF 2020b). Other potential threats include overcollection, overgrazing, and road mortality (NMDGF 1996; Graeter et al. 2013; USFWS 2014b).

Midland Smooth Softshell Turtle

The Midland Smooth Softshell Turtle (*Apalone mutica mutica*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Midland Smooth Softshell Turtle's climate change vulnerability is impacted by factors related to distribution, demography, life history, evolutionary potential and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Midland Smooth Softshell Turtle is found across the eastern United States and is on the western edge of its range in New Mexico, only found in the Canadian River basin (Stebbins 1985; Painter et al. 2017). The population level is unknown, but likely low (Applegarth 1982). Midland Smooth Softshell Turtle habitat consists primarily of rivers and large streams that have sandy or muddy bottoms, but it can also be found in creeks and smaller streams; it is generally not found in lakes (Hubbard et al. 1979; Garrett and Barker 1987). They are active or basking during the day from April to October and hibernate through the winter (Collins 1982). Midland Smooth Softshell Turtles feed on insects, worms, crayfish, snails, tadpoles, frogs, fish, and occasionally plant material (Hubbard et al. 1979; Collins 1982). Mating likely occurs in the spring, and by May to July, females can produce one to three clutches of four to 33 eggs that are buried 15 to 25 cm (6 to 10 in) deep in sand (Applegarth 1982; Collins 1982). The young emerge in summer or fall, although hatching can be delayed, and eggs may overwinter until the following spring (Hubbard et al. 1979; Collins 1982). Males can become sexually mature in four years while females take six to nine years to reach reproductive age (Collins 1982). Midland Smooth Softshell Turtle is threatened by accidental bycatch, harvest, overcollection, pollution, and hydrological manipulation by humans (Applegarth 1982; Reed and Gibbons 2003).

Mojave Rattlesnake

The Mojave Rattlesnake (*Crotalus scutulatus scutulatus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Mojave Rattlesnake's climate change vulnerability is impacted by factors related to distribution, demography, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Mojave Rattlesnake is found in desert and lowland grasslands in relatively flat terrain at 1,100 to 1,500 m (3,610 to 4,920 ft) elevation near the edges of pine-oak forests in southwestern New Mexico (Campbell and Lamar 1989; Pederson and Painter 1990; Degenhardt et al. 1996; Mitchell et al. 2020). They are active during the warmer months and hibernate during winter, although they will emerge from their burrows on warm winter days (Ernst 1992; Mitchell et al. 2020). During the summer they will become nocturnal to avoid the heat of the day (Mitchell et al. 2020). Mojave Rattlesnakes prey on a variety of small animals, including rodents, lizards, and toads and typically capture prey by ambush, although they also use olfaction to forage for prey (Pederson and Painter 1990; NMDGF 2007). Mating occurs in the spring and young are born live in August to October (Pederson and Painter 1990). A small proportion of young will survive their first winter, become sexually mature at approximately three years of age, and live as long as 20 years (NMDGF 2007). Rattlesnakes bask until they are 80 to 90°F (27 to 32°C) to optimize movement and digestion, and soil temperature combined with rainfall also appear to interact to affect snake activity patterns (Price 1985; NMDGF 2007). It is known to hybridize with the Arizona Black Rattlesnake (*C. cereberus*) and the Prairie Rattlesnake (*C. viridis*), although fitness impacts resulting from hybridization are unknown (Mitchell et al. 2020). Threats to Mojave Rattlesnake include overcollection, road kills, harvest, and grazing (Graeter et al. 2013; Mitchell et al. 2020).

Mottled Rock Rattlesnake

The Mottled Rock Rattlesnake (*Crotalus lepidus lepidus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less

Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Mottled Rock Rattlesnake's climate change vulnerability is impacted by factors related to distribution, demography, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Mottled Rock Rattlesnake inhabits rocky areas within pine-oak forests, mesquite grasslands, and deserts (NMDGF 1988; Campbell and Lamar 1989). It is relatively common within Mexico and is on the northern edge of its range in New Mexico, occurring primarily within Carlsbad Caverns National Park and the Guadalupe Mountains, This species likely has a low population density (NMDGF 1988; NMDGF 1996). Though they are mostly a montane species that occurs from 1,200 to 2,600 m (4,000 to 8,500 ft) in elevation, they can also be found on the borders of lowlands (NMDGF 1988). The Mojave Rattlesnake's periods of activity depend greatly on the conditions, with individuals being observed most frequently following summer rains when the humidity is high, surface temperatures are cooler, and prey animals are also more active (Swinford 1991). In general, Mottled Rock Rattlesnakes are active from March to October and hibernate underground during the winter (Swinford 1991). They hunt mainly by ambushing prey that can include lizards, snakes, and small mammals (NMDGF 1988; Holycross and Jones 2020). Breeding takes place in the spring, with females producing two to eight live young by late summer or early fall and young staying with their mother for up to two weeks (Tennant 1984; NMDGF 1988; Holycross and Jones 2020). Most young do not survive their first winter, but those that do reach sexual maturity at around three years of age and can live for up to 20 years (NMDGF 2007). The range of Mottled Rock Rattlesnake is projected to decline by 4% by 2039 and 9% by 2099 due to climate change (Hatten et al. 2016). Other threats to the species include overcollection, road mortality, legal harvest, and loss or alteration of habitat resulting from human activities such as grazing and mining (NMDGF 1988; NMDGF 1994; Graeter et al. 2013; Holycross and Jones 2020).

Mountain Skink

The Mountain Skink (*Plestiodon callicephalus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Mottled Rock Rattlesnake's climate change vulnerability is impacted by factors related to distribution and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Mountain Skink is fairly common within Mexico but is on the northeastern edge of its range in New Mexico and is limited to the Peloncillo Mountains (NMDGF 1988; NMDGF 1994). It is typically found on rocky hillsides or canyon slopes within riparian areas, with forest cover to provide leaf litter (Degenhardt et al. 1996). While skinks are generally relatively dependent on moisture, this species can be found in arid environments with limited mesic microhabitats (NMDGF 1988). They are active during the day, particularly during May and June, but spend much of their time under rocks, leaf litter, and vegetation and likely hibernate during the colder months (NMDGF 1988). Mountain Skinks forage in well-rotted leaf litter for prey that includes insects, spiders, and other macroinvertebrates (NMDGF 1988). Other skinks in the *Plestiodon* genus have small home ranges of less than 30 m (98 ft) and make movements of a few hundred meters (Fitch 1954; Fitch 1955). Egg laying occurs in abundant leaf litter, and females will attend eggs until after hatching; live birth has also been reported (Stebbins 1985; Tanner 1987; NMDGF 1994). The Mountain Skink is threatened by overcollecting and habitat degradation or destruction through overgrazing, vegetation clearing, or uncontrolled fire (NMDGF 1988; NMDGF 1994).

Narrow-headed Gartersnake

The Narrow-headed Gartersnake (*Thamnophis rufipunctatus*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Narrow-headed Gartersnake's climate change vulnerability is impacted by factors related to distribution, demography and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It is also impacted by barriers, land-use changes, and other biologic threats which could increase the effects of climate change.

In New Mexico, their distribution is restricted to the Gila and San Francisco River bottoms at 1,125 to 2,000 m (3,690 to 6,560 ft) elevation in the southwestern part of the State (Degenhardt et al. 1996). The Narrow-headed Gartersnake is most often found in clear, rocky streams and rivers or the shorelines of lakes and prefers stretches of pool and riffle habitat with abundant cobble and boulders (USFWS 2013f). Basking along the shoreline is a very common behavior for this species, but most of their hunting is done in the water (NMDGF 1988; Christman and Jennings 2011). Prey items can include tadpoles, frogs, toads, and salamanders, but by far the most common prey is fish (Stebbins 1985; NMDGF 1994). Narrow-headed Gartersnakes likely breed in the early spring, with females giving birth to broods of six to 18 young in early summer (Goldberg 2003). This species is highly dependent on water for its persistence, so dams, water diversion, and groundwater pumping all have the potential to be harmful (USFWS 2013f). Snake fungal disease has been documented in Narrow-headed Gartersnakes in Arizona, although it hasn't yet been documented in New Mexico (NAU 2019). Narrow-headed Gartersnakes are also threatened by invasive species including American Bullfrogs, predatory sportfishes, and crayfish, which can contribute to predation of the gartersnake or to competition for prey (NMDGF 1988; Fernandez and Rosen 1996). They are also threatened by overcollection, direct human mortality, road mortality, and severe fire (NMDGF 1996; Graeter et al. 2013; Jennings and Christman 2015).

New Mexico Ridge-nosed Rattlesnake

The New Mexico Ridge-nosed Rattlesnake (*Crotalus willardi obscurus*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under the RCP 4.5 Scenario and Extremely Vulnerable under the RCP 8.5 Scenario. The New Mexico Ridge-nosed Rattlesnake's climate change vulnerability is impacted by factors related to distribution, demography, evolutionary potential and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It is impacted by barriers, land-use changes, and other anthropogenic factors, that could increase the effects of climate change. It also has documented or modeled responses to climate change that impact its vulnerability score.

The New Mexico Ridge-nosed Rattlesnake has a small range in the Animas, Peloncillo and Sierra de San Luis Mountains in New Mexico, Arizona and Mexico (Holycross and Smith 1997; Campbell and Lamar 2004). The population in the Animas Mountains is estimated at 300 individuals and is likely half the population for the full species' range (Davis 2008). The species also has an elevated inbreeding coefficient, suggesting low genetic diversity (Davis et al. 2015). The New Mexico Ridge-nosed Rattlesnake is a montane species that inhabits pine-oak woodlands, often on rocky slopes in wooded, shrubby, or open areas at 2,025 to 2,515 m (6,640 to 8,250 ft) elevation (NMDGF 1988; Painter 1996; Holycross and Goode 2020). The most important habitat feature is the availability of rocky areas suitable to be used as shelter (Barker 1991). They are most active during the day from April to October and are most commonly observed July to September (NMDGF 1988). Individuals, particularly pregnant females, will bask in the sun to regulate their body temperatures during warmer times of year but will retreat underground to hibernate by mid-November (Holycross and Goode 2020). New Mexico Ridge-nosed Rattlesnakes will prey on lizards, small mammals, centipedes, and birds (Holycross and Goode 2020). Their breeding season can last from mid-June to early October, with the peak being in late July and August (Holycross and Goode 2020). Females give birth to two to nine live young and provide some degree of parental care; juvenile recruitment is low, with few hatchlings surviving through their first year due to predation, starvation, and cold (NMDGF 1988; NMDGF 2007; Holycross and Goode 2020). Gestation period averages 13 months, which indicates that females likely reproduce only at intervals of two years or more (Holycross and Goldberg 2001). Fire, whether natural or prescribed, has the potential to result in loss of suitable habitat in areas that have elevated fuel loads due to previous fire suppression (Holycross and Goldberg 2001). In such areas, the repeated effects of fires could lead to local extirpation of the New Mexico Ridge-nosed Rattlesnake (NMDGF 1996). The New Mexico Ridge-nosed Rattlesnake is also threatened by road mortality, direct human mortality, overcollection, over grazing, logging and mining (Graeter et al. 2013; NMDGF 2016; Holycross and Goode 2020; NMDGF 2020b). Climate change is also of concern, with conservative modeling suggesting habitat will recede 750 km (466 mi) upwards within its current range, resulting in an overall loss of habitat and increasing likelihood of extirpation (Davis et al. 2015).

North American Racer

The North American Racer (*Coluber constrictor*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The North American Racer's climate change vulnerability is impacted by abiotic niche factors, which influence its ability to respond to climate change impacts.

The North American Racer can be found in grasslands, brushlands, woodlands, semi-desert shrubland, and agricultural areas across much of North America (Degenhardt et al. 1996; Persons and Drost 2020). While they are not known to inhabit aquatic environments, they are typically found near water in the drier parts of their range (Degenhardt et al. 1996). They can be active in temperatures ranging from 15.5 to 32.4°C (60 to 90°F) and otherwise retreat under rocks or into burrows due to extreme temperatures (Brown and Parker 1976; Brown and Parker 1982). North American Racers are active from April to October (Hammerson 1982) and will hibernate during the cooler times of the year in rodent burrows that may be as deep as 75 to 100 cm (30 to 42 in) (Swain and Smith 1978; Collins 1982; Hammerson 1982). Prey includes rodents, ground-nesting birds and their eggs, lizards, hatchling turtles, frogs, smaller snakes, and insects (Tennant 1984). Mating occurs in the spring after which females lay clutches of five to 28 eggs, sometimes in communal nests (Rosen 1991). Suitable hibernation sites and food availability may be limiting factors in some years (Brown and Parker 1976; Swain and Smith 1978). After six to nine weeks young hatch in August to September and become sexually mature in two to three years (Rosen 1991). Snake fungal disease has been documented in North American Racers (Persons and Drost 2020). The North American Racer is sensitive to drought, with significant population declines observed despite high population gains in previous years (Persons and Drost 2020). They are also threatened by road mortality, grazing, and fire (Friggens et al. 2013; Graeter et al. 2013; Persons and Drost 2020).

Ornate Box Turtle

The Ornate Box Turtle (*Terrapene ornata*) will experience a high degree of climate exposure and has a moderately-low adaptive capacity. Overall, it has a CCVI ranking of Highly Vulnerable under the RCP 4.5 Scenario and Extremely Vulnerable under the RCP 8.5 Scenario. The Ornate Box Turtle's climate change vulnerability is impacted by factors related to demography, life history, and abiotic niche, which influence its ability to persist in place and respond to climate change impacts. It is impacted by barriers, land-use changes, other anthropogenic factors, and other biologic factors that could increase the effects of climate change. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Ornate Box Turtle resides in arid and semiarid plains, grasslands and open prairies (Garrett and Barker 1987). They require a temperature range of 15.5 to 35°C (60 to 95°F) for breeding and other activities; this will likely restrict available habitat as the climate changes (Legler 1960; Hegewisch et al. 2024). Ornate Box Turtles require deeper sandy soil for nesting and burrowing to escape freezing temperatures; soil compaction from agriculture and other land development may restrict access to these soils (Legler 1960; Ward 1978; Garrett and Barker 1987). The Ornate Box Turtle dispersal time is dependent on rainfall, and hibernation time is dependent on air temperature (Redder et al. 2006). Fire ants (*Solenopsis* spp.) are known to prey on turtle nests (Graeter et al. 2013). The Ornate Box Turtle is also threatened by direct mortality from road traffic and development and indirect impacts from illegal collection for the international pet trade (Stickel 1978; Redder et al. 2006; Painter et al. 2017). Males are sexually mature at eight to nine years and females at 10 to 11 years (Legler 1960; Redder et al. 2006). The Ornate Box Turtle can live to 37 to 50 years of age (Legler 1960; Redder et al. 2006). The Ornate Box Turtle experiences temperature-dependent sex determination, which will likely result in long-term negative effects from climate change with reductions in population size and reduced mating opportunities (Redder et al. 2006). Sex ratios likely vary across years, with some studies finding one male to 1.7 females (Legler 1960; Redder et al. 2006). The Ornate Box Turtle's range is predicted to decrease by 45% by 2039 and 72% by 2099 relative to its current range due to climate change (Hatten et al. 2016).

Plain-bellied Water Snake

The Plain-bellied Water Snake (*Nerodia erythrogaster transversa*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Plain-bellied Water Snake's climate change vulnerability is impacted by factors related to distribution, evolutionary potential and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Plain-bellied Water Snake inhabits a variety of aquatic habitats including marshes, ponds, lakes, streams, and rivers across the U.S. (NMDGF 1988). It is on the western edge of its range in New Mexico and is very limited in its range, primarily found in ponds and streams rather than larger water bodies, at 900 to 1,100 m (2,950 to 3,610 ft) elevation (NMDGF 1988; Degenhardt et al. 1996; NMDGF 1996). Though they may occasionally move away from water, they are typically restricted to areas of permanent water (NMDGF 1988). They are usually nocturnal and will either take refuge under rocks or other cover during the day or spend time basking (Tennant 1984; NMDGF 1988). In the southern reaches of their range, they may be active year round and only hibernate during periods of cold weather (Tennant 1984). Plain-bellied Water Snakes feed on fish, young frogs, and other small vertebrates and crustaceans (Tennant 1984). Young snakes will predate tadpoles, minnows, dragonfly nymphs, and other aquatic insects (Tennant 1984). Plain-bellied Water Snakes breed in the early spring, and the females give birth to litters of five to 25 live young in August and September (Tennant 1984). The population in New Mexico is unknown, but likely low; some 40 snakes were captured in Eddy County with no recaptures, suggesting the population is small but robust (Christman and Kamees 2007). Anthropogenic threats to the Plain-bellied Water Snake include road mortality, direct take, and the destruction or degradation of habitat resulting from stream channelization, water diversion, or other practices (NMDGF 1988; Graeter et al. 2013).

Plains Gartersnake

The Plains Gartersnake (*Thamnophis radix*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Plains Gartersnake's climate change vulnerability is impacted by factors related to demography and abiotic niche, which influence its ability to persist in place and respond to climate change impacts.

The Plains Gartersnake is found in a wide variety of habitats including forest, wetland, grassland, cropland, and urban areas, particularly if water is nearby (Hammerson 1982; Degenhardt et al. 1996). They can be active any time of day or night depending on the temperature and will often actively search for prey in or near shallow water (Hammerson 1982). They will also bask on the ground to warm their bodies during their seasonal activity period which extends from mid-March or May to September or October (Hammerson 1982). Plains Gartersnakes prey upon amphibians, fish, small mammals, insects, earthworms, and carrion (Stebbins 1985). Breeding has been observed in May and June, but likely occurs from spring to fall with hatchlings appearing from late July to September (Hammerson 1982). Females give birth to a single litter per season that may consist of five to 92 young; fewer than 40 is more typical (Stanford and King 2004). Plains Gartersnakes become sexually mature at two years of age and typically lived for six to seven years (Stanford and King 2004). Plains Gartersnakes are threatened by road mortality, direct take, fire, and destruction or degradation of habitat resulting from stream channelization or water diversion (Vogel et al. 1996; Graeter et al. 2013).

Pyro Mountain Kingsnake

The Pyro Mountain Kingsnake (*Lampropeltis pyromelana*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Pyro Mountain Kingsnake's climate change vulnerability is impacted by factors related to demography and abiotic niche, which influences its ability to persist in place and respond to climate change impacts.

The Pyro Mountain Kingsnake can be found in rocky habitat often near streams, in montane or mesic canyon areas with either woodland or chaparral vegetation at 1,380 to 2,500 m (4,530 to 8,200 ft) elevation in southwestern New Mexico (Degenhardt et al. 1996; Stebbins 2003). They either bask during the day or take cover among rocks, logs, or dense vegetation (Stebbins 2003). Pyro Mountain Kingsnakes are secretive snakes; they are most active during the spring and fall and during the summer rains. They hibernate during the winter (Holycross et al. 2020b; Barnes 2023). Prey items consist of small lizards, mammals, and snakes, which are either killed through constriction or eaten alive (Holycross et al. 2020b). Breeding likely takes place in the spring with three to six eggs being laid by the females (UDWR 2024). Eggs then hatch in the late summer or early fall (Holycross et al. 2020b). Snake fungal disease has been documented in Pyro Mountain Kingsnakes in Arizona (NAU 2019). The Pyro Mountain Kingsnake is threatened by road mortality, overcollection, direct fire mortality, and habitat degradation by collectors (Goode 1994; Holycross et al. 2020b).

Reticulate Gila Monster

The Reticulate Gila Monster (*Heloderma suspectum suspectum*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Reticulate Gila Monster's climate change vulnerability is impacted by factors related to distribution, demography, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It is impacted by barriers, land-use changes, and other anthropogenic factors that could increase the effects of climate change. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Reticulate Gila Monster is most common in desert and mesquite-grassland but can also be found in forests or riparian areas at 1,180 to 1,950 m (3,870 to 6,400 ft) elevation in southwestern New Mexico (Jones 1988; Campbell and Lamar 1989). Within these habitats, the most important features are rock cavities or crevices or burrows created by other animals that serve as refugia for thermoregulation, water conservation, protection against predators, access to foraging areas, and access to mates; the presence of these features is likely a limiting factor (NMDGF 1988; NMDGF 2017d). It is estimated that Reticulate Gila Monsters may spend as much as 96% of their time in such subsurface retreats (NMDGF 1996). Prey items can include small mammals, snakes, lizards, eggs, and invertebrates; it can eat most of its annual caloric need during spring, consuming 30 to 50% of its body weight in a single meal (NMDGF 1988; NMDGF 2007). Reticulate Gila Monsters can satisfy their water needs through their food alone but will drink if standing water is available (NMDGF 2017d). Breeding occurs in the spring and summer with males engaging in ritual combat to win dominance over an area and access to the females within it (NMDGF 2007). Females lay two to 12 eggs that hatch in the fall or overwinter and hatch in the following spring (NMDGF 2007). Anthropogenic threats to Reticulate Gila Monsters include road mortality, overcollection, intentional human mortality, conversion of habitat for agriculture or residential purposes, development of large solar arrays, and habitat degradation caused by reptile collection for the commercial pet trade (Goode 1994; Watson and Gruber 2006; NMDGF 2017d). Climate change modeling projects the Reticulate Gila Monster's range will contract 20% by 2039 but expand by 2099, resulting in only a 5% contraction by 2099 (Hatten et al. 2016).

Slevin's Bunchgrass Lizard

The Slevin's Bunchgrass Lizard (*Sceloporus slevini*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Slevin's Bunchgrass Lizard's climate change vulnerability is impacted by factors related to distribution, demography, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It is impacted by barriers, land-use changes, and other anthropogenic factors that could increase the effects of climate change. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Slevin's Bunchgrass Lizard is a montane species, found on high grassy plains habitat, often on hillsides where thick bunchgrasses are present in southwest New Mexico, southeast Arizona, and into northern Mexico (NMDGF 1995; Stebbins 2003; Watkins-Colwell et al. 2003). In New Mexico, they are found at elevations of 1,500 to 1,800 m (4,920 to 5,900 ft) but can be found at elevations of up to 3,600 m (11,800 ft) in Mexico (NMDGF 1988). As their name suggests, Slevin's Bunchgrass Lizards generally utilize dense bunchgrass as an important habitat feature, including as a refuge from predators (NMDGF 1988). They are most active from late June to September, during the period of summer rains, and will search out thermal cover during periods of cold weather and extreme heat (NMDGF 1985; NMDGF 1988). Dispersal is not well known, but they can likely travel a few hundred meters from their home territory; home range is likely much less than one ha (2.5 ac) (Eifler and Eifler 1998). Females lay five to 10 eggs during the summer, hidden in underground burrows (Ortega and Barbault 1986; Smith et al. 1990). A closely-related montane bunchgrass lizard, the Montane Lizard (*Sceloporus scalaris*), exhibits a two to one male to female sex ratio and generally has a single reproductive event, with approximately 44% of the lifetime fertility occurring from the first reproduction (Ballinger and Congdon 1981). The greatest threat facing Slevin's Bunchgrass Lizard is overgrazing, which leads to the destruction of its habitat (NMDGF 1988; NMDGF 1996). Some research suggests that the lizard was originally a grassland species that has been forced onto mountain slopes by overgrazing in the grassland areas they once inhabited (NMDGF 1994). Slevin's Bunchgrass Lizard is vulnerable to overcollection at a local scale, and they are also threatened by overgrazing and fire, which can significantly reduce the bunchgrasses they depend on (NMDGF 1996; NMDGF 2016). The Slevin's Bunchgrass Lizard is likely vulnerable to climate change due to low dispersal ability, drought impacts, and a short reproductive period with one or fewer reproductive events per year (Friggens 2015). Climate change modeling suggests local extinction rates for species in the Phrynosomatidae family average 4% worldwide and that these averages will increase to 16% by 2050 and 30% by 2080. (Sinervo et al. 2010).

Smooth Greensnake

The Smooth Greensnake (*Opheodrys vernalis blanchardi*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Smooth Greensnakes's climate change vulnerability is impacted by abiotic niche factors, which influence its ability to respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Smooth Greensnake can be found in grassy marshes, damp meadows, and riparian habitats, generally preferring wetland habitats (Hammerson 1986; Finch 1992). They are primarily diurnal and feed almost exclusively on insects (Jones-Burdick 1949; Collins 1974). The Smooth Greensnake breeds in May and June and females lay a single clutch of three to 11 eggs in nests under grass clumps, rocks, logs, or in cavities in the soil; communal nesting seems fairly common (Stille 1954; Cook 1964; Fowler 1966; Collins 1974). A single study reported that the Smooth Greensnake failed to reproduce if the average May temperature was above 8°C (46°F), and these temperatures seem likely to occur more frequently in the lower 50% of their breeding range in New Mexico as the climate changes (Stille 1954; Hegewisch et al. 2024). Young hatch in August to September and reach sexual maturity at 20 months of age (Stille 1954). Smooth Greensnakes hibernate during the winter and have been found associated with Common Garter Snakes (*Thamnophis sirtalis*), Plains Garter Snakes, and Redbelly Snakes (*Storeria occipitomaculata*) (Carpenter 1953). They are threatened by road mortality, fire, habitat destruction and degradation resulting from draining of wetlands and dam construction, and the use of pesticides and herbicides (Platt et al. 1974; Conant 1975; Graeter et al. 2013).

Sonoran Lyresnake

The Sonoran Lyresnake (*Trimorphodon lambda*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Sonoran Lyresnake's climate change vulnerability is impacted by factors related to movement and abiotic niche, which influence its ability to persist in place and respond to climate change impacts.

The Sonoran Lyresnake is found in upland rocky areas at 1,200 to 1,750 m (3,940 to 5,750 ft) elevation in grassland, desert scrub and woodlands; they are rarely found in lowland desert lacking rocks (Degenhardt et al. 1996; Ernst and Ernst 2003; Stebbins 2003; Brennan and Holycross 2006). They are secretive, mostly located in cracks, crevices and rocks, and display high site fidelity for particular crevices (LaDuc and Devitt 2020). They are almost entirely nocturnal and are rarely found in the open except after light precipitation events when olfactory conditions are enhanced (Tennant 1984). Sonoran Lyresnakes primarily feed on small lizards they subdue with salivary venom; they will occasionally feed on larger lizards as well as rodents, bats, birds, and amphibians (Tennant 1984; La Duc and Devitt 2020). They likely breed in the spring, with females laying seven to 20 eggs in June, although in some parts of their range they do not reproduce every year (Tennant 1984; LaDuc and Devitt 2020). These eggs hatch during September or October (Tennant 1984). The Sonoran Lyresnake basks under low vegetation during the spring and fall and hibernates during the late fall and winter (LaDuc and Devitt 2020). They are known to hybridize with the Texas Lyrsnake (*T. vilkinsonii*); the fitness of these hybrids is unknown (Barnes 2023). They are primarily threatened by road mortality and localized overcollection (Graeter et al. 2013).

Sonoran Mud Turtle

The Sonoran Mud Turtle (*Kinosternon sonoreinse sonoriense*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Sonoran Mud Turtle's climate change vulnerability is impacted by factors related to distribution, movement, demography, life history, and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts.

The Sonoran Mud Turtle habitat can include stream pools, ephemeral pools, stock tanks, marshes, and lakes, typically in woodlands (Degenhardt and Christiansen 1974; Stebbins 1985). Some individuals have been reported to migrate seasonally to take advantage of additional resources and avoid dehydration during the dry season (Stone et al. 2022). Prey items can vary widely and include insects, crustaceans, snails, fish, frogs, snakes, birds, and some plant material (Stebbins 1985; Stone et al. 2005a; Stone et al. 2005b; Ernst and Lovich 2009). Sonoran Mud Turtle nesting occurs from late May to September with females producing one to two clutches on average with one to 12 eggs per clutch (Ernst and Lovich 2009; Stone et al. 2022). Males mature in five to six years, while females take approximately eight years to reach maturity (Ernst and Lovich 2009). A variety of population estimates across the range suggests a 75% population decline from 1983-2001 and a low population density for the closely related Sonoyta Mud Turtle (*K. s. longfemorale*), with current estimates under 10,000 individuals for the parent species (Riedle et al. 2012; Grageda García and García Miranda 2018; Drost et al. 2021; Natureserve 2024). Major anthropogenic threats to the Sonoran Mud Turtle include the damming of large rivers, groundwater pumping and water diversion (Stone et al. 2022). Dam leakage and siltation in impoundments are also contributing to habitat loss (Stone et al. 2022). The Sonoran Mud Turtle experiences high egg and juvenile predation from the non-native American Bullfrog and Virile Crayfish (*Faxonius virilis*) where these species are present (Stone et al. 2022).

Texas Lyresnake

The Texas Lyresnake (*Trimorphodon vilkinsonii*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Texas Lyresnake's climate change vulnerability is impacted by abiotic factors, which influence its ability to respond to climate change impacts.

The Texas Lyresnake can be found in dry, rocky terrain at 1,200 to 1,750 m (3,940 to 5,750 ft) elevation on mountains, canyons, hills, rock outcrops, fissured bluffs, and arroyos (Larson and Moir 1986; Degenhardt et al. 1996; Painter and Degenhardt 1997). They are secretive, are almost entirely nocturnal, and can rarely be found in the open except after light precipitation events when olfactory conditions are enhanced (Tennant 1984). Texas Lyresnakes use their salivary venom to subdue small lizards and occasionally rodents but will also use their body to constrict larger prey (Tennant 1984). They likely breed in the spring, with females laying twelve eggs in June that hatch in late summer or early fall (Schmidt and Davis 1941; Tennant 1984). The Texas Lyresnake hibernates during the late fall and winter (Brennan and Holycross 2006). They are primarily threatened by road mortality and localized overcollection (Graeter et al. 2013).

Texas Spotted Whiptail

Texas Spotted Whiptail (*Aspidoscelis gularis gularis*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Texas Spotted Whiptail's climate change vulnerability is impacted by abiotic niche factors, which influence its ability to respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Texas Spotted Whiptail may be found in arid canyon bottoms, washes and semiarid prairies at 900 to 1,300 m (2,950 to 4,260 ft) elevation; they are generally near water (Garrett and Barker 1987; Degenhardt et al. 1996; Painter and Degenhardt 1997). It is relatively common across much of its range, although in New Mexico, it is only found in the southeast (Painter et al. 2017). They are primarily diurnal and use burrows for shelter, nests, and brumation during the winter months (Degenhardt et al. 1996). Based on the biology of the closely-related *Aspidoscelis tigris*, prey likely consists primarily of small arthropods and their eggs (Best and Gennaro 1985). Texas Spotted Whiptails likely breed in the spring and the females lay one to five eggs in the summer

(Anderson and Karasov 1988). Sexual maturity is likely reached around two years of age; they have an average lifespan of approximately seven years (Burkholder and Walker 1973). Climate change modeling suggests local extinction rates for species in the Phrynosomatidae family average 4% worldwide and that these averages will increase to 16% by 2050 and 30% by 2080. (Sinervo et al. 2010).

Trans-Pecos Rat Snake

The Trans-Pecos Rat Snake (*Bogertophis subocularis subocularis*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Trans-Pecos Rat Snake's climate change vulnerability is impacted by factors related to demography and abiotic niche, which influence its ability to persist in place and respond to climate change impacts.

The Trans-Pecos Rat Snake can be found in dry, rocky terrain in basins or on desert slopes at 1,000 to 1,600 m (3,280 to 5,250 ft) elevation, with vegetation ranging from grassland to woodland to desert scrub (Degenhardt et al. 1996; Werler and Dixon 2000). The most important habitat feature for Trans-Pecos Rat Snakes is the presence of rock crevices, which they use as daytime retreats during extreme temperatures and hibernation locations (Degenhardt et al. 1996; Barnes 2023). Prey items are varied and can include rodents, bats, birds, and lizards, with small lizards being particularly important for young snakes (Stebbins 1985; Conant 1975). Trans-Pecos Rat Snake females produce three to 11 eggs in a clutch (Tennant 1984). Young become sexually mature after two to three years and can produce offspring for at least 14 years (Tennant 1984). Temperature and rainfall directly impact snake activity, with activity peaking after spring rains but before high summer temperatures. The Trans-Pecos Rat Snake responds to severe climate change impacts on summer temperatures by limiting activity to temperate summer nights (Tennant 1984; Price 1985). Potential threats to this species include collection of gravid females for the pet trade, road mortality, and parasitism by ticks (Tennant 1984; Price 1985; Graeter et al. 2013; Painter et al. 2017).

Western Blind Snake

The Western Blind Snake (*Rena humilis segregus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Western Blind Snake's climate change vulnerability is impacted by abiotic niche factors, which influence its ability to respond to climate change impacts.

The Western Blind Snake can be found across a variety of habitats, particularly in low-elevation deserts and valleys below sea level to around 1,520 m (5,000 ft) elevation, provided fossorial habitat for burrowing is available, such as rock crevices; woody or plant debris; and loose, damp soil (Degenhardt et al. 1996; Werler and Dixon 2000; Stebbins 2003; Wallach and Mitchell 2020). They likely feed opportunistically on any soft-bodied arthropods they come across including ant larvae, termite larvae, beetle larvae, fly larvae, desert cockroaches, grasshopper nymphs, crickets, spiders, butterfly and moth larvae, harvestmen, whipscorpions, millipedes, and centipedes (Wallach and Mitchell 2020). Western Blind Snakes are primarily nocturnal but can be crepuscular under certain conditions (Wallach and Mitchell 2020). They retreat to burrows during the day and during winter to hibernate or the heat of the summer to aestivate; their large surface to body ratio makes them particularly sensitive to desiccation, thus they are often found near water or moist soils (Wallach and Mitchell 2020). Western Blind Snake breeding begins in early spring with females laying two to six eggs from July to August (Wallach and Mitchell 2020). Very little is known about their lifespan or reproduction (Wallach and Mitchell 2020). The Western Blind Snake is preyed on by several mammalian, avian, reptilian, and large arthropod predators (Wallach and Mitchell 2020). Potential threats to this species include nematode infestation, predation, and road mortality (Wallach and Mitchell 2020; Barnes 2023).

Western Massasauga

The Western Massasauga (*Sistrurus tergeminus*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Western Massasauga's climate change vulnerability is impacted by factors related to movement, demography and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It is impacted by barriers, land-use changes, and other anthropogenic factors that could increase the effects of climate change.

The Western Massasauga can be found in desert grasslands and shortgrass prairies at 925 to 2,100 m (3,030 to 6,900 ft) elevation, preferring hibernacula in compacted clay soils in short-grass prairie habitats (Pederson and Painter 1990; Holycross 2020). Like other rattlesnakes, they are primarily ambush hunters and can be active either during the day or at night depending on the season and the weather (Pederson and Painter 1990; Finch 1992; Holycross 2020). Western Massasauga regulate their body temperature by basking or retreating to refugia beneath rocks, in rodent burrows, or under brush (NMDGF 2007; Holycross 2020). Some research suggests limited movement, overall, with the Western Massasauga having small home ranges and extremely limited natal dispersal and/or reduced movement associated with mating (Clark et al. 2008; Holycross 2020). Breeding typically starts in April with two to 19 live young being born from August to October, and females likely reproduce biennially (Pederson and Painter 1990; Finch 1992; Holycross 2020). In New Mexico, the snakes will hibernate during the colder part of the year until spring warmth allows for normal activity (Pederson and Painter 1990). The majority of young are killed during their first winter by starvation, predators, or the cold (NMDGF 2007). Declines of Western Massasauga populations are largely attributed to loss of habitat resulting from overgrazing or conversion to croplands (Finch 1992; Rosen et al. 1996). Climate change modeling suggests the Western Massasauga will experience a northward range shift by 2070, which could increase its range in New Mexico (Ryberg et al. 2015). The Western Massasauga is threatened by habitat fragmentation, agricultural conversion, road mortality, overcollection, and persecution by humans (AGFD 1988; Finch 1992).

Western Painted Turtle

The Western Painted Turtle (*Chrysemys picta bellii*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Western Painted Turtle's climate change vulnerability is impacted by factors related to demography, life history and abiotic niche, which influence its ability to persist in place and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Western Painted Turtle can be found in rivers, lakes, ditches, and cattle tanks, and prefers still or slow-moving shallow water with a muddy bottom and aquatic vegetation (Garrett and Barker 1987). They spend a large portion of the day basking on logs, the bank, or partially-submerged vegetation (Ernst and Barbour 1972; Degenhardt et al. 1996). They primarily feed on aquatic vegetation but will sometimes ambush prey (Ernst and Barbour 1972). Western Painted Turtles breed from March to mid-June, laying five to eight eggs, although rarely up to 20 eggs, from May to mid-July, and a few females in New Mexico will produce up to three clutches annually (Ernst and Barbour 1972; Christiansen and Moll 1973; Hammerson 1982). Incubation and hatching success are sensitive to humidity and temperature, and gender ratios are temperature dependent (Degenhardt et al. 1996). After hatching, young often remain in the nest through the winter and emerge in the spring (Degenhardt et al. 1996). Sexual maturity occurs at ages three to five for males and ages five to 10 for females; maximum breeding age is likely 20 or more (Ernst and Barbour 1972; Christiansen and Moll 1973). Western Painted Turtle nests and juveniles experience predation by a variety of mammals, snakes, birds, and fish (Hermann 1970; Ernst and Barbour 1972). Recorded mortality of Western Painted Turtle has been attributed to drought, which could increase in frequency or intensity in the future as the climate changes (Friggens et al. 2013). Western Painted Turtles are threatened by wetland draining, pesticides, heavy metal accumulation, and overcollection for the pet trade (Hall 1980; Reed and Gibbons 2003; NMDGF 2015a).

Western River Cooter

The Western River Cooter (*Pseudemys gorzugi*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Moderately Vulnerable under the RCP 4.5 Scenario and Highly Vulnerable under the 8.5 Scenario. The Western River Cooter's climate change vulnerability is impacted by factors related to demography, life history, evolutionary potential and abiotic niche, which influence its ability to persist in place and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Western River Cooter is commonly found in rivers and tributary streams and prefers larger, deeper pools with relatively clear water (Pierce et al. 1984). In New Mexico, they are limited to the Black, Delaware, and Pecos Rivers (Suriyamongkol and Mali 2019). Western River Cooters spend most of their time submerged in search of food or basking at or above the water's surface and only leave the water to find sandy soil suitable for nesting (NMDGF 1988). Breeding occurs from April to May, followed by hatching of young starting in May and continuing through September (Suriyamongkol and Mali 2019). Clutch size can vary from five to 29, and females can have multiple clutches within the same season (Mali and Suriyamongkol 2019). Low genetic diversity has been documented in Texas and New Mexico populations (Mali and Forstner 2017). Increased flow variability and changes in water quality resulting from climate change, coupled with water demands from agriculture and industry, may cause negative impacts on Western River Cooter populations (Jensen et al. 2006; Cheek and Taylor 2015). Suitable habitat and climatic conditions are projected to decline by up to 90% by 2070 (Salas et al. 2017a). Destruction of habitat can occur as a result of dam and canal development projects, which also lead to habitat fragmentation and reduced gene flow. Turtles are also threatened by recreational shooting, bycatch on trotlines set for catfish, and collection for the pet trade (Pierce et al. 1984; Mali and Suriyamongkol 2019).

Yaqui Black-headed Snake

The Yaqui Black-headed Snake (*Tantilla yaquia*) will experience a high degree of climate exposure and has a high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under both RCP 4.5 and RCP 8.5 Scenarios. The Yaqui Black-headed Snake's climate change vulnerability is impacted by factors related to distribution, evolutionary potential, and abiotic niche, which influence its ability to shift in space and respond to climate change impacts.

The Yaqui Black-headed Snake is found primarily found in Mexico and is on the extreme northern edge of its range in the United States (Rorabaugh 2020). In New Mexico, it is found in only two locations in the southern Peloncillo Mountains of Hidalgo County in oak-juniper (*Juniperus* spp.) or pine-oak woodlands, generally found on rock hills or canyons at 1,325 to 1,586 m (4,340 to 5,200 ft) elevation near riparian areas (NMDGF 1994; Degenhardt et al. 1996; Rorabaugh 2020). They are secretive and fossorial, spending much of their time under rocks, logs, and other surface debris (Rorabaugh 2020). The Yaqui Black-headed Snake likely lays one to four eggs annually in late spring and summer (Stebbins 2003; Rorabaugh 2020). The Yaqui Black-headed Snake is nocturnal and hibernates to reduce impacts from extreme temperatures (Rorabaugh 2020). The Yaqui Black-headed Snake is threatened by road mortality and collecting (NMDGF 1994; Graeter et al. 2013). Climate change could increase desiccation potential for this fossorial snake, and catastrophic wildfires could reduce ground cover consistently used by the Yaqui Black-headed Snake (Rorabaugh 2020).

Yarrow's Spiny Lizard

Yarrow's Spiny Lizard (*Sceloporus jarrovii jarrovii*) will experience a high degree of climate exposure and has a moderately-high adaptive capacity. Overall, it has a CCVI ranking of Less Vulnerable under the RCP 4.5 Scenario and Moderately Vulnerable under the RCP 8.5 Scenario. The Western Painted Turtle's climate change vulnerability is impacted by factors related to distribution, life history and abiotic niche, which influence its ability to shift in space, persist in place, and respond to climate change impacts. It also has documented or modeled responses to climate change that impact its vulnerability score.

The Yarrow's Spiny Lizard is a montane species that occurs occur at 1,370 to 3,550 m (4,500 to 11,600 ft) elevation in evergreen and coniferous forests and is endemic to the sky islands of southeastern Arizona, southwestern New Mexico, and into northern Mexico (Stebbins 2003; Loughran 2022). This lizard has a very limited ability to lower body temperature by panting and cannot tolerate high heat loads; they typically rely on thermal refugia and shade from canopy cover and rock crevices to escape high temperatures (Loughran 2022). Annual survival is generally no more than 50%, while some years can be 15 to 30%; populations have experienced decreased survival during periods of drought (NatureServe 2024). The Yarrow's Spiny Lizard is also susceptible to helminth parasites, with five species of nematodes and two species of cestodes having been documented as using the lizard as a host (Goldberg et al. 1995). In the face of rising temperatures due to climate change, the stamina of individuals may be reduced by 5-10%, which will result in reduced territory acquisition, social displays, and survivorship, and ultimately result in reduced fitness and population growth (Beal et al. 2014). Climate change modeling suggests local extinction rates for species in the Phrynosomatidae family average 4% worldwide and that these averages will increase to 16% by 2050 and 30% by 2080. (Sinervo et al. 2010).

APPENDIX 6. Literature cited for all Species of Greatest Conservation Need assessments.

1) Adams, R. A. 2003. Bats of the Rocky Mountain west: natural history, ecology, and conservation. University Press of Colorado, Boulder, Colorado, USA.
2) [AGFD] Arizona Game and Fish Department. 1988. Threatened native wildlife in Arizona. Arizona Game and Fish Department, Phoenix, Arizona, USA.
3) [AGFD] Arizona Game and Fish Department. 1995. Status designations notebook. Arizona Game and Fish Department, Heritage Data Management System, Phoenix, Arizona, USA.
4) [AGFD] Arizona Game and Fish Department. 1996. Wildlife of special concern in Arizona. Public Review Draft, Arizona Game and Fish Department, Phoenix, Arizona, USA.
5) [AGFD] Arizona Game and Fish Department. 2002a. *Catostomus discobolus yarrovii*. Unpublished abstract compiled and edited by the Arizona Game and Fish Department, Heritage Data Management System, Phoenix, Arizona, USA.
6) [AGFD] Arizona Game and Fish Department. 2002b. *Catostomus insignis*. Unpublished abstract compiled and edited by the Arizona Game and Fish Department, Heritage Data Management System, Phoenix, Arizona, USA.
7) [AGFD] Arizona Game and Fish Department. 2003. *Gila nigra*. Unpublished abstract compiled and edited by the Arizona Game and Fish Department, Heritage Data Management System, Phoenix, Arizona, USA.
8) [AGFD] Arizona Game and Fish Department. 2024. Arizona wildlife conservation strategy. Arizona Game and Fish Department, Phoenix, Arizona, USA.
9) [AIBAP] Arizona Important Bird Areas Program. 2018. Bringing birds home: a guide to enhancing grasslands for birds and other wildlife. Sonoran Joint Venture, Audubon Arizona, Tucson Audubon Society, Tucson, Arizona, USA.
10) Alò, D., and T. F. Turner. 2005. Effects of habitat fragmentation on effective population size in the endangered Rio Grande silvery minnow. Conservation Biology 19:1138-1148.
11) Altman, B. 1997. Olive-sided flycatcher in western North America: status review. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Portland, Oregon, USA.
12) Altman, B., and R. Sallabanks. 2000. Olive-sided flycatcher (*Contopus cooperi*). Page 28 *in* A. Poole and F. Gill, editors. The birds of North America 502. The birds of North America, Inc., Philadelphia, Pennsylvania, USA.
13) Alves, J. E., K. A. Patten, D. E. Brauch, and P. M. Jones. 2008. Rangewide status of Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*): 2008. Colorado Division of Parks and Wildlife, Rio Grande Cutthroat Trout Conservation Team Report, Fort Collins, Colorado, USA.
14) Amburgey, S, W. C. Funk, M. Murphy, and E. Muths. 2012. Effects of hydroperiod duration on survival, developmental rate, and size at metamorphosis on boreal chorus frog tadpoles (*Pseudacris maculata*). Herpetologica 68(4):456-467.
15) Ammerman, L. K., C. L. Hice, and D. J. Schmidly. 2012. Bats of Texas. Texas A&M University Press, College Station, Texas, USA.
16) Anderson, D. W., and F. Gress. 1983. Status of a northern population of California brown pelicans. Condor 85:79-88.
17) Anderson, D. W., and J. O. Keith. 1980. The human influence on seabird nesting success: conservation implications. Biological Conservation 18(1):65-80.

18) Anderson, R., and W. Karasov. 1988. Energetics of the lizard *Cnemidophorus tigris* and life history consequences of food-acquisition mode. Ecological Monographs 58(2):79-110.
19) Anderson, W. L., and R. E. Duzan. 1978. DDE residues and eggshell thinning in loggerhead shrikes. Wilson Bulletin 90:215-220.
20) Angelo, S. 2009. Determinant factors of summer roost selection for cave bats (*Myotis velifer*) in central Texas. Thesis, Antioch University New England, Keene, New Hampshire, USA.
21) [AOU] American Ornithologists' Union. 1983. Check-list of North American birds. Sixth edition. Allen Press, Inc., Lawrence, Kansas, USA.
22) [AOU] American Ornithologists' Union. 1998. Check-list of North American birds. Seventh edition. Allen Press, Inc., Lawrence, Kansas, USA.
23) Appel, C., W. J. Zielinski, F. V. Schlexer, R. Callas, and W. T. Bean. 2017. Distribution of the North American porcupine (*Erethizon dorsatum*) in northern California. Western Wildlife 4:17–28.
24) Applegarth, J. S. 1982. A survey of the softshell turtle (*Trionyx muticus* and *Trionyx spiniferus*) living in Conchas Reservoir, San Miguel County, New Mexico, USA. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
25) Archdeacon, T. P., R. K. Dudley, W. J. Remshardt, W. Knight, M. Ulibarri, and E. J. Gonzales. 2023. Hatchery supplementation increases potential spawning stock of Rio Grande silvery minnow after population bottlenecks. Transactions of the American Fisheries Society 152(2):187–200.
26) Archdeacon, T. P., S. D., Blocker, S. R. Davenport, and K. R. Henderson. 2015. Seasonal variation in reproductive condition of the Pecos bluntnose shiner (*Notropis simus pecosensis*). Western North American Naturalist 75(3):271-280.
27) Arita, H. T. 1991. Spatial segregation in long-nosed bats, *Leptonycteris nivalis* and *Leptonycteris curasoae*, in Mexico. Journal of Mammalogy 72:706-714.
28) Armitage, K. B. 1991. Social and population dynamics of yellow-bellied marmots: results from long-term research. Annual Review of Ecology and Systematics 22:379-407.
29) Armitage, K. B. 2013. Climate change and the conservation of marmots. Natural Science 5:36-43.
30) Armstrong, D. M. 1987. Rocky Mountain mammals: a handbook of mammals of Rocky Mountain National Park and vicinity. Colorado Associated University Press, Boulder, Colorado, USA and Rocky Mountain Nature Association, Estes Park, Colorado, USA.
31) Armstrong, D. M. 2011. Rocky Mountain mammals. University Press of Colorado, Denver, Colorado, USA.
32) Arnett, E. B., and E. F. Baerwald. 2013. Impacts of wind energy development on bats: implications for conservation. Pages 435-456 *in* R. A. Adams and S. C. Pedersen, editors. Bat evolution, ecology, and conservation. Springer Science+Business Media, New York, New York, USA.
33) Arritt, S. 1997a. Jaguar! New Mexico Partners Conserving Endangered Species. 2(3) New Mexico Department of Game and Fish, Conservation Services Division, Santa Fe, New Mexico, USA.
34) Arritt, S. 1997b. Little grouse on the prairie: reversing the decline of lesser prairie-chickens. 2(4). Pages 8-13 *in* New Mexico Partners Conserving Endangered Species. New Mexico

Department of Game and Fish, Conservation Services Division, Santa Fe, New Mexico, USA.
35) [ASIR] American Southwest Ichthyological Research, LLC. 2008. Life history of southern red-belly dace in New Mexico: final report. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
36) Ault, T. R., J. S. Mankin, B. I. Cook, and J. E. Smerdon. 2016. Relative impacts of mitigation, temperature, and precipitation on 21st century megadrought risk in the American southwest. Science Advances 2(10):e1600873.
37) Austin, G. T. 1970. Interspecific territoriality of migrant calliope and resident broad-tailed hummingbirds. Condor 72:234.
38) Bagne, K. E., and D. M. Finch. 2013. Vulnerability of species to climate change in the southwest: Threatened, Endangered, and at-risk species at Fort Huachuca, Arizona. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, General Technical Report RMRS-GTR-302, Fort Collins, Colorado, USA.
39) Bailey, A. M., and R. J. Niedrach. 1965. Birds of Colorado. Volume 2. Denver Museum of Natural History, Denver, Colorado, USA.
40) Bailey, F. M. 1928. Birds of New Mexico. Judd and Detweiler, Inc., Washington, D.C., USA.
41) Bailey, V. 1932. Mammals of New Mexico. North American Fauna 53:1-412.
42) Ballinger, R. E., and J. D. Congdon. 1981. Population ecology and life history strategy of a montane lizard (*Sceloporus scalaris*) in southeastern Arizona. Journal of Natural History 15(2):213-222.
43) Ballmann, A. E., M. R. Torkelson, E. A. Bohuski, R. E. Russell, and D. S. Blehert. 2017. Dispersal hazards of *Pseudogymnoascus destructans* by bats and human activity at hibernacula in summer. Journal of Wildlife Diseases 53(4):725-735.
44) Baltosser, W. H. 1980. A biological inventory of endangered species occurring in Guadalupe Canyon, Hidalgo County, New Mexico. New Mexico Department of Game and Fish, Contract 519-68-06, Santa Fe, New Mexico USA.
45) Baltosser, W. H. 1991. Avifauna of the Bernardo and La Joya State wildlife refuges. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
46) Banfield, A. W. F. 1974. The mammals of Canada. University of Toronto Press, Toronto, Ontario, CAN.
47) Bangs, M. R., M. R. Douglas, S. M. Mussmann, and M. E. Douglas. 2018. Unraveling historical introgression and resolving phylogenetic discord within *Catostomus* (Osteichthys: Catostomidae). BMC Evolutionary Biology 18(1):86.
48) Barber, W. E., D. C. Williams, and W. L. Minckley. 1970. Biology of the Gila spikedace, *Meda fulgida*, in Arizona. Copeia 1970:9-18.
49) Barkalow, A. L., M. P. Zeigler, and J. M. Wick. 2020. Small-bodied fishes monitoring in the San Juan River: 2019: final report. U.S. Department of the Interior, U.S. Fish and Wildlife Service, San Juan River Basin Recovery Implementation Program, Albuquerque, New Mexico, USA.

50) Barker, D. G. 1991. An investigation of the natural history of the New Mexico ridgenose rattlesnake, *Crotalus willardi obscurus*. New Mexico Department of Game and Fish, Contract NM 516.6-76-76, Santa Fe, New Mexico, USA.
51) Barlow, G. W. 1958. Daily movements of desert pupfish, *Cyprinodon macularius*, in shore pools of the Salton Sea, California. Ecology 39(4):580-587.
52) Barlow, J. C. 1962. Natural history of the bell vireo (*Vireo bellii*) Audubon. University of Kansas, Museum of Natural History 12(5):241-296.
53) Barlow, J. C., S. N. Leckie, and C. T. Baril. 1999. Gray vireo *(Vireo vicinior*). Page 24 *in* A. Poole and F. Gill, editors. The birds of North America 447. The Birds of North America, Inc., Philadelphia, Pennsylvania, USA.
54) Barnes, B. 2023. The Black Range Naturalist 6(3):1-86.
55) Barrows, C. W. 1981. Roost selection by spotted owls: an adaptation to heat stress. Condor 83(4):302-309.
56) Barrus, A. 2023. How a Bolson tortoise named Gertie led her species to a new home in the U.S. Part two: operation recovery. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Washington, D.C., USA.
57) Bartlett, R. D., and P. P. Bartlett. 1999. A field guide to Texas reptiles and amphibians. Gulf Publishing Company, Houston, Texas, USA.
58) Baumgarten, A. M. 1968. Tree sparrow in life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows and allies. U.S. National Museum Bulletin 237(2):1137-1165.
59) Beal, M. S., M. S. Lattanzio, and D. B. Miles. 2014. Differences in the thermal physiology of adult Yarrow's spiny lizards (*Sceloporus jarrovii*) in relation to sex and body size. Ecology and Evolution 4(22):4220-4229.
60) Becker, G. C. 1983. Fishes of Wisconsin. The University of Wisconsin Press. Madison, Wisconsin, USA.
61) Bednarz, J. C. 1977. The white-sided jackrabbit in New Mexico: distribution, numbers, and biology in the grasslands of Hidalgo County. Final Report to the New Mexico Department of Game and Fish, Contract 516-64-25, Santa Fe, New Mexico, USA.
62) Bednarz, J. C. 1979. Ecology and status of the Pecos gambusia, *Gambusia nobilis* (Poeciliidae), in New Mexico. The Southwestern Naturalist 24:311-322.
63) Bednarz, J. C. 1983. The status of the Harris' hawk in New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
64) Bednarz, J. C., and J. A. Cook. 1984. Distribution and numbers of the white-sided jackrabbit (*Lepus callotis gaillardi*) in New Mexico. Southwestern Naturalist 29:358-360.
65) Beever, E. A., P. F. Brussard, and J. Berger. 2003. Patterns of apparent extirpation among isolated populations of pikas (*Ochotona princeps*) in the Great Basin. Journal of Mammalogy 84:37-54.
66) Behler, J. L., and F. W. King. 1979. The Audubon Society field guide to North American reptiles and amphibians. Alfred A. Knopf, New York, USA.
67) Behnke, R. J. 1967. Rare and endangered species: the Rio Grande trout (*Salmo clarkii virginalis*). Colorado State University, Colorado Cooperative Fishery Unit, Fort Collins, Colorado, USA.

68) Behnke, R. J. 1992. Native trout of western North America. American Fisheries Society Monograph 6.
69) Bell, D. A., R. P. Kovach, C. C. Muhlfeld, R. Al-Chokhachy, T. J. Cline, D. C. Whited, D. A. Schmetterling, P. M. Lukacs, and A. R. Whiteley. 2021. Climate change and expanding invasive species drive widespread declines of native trout in the northern Rocky Mountains, USA. Science Advances 7(52):eabj5471.
70) Bendell, J. F. 1974. Effects of fire on birds and mammals. Pages 73-138 *in* T. T. Kozlowski, and C. E. Ahlgren, editors. Fire and ecosystems. Academic Press, New York, New York, USA.
71) Benedict, L., N. B. Warning, N. A. Najar, S. G. Pitt, P. E. Lowther, D. E. Kroodsma, and G. H. Farley. 2021. Rock wren (*Salpinctes obsoletus*). Page 20 *in* P. G. Rodewald and B. K. Keeney, editors. Birds of the world, version 2.0. Cornell Lab of Ornithology, Ithaca, New York, USA.
72) Bennetts, R. E., G. C. White, and F. G. Hanksworth. 1996. The influence of dwarf mistletoe on bird communities in Colorado ponderosa pine forests. Ecological Applications 6:899-909.
73) Bent, A. C. 1919. Life histories of North American diving birds: order Pygopodes. U.S. National Museum Bulletin 107:1-245.
74) Bent, A. C. 1938. Life histories of North American birds of prey. U.S. National Museum Bulletin 170.
75) Bent, A. C. 1939. Life histories of North American woodpeckers. U.S. National Museum Bulletin 174.
76) Bent, A. C. 1942. Life histories of North American flycatchers, larks, swallows, and their allies. U.S. National Museum Bulletin 179.
77) Bent, A. C. 1946. Life histories of North American jays, crows, and titmice. U.S. National Museum Bulletin 191.
78) Bent, A. C. 1948. Life histories of the North American nuthatches, wrens, thrashers and their allies. U.S. National Museum Bulletin 195.
79) Bent, A. C. 1950. Life histories of North American wagtails, shrikes, vireos, and their allies. U.S. National Museum Bulletin 197:411.
80) Bent, A. C. 1953. Life histories of North American wood warblers. U.S. National Museum Bulletin 203.
81) Bent, A. C. 1968. Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows, and allies. U.S. National Museum Bulletin 237.
82) Bessert, M. L. 2006. Molecular systematics and population structure in the North American endemic fish genus *Cycleptus* (Teleostei: Catostomidae). Dissertation, University of Nebraska, Lincoln, Nebraska, USA.
83) Best, T. L., and A. Gennaro. 1985. Food habits of the western whiptail lizard (*Cnemidophorus midophorus tigris*) in southeastern New Mexico. The Great Basin Naturalist 45(3):527-534.
84) Best, T. L., J. L. Bartig, and S. L. Burt. 1992. *Tamias canipes*. Mammalian Species 411:1-5.
85) Bestgen, K. R. 1985. Results of identification of collections of larval fish made in the upper Salt and Gila Rivers, Arizona. Report to the U.S. Department of the Interior, U.S. Fish and Wildlife Service, Office of Endangered Species, Albuquerque, New Mexico, USA.

86) Bestgen, K. R., and D. L. Propst. 1989. Distribution, status, and notes on the ecology of *Gila robusta* (Cyprinidae) in the Gila River drainage, New Mexico. Southwestern Naturalist 34:402-412.
87) Bestgen, K. R., and S. P. Platania. 1990. Extirpation of *Notropis simus simus* (Cope) and *Notropis orca Woolman* (Pisces: Cyprinidae) from the Rio Grande in New Mexico, with notes on their life history. Occasional Papers, The Museum of Southwestern Biology 6:1-8.
88) Bestgen, K. R., and S. P. Platania. 1991. Status and conservation of the Rio Grande silvery minnow, *Hybognathus amarus*. Southwestern Naturalist 36:225-232.
89) Bestgen, K. R., S. P. Platania, J. E. Brooks, and D. L. Propst. 1989. Dispersal and life history traits of *Notropis girardi* (Cypriniformes: Cyprinidae), introduced into the Pecos River, New Mexico. American Midland Naturalist 122:228-235.
90) Bestgen, K. R., R. Compton, and K. Zelasko. 2003. Distribution and status of Rio Grande chub in Colorado. Colorado State University, Larval Fish Laboratory Contribution 135, Fort Collins, Colorado, USA.
91) Bezzerides, N., and K. R. Bestgen. 2002. Status review of roundtail chub (*Gila robusta*), flannelmouth sucker (*Catostomus latipinnis*), and bluehead sucker (*Catostomus discobolus*) in the Colorado River basin. Colorado State University, Fort Collins, Colorado, USA.
92) Biermann, G. C., W. B. McGillivray, and K. E. Nordin. 1987. The effect of cowbird parasitism on Brewer's sparrow productivity in Alberta. Journal of Field Ornithology 58:350-354.
93) Black, C. 1997. Animas Foundation Gray Ranch bird list. Submitted to the Animas Foundation, Animas, New Mexico, USA.
94) Blake, J. G. 1982. Influence of fire and logging on nonbreeding bird communities of ponderosa pine forests. Journal of Wildlife Management 46:404-415.
95) Bock, C. E. 1970. The ecology and behavior of the Lewis woodpecker (*Asyndesmus lewis*). University of California Press, Berkeley, California, USA.
96) Bock, C. E., M. Raphael, and J. H. Bock. 1978. Changing avian community structure during early post-fire succession in the Sierra Nevada. Wilson Bulletin 90:119-123.
97) Bock, C. E., V. A. Saab, T. D. Rich, and D. S. Dobkin. 1992. Effects of livestock grazing on neotropical migratory landbirds in western North America. *In* Status and management of neotropical migratory birds. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, General Technical Report 296, Estes Park, Colorado, USA.
98) Bonter, D. N., and M. G. Harvey. 2008. Winter survey data reveal range-wide decline in evening grosbeak populations. The Condor 110(2):376-381.
99) Bouzat, J. L., and K. Johnson. 2004. Genetic structure among closely spaced leks in a peripheral population of lesser prairie-chickens. Molecular Ecology 13:499-505.
100) Bowers, R. K., Jr., and J. B. Dunning Jr. 2020. Buff-breasted flycatcher (*Empidonax fulvifrons*). *In* A. F. Poole and F. B. Gill, editors. Birds of the world, version 1.0. Cornell Lab of Ornithology, Ithaca, NY, USA. < https://doi.org/10.2173/bow.bubfly.01 >
101) Boyne, A. 2000. Draft update COSEWIC status report on piping plover (*Charadrius melodus*). Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario, CAN.

102) Braga, A. F., and C. L. Buck. 2021. Hibernation patterns in grey-collared chipmunks (*Neotamias cinereicollis*). The FASEB Journal Volume 35(1). <https://doi.org/10.1096/fasebj.2021.35.S1.03844>
103) Braun, C. E. 1994. Band-tailed pigeon. Chapter 5 *in* T. C. Tacha and C. E. Braun, editors. Migratory shore and upland game bird management in North America. International Association of Fish and Wildlife Agencies, Washington, D.C., USA.
104) Braun, C. E., M. F. Baker, R. L. Eng, J. S. Gashwiler, and M. H. Schroeder. 1976. Conservation committee report on effects of alteration of sagebrush communities on the associated avifauna. Wilson Bulletin 88:165-171.
105) Braun, C. E., and S. O. Williams. 2015. History and status of the white-tailed ptarmigan in New Mexico. Western Birds 46:233-243.
106) Braun, J. K., B. Yang, S. B. González-Pérez, and M. A. Mares. 2015. *Myotis yumanensis* (Chiroptera: Vespertilionidae). Mammalian Species 47(918):1-14.
107) Brennan, T. C., and A. T. Holycross. 2006. A field guide to amphibians and reptiles in Arizona. Arizona Game and Fish Department, Phoenix, Arizona, USA.
108) Brodhead, K., M. Stoleson, H. Scott, and D. M. Finch. 2007. Southwestern willow flycatchers (*Empidonax traillii extimus*). Pages 1213-1228 *in* A grazed landscape: factors influencing brood parasitism. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Albuquerque, New Mexico, USA.
109) Brooks, J. E. 1990. Bitter Lake National Wildlife Refuge fish list. Dexter National Fish Hatchery, Dexter, New Mexico, USA.
110) Brown, C. R., M. B. Brown, P. Pyle, and M. A. Patten. 2020a. Cliff swallow (*Petrochelidon pyrrhonota*). *In* P. G. Rodewald, editor. Birds of the world, version 1.0. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.cliswa.01>.
111) Brown, C. R., D.A. Airola, and S. Tarof. 2021. Purple martin (*Progne subis*). *In* P. G. Rodewald, editor. The birds of North America, version 2.0. Cornell Lab of Ornithology, Ithaca, New York, USA. < https://doi.org/10.2173/bow.purmar.02>
112) Brown, D. E. 1983. NOTES -- on the status of the jaguar in the southwest. The Southwestern Naturalist 28(4):459-479.
113) Brown, D. E., A. T. Smith, J. K. Frey, and B. R. Schweiger. 2020. A review of the ongoing decline of the white-tailed jackrabbit. Journal of Fish and Wildlife Management 11(1):341-352.
114) Brown, D. K., A. A. Echelle, D. L. Propst, J. E. Brooks, and W. L. Fisher. 2001. Catastrophic wildfire and number of populations as factors influencing risk of extinction for Gila trout (*Oncorhynchus gilae*). Western North American Naturalist 61(2):139-148.
115) Brown, D., M. Traphagen, C. Lorenzo, and M. Gomez-Sapiens. 2018. Distribution, status and conservation needs of the white-sided jackrabbit, *Lepus callotis* (Lagomorpha). Revista Mexicana de Biodiversidad 89:310-320.
116) Brown, L. N. 1967. Seasonal activity patterns and breeding of the western jumping mouse (*Zapus princeps*) in Wyoming. American Midland Naturalist 78(2):460-470.

117) Brown, P. E., and R. D. Berry. 2004. Foraging habitat and home range of Allen's big-eared bat (*Idionycteris phyllotis*) in the Arizona desert as determined by radio-telemetry. Bat Research News 45:207-208.
118) Brown, W. S., and W. S. Parker. 1976. Movement ecology of *Coluber constrictor* near communal hibernacula. Copeia 1976(2):225-242.
119) Brown, W. S., and W. S. Parker. 1982. Niche dimensions and resource partitioning in a Great Basin Desert snake community. *In* N. J. Scott Jr., editor. Herpetological communities. U.S. Geologic Survey, Western Ecological Research Center, Sacramento, California, USA.
120) Buchanan, T. M., and M. M. Stevenson. 2003. Distribution of bigscale logperch, *Percina macrolepida* (Percidae), in the Arkansas River basin. Southwestern Naturalist 48:454-460.
121) Bull, E. L., A. L. Wright, and M. G. Henjum. 1989. Nesting and diet of long-eared owls in conifer forests, Oregon. Condor 91:908-912.
122) Burbrink, F. T., H. Yao, M. Ingrasci, R. W. Bryson Jr., T. J. Guiher, and S. Ruane. 2011. Speciation at the Mogollon Rim in the Arizona mountain kingsnake (*Lampropeltis pyromelana*). Molecular Phylogenetics and Evolution 60:445-454.
123) Burger, J. 1984. Colony stability in least terns. Condor 86:61-67.
124) Burger, J. 1993. Shorebird squeeze. Natural History 5(93):8-14.
125) Burkett, D. 1996. Herpetofauna of White Sands Missile Range. U.S. Department of Defense, White Sands Missile Range, New Mexico, USA.
126) Burkholder, G., and J. Walker. 1973. Habitat and reproduction of the desert whiptail lizard, *Cnemidophorus tigris* (Baird and Girard) in southwestern Idaho at the northern part of its range. Herpetologica 29(1):76-83.
127) Burr, B. M., and R. L. Mayden. 1999. A new species of *Cycleptus* (Cypriniformes: Catostomidae) from Gulf slope drainages of Alabama, Mississippi, and Louisiana, with a review of the distribution, biology, and conservation status of the genus. Bulletin of the Alabama Museum of Natural History 20:19-57.
128) Burt D. M., G. J. Rolof, and D. R. Etter. 2017. Climate factors related to localized changes in snowshoe hare (*Lepus americanus*) occupancy. Canadian Journal of Zoology 95(1):15–22.
129) Bury R. B., D. J. Morafka, C. J. McCoy. 1988. Part I: distribution, abundance and status of the Bolson tortoise. American Carnegie Museum 57:5–30.
130) Busbee, E. L. 1977. The effects of dieldrin on the behavior of young loggerhead shrikes. Auk 94:28-35.
131) Busch, J. D., P. M. Waser, and J. A. DeWoody. 2007. Recent demographic bottlenecks are not accompanied by a genetic signature in banner-tailed kangaroo rats (*Dipodomys spectabilis*). Molecular Ecology 16(12):2450-2462.
132) Cadman, M. D. 1986. Status report on the loggerhead shrike *Lanius ludovicianus*. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario, CAN.
133) Calamusso, B., and J. N. Rinne. 1996. Distribution of Rio Grande cutthroat trout and its co-occurrence with the Rio Grande sucker and Rio Grande chub on the Carson and Santa Fe National Forests; desired future conditions for southwestern riparian ecosystems: bringing interests and concerns together. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, USA.

134) Calamusso, B., J. N. Rinne, and P. R. Turner. 2002. Distribution and abundance of the Rio Grande sucker in the Carson and Santa Fe National Forests, New Mexico. Southwestern Naturalist 47(2):182-186.
135) Calamusso, B., J. N. Rinne, and R. J. Edwards. 2005. Historic changes in the Rio Grande fish fauna: status, threats, and management of native species: proceedings of the American Fisheries Society symposium. American Fisheries Society, Bethesda, Maryland, USA.
136) Calder, W. A. 1973. The timing of maternal behavior of the broad-tailed hummingbird preceding nest failure. The Wilson Bulletin. 85(3):283-290.
137) Caldwell, J. M. 2013. Movements and distribution of gray redhorse and Rio Grande blue sucker in the Black River, New Mexico. Annual Performance Report to the U.S. Department of the Interior, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA.
138) Cameron, G. N., and P. A. McClure. 1988. Geographic variation in life history traits of the hispid cotton rat (*Sigmodon hispidus*). Pages 33-64 *in* M. S. Boyce, editor. Evolution of life histories of mammals: theory and pattern. Yale University Press, New Haven, Connecticut, USA.
139) Campbell, J. A., and W. W. Lamar. 1989. The venomous reptiles of Latin America. Cornell University Press, Comstock Publishing Associates, Ithaca, New York, USA.
140) Campbell, J. A., and W. W. Lamar. 2004. The venomous reptiles of the Western Hemisphere. 2 Volumes. Cornell University Press, Ithaca, New York, USA.
141) Campbell, J. B. 1970. Life history of *Bufo boreas boreas* in the Colorado front range. Dissertation, University of Colorado, Boulder, Colorado, USA.
142) Carey, M., D. E. Burhans, and D. A. Nelson. 2020. Field sparrow (*Spizella pusilla*). *In* A. Poole, editor. The birds of the world, version 2.0. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.fiespa.01>
143) Carman, S. M. 2006. Colorado River basin chubs: roundtail chub (*Gila robusta*), Gila chub (*Gila intermedia*), headwater chub (*Gila nigra*) recovery plan. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
144) Carman, S. M. 2010. White Sands pupfish status report 2009. New Mexico Department of Game and Fish, Conservation Services Division, Santa Fe, New Mexico, USA.
145) Carpenter, C. C. 1953. A study of hibernacula and hibernating associations of snakes and amphibians in Michigan. Ecology 34:74-80.
146) Carr, L. W., and L. Fahrig. 2001. Effect of road traffic on two amphibian species of differing vagility. Conservation Biology 15:1071-1078.
147) Carter, C. D., and J. N. Rinne. 2005. Short-term effects of the Picture Fire on fishes and aquatic habitat. Hydrology and Water Resources in Arizona and the Southwest 35:21-35.
148) Cashner, R. C., and W. J. Matthews. 1988. Changes in the known Oklahoma fish fauna from 1973 to 1988. Proceedings of the Oklahoma Academy of Science 68:1-7.
149) Cassidy, R., M. DeGray, S. McWilliams, M. Reidy, J. Sanchez, R. Skinner and D. Trujillo. 1996. Dome Fire assessment. U.S. Department of Agriculture, U.S. Forest Service, Santa Fe National Forest, Jemez Ranger District, Santa Fe, New Mexico, USA.
150) Castillo, J. A., C. W. Epps, A. R. Davis, and S. A. Cushman. 2014. Landscape effects on gene flow for a climate-sensitive montane species, the American pika. Molecular Ecology 23(4):843-856.

151) Castner, S. V., T. K. Snow and D. C. Noel. 1993. Bat inventory of the U.S. Army Yuma Proving Ground. Arizona Game and Fish Department, Nongame and Endangered Wildlife Program Technical Report, Phoenix, Arizona, USA.
152) Chafin, T. K., M. R. Douglas, M. R. Bangs, B. T. Martin, S. M. Mussmann, and M. E. Douglas. 2021. Taxonomic uncertainty and the anomaly zone: phylogenomics disentangle a rapid radiation to resolve contentious species (*Gila robusta* complex) in the Colorado River. Genome Biology and Evolution 13(9):1-19.
153) Chase, C. A., III, S. J. Bissell, H. E. Kingery, and W. D. Graul, editors. 1982. Colorado bird distribution lat/long study. Colorado Field Ornithology, Denver, Colorado, USA.
154) Cheek, C. A., and C. M. Taylor. 2015. Salinity and geomorphology drive long-term changes to local and regional fish assemblage attributes in the lower Pecos River, Texas. Ecology of Freshwater Fish 25(3):340-351.
155) Cheng, T. L., L. D. Reichard, J. T. Coleman, T. J. Weller, W. E. Thogmartin, B. E. Reichert, A. B. Bennett, H. G. Broders, J. Campbell, K. Etchison, and D. J. Feller. 2021. The scope and severity of white-nose syndrome on hibernating bats in North America. Conservation Biology 35(5):1586-1597.
156) Chernoff, B., R. R. Miller, and C. R. Gilbert. 1982. *Notropis orca* and *Notropis simus*, cyprinid fishes from the American southwest with description of a new subspecies. Occasional Papers, Museum of Zoology, University of Michigan 698:1-49.
157) Chesser, R. K. 1983. Cranial variation among populations of the black-tailed prairie dog in New Mexico. Occasional Papers, Museum at Texas Tech University 84:1-13.
158) Chesser, R. T., K. J. Burns, C. Cicero, J. L. Dunn, A. W. Kratter, I. J. Lovette, P. C. Rasmussen, J. V. Remsen Jr., J. D. Rising, D. F. Stotz, and K. Winker. 2016. Fifty-seventh supplement to the American Ornithologists' Union check-list of North American birds. The Auk 133:544-560.
159) Chesser, R. T., S. M. Billerman, K. J. Burns, C. Cicero, J. L. Dunn, B. E. Hernández-Baños, R. A. Jiménez, A. W. Kratter, N. A. Mason, P. C. Rasmussen, J. V. Remsen Jr., D. F. Stotz, and K. Winker, editors. 2022. Sixty-third supplement to the American Ornithological Society's check-list of North American birds. Ornithology 139:1-13.
160) Choate, L. L. 1990. Westward ho: continued dispersal of the pygmy mouse, *Baiomys taylori*, on the Llano Estacado and in adjacent areas of Texas. Occasional Papers, Museum of Texas Tech University 134:1-8.
161) Christiansen, J. L., and E. O. Moll. 1973. Latitudinal reproductive variation within a single subspecies of painted turtle, *Chrysemys picta bellii*. Herpetologica 29:152-163.
162) Christman, B. L. 2006. Chytrid fungus and *Bufo boreas* distribution investigation, Rio Arriba County. New Mexico Department of Game and Fish, Contract 06-516.0000.0030, Santa Fe, New Mexico, USA.
163) Christman, B. L. 2009. Investigation of the current distribution of the northern leopard frog (*Rana pipiens*) in New Mexico. Unpublished Report to New Mexico Game and Fish, Santa Fe, New Mexico, USA.
164) Christman, B. L., and L. K. Kamees. 2007. Current distribution of the blotched watersnake (*Nerodia erythrogaster transversa*) and Rio Grande cooter (*Pseudemys gorzugi*) in the lower

Pecos River system Eddy County, New Mexico 2006-2007. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

165) Christman, B. L., and R. D. Jennings. 2011. Pre-monsoonal and post monsoonal habitat use of the narrow-headed gartersnake. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.

166) Christman, B. L., R. D. Jennings, and T. J. Giermakowski. 2020. Status assessment of Arizona black rattlesnake (*Crotalus cerberus*) in New Mexico. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.

167) Christman, B. L., R. D. Jennings, and T. J. Giermakowski. 2021. Status assessment of Arizona black rattlesnake (*Crotalus cerberus*) in New Mexico. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.

168) Chung-MacCoubrey, A. 1995. Species composition and roost requirements of bats using water sources in piñon-juniper woodlands. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado, USA.

169) Chung-MacCoubrey, A. L. 2005. Use of piñon-juniper woodlands by bats in New Mexico. Forest Ecology and Management 204(2-3):209-220.

170) Cicero, C. 2000. Oak titmouse (*Baeolophus inornatus*) and juniper titmouse (*Baeolophus ridgwayi*). Page 28 *in* A. Poole and F. Gill, editors. The birds of North America 485. The Birds of North America, Inc., Philadelphia, Pennsylvania, USA.

171) Citron, J. L., and J. Frey. 2024. Wild carnivores of New Mexico. University of New Mexico Press, Albuquerque, New Mexico, USA.

172) Clark, J. P., and S. E. Hygnstrom. 1994. Horned larks: prevention and control of wildlife damage. University of Nebraska-Lincoln, Institute of Agriculture and Natural Resources, Lincoln, Nebraska, USA.

173) Clark, R. J. 1975. A field study of the short-eared owl, *Asio flammeus* (Pontoppidan), in North America. Wildlife Monographs 47:1-67.

174) Clark, R. W., W. S. Brown, R. Stechert, and K. R. Zamudio. 2008. Integrating individual behaviour and landscape genetics: the population structure of timber rattlesnake hibernacula. Molecular Ecology 17(3):719-730.

175) Clark, T. W. 1971. Ecology of the western jumping mouse in Grand Teton National Park, Wyoming. Northwest Science 45:229-238.

176) Clark, T. W. 1982. Prairie dog colony attributes and associated vertebrate species. Great Basin Naturalist 42(4):572-582.

177) Clark, T. W., T. M. Campbell III, D. G. Socha, and D. E. Casey. 1982. Prairie dog colony attributes and associated vertebrate species. The Great Basin Naturalist 42(4):572-582.

178) Clarkson, R. W., and W. L. Minckley. 1988. Morphology and foods of Arizona catostomid fishes: *Catostomus insignis*, *Pantosteus clarki*, and their putative hybrids. Copeia 1988:422-433.

179) Coates, S. E., B. W. Wright, and J. D. Carlisle. 2019. Long-billed curlew nest site selection and success in the intermountain west. The Journal of Wildlife Management 83(5):1197-1213.

180) Cole, C. J., C. W. Painter, H. C. Dessauer, and H. L. Taylor. 2007. Hybridization between the endangered unisexual gray-checkered whiptail lizard (*Aspidoscelis dixoni*) and the

bisexual western whiptail lizard (*Aspidoscelis tigris*) in southwestern New Mexico. American Museum Novitates 3555 (31):1-31.

181) Cole, F. R., and D. E. Wilson. 2006. *Leptonycteris yerbabuenae*. Mammalian Species 797:1-7.

182) Collins, J. T. 1974. Amphibians and reptiles in Kansas. University of Kansas, Museum of Natural History, Lawrence, Kansas, USA.

183) Collins, J. T. 1982. Amphibians and reptiles in Kansas. Second edition. University of Kansas, Museum of Natural History, Lawrence, Kansas, USA.

184) Collins, J. T., S. L. Collins, J. Horak, D. Mulhern, W. Busby, C. C. Freeman, and G. Wallace. 1995. An illustrated guide to Endangered or Threatened species in Kansas. University Press of Kansas, Wichita, Kansas, USA.

185) Conant, R. 1975. A field guide to reptiles and amphibians of eastern and central North America. Second edition. Houghton Mifflin Company, Boston, Massachusetts, USA.

186) Conaway, C. H. 1952. Life history of the water shrew (*Sorex palustris navigator*). American Midland Naturalist 48(1):219-248.

187) Converse, R. L, M. Baron-Deutsch, A. Gjuillin, and A. J. Rowe. 2014. Reproduction of reintroduced North American river otter (*Lontra canadensis*) confirmed in New Mexico. International Union for Conservation of Nature Otter Specialist Group Bulletin 31(1):35-39.

188) Cook, B. I., T. R. Ault, and J. E. Smerdon. 2015. Unprecedented 21st century drought risk in the American Southwest and Central Plains. Science Advances 1(1):e1400082.

189) Cook, F. R. 1964. Communal egg laying in the smooth green snake. Herpetologica 20(3):206.

190) Cook, J. A. 1986. The mammals of the Animas Mountains and adjacent areas, Hidalgo County, New Mexico. Occasional Papers, The Museum of Southwestern Biology 4:1-45.

191) Cope, E. D., and H. C. Yarrow. 1875. Report upon the collections of fishes made in portions of Nevada, Utah, California, Colorado, New Mexico, and Arizona, during 1871, 1872, 1873, and 1874. Report of the Geographic and Geologic Exploration Survey West of the 100th Meridian 5(6):637–700.

192) Corbett, R. J. M., C. L. Chambers, and M. J. Herder. 2008. Roosts and activity areas of *Nyctinomops macrotis* in northern Arizona. Acta Chiropterologica 10:323-329.

193) Cordes, J. E., and J. M. Walker. 2006. Evolutionary and systematic implications of skin histocompatibility among parthenogenetic teiid lizards: three color pattern classes of *Aspidoscelis dixoni* and one of *Aspidoscelis tesselata*. Copeia 1:14-26.

194) Cordova, L., and T. Rawlinson. 2015. Sacramento Mountain salamander (*Aneides hardii*) 2015 inventory and monitoring annual report. U.S. Department of Agriculture, U.S. Forest Service, Lincoln National Forest, Ruidoso, New Mexico, USA.

195) Cordova, S. J. N. 2017. Genetic approaches to population ecology and conservation of the Sacramento Mountain salamander. Thesis, University of New Mexico, Albuquerque, New Mexico, USA.

196) Corn, P. S. 1994. What we know and don't know about amphibian declines in the west. Pages 59-67 *in* W. W. Covington and L. F. DeBano, editors. Sustainable ecological systems: implementing an ecological approach to land management. U.S. Department of Agriculture,

U.S. Forest Service, Rocky Mountain Forest and Range Exploration Station, General Technical Report RM-247, Fort Collins, Colorado, USA.

197) Cornell Lab. 2024. All about birds: various species. Cornell Lab of Ornithology, Cornell University, Ithaca, New York, USA. <https://www.allaboutbirds.org/news/>.

198) Cosentino B., R. Schooley, B. Bestelmeyer, J. Kelly, and J. Coffman. 2014. Constraints and time lags for recovery of a keystone species (*Dipodomys spectabilis*) after landscape restoration. Landscape Ecology 29: 665–675.

199) Coulson, R. N., J. L. Tracy, G. Drus, T. Giermakowski, M. T. Tchakerian, and M. Johnson. 2016. Fire-smart southwestern riparian landscape management and restoration of native biodiversity in view of species of conservation concern and the impacts of tamarisk beetles: final report. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Desert Landscape Conservation Cooperative, Las Cruces, New Mexico, USA.

200) Cowardin, L. M., V. Carter, F. C. Golet, and E. T. Laroe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Washington, D.C., USA.

201) Cowley, D. E., and J. E. Sublette. 1987. Food habits of *Moxostoma congestum* (Baird and Girard) and *Cycleptus elongatus* (Lessueur) (Catostomidae: Cyprinformes) taken from Black River Eddy County, New Mexico. Southwestern Naturalist 32:411-13.

202) Cox, J. J., G. Wolf, and M. Springer. 2018. Food habits of a reintroduced river otter population in north-central New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

203) Cox, J. J., and S. M. Murphy. 2019. Demographic and genetic status of a reintroduced river otter population in North-central New Mexico. New Mexico Department of Game and Fish, Share with Wildlife Program, Agreement 171012, Santa Fe, New Mexico, USA.

204) Crabtree, C. B., and D. G. Buth. 1987. Biochemical systematics of the Catostomid genus *Catostomus*: assessment of *C. clarki*, *C. plebeius* and *C. discobolus* including the Zuni sucker, *C. d. yarrowi*. Copeia 1987(4):843–854.

205) Crockett, A. B., and H. H. Hadow. 1975. Nest site selection by Williamson and red-naped sapsuckers. The Condor 77(3):365-368.

206) Cross, F. B., and J. T. Collins. 1995. Fishes in Kansas. Second edition, revised. University of Kansas, Museum of Natural History, Lawrence, Kansas, USA.

207) Cross, F. B., R. E. Moss, and J. T. Collins. 1985. Assessment of dewatering impacts on stream fisheries in the Arkansas and Cimarron Rivers. University of Kansas, Museum of Natural History, Lawrence, Kansas, USA.

208) Crother, B. I., editor. 2008. Scientific and standard English names of amphibians and reptiles of North America north of Mexico, with comments regarding confidence in our understanding. Sixth edition. Society for the Study of Amphibians and Reptiles Herpetological Circular 37:1-84.

209) Cryan, P. M., and M. A. Bogan. 2003. Recurrence of Mexican long-tongued bats (*Choeronycteris mexicana*) at historical sites in Arizona and New Mexico. Western North American Naturalist 63(3):314-319.

210) Cudworth, N. L., and J. L. Koprowski. 2013. Foraging and reproductive behavior of Arizona gray squirrels (*Sciurus arizonensis*): impacts of climatic variation. Journal of Mammalogy 94(3):683-690.
211) Cudworth, N. L., and J. L. Koprowski. 2014. Survival and mortality of the Arizona gray squirrel (*Sciurus arizonensis*). The Southwestern Naturalist 59(3):423-426.
212) Cully, J. F., Jr., A. M. Barnes, T. J. Quan, and G. Maupin. 1997. Dynamics of plague in a Gunnison's prairie dog colony complex from New Mexico. Journal of Wildlife Diseases 33:706-719.
213) Cully, J. F., Jr., and E. S. Williams. 2001. Interspecific comparisons of sylvatic plague in prairie dogs. Journal of Mammalogy 82:894-905.
214) Cummer, M. R. 2005. The effect of wildfire on populations of the Jemez Mountains salamander with consideration to arthropod prey availability following the Cerro Grande fire of northern New Mexico. Thesis, Utah State University, Logan, Utah, USA.
215) Cummer, M. R., B. L. Christman, and M. A. Wright. 2003. Investigations of the status and distribution of amphibians and reptiles on the Valles Caldera National Preserve, Sandoval County, New Mexico 2002. Valles Caldera Trust, Los Alamos, New Mexico, USA.
216) Cummer, M. R., B. L. Christman, and M. A. Wright. 2004. Investigations of the status and distribution of amphibians and reptiles on the Valles Caldera National Preserve, Sandoval County, New Mexico 2003. Unpublished Report to the Valles Caldera Trust, Los Alamos, New Mexico, USA.
217) Cummer, M. R., and C. W. Painter. 2007. Three case studies of the effect of wildfire on the Jemez Mountains salamander (*Plethodon neomexicanus*): microhabitat temperatures, size distributions, and a historical locality perspective. The Southwestern Naturalist 52(1):26-37.
218) Cummer, M. R., D. E. Green, and E. M. O'Neill. 2005. Aquatic chytrid pathogen detected in terrestrial plethodontid salamander. Herpetological Review 36(3):248-249.
219) Custer, T. W., and F. A. Pitelka. 1977. Demographic features of a Lapland longspur population near Barrow, Alaska. The Auk 94(3):505-525.
220) Daily, G. C. 1993. Heartwood decay and vertical distribution of red-naped sapsucker nest cavities. Wilson Bulletin 105:674-679.
221) Dalquest, W. W., and L. J. Peters. 1966. A life history study of four problematic fish in Lake Diversion, Archer and Baylor Counties, Texas. Texas Parks and Wildlife Department, Austin, Texas, USA.
222) Darr, M., and C. Rustay. 2019. Grace's warbler (*Setophaga graciae*) species account. Pages 1-14 *in* C. Rustay, S. Norris, and M. Darr, editors. New Mexico bird conservation plan, version 2.2. New Mexico Avian Conservation Partners, Albuquerque, New Mexico, USA.
223) Davenport, S. R., and T. Archdeacon. 2008. Status of bigscale logperch (*Pericna macrolepida*) and greenthroat darter *(Etheostoma lepidum*) in New Mexico. New Mexico Department of Game and Fish, Share with Wildlife Program, Albuquerque, New Mexico, USA.
224) Davidson, A. D., M. T. Friggens, K. T. Shoemaker, C. L. Hayes, J. Erz, and R. Duran. 2014. Population dynamics of reintroduced Gunnison's prairie dogs in the southern portion of their range. The Journal of Wildlife Management 78(3):429-439.

225) Davis, M. A. 2008. Population dynamics of the New Mexico ridge-nosed rattlesnake (*Crotalus willardi obscurus*) in the Madrean Archipelago: a threatened species in a changing ecosystem. Thesis, Colorado State University, Fort Collins, Colorado, USA.
226) Davis, M. A., M. R. Douglas, C. T. Webb, M. L. Collyer, A. T. Holycross, C. W. Painter, L. K. Kamees, and M. E. Douglas. 2015. Nowhere to go but up: impacts of climate change on demographics of a short-range endemic (*Crotalus willardi obscurus*) in the sky-islands of southwestern North America. PLoS One 10(6):e0131067.
227) Davis, W. B., and D. J. Schmidly. 1994. The mammals of Texas. Texas Parks and Wildlife Press, Austin, Texas, USA.
228) Davis, W. H., and P. J. Kalisz. 1992. Burrow systems of the prairie vole, *Microtus ochrogaster*, in central Kentucky. Journal of Mammalogy 73(3):582-585.
229) Dawson, J. W., and R. W. Mannan. 1991. Dominance hierarchies and helper contributions in Harris' hawks. Auk 108:649-660.
230) Deacon, J. E., and J. E. Williams. 1984. Annotated list of the fishes of Nevada. Proceedings of the Biological Society of Washington 97(1):103-118.
231) Defenders of Wildlife. 2022. Petition to list the pinyon jay (*Gymnorhinus cyanocephalus*) as Endangered or Threatened under the Endangered Species Act. Submitted to the U.S. Department of the Interior, U.S. Fish and Wildlife Service. Washington, D.C., USA.
232) Degenhardt, W. G. 1974. Distribution, reproduction, and ecology of the two New Mexican plethodontids: the Jemez Mountains salamander, *Plethodon neomexicanus*, and the Sacramento Mountain salamander, *Aneides hardyi*. U.S. Department of Agriculture, U.S. Forest Service, Western Interstate Commission for Higher Education, Santa Fe, New Mexico, USA.
233) Degenhardt, W. G., and J. Christiansen. 1974. Distribution and habitats of turtles in New Mexico. The Southwestern Naturalist 19(1):21-46.
234) Degenhart, W. G., and K. L. Jones. 1972. A new *Sceloporus graciosus* from New Mexico and Texas. Herpetologica 28:212-217.
235) Degenhardt W. G., C. W. Painter, and A. H. Price. 1996. Amphibians and reptiles of New Mexico. University of New Mexico Press, Albuquerque, New Mexico, USA.
236) DeGraaf, R. M., V. E. Scott, R. H. Hamre, L. Ernst, and S. H. Anderson. 1991. Forest and rangeland birds of the United States. U.S. Department of Agriculture Handbook, Amherst, Massachusetts, USA.
237) Desmond, M. J., and C. B. Sutton. 2017. Breeding habitat requirements and territory size of Bendire's thrasher (*Toxostoma bendirei*). New Mexico State University, Department of Fish, Wildlife, and Conservation Ecology, Las Cruces, New Mexico, USA.
238) Desmond, M., and S. Agudelo. 2005. Influence of landscape and within-patch characteristics on avian community dynamics in Chihuahuan Desert grasslands. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.
239) Dibble K. L., C. B. Yackulic, K. R. Bestgen, K. Gido, M. T. Jones, M. C. McKinstry, D. B. Osmundson, D. Ryden, and R. C. Schelly. 2023. Assessment of potential recovery viability for Colorado pikeminnow *Ptychocheilus lucius* in the Colorado River in Grand Canyon. Journal of Fish and Wildlife Management 14(1):239–268.

240) Dick-Peddie, W. A. 1993. New Mexico vegetation, past, present and future. University of New Mexico Press, Albuquerque, New Mexico, USA.
241) Dickson, J. G. 1981. Effects of forest burning on songbirds. Pages 67-72 *in* G. W. Wood, editor. Prescribed fire and wildlife in southern forests. Belle W. Baruch Forest Science Institute of Clemson University, Georgetown, South Carolina, USA.
242) Dixon, J. R. 1967. Aspects of the biology of the lizards of the White Sands, New Mexico. Los Angeles County Museum of Natural History Contributions in Science 129:1-22.
243) Dobbs, R. C, P. R. Martin, and T. E. Martin. 2020. Green-tailed towhee (*Pipilo chlorurus*). *In* A. Poole editor. Birds of the world, version 1.0. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.gnttow.01>
244) Douglas, M. R., M. A. Davis, M. Amarello, J. J. Smith, G. W. Schuett, H. W. Herrmann, A. T. Holycross, and M. E. Douglas. 2016. Anthropogenic impacts drive niche and conservation metrics of a cryptic rattlesnake on the Colorado Plateau of western North America. Royal Society Open Science 3(4):160047.
245) Downhower, J. F., and E. R. Hall. 1966. The pocket gopher in Kansas. University of Kansas, Museum of Natural History 44:1-32.
246) Downhower, J. F., L. Brown, R. Pederson, and G. Staples. 1983. Sexual selection and sexual dimorphism in mottled sculpins. Evolution 37(1):96-103.
247) Dronkert-Egnew, A. E. 1991. River otter population status and habitat use in northwestern Montana. Thesis, University of Montana, Missoula, Montana, USA.
248) Drost, C. A., J. E. Lovich, P. C. Rosen, M. Malone, and S. D. Garber. 2021. Non-native pond sliders cause long-term decline of native Sonora mud turtles: a 33-year before-after study in an undisturbed natural environment. Aquatic Invasions 16(3):542-570.
249) DuBois, A. D. 1935. Nests of horned larks and longspurs on a Montana prairie. Condor 37:56-72.
250) Dudley, R. K., and S. P. Platania. 2007. Flow regulation and fragmentation imperil pelagic-spawning riverine fishes. Ecological Applications 17(7):2017-2086.
251) Dunn, J. L., and K. L. Garrett. 1997. A field guide to warblers of North America. Houghton Mifflin Company, Boston, Massachusetts, USA.
252) Dunn, J. P., J. A. Chapman, and R. E. Marsh. 1982. Jackrabbits: *Lepus californicus* and allies. Pages 146-163 *in* J.A. Chapman and G. A. Feldhamer. editors. Wild mammals of North America: biology, management, and economics. The Johns Hopkins University Press. Baltimore, Maryland, USA.
253) Dwyer, J. F., and J. C. Bednarz. 2020. Harris's hawk (*Parabuteo unicinctus*). *In* Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, editors. Birds of the world, version 1.0. S. M. Cornell Lab of Ornithology, Ithaca, New York, USA. < https://doi.org/10.2173/bow.hrshaw.01>
254) Dwyer, J. F., J. C. Bednarz, and R.J. Raitt. 2020. Chihuahuan Raven (*Corvus cryptoleucus*). *In* A. Poole, editor. The birds of North America online. Cornell Lab of Ornithology, Ithaca, New York, USA. < https://doi.org/10.2173/bow.chirav.01>
255) Echelle, A. A., and A. F. Echelle. 1980. Status of the Pecos gambusia, *Gambusia nobilis*. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Endangered Species Report 10:1-73.

256) Echelle, A. F., A. A. Echelle, and D. R. Edds. 1989. Conservation genetics of a spring-dwelling desert fish, the Pecos gambusia (*Gambusia nobilis*, Poeciliidae). Conservation Biology 3(2):159-169.
257) Edwards, R. J., G. P. Garrett, and E. Marsh-Matthews. 2002. Conservation and status of the fish communities inhabiting the Conchos basin and middle Rio Grande, Mexico and USA. Reviews in Fish Biology and Fisheries 12:119-132.
258) Edwards, R. J., G. P. Garrett, and E. Marsh-Matthews. 2003. Fish assemblages of the Río Conchos basin, México, with emphasis on their conservation and status. Pages 75-89 *in* G. P. Garrett and N. L. Allan, editors. Aquatic fauna of the northern Chihuahuan Desert. Contributed Papers from a Special Session within the Thirty-Third Annual Symposium of the Desert Fishes Council. Museum of Texas Tech University, Special Publications 46, Lubbock, Texas, USA.
259) Ehrlich, P., and G. C. Daily. 1988. Red-naped sapsuckers feeding at willows: possible keystone herbivores. American Birds 42(3):357-365.
260) Ehrlich, P. R., D. S. Dobkin, and D. Wheye. 1988. The birder's handbook, a field guide to the natural history of North American birds. Simon and Schuster, Inc., New York, New York, USA.
261) Eifler, D. A., and M. A. Eifler. 1998. Foraging behavior and spacing patterns of the lizard *Cnemidophorus uniparens*. Journal of Herpetology 32:24-33.
262) Eisenhour, D. J. 1999. Systematics of *Macryhbopsis tetranema* (Cypriniformes: Cyprinidae). Copeia 1999(4):969-980.
263) Eisler, R. 1991. Cyanide hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish and Wildlife Service. Biological Report 85(1.23):1-55.
264) Eisler, R. 1998. Nickel hazards to fish, wildlife, and invertebrates: a synoptic review. Biological Science Report. ontaminant hazard reviews 34. U.S. Department of the Interior, U.S. Geological Survey, Patuxent Wildlife Research Center, Laurel, Maryland, USA.
265) Elmore, L. W., D. A. Miller, and F. J. Vilella. 2004. Selection of diurnal roosts by red bats (*Lasiurus borealis*) in an intensively managed pine forest in Mississippi. Forest Ecology and Management 199:11-20.
266) Enquist, C., and D. Gori. 2008. A climate change vulnerability assessment for biodiversity in New Mexico, part I: implications of recent climate change on conservation priorities in New Mexico. The Nature Conservancy, Santa Fe, New Mexico, USA.
267) Envirological Services. 2016. Population size estimation of breeding red-faced and Grace's warblers in pine woodlands of New Mexico: 2015 report. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.
268) Envirological Services. 2018. Population size estimation of breeding red-faced and Grace's warblers in pine woodlands of New Mexico: 2017 report. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, NM, USA.
269) Ernst, C. H. 1992. Venomous reptiles of North America. Smithsonian Institution Press, Washington, D.C., USA.
270) Ernst, C. H., and E. M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, D.C., USA.

271) Ernst. C. H., and J. E. Lovich. 2009. Turtles of the United States and Canada. Second edition. Johns Hopkins University Press, Baltimore, Maryland, USA.
272) Ernst, C. H., and R. W. Barbour. 1972. Turtles of the United States. University Press of Kentucky, Lexington, Kentucky, USA.
273) Eshelman, B. D., and G. N. Cameron. 1987. *Baiomys taylori*. Mammalian Species 285:1-7.
274) Evans, K. E., and R. N. Conner. 1979. Snag management. Pages 214-225 *in* Management of north central and northeastern forests for nongame birds. U.S. Department of Agriculture, U.S. Forest Service, General Technical Report NC-51, Madison, Wisconsin, USA.
275) Fagan, W. F., P. J. Unmack, C. Burgess, and W. L. Minckley. 2002. Rarity, fragmentation, and extinction risk in desert fishes. Ecology 83(12):3250–3256.
276) Fagerstone, K. A. 1987. Black-footed ferret, long-tailed weasel, short-tailed weasel, and least weasel. Pages 549-573 *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Malloch, editors. Wild furbearer management and conservation in North America. Toronto, Ontario, CAN.
277) [FEIS] Fire Effects Information System. 1996. Prescribed fire and fire effects research. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado, USA.
278) Fellows, S. D., and S. L. Jones. 2009. Status assessment and conservation action plan for the long-billed curlew (*Numenius americanus*). U.S. Department of the Interior, U.S. Fish and Wildlife Service, Biological Technical Publication, Washington, D.C., USA.
279) Ferguson, G. W., W. H. Gehrmann, A. M. Brinker, and G. C. Kroh. 2014. Daily and seasonal patterns of natural ultraviolet light exposure of the western sagebrush lizard (*Sceloporus gracious gracilis*) and the dunes sagebrush lizard (*Sceloporus arenicolus*). Herpetologica 70(1):56-68.
280) Fernandez, P. J., and P. C. Rosen. 1996. Effects of the introduced crayfish *Orconectes virilis* on native aquatic herpetofauna in Arizona: final report. Arizona Game and Fish Department, Phoenix, Arizona, USA.
281) Ferreira, M. S., T. J. Thurman, M. R. Jones, L. Farelo, A. V. Kumar, S. M. E. Mortimer, J. R. Demboski, S. L. Mills, P. C. Alves, J. Melo-Ferreira, and J. M. Good. 2023. The evolution of white-tailed jackrabbit camouflage in response to past and future seasonal climates. Science 379(6638):1238-1242.
282) Fetz, T. 2008. Annual report for bird and vegetation community relationships in the middle Rio Grande bosque study. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
283) Finch, D. M. 1983. Brood parasitism of the Abert's towhee: timing, frequency, and effects. Condor 85:355-359.
284) Finch, D. M. 1992. Threatened, Endangered, and vulnerable species of terrestrial vertebrates in the Rocky Mountain region. U.S. Department of Agriculture, U.S. Forest Service, General Technical Report RM-215, Lakewood, Colorado, USA.
285) Findley, J. S. 1987. The natural history of New Mexican mammals. University of New Mexico Press, New Mexico Natural History Series, Alburquerque, New Mexico, USA.

286) Findley, J. S., A. H. Harris, D. E. Wilson, and C. Jones. 1975. Mammals of New Mexico. University of New Mexico Press, Albuquerque, New Mexico, USA.
287) Fischer, D. H., and E. G. Bolen. 1981. Nestling diets of red-winged and yellow-headed blackbirds on playa lakes of west Texas. Prairie Naturalist 13:81-84
288) Fischer, S. 2020. Post-fledging and migration ecology of gray vireos (*Vireo vicinior*) and using ArtScience to explore gender and identity. Thesis, University of Toledo, Toledo, Ohio, USA.
289) Fisher, J. T., and L. Wilkinson. 2005. The response of mammals to forest fire and timber harvest in the North American boreal forest. Mammal Review 35(1):51-81.
290) Fitch, H. S. 1954. Life history and ecology of the five- lined skink (*Eumeces fasciatus*). University of Kansas, Museum of Natural History 8:1-156.
291) Fitch, H. S. 1955. Habits and adaptations of the Great Plains skink (*Eumeces obsoletus*). Ecological Monographs 25(1):59-83.
292) Fitzgerald, J. P., C. A. Meaney, and D. M. Armstrong. 1994. Mammals of Colorado. Denver Museum of Natural History, Denver, Colorado, USA and University Press of Colorado, Boulder, Colorado, USA.
293) Fitzgerald, L. A., and C. W. Painter. 2004. Dispersal of sand dune lizards (*Sceloporus arenicolus*) in the mescalero sands ecosystem. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
294) Flood, N. J., Schlueter, C. L., Reudink, M. W., P. Pyle, M. A. Patten, J. D. Rising and P. L. Williams. 2020. Bullock's oriole (*Icterus bullockii*). *In* P. G. Rodewald, editor. Birds of the world, version 1.0. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.bulori.01>
295) Forstner, M. R. J., J. R. Dixon, T. M. Guerra, J. M. Winters, J. N. Stuart, and S. K. Davis. 2014. Status of U.S. populations of the Big Bend slider (*Trachemys gaigeae*). Pages 335-367 *in* C. A. Hoyt and J. Karges, editors. Proceedings of the sixth symposium on the natural resources of the Chihuahuan Desert region. Chihuahuan Desert Research Institute, Fort Davis, Texas, USA.
296) Fowler, J. A. 1966. A communal nesting site for the smooth green snake in Michigan. Herpetologica 22(3):231.
297) Francis, C., C. Ortega, and A. Cruz. 2005. Noise pollution changes avian communities and species interactions. Current Biology 19(16):1415–1419.
298) Frankham, R., C. J. Bradshaw, and B. W. Brook. 2014. Genetics in conservation management: revised recommendations for the 50/500 rules, Red List criteria and population viability analyses. Biological Conservation 170:56-63.
299) Franks, S., D. B. Lank, and W. H. Wilson. 2014. Western sandpiper (*Calidris mauri*). *In* A. Poole, editor. The birds of North America online. Cornell Laboratory of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.wessan.01>
300) Franzreb, K. E. 1976. Nest site competition between mountain chickadees and violet-green swallows. Auk 93: 836-837.
301) Franzreb, K. E. 1977. Bird population changes after timber harvesting of a mixed conifer forest in Arizona. U.S. Department of Agriculture,U.S. Forest Service, Rocky Mountain

Forest and Range Experiment Station, Research Paper RM-184, Fort Collins, Colorado, USA.

302) Frase, B. A., and R. S. Hoffmann. 1980. *Marmota flaviventris*. Mammalian Species 135:1-8.

303) Frei, B., K. G. Smith, J. H. Withgott, P. G. Rodewald, P. Pyle, and M. A. Patten. 2020. Red-headed woodpecker (*Melanerpes erythrocephalus*), *In* A. Poole, editor. Birds of the world. Cornell Laboratory of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.rehwoo.01>

304) Frey, J. K. 1995a. Personal communication. University of New Mexico, Department of Biology, Mammalogist, Albuquerque, New Mexico, USA.

305) Frey, J. K. 1995b. Mammals of the Negrito Creek watershed, Gila National Forest, Reserve Ranger District, Catron County, New Mexico. U.S. Department of Agriculture, U.S. Forest Service, Silver City, New Mexico, USA.

306) Frey, J. K. 1998. Natural history characteristics of focal species for the sky island/greater Gila reserve design. Sky Island Alliance, Albuquerque, New Mexico, USA.

307) Frey, J. K. 2004. Taxonomy and distribution of the mammals of New Mexico: an annotated checklist. Museum of Texas Tech University, Lubbock, Texas, USA.

308) Frey, J. K. 2005. Status assessment of montane populations of the New Mexico meadow jumping mouse (*Zapus hudsonius luteus*) in New Mexico. New Mexico State University, Las Cruces, New Mexico, USA.

309) Frey, J. K. 2006. Status of the New Mexico meadow jumping mouse (*Zapus hudsonius luteus*) in the Sangre de Cristo Mountains, New Mexico. Southwest Ecosystem Consultants, Radium Springs, New Mexico, USA.

310) Frey, J. K. 2008. Morphology and genetics of the New Mexico jumping mouse. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.

311) Frey, J. K. 2010. Review of the western heather vole (*Phenacomys intermedius*) at its southern range limits, New Mexico. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.

312) Frey, J. K. 2021. Status and limiting factors for the Arizona montane vole in New Mexico. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA

313) Frey, J. K., and D. Kopp. 2013. Habitat suitability for the Organ Mountains chipmunk. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.

314) Frey, J. K., E. A. Beever, C. D. Hathcock, R. R. Parmenter, and M. L. Westover. 2019. Discovery of the yellow-bellied marmot (*Marmota flaviventris*) in the Jemez Mountains, New Mexico: examining competing hypotheses for range extension. Western North American Naturalist 79(3):285-294.

315) Frey, J. K., and F. McKibben. 2018. Distribution, abundance, and habitat selection by the Peñasco least chipmunk (*Neotamias minimus atristriatus*). New Mexico Department of Game and Fish, Share with Wildlife Program, Agreement 1710122, Santa Fe, New Mexico, USA.

316) Frey, J. K., J. C. Lewis, R. K. Guy, and J. N. Stuart. 2013. Use of anecdotal occurrence data in species distribution models: an example based on the white-nosed coati (*Nasua narica*) in the American southwest. Animals 3(2):327-348.
317) Frey, J. K., and J. L. Malaney. 2006. Snowshoe hare (*Lepus americanus*) and mountain cottontail (*Sylvilagus nuttallii*) biogeography at their southern range limit. Journal of Mammalogy 87(6):1175-1182.
318) Frey, J. K., and K. Boykin. 2007. Status assessment of the Peñasco least chipmunk (*Tamias minimus atristriatus*). New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
319) Frey, J. K., M. T. Hill, B. R. Christman, J. C. Truett, and S. O. MacDonald. 2008. Distribution and habitat of the Arizona gray squirrel (*Sciurus arizonensis*) in New Mexico. The Southwestern Naturalist 53(2):248-255.
320) Frey, J. K., and M. T. Calkins. 2010. Status of the ermine (*Mustela erminea*) at its southern range limits, New Mexico. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.
321) Frey, J. K., and M. T. Calkins. 2014. Snow cover and riparian habitat determine the distribution of the short-tailed weasel (*Mustela erminea*) at its southern range limits in arid western North America. Mammalia 78(1):45-56.
322) Frey, J. K., and M. T. Calkins. 2020. Habitat use of the Rocky Mountain water shrew in the White Mountains, Arizona. Journal of Fish and Wildlife Management 11(1):196–209.
323) Frey, J. K., and Q. Hays. 2017. Surveys for the Peñasco least chipmunk (*Tamias minimus atristriatus*) 2016. New Mexico Department of Game and Fish, Share with Wildlife Program, Contract 16-516.0000.00031, Santa Fe, New Mexico, USA.
324) Frey, J. K., and T. L. Yates. 1996. Mammalian diversity in New Mexico. New Mexico Journal of Science 36:4-37.
325) Friedmann, H. 1963. Host relations of the parasitic cowbirds. U.S. National Museum Bulletin 223.
326) Friggens, M. 2015. State Wildlife Action Plan climate change chapter. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Albuquerque, New Mexico, USA.
327) Friggens, M. M., D. M. Finch, K. E. Bagne, S. J. Coe, and D. L. Hawksworth. 2013. Vulnerability of species to climate change in the southwest: terrestrial species in the middle Rio Grande. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, General Technical Report RMRS-GTR-306, Fort Collins, Colorado, USA.
328) Friggens, M., and P. Martin. 2006. Re-establishment of Gunnison's prairie dogs to the Sevilleta National Wildlife Refuge: final report. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
329) Fritts, T. H., R. D. Jennings, and N. Scott Jr. 1984. A review of the leopard frogs of New Mexico. Denver Wildlife Research Center, University of New Mexico, Albuquerque, New Mexico, USA and New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
330) Fujita, M. S., and T. H. Kunz. 1984. *Pipistrellus subflavus*. Mammalian Species 228:1-6.

331) Fuller, P. L., L. G. Nico, and J. D. Williams. 1999. Nonindigenous fishes introduced to inland waters of the United States. American Fisheries Society, Special Publication 27, Bethesda, Maryland, USA.
332) Funk J., C. Barnett-Loro, M. Rising, and J. Dyette. 2016. Confronting climate change in New Mexico. Union of Concerned Scientists, Cambridge, Massachusetts, USA.
333) Garrett, J. M., and D. G. Barker. 1987. A field guide to reptiles and amphibians of Texas. Texas Monthly Press, Austin, Texas, USA.
334) Garrett, G. P., and G. C. Matlock. 1991. Rio Grande cutthroat trout in Texas. Texas Journal of Science 43:405–410.
335) [GBBO] Great Basin Bird Observatory. 2010. Nevada comprehensive bird conservation plan, version 1.0. Great Basin Bird Observatory, Reno, Nevada, USA.
336) [GBIF] Global Biodiversity Information Facility. 2021. GBIF data accessed through GeoCAT portal. <http://geocat.kew.org/>.
337) Geluso, K. 2000. Distribution of the spotted bat (*Euderma maculatum*) in Nevada, including notes on reproduction. Southwestern Naturalist 45:347-352.
338) Geluso, K. 2006. Recurrence of the spotted bat and Allen's big eared bat in New Mexico. New Mexico Department of Game and Fish, Share with Wildlife Program, Contract 06-516.0000.0031, Santa Fe, New Mexico, USA.
339) Geluso, K. 2009. Records of the yellow-nosed cotton rat (*Sigmodon ochrognathus*) in southwestern New Mexico. Western North American Naturalist 69(4):548–550.
340) Geluso, K. 2016. Mammals of the active floodplains and surrounding areas along the Gila and Mimbres Rivers, New Mexico. New Mexico Department of Game and Fish, Share with Wildlife Program, Contract 51600-0000047622, Santa Fe, New Mexico, USA.
341) Geluso, K. N., and K. N. Geluso. 2020. New distributional records and observations of natural history for the yellow-nosed cotton rat (*Sigmodon ochrognathus*) in southwestern New Mexico. Occasional Papers, Museum of Texas Tech University 362:1-21.
342) Geluso, K., K. N. Geluso, and B. R. Andersen. 2017. Distribution of the northern pygmy mouse (*Baiomys taylori*) in southwestern New Mexico, with notes on reproduction. Occasional Papers, Museum of Texas Tech University 349:1-9.
343) Geluso, K, N, T. R. Mollhagen, J. M. Tigner, and M. A. Bogan. 2005. Westward expansion of the eastern pipistrelle (*Pipistrellus subflavus*) in the United States, including new records from New Mexico, South Dakota, and Texas. Western North American Naturalist 65(3):405-409.
344) Gennard, A. L. 1972. Home range and movements of *Holbrookia maculata maculata* in eastern New Mexico. Herpetologica 28(2):165-168.
345) Gennard, A. L. 1974. Growth, size, and age at sexual maturity of the lesser earless lizard, *Holbrookia maculata maculata*, in eastern New Mexico. Herpetologica 30(1):85–90.
346) Gergus, E. W. A., T. W. Reeder, and B. K. Sullivan. 2004. Geographic variation in *Hyla wrightorum*: advertisement calls, allozymes, mtDNA, and morphology. Copeia 2004:758-769.
347) Getz, L. L. 1997. Natal philopatry in the prairie vole, *Microtus ochrogaster*, in a low food habitat. American Midland Naturalist 138:412-413.

348) Getz, L. L., B. McGuire, T. Pizzuto, J. E. Hofmann, and B. Frase. 1993. Social organization of the prairie vole (*Microtus ochrogaster*). Journal of Mammalogy 74(1):44-58.
349) Gibbons, D., C. Morrissey, and P. Mineau. 2015. A review of the direct and indirect effects of neonicotinoids and fipronil on vertebrate wildlife. Environmental Science and Pollution Research 22:103-118.
350) Gibson, P. P., J. D. Olden, and M. W. O'Neill. 2015. Beaver dams shift desert fish assemblages toward dominance by non-native species (Verde River, Arizona, USA). Ecology of Freshwater Fish 24(3):355-372.
351) Giesen, K. M. 1998. Lesser prairie-chicken (*Typanuchus pallidicinctus*). Page 20 *in* A. Poole and F. Gill, editors. The birds of North America 364. The Birds of North America, Inc., Philadelphia, Pennsylvania, USA.
352) Gilbert, E. I., and S. M. Carman. 2011. Zuni bluehead sucker monitoring and conservation efforts, 2010. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
353) Gillihan, S. W. 2006. Sharing the land with piñon-juniper birds. Partners in Flight Western Working Group, Salt Lake City, Utah, USA.
354) Gillis, E. A., and V. O. Nams. 1998. How red-backed voles find habitat patches. Canadian Journal of Zoology 76:791-794.
355) Gillis, J. E. 1975. Characterization of a hybridizing complex of leopard frogs. Dissertation, Colorado State University, Fort Collins, Colorado, USA.
356) Glenn, W. 1996. Eyes of fire, encounter with a borderlands jaguar. Printer Corner Press, El Paso, Texas, USA.
357) Goldberg, S. R. 2003. *Thamnophis rufipunctatus* (narrow-headed garter snake) reproduction. Herpetological Review 34:158.
358) Goldberg, S. R., C. R. Bursey, and R. L. Bezy. 1995. Helminths of isolated montane populations of Yarrow's spiny lizard, *Sceloporus jarrovii* (Phrynosomatidae). The Southwestern Naturalist 40(3):330-333.
359) Goode, M. J. 1994. Microhabitat destruction caused by unethical collectors: potential effects on reptile abundance. *In* Proceedings of the Arizona/New Mexico chapters of The Wildlife Society. The Wildlife Society, Albuquerque, New Mexico, USA.
360) Grace, J., F. Berninger, and L. Nagy. 2002. Impacts of climate change on the tree line. Annals of Botany 90:537–544.
361) Graces, W. C. 1980. Annual oak mast yields from visual estimates. *In* Proceeding of the symposium on the ecology management and utilization of California oaks. U.S. Department of Agriculture, U.S. Forest Service, Pacific Southwest Forest and Range Experiment Station, General Technical Report PSW-44, Berkley, California, USA.
362) Grady, J. M., and R. C. Cashner. 1988. Evidence of extensive intergeneric hybridization among the cyprinid fauna of Clark Creek, Wilkinson County, Mississippi. Southwestern Naturalist 33:137-146.
363) Graeter, G. J., K. A. Buhlman, L. R. Wilkinson, and J. W. Gibbons, editors. 2013. Inventory and monitoring: recommended techniques for reptiles and amphibians. Partners in Amphibian and Reptile Conservation Technical Publication IM-1, Birmingham, Alabama, USA.

364) Grageda García, M. A., and H. D. García Miranda. 2018. Current situation of the Sonoyta mud turtle (*Kinosternon sonoriense longifemorale*) population at Agua Dulce RAMSAR site in El Pinacate Biosphere Reserve, Sonora, Mexico. Reserva de la Biosfera El Pinacate y Gran Desierto de Altar, Sonora, MEX.
365) Gray, R. H. 1983. Seasonal, annual and geographic variation in color morph frequencies of the cricket frog, *Acris crepitans*, in Illinois. Copeia 1983(2):300-311.
366) Green, M. T., P. E. Lowther, S. L. Jones, S. K. Davis and B. C. Dale. 2020. Baird's sparrow (*Ammodramus bairdii*). *In* A. Poole, editor. Birds of the world. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.baispa.01>
367) Griffth, J. S., and T. R. Tiersch. 1989. Ecology of fishes in Redfield Canyon, Arizona, with emphasis on *Gila robusta intermedia*. The Southwestern Naturalist 34:131-134.
368) Grubb, T. G. 1995. Food habits of bald eagles breeding in the Arizona desert. Wilson Bulletin 107(2):258-274.
369) Grubb, T. G., J. L. Ganey, and S. E. Masek. 1994. An assessment of canopy cover at Mexican spotted owl nest sites. The Wildlife Society First Annual Conference Abstracts. The Wildlife Society, Albuquerque, New Mexico, USA.
370) Guralnick, R. 2007. Differential effects of past climate warming on mountain and flatland species distributions: a multispecies North American mammal assessment. Global Ecology and Biogeography 16(1):14-23.
371) Gutierrez, R. J., A. B. Franklin, and W. S. Lahaye. 2020. Spotted owl. *In* A. Poole and F. Gill, editors. Birds of the world. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.spoowl.01>
372) Gyug, L. W., R. C. Dobbs, T. E. Martin, and C. J. Conway 2023. Williamson's sapsucker (*Sphyrapicus thyroideus*), version 2.0. *In* M. Billerman and B. K. Keeney, editors. Birds of the world, version 2.0. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.wilsap.02>
373) Haddon, P. C., and R. C. Knight. 1983. A guide to little tern conservation. Royal Society for the Protection of Birds, Sandy, GBR.
374) Hafner, D. J. 1998a. Personal communication. New Mexico Museum of Natural History, Science Division, Chairman, Albuquerque, New Mexico, USA.
375) Hafner, D. J. 1998b. *Geomys arenarius*. Pages 60-61 *In* D. Hafner, E. Yensen, and G.L. Kirkland Jr., editors. North American rodents: status survey and conservation action plan. Volume 2. International Union for Conservation of Nature, Gland, CH.
376) Hagen, C. A. 2003. A demographic analysis of lesser prairie-chicken populations in southwestern Kansas: survival, population viability, and habitat use. Dissertation, Kansas State University, Manhattan, Kansas, USA.
377) Hakkila, M. 1994. An assessment of potential habitat and distribution of the gray-banded kingsnake (*Lampropeltis alterna*) in New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
378) Hall, E. R. 1981. The mammals of North America. Second edition. John Wiley and Sons, New York, New York, USA.
379) Hall, R. J. 1980. Effects of environmental contaminants on reptiles: a review. U.S. Fish and Wildlife Service Special Report 228:1-12.

380) Hall, T. C. 1994. Magpies. *In* Prevention and control of wildlife damage. University of Nebraska-Lincoln, Institute of Agriculture and Natural Resources, Cooperative Extension Division, Lincoln, Nebraska, USA.
381) Hallman, C. A., R. P. B. Foppen, C. A. M. van Turnhout, H. de Kroon, and E. Jongejans. 2014. Declines in insectivorous birds are associated with high neonicotinoid concentrations. Nature 511:341-343.
382) Halterman, M. D., S. A. Laymon, and M. J. Whitfield. 1989. Status and distribution of the elf owl in California. Western Birds 20:71-80.
383) Hammerson, G. A. 1982. Amphibians and reptiles in Colorado. Colorado Division of Wildlife, Publication DOW-M-I-27-82, Monte Vista, Colorado, USA.
384) Hammerson, G. A. 1986. Amphibians and reptiles in Colorado. Colorado Division of Wildlife. Denver, Colorado, USA.
385) Hammerson, G. A. 1999. Amphibians and reptiles in Colorado. Second edition. University Press of Colorado, Boulder, Colorado, USA and Colorado Division of Wildlife, Monte Vista, Colorado, USA.
386) Hammerson, G. A., H. Gadsden, and P. Lavin. 2019. *Aspidoscelis inornata*. The International Union for Conservation of Nature Red List of Threatened Species 2019:e.T89931365A89931433. <https://dx.doi.org/10.2305/IUCN.UK.2019-2.RLTS.T89931365A89931433.en>
387) Hammerson, G. A., and L. J. Livo. 1999. Conservation status of the northern cricket frog (*Acris crepitans*) in Colorado and adjacent areas at the northwestern extent of the range. Herpetological Review 30:78-80.
388) Hampe, A., and R. J. Petit. 2005. Conserving biodiversity under climate change: the rear edge matters. Ecology Letters 8:461–467.
389) Hann, H. W. 1950. Nesting behavior of the American dipper in Colorado. Condor 52:49-62.
390) Harig, A. L., and K. D. Fausch. 2002. Minimum habitat requirements for establishing translocated cutthroat trout populations. Ecological Applications 12:535-551.
391) Harrell, H. L. 1978. Response of the Devil's River (Texas) fish community to flooding. Copeia 1978(1):60-68.
392) Harris, R. D. 1944. The chestnut-collared longspur in Manitoba. Wilson Bulletin 56:105-115.
393) Harrison, C. 1978. A field guide to the nests, eggs and nestlings of North American birds. William Collins and Sons, Cleveland, Ohio, USA.
394) Harrison, H. H. 1975. A field guide to birds' nests in the United States east of the Mississippi. Houghton Mifflin Co., Boston, Massachusetts, USA.
395) Hass, C. 1997. Ecology of white-nosed coatis in the Huachuca Mountains, Arizona: a preliminary study. Arizona Game and Fish Department, Phoenix, Arizona, USA.
396) Hatch, M. D., W. H. Baltosser, and C. G. Schmitt. 1985. Life history and ecology of the bluntnose shiner (*Notropis simus pecosensis*) in the Pecos River of New Mexico. Southwestern Naturalist 30:555-62.

397) Hathaway, J., and D. E. Northup. 2019. Early detection of *P. destructans* in New Mexico. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.
398) Hathcock, C. D., B. E. Thompson, J. T. Berryhill, D. C. Keller, and M. A. Wright. 2017. Status of federally listed Threatened and Endangered species at Los Alamos National Laboratory. U.S. Department of Energy, Los Alamos National Laboratory, Los Alamos, New Mexico, USA.
399) Hatten, J. R., J. T. Giermakowski, J. A. Holmes, E. M. Nowak, M. J. Johnson, K. E. Ironside, C. van Riper III, M. Peters, C. Truettner, and K. L. Cole. 2016. Identifying bird and reptile vulnerabilities to climate change in the Southwestern United States. U.S. Department of the Interior, U.S. Geological Survey, Open-File Report 2016-1085, Reston, Virginia, USA.
400) Hawks Aloft. 1999. Nest site selection, reproductive success, and territory reoccupation of ferruginous hawks in three regions of New Mexico. New Mexico Department of Game and Fish, Contract 99-516-17, Santa Fe, New Mexico, USA.
401) Hawks Aloft. 2011. Bird and vegetation community relationships in the middle Rio Grande bosque. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.
402) Hawks, S., and M. Mika. 2013. Fall 2012 raptor migration studies in the Manzano Mountains of central New Mexico and raptor migration modeling in the southwest. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
403) HawkWatch International. 2002. Fall 2001 flammulated owl banding study in the Manzano Mountains of central New Mexico. New Mexico Department of Game and Fish, Contract 02-516.72, Santa Fe, New Mexico, USA.
404) Hayes, C. 2014. Revisions to list of New Mexico SGCN candidates. New Mexico Department of Game and Fish, New Mexico, USA.
405) Haynes, L., and S. Schuetze. 1997. A sampler of Arizona's Threatened and Endangered wildlife. Arizona Game and Fish Department and the Arizona Department of Agriculture, Phoenix, Arizona, USA.
406) Hayward, B., E. Heske, and C. Painter. 1997. Effects of livestock grazing on small mammals at a desert cienaga. The Journal of Wildlife Management 61(1):123-129.
407) Hayward, G. D., P. H. Hayward, and E. O. Garton. 1987. Movement and home range use by boreal owls in central Idaho. Pages 175-184 *in* R.W. Nero, R. J. Clark, R. J. Knapton, and R. H. Hamre, editors. Biology and conservation of northern forest owls: symposium proceedings, Manitoba, Canada. U.S. Department of Agriculture, U.S. Forest Service, General Technical Report RM-142, Fort Collins, Colorado, USA.
408) Hedrick, P. W., and R. Fredrickson, 2010. Genetic rescue guidelines with examples from Mexican wolves and Florida panthers. Conservation Genetics 11:615–626.
409) Hedrick, P. W., K. M. Parker, and R. N. Lee. 2001. Using microsatellite and MHC variation to identify species, ESUs, and MUs in the endangered Sonoran topminnow. Molecular Ecology 10:1399-1412.
410) Hegewisch, K. C., J. T. Abatzoglou, O. Chegwidden, and B. Nijssen. 2024. 'Climate Mapper' web tool. Climate Toolbox, University of California Merced, California, USA. <https://climatetoolbox.org/>

411) Hendricks, D. P. 1977. Brown-capped rosy finch nesting in New Mexico. Auk 94:384-385.
412) Hendrickson, D. A., and A. E. Cohen. 2015. *Notropis jemezanus* Rio Grande shiner in fishes of Texas project database, version 2.0. <https://doi.org/doi:10.17603/c3wc70>.
413) Henry, S. G. 1998. Elf owl. Pages 162-165 *in* R. L. Glinski, editor. The raptors of Arizona. University of Arizona Press, Tucson, Arizona, USA.
414) Henry, S. G., F. R. Gehlbach, D. Molfetto, and P. Howard 2020. Elf owl (*Micrathene whitneyi*). *In* S. M. Billerman, editor. Birds of the world, version 1.0. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.elfowl.01>
415) Herkert, J. R. 1991. Study suggests increases in restored prairie fragments to conserve breeding bird communities (Illinois). Restoration and Management Notes 9(2):107.
416) Herrmann, S. J. 1970. Systematics, distribution and ecology of Colorado *Hirudinea*. American Midland Naturalist 83(1):1-37.
417) Hill, D. P., and L. K. Gould. 1997. Chestnut-collared longspur (*Calcarius ornatus*). *In* A. Poole and F. Gill, editors. The birds of North America 288. Academy of Natural Sciences, Philadelphia, Pennsylvania, USA and American Ornithologists' Union, Washington, D.C., USA. <https://doi.org/10.2173/bow.chclon.01>
418) Hill, M., and L. Fitzgerald. 2007. Radiotelemetry and population monitoring of sand dune lizards (*Sceloporus arenicolus*) during the nesting season: final report. Texas A&M University, College Station, Texas, USA and New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
419) Hill, R. A. 1976. Host-parasite relationships of the brown-headed cowbird in a prairie habitat of west-central Kansas. Wilson Bulletin 88:555-565.
420) Hilton, C. D., and T. L. Best. 1993. *Tamias cinereicollis*. Mammalian Species 436:1-5.
421) Hoagstrom, C. W., and J. E. Brooks. 2005. Distribution and status of Arkansas River shiner *Notropis girardi* and Rio Grande shiner *Notropis jemezanus*, Pecos River, New Mexico. Texas Journal of Science 57(1):35-58.
422) Hoffman, S., and D. James. 1987. Fall raptor migration through the Manzano mountains New Mexico: final report. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
423) Hoffmeister, D. F. 1986. Mammals of Arizona. The University of Arizona Press, Tucson, Arizona, USA and the Arizona Game and Fish Department, Phoenix, Arizona, USA.
424) Holm, E., and E. J. Crossman. 2001. Updated status of the central stoneroller, *Campostoma anomalum*, in Canada. Canadian Field-Naturalist 115(1):157-167.
425) Holmer, S. 2016. Endangered Species Act: a record of success. American Bird Conservancy, The Plains, Virginia, USA.
426) Holroyd, S., C. L. Lausen, S. Dulc, E. de Freitas, R. Crawford, J. O'Keefe, C. Boothe, J. Segers, and J. Reichard. 2023. Best management practices for the use of bat houses in U.S. and Canada with focus on summer habitat mitigation for little brown myotis, yuma myotis, and big brown bat. Wildlife Conservation Society, Toronto, Ontario, CAN, U.S. Fish and Wildlife Service, Washington D.C., USA, and Canadian Wildlife Health Cooperative, Calgary, Alberta, CAN.

427) Holycross, A. T. 2020. *Sistrurus tergeminus*, western massasauga. Pages 657-669 *in* A. T. Holycross and M. J. Mitchell, editors. Snakes of Arizona. ECO Publishing, Rodeo, New Mexico, USA.
428) Holycross, A. T., L. J. Vitt, and C. W. Painter. 2020a. *Lampropeltis knoblochi*, Madrean mountain kingsnake. Pages 196-204 *in* A. T. Holycross and M. J. Mitchell, editors. Snakes of Arizona. ECO Publishing, Rodeo, New Mexico, USA.
429) Holycross, A. T., L. J. Vitt, and C. W. Painter. 2020b. *Lampropeltis pyromelana*, Arizona mountain kingsnake. Pages 205-213 *in* A. T. Holycross and M. J. Mitchell, editors. Snakes of Arizona. ECO Publishing, Rodeo, New Mexico, USA.
430) Holycross, A. T., and L. L. C. Jones. 2020. *Crotalus lepidus*, rock rattlesnake. Pages 529-543 *in* A. T. Holycross and M. J. Mitchell editors. Snakes of Arizona. ECO Publishing, Rodeo, New Mexico, USA.
431) Holycross, A. T., and M. Goode. 2020. *Crotalus willardi*, ridge-nosed rattlesnake. Pages 642-656 *in* A. T. Holycross and M. J. Mitchell, editors. Snakes of Arizona. ECO Publishing, Rodeo, New Mexico, USA.
432) Holycross, A. T., and S. R. Goldberg. 2001. Reproduction in northern populations of the ridgenose rattlesnake, *Crotalus willardi* (Serpentes: Viperidae). Copeia 2001:473-481.
433) Holycross, A. T., and S. W. Smith. 1997. Geographic distribution: *Crotalus willardi obscurus*. Herpetological Review 28:97.
434) Horncastle, V. J., C. L. Chambers, and B. G. Dickson. 2019. Grazing and wildfire effects on small mammals inhabiting montane meadows. The Journal of Wildlife Management 83(3):534–543.
435) Howard, W. E., and H. E. Childs Jr. 1959. Ecology of pocket gophers with emphasis on *Thomomys bottae mewa*. Hilgardia 29:277-358.
436) Howe, W. H. 1986. Status of the yellow-billed cuckoo (*Coccyzus americanus*) in New Mexico. New Mexico Department of Game and Fish, New Mexico, USA.
437) Howe, W. H. 2021. New Mexico bird finding guide. Fourth edition. New Mexico Ornithological Society, Outskirts Press, Parker, Colorado, USA.
438) Hubbard, J. P. 1965. The summer birds of the forests of the Mogollon Mountains, New Mexico. Condor 67:404-415.
439) Hubbard, J. P. 1978. Revised checklist of the birds of New Mexico. New Mexico Ornithological Society Publication 6.
440) Hubbard, J. P. 1987. The vegetative communities and vertebrate fauna of the Gray Ranch, Hidalgo County, New Mexico. New Mexico Department of Game and Fish, Endangered Species Program, Santa Fe, New Mexico, USA.
441) Hubbard, J. P., M. C. Conway, H. Campbell, G. Schmitt, and M. D. Hatch. 1979. Handbook of species endangered in New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
442) Hubbs, C. L. 1954. Establishment of a forage fish, the red shiner (*Notropis lutrensis*), in the lower Colorado River system. California Fish and Game 40:287-94.
443) Hubbs, C. L., and J. Karges. 1999. Additional data on habitat segregation between *Gambusia spp*. Texas Journal of Science 51(4):339-341.

444) Hubbs, C., R. J. Edwards, and G. P. Garrett. 1991. An annotated checklist of the freshwater fishes of Texas, with keys to identification of species. The Texas Journal of Science 43:1-56.
445) Hubbs, C., R. J. Edwards, and G. P. Garrett. 2002. Threatened fishes of the world: *Gambusia nobilis* (Baird and Girard), 1853 (Poeciliidae). Environmental Biology of Fishes 64:428.
446) Hubbs, C., R. J. Edwards, and G. P. Garrett. 2008. An annotated checklist of the freshwater fishes of Texas, with keys to identification of species. Second edition. Texas Journal of Science 43(4):1-87.
447) Hunter, W. F., and P. H. Baldwin. 1962. Nesting of the black swift in Montana. Wilson Bulletin 74:409-416.
448) Hutto, R. L. 1995. Composition of bird communities following stand-replacement fires in northern Rocky Mountain (USA) conifer forests. Conservation Biology 9(5):1041-1058.
449) [IDNR] Illinois Department of Natural Resources. 2022. An Illinois species status assessment for mottled sculpin. Mottled Sculpin Recovery Team and Illinois Department of Natural Resources, Chicago, Illinois, USA.
450) Ikenson, B. 2002. Rio Grande silvery minnow. Endangered Species Bulletin 27(2):34-35.
451) Ingold, D. J. 1991. Nest-site fidelity in red-headed and red-bellied woodpeckers. Wilson Bulletin 103(1):118.
452) Ingrasci, M. J., J. A. Lemos-Espinal, and A. T. Holycross. 2004. *Lampropeltis pyromelana* (Sonoran Mountain kingsnake). Activity. Herpetological Review 35(1):68–69.
453) [ITIS] Integrated Taxonomic Information System. 2024. Online database. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA. <www.itis.gov, https://doi.org/10.5066/F7KH0KBK>.
454) Jacobson, H. N., F. E. McKibben, and J. K. Frey. 2021. Survey for the Peñasco least chipmunk in the south Sacramento restoration project, Sacramento Ranger District, Lincoln National Forest. Department of Fish, New Mexico State University, Wildlife and Conservation Ecology, Las Cruces, New Mexico, USA.
455) Jacobson, H. N., and J. K. Frey. 2024. Extirpation, habitat selection and niche reduction of an endemic sky island chipmunk. New Mexico State University, Department of Fish, Wildlife and Conservation Ecology, Las Cruces, New Mexico, USA.
456) Jaques, D. L., and D. W. Anderson. 1987. Conservation implications of habitat use and behavior of wintering brown pelicans (*Pelecanus occidentalis californicus*). University of California, Davis, California, USA.
457) Jeffrey, R. G. 1980. Band-tailed pigeon. Pages 212-245 *in* G. C. Sanderson, editor. Management of migratory shore and upland game birds of North America. University of Nebraska Press, Lincoln, Nebraska, USA.
458) Jelks, H. L., S. W. Walsh, N. M. Burkhead, S. Contreras-Balerdas, D. Diaz-Pardo, D. A. Hendrickson, J. Lyons, N. E. Mandrak, F. McCormick, J. S. Nelson, S. P. Platania, B. A. Porter, C. B. Renaud, J. J. Schimtter-Soto, E. B. Taylor, and M. L. Warren Jr. 2008. Conservation status of imperiled North American freshwater and diadromous fishes. Fisheries 33:372-407.

459) Jenkins, R. E. 1980. *Moxostoma congestum*, gray redhorse (Baird and Girard). Page 418 *in* D. S. Lee, C. R. Gilbert, C. H. Hocutt, R. E. Jenkins, D. E. McAllister, and J. R. Stauffer Jr., editors. Atlas of North American freshwater fishes. North Carolina State, Museum of Natural History, Raleigh, North Carolina, USA.
460) Jenkins, R. E., and N. M. Burkhead. 1994. Freshwater fishes of Virginia. American Fisheries Society, Bethesda, Maryland, USA.
461) Jennings, M. R., and M. P. Hayes. 1994. Amphibian and reptile species of special concern in California. California Department of Fish and Game, Contract 8023, Sacramento, California, USA.
462) Jennings, R. D. 1988. Ecological studies of the Chiricahua leopard frog, *Rana chiricahuensis*, in New Mexico. New Mexico Department of Game and Fish, Share with Wildlife Program, Contract 516.6-76-05, Santa Fe, New Mexico, USA.
463) Jennings, R. D. 1990. Activity and reproductive phenologies and their ecological correlates among populations of the Chiricahua leopard frog, *Rana chiricahuensis*. New Mexico Department of Game and Fish, Endangered Species Program, Share with Wildlife Program, Santa Fe, New Mexico, USA.
464) Jennings, R. D. 1995. Investigations of recently viable leopard frog populations in New Mexico: *Rana chiricahuensis* and *Rana yavapaiensis*. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
465) Jennings, R. D., and B. L. Christman. 2015. Comparisons of the population status of narrow-headed gartersnakes among sites experiencing post-fire flows and receiving translocations with an unaffected population. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.
466) Jennings, R. D., and N. J. Scott Jr. 1991. Global amphibian population declines: insights from leopard frogs in New Mexico. University of New Mexico, Museum of Southwestern Biology, Albuquerque, New Mexico, USA and Department of Game and Fish, Santa Fe, New Mexico, USA.
467) Jensen, R., W. Hatler, M. Mecke, and C. Hart. 2006. The influences of human activities on the waters of the Pecos basin of Texas. Texas Water Resources Institute, SR-2006-03, College Station, Texas, USA.
468) Jester, D. B. 1973. Life history, ecology, and management of the smallmouth buffalo, *Ictiobus bubalus*, (Rafinesque), with reference to Elephant Butte Lake. New Mexico State University, Agricultural Experiment Station Research, Report 261, Las Cruces, New Mexico, USA.
469) Jester, D. B., and R. R. Suminski. 1982. Age and growth, fecundity, abundance, and biomass production of the White Sands pupfish, *Cyprinodon tularosa* (Cyprinodontidae), in a desert pond. Southwestern Naturalist 27:43-54.
470) Johnsgard, P. A. 1987. Diving birds of North America. University of Nebraska Press, Lincoln, Nebraska, USA.
471) Johnson, D. R. 1967. Diet and reproduction of Colorado pikas. Journal of Mammalogy 48(2):311-315.

472) Johnson, E. D., and P. J. Zwank. 1990. Flammulated owl biology on the Sacramento Unit of the Lincoln National Forest: final report. U.S. Department of Agriculture, U.S. Forest Service, Lincoln National Forest, Ruidoso, New Mexico, USA.

473) Johnson, G. D., and K. A. Fagerstone. 1994. Primary and secondary hazards of zinc phosphide to non-target wildlife: a review of the literature. U.S. Department of Agriculture, Denver Wildlife Research Center Research, Denver, Colorado, USA.

474) Johnson, K. 2000. Lesser prairie-chicken habitat use on the Sand Ranch and population status in the Caprock Wildlife Habitat Management Area. University of New Mexico, Contract 01-516.02, Alburquerque, New Mexico, USA.

475) Johnson, K., and G. Sadoti. 2019. Model transferability and implications for woodland management: a case study of pinyon jay nesting habitat. Avian Conservation and Ecology 14(2):17.

476) Johnson, K., J. Smith, and N. Petersen. 2016. Grassland/shrubland species of conservation concern at Holloman Air Force Base: pilot study of nesting priority species. University of New Mexico, Natural Heritage New Mexico Publication 16-GTR-391, Alburquerque, New Mexico, USA.

477) Johnson, K., M. Darr, and C. Rustay. 2020. Pinyon jay (*Gymnorhinus cyanocephalus*) species account. New Mexico bird conservation plan, version 2.2. New Mexico Avian Conservation Partners, Albuquerque, New Mexico, USA.

478) Johnson, M. J., C. Van Riper III, and K. M. Pearson. 2002. Black-throated sparrow (*Amphispiza bilineata*). *In* P. G. Rodewald, editor. The birds of North America, version 2.0. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.bktspa.01>

479) Johnson, R. E. 1983. Nesting biology of the rosy finch on the Aleutian Islands, Alaska. Condor 85:447-452.

480) Johnson, R. R., and L. T. Haight. 2020. Canyon towhee (*Melozone fusca*). *In* A. F. Poole and F. B. Gill, editors. Birds of the world, version 1.0. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.cantow.01>

481) Johnson, S. R., and D. R. Herter. 1989. The birds of the Beaufort Sea. BP Exploration (Alaska) Inc., Anchorage, Alaska, USA. <https://birdsoftheworld.org/bow/species/cantow/cur/introduction>

482) Johnson, T., and R. H. Wauer. 1996. Avifaunal response to the 1977 La Mesa fire. *In* C. D. Allen, editor. Fire effects in southwestern forests: sroceedings of the second La Mesa fire symposium. U.S. Department of Agriculture, U.S. Forest Service, General Technical Report RM-GTR-286, Fort Collins, Colorado, USA.

483) Johnson, T. H. 2018. Population decline of breeding peregrine falcons in northern New Mexico - 2017. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

484) Jones, A. K., S. W. Liphardt, J. L. Dunnum, T. W. Perry, J. Malaney, and J. A. Cook. 2021. An overview of the mammals of the Gila region, New Mexico. Therya 12(2):213-236.

485) Jones, B. K. 1988. Distribution and habitat associations of herpetofauna in Arizona: comparisons by habitat type. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado, USA.

486) Jones, C., and C. G. Schmitt. 1997. Mammal species of concern in New Mexico. Pages 179-205 *in* T. L. Yates, W. L. Gannon, and D. E. Wilson, editors. Life among the muses: papers in honor of James S. Findley. University of New Mexico, Museum of Southwestern Biology, Albuquerque, USA.
487) Jones, E. N. 1990. Effects of forage availability on home range and population density of *Microtus pennsylvanicus*. Journal of Mammalogy 71(3):382-389.
488) Jones, G., D. S. Jacobs, T. H. Kunz, M. R. Willig, and P. A. Racey. 2009. Carpe noctem: the importance of bats as bioindicators. Endangered Species Research 8(1-2):93-115.
489) Jones, K. B. 1981. Effects of grazing on lizard abundance and diversity in western Arizona. The Southwestern Naturalist 26(2):107-115.
490) Jones J. K., Jr., D. M. Armstrong, R. F. Hoffmann, and C. Jones. 1983. Mammals of the northern Great Plains. University of Nebraska Press, Lincoln, Nebraska, USA.
491) Jones, S. L., J. S. Dieni, N. B. Warning, D. Leatherman, L. Dargis, and L. Benedict 2023. Canyon wren (*Catherpes mexicanus*). *In* P. G. Rodewald, editor. Birds of the world, version 2.0. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.canwre.02>
492) Jones, W. T., P. M. Waser, L. F. Elliott, N. E. Link, and B. B. Bush. 1988. Philopatry, dispersal, and habitat saturation in the banner-tailed kanagaroo rat, *Dipodomys spectabilis*. Ecology 69(5):1466-1473.
493) Jones, Z. F., C. E. Bock, and J. H. Bock. 2003. Rodent communities in a grazed and ungrazed Arizona grassland, and a model of habitat relationships among rodents in southwestern grass/shrublands. The American Midland Naturalist 149(2):384-394.
494) Jones-Burdick, W. H. 1949. Guide to the snakes of Colorado (revised). University of Colorado Museum 5:1-23.
495) Kamees, L., and D. Burkett. 1996. A checklist of birds for White Sands Missile Range, New Mexico (updated). New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
496) Karalus, K. E., and A. W. Eckert. 1974. The owls of North America. Doubleday and Company, Inc., Garden City, New York, USA.
497) Kaspari, M., and A. Joern. 1993. Prey choice by three insectivorous grassland birds: reevaluating opportunism. Oikos 68:414-430.
498) Kaufmann, J. H., D. V. Lanning, and S. E. Poole. 1976. Current status and distribution of the coati in the United States. Journal of Mammalogy 57(4):621-637
499) Keinath, D. A., and G. D. Hayward. 2003. Red-backed vole (*Clethrionomys gapperi*) response to disturbance in subalpine forests: use of regenerating patches. Journal of Mammalogy 84(3):956–966.
500) Kelleyhouse, D. G. 1979. Fire/wildlife relationships in Alaska. Pages 1-36 *in* M. Hoefs and D. Russell, editors. Wildlife and wildfire: proceedings of workshop. Whitehorse, Yukon Territory, CAN.
501) Kelsch, S. W., and F. S. Hendricks. 1986. An electrophoretic and multivariate morphometric comparison of the American catfishes *Ictalurus lupus* and *I. punctatus*. Copeia 1986:646-652.

502) Kelsch, S. W., and F. S. Hendricks. 1990. Distribution of the headwater catfish *Ictalurus lupus* (Osteichthyes: Ictaluridae). Southwestern Naturalist 35:292-297.
503) Killion, M. J., W. E. Grant, and S. B. Vinson. 1995. Response of *Baiomys taylori* to changes in density of imported fire ants. Journal of Mammalogy 76:141-147.
504) Kimball, B. A., and K. R. Perry. 2008. Manipulating beaver (*Castor canadensis*) feeding responses to invasive tamarisk (*Tamarix* spp.). Journal of Chemical Ecology 34:1050.
505) King, R. 1977. Population status, breeding ecology and habitat requirements of the long-billed curlew. Thesis, Colorado State University, Fort Collins, Colorado, USA.
506) Kingery, H. E., and P. R. Julian. 1971. Cassin's sparrow parasitized by cowbird. Wilson Bulletin 83:439.
507) Kleeberger, S., and J. Werner. 1982. Home range and homing behavior of *Plethodon cinereus* in northern Michigan. Copeia 409–415.
508) Klute, D. S., L. W. Ayers, M. T. Green, W. H. Howe, S. L. Jones, J. A. Shaffer, S. R. Sheffield, and T. S. Zimmerman. 2003. Status assessment and conservation plan for the western burrowing owl in the United States. U.S. Department of the Interior, U.S. Fish and Wildlife Services, Denver, Colorado, USA.
509) Knopf, A. A. 1988. Handbook of species Endangered in New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
510) Knopf, F. L., and J. R. Rupert. 1995. Habits and habitats of mountain plovers in California. Condor 97(3):743-751.
511) Knorr, O. A. 1961. The Geographical and ecological distribution of the black swift in Colorado. Wilson Bulletin 73:155-170.
512) Knudsen, G. R., R. D. Dixon, and S. K. Amelon. 2013. Potential spread of white-nose syndrome of bats to the Northwest: epidemiological considerations. Northwest Science 87:292-306.
513) Kobilinsky, D. 2017. On the border of decline? Biologists worry about the impacts of habitat fragmentation. Wildlife Professional 11(5):30-32.
514) Koehler, G. M., and J. D. Brittell. 1990. Managing spruce-fir habitat for lynx and snowshoe hares. Journal of Forestry 88(10):10-14.
515) Koritarov, V., J. Kuiper, K. Hlava, A. Orr, K. Rollins, D. Brunner, H. Green Jr., J. Makar, A. Ayers, M. Holm, and K. Simunich. 2013. Energy zones study: a comprehensive web-based mapping tool to identify and analyze clean energy zones in the Eastern Interconnection. Argonne National Lab, Argonne, Illinois, USA. <https://gem.anl.gov/tool>.
516) Korpimaki, E. 1988. Costs of reproduction and success of manipulated broods under varying food conditions in Tengmalm's owl. The Journal of Animal Ecology 57(3):1027-1039.
517) Kozma, J. M. 1995. Neotropical migrant and Chihuahuan Desert bird community use of arroyo-riparian habitat and adjacent upland in south-central New Mexico. Thesis, Texas Tech University, Lubbock, Texas, USA.
518) Kridelbaugh, A. L. 1982. An ecological study of loggerhead shrikes in central Missouri. Thesis, University of Missouri, Columbia, Missouri, USA.
519) Kriger, K. M., and J. Hero. 2009. Chytridiomycosis, amphibian extinctions, and lessons for the prevention of future panzootics. EcoHealth 6:6-10.

520) Kruse, A. D., and L. J. Piehl. 1986. The impact of prescribed burning on ground-nesting birds. Pages 153-156 *in* G. K. Clambey and R. H. Pemble, editors. The prairie: past, present and future. Proceedings of the 9th North American prairie conference. Moorhead, Minnesota, USA.

521) Kryštufek, B., A. S. Tesakov, V. S. Lebedev, A. A. Bannikova, N. I. Abramson, and G. Shenbrot. 2020. Back to the future: the proper name for red-backed voles is *Clethrionomys tilesius* and not *Myodes pallas*. Mammalia 84(2):214-217.

522) Kull, R. C., Jr. 1977. Color selection of nesting material by killdeer. The Auk 94(3):602-604.

523) Kumar, A. V., M. Zimova, J. R. Sparks, and L. S. Mills. 2020. Snow-mediated plasticity does not prevent camouflage mismatch. Oecologia 194:301–310.

524) Kurta, A., L. Winhold, J. O. Whitaker Jr., and R. Foster. 2007. Range expansion and changing abundance of the eastern pipistrelle (Chiroptera: Vespertilionidae) in the central Great Lakes region. American Midland Naturalist 157:404-411.

525) Kyle, S. C., and W. M. Block. 2000. Effects of wildfire severity on small mammals on northern Arizona ponderosa pine forests. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Southwest Forest Science Complex, Fort Collins, Colorado, USA.

526) LaDuc, T. J., and T. J. Devitt. 2020. *Trimorphodon lambda*, Sonoran lyresnake. Pages 456-452 *in* A. T. Holycross and M. J. Mitchell, editors. Snakes of Arizona. ECO Publishing, Rodeo, New Mexico, USA.

527) LaPré, L. 2011. Wind energy compliance with the Eagle Act in the Mojave Desert. The Western Section of The Wildlife Society and Wildlife Research Institute, Western Raptor Symposium, Riverside, California, USA.

528) Larson, M., and W. H. Moir. 1986. Forest and woodland habitat types (plant assoc.) of southern New Mexico and central Arizona (north of the Mogollon Rim). U.S. Department of Agriculture, U.S. Forest Service, Southwest Forest Science Complex, Fort Collins, Colorado, USA.

529) Larson, R. D., and D. L. Propst. 2000. Distribution and food habits of piscivorous fishes inhabiting the Pecos River between Sumner Dam and Brantley Reservoir, New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

530) Lateral Lines. 2012. Final poster depicting the native fishes of the Gila River basin, New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

531) Laws, J., M. T. Hill, and J. K. Frey. 2023. Northernmost record of the long-nosed bat (*Leptonycteris* sp.) in New Mexico: conservation implications. Western Wildlife 10:6-10.

532) Leachman, B., and B. Osmundson. 1990. Status of the mountain plover (a literature review). U.S. Department of the Interior, U.S. Fish and Wildlife Service, Washington, D.C., USA.

533) Lechleitner, R. R., J. V. Tileston, and L. Kartman. 1962. Die-off of a Gunnison's prairie dog colony in central Colorado. Part I: Ecological observations and description of the epizootic. Zoonoses Research 1:185-199.

534) Lee, D. S., C. R. Gilbert, C. H. Hocutt, R. E. Jenkins, D. E. McAllister, and J. R. Stauffer Jr. 1980. Atlas of North American freshwater fishes. North Carolina State, Museum of Natural History, Raleigh, North Carolina, USA.
535) Legler, J. M. 1960. Natural history of the ornate box turtle, *Terrapene ornata ornata* (Agassiz). University of Kansas Publication. Museum of Natural History 11(10):527-669.
536) Lehner, F., E. R. Wahl, A. W. Wood, D. B. Blatchford, and D. Llewellyn. 2017. Assessing recent declines in upper Rio Grande runoff efficiency from a paleoclimate perspective. Geophysical Research Letters 44(9):4124-4133.
537) Lehtinen, S. F., and J. B. Layzer. 1988. Reproductive cycle of the plains minnow, *Hybognathus placitus* (Cyprinidae), in the Cimarron River, Oklahoma. Southwestern Naturalist 33:27-33.
538) Levad, R. 2003. Inventory and evaluation of New Mexico waterfalls as potential nesting sites for black swifts. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.
539) Ligon, J. S. 1961. New Mexico birds and where to find them. University of New Mexico Press, Albuquerque, New Mexico, USA.
540) Line, L. 1993. Silence of the songbirds. National Geographic 183(6):68-91.
541) Linkhart, B. D., and R. T. Reynolds. 1994. *Peromyscus* carcass in the nest of a flammulated owl. Journal of Raptor Research 28(1):43-44.
542) Linnell M. A., K. Moriarty, D. S. Green, and T. Levi. 2018. Density and population viability of coastal marten: a rare and geographically isolated small carnivore. PeerJ 6:e4530.
543) List, R., G. Ceballos, and J. Pacheco. 1999. Status of the North American porcupine (*Erethizon dorsatum*) in Mexico. The Southwestern Naturalist 44(3):400-404.
544) Littrell, B. M., C. Thomas, C. S. Williams, and T. H. Bonner. 2003. Gut content analysis of the headwater catfish *Ictalurus lupus* from two west Texas streams. The Texas Journal of Science 55(4):323-328.
545) Löfgren, O., B. Hörnfeldt, and B. G. Carlsson. 1986. Site tenacity and nomadism in Tengmalm's owl (*Aegolius funereus* (L.) in relation to cyclic food production. Oecologia 69:321-326.
546) Longcore, J. E., A. P. Pessier, and D. K. Nichols. 1999. *Batrachochytrium dendrobatidis* gen. et sp. nov., a chytrid pathogenic to amphibians. Mycologia 219-227.
547) Loughran, C. L. 2022. Thermoregulation and spatial distribution of lizards in the southwestern USA: adaptation to a changing climate. University of New Mexico, Albuquerque, New Mexico, USA.
548) Lowe, C. H., D. S. Hinds, and E. A. Halpern. 1967. Experimental catastrophic selection and tolerances to low oxygen concentration in native Arizona freshwater fishes. Ecology 48:1013-1017.
549) Lowther, P. E., D. E. Kroodsma, and G. H. Farley. 2000. Rock wren (*Salpinctes obsoletus*). *In* A. F. Poole and F. B. Gill, editors. The birds of North America 486. The Birds of North America, Inc., Philadelphia, Pennsylvania, USA. <https://doi.org/10.2173/bna.486>
550) Lundberg, A. 1979. Residency, migration and a compromise: adaptations to nest-site scarcity and food specialization in three Fennoscandian owl species. Oecologia 41:273-281.

551) Luttrell, G. R., A. A. Echelle, W. L. Fisher, and D. J. Eisenhour. 1999. Declining status of two species of the *Macrhybopsis aestivalis* complex (Teleostei: Cyprinidae) in the Arkansas River basin and related effects of reservoirs as barriers to dispersal. Copeia 1999:981-989.
552) MacArthur, R. A., and L. C. H. Wang. 1973. Physiology of thermoregulation in the pika, *Ochotona princeps*. Canadian Journal of Zoology 51(1):11-16.
553) Macfarlane, W. W., J. M. Wheaton, N. Bouwes, M. L. Jensen, J. T. Gilbert, N. Hough-Snee, and J. A. Shivik. 2017. Modeling the capacity of riverscapes to support beaver dams. Geomorphology 277:72-99.
554) Macias G. C., and H. Drummond. 1988. Seasonal and ontogenetic variation in the diet of the Mexican garter snake, *Thamnophis eques*, in Lake Tecocomulco, Hidalgo. Journal of Herpetology 22:129-134.
555) Maier, T. J. 2002. Long-distance movements by female white-footed mice, *Peromyscus leucopus*, in extensive mixed-wood forest. Canadian Field-Naturalist 116:108-111.
556) Malaney, J. L., and J. K. Frey. 2006. Summer habitat use by snowshoe hare and mountain cottontail at their southern zone of sympatry. Journal of Wildlife Management 70(3):877-883.
557) Malcolm, K., B. Dykstra, K. Johnson, D. Lightfoot, E. Muldavin, and M. Ramsey. 2020. Symposium proceedings on piñon-juniper habitats: status and management for wildlife: 2016. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Proceedings RMRS-P-77, Fort Collins, Colorado, USA.
558) Mali, I., and M. R. J. Forstner. 2017. Survey of western river cooter (*Pseudemys gorzugi*) in New Mexico within the Black River drainage. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
559) Mali, I., and T. Suriyamongkol. 2019. Surveys for western river cooter (*Pseudemys gorzugi*) in the Pecos River drainage and its tributaries. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
560) Malone, J. H. 2002. Parental care in the barking frog. New Mexico Department of Game and Fish, Contract 02-516.14, Santa Fe, New Mexico, USA.
561) Mangineli, J. 1993. White Sands National Monument: checklist of mammals. U.S. National Park Service, Alamogordo, New Mexico, USA.
562) Manjarrez, J. 1998. Ecology of the Mexican garter snake (*Thamnophis eques*) in Toluca, Mexico. Journal of Herpetology 32(3):464-468.
563) Mann, S. L., R. J. Steidl, and V. M. Dalton. 2002. Effects of cave tours on breeding *Myotis velifer*. Journal of Wildlife Management 66:618-624.
564) Manville, A. M., II. 2000. Personal communication. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Division of Migratory Bird Management, Wildlife Biologist, Arlington, Virginia, USA.
565) Maples, M. T., D. W. Holt, and R. W. Campbell. 1995. Ground-nesting long-eared owls. The Wilson Bulletin 107:563-565.
566) Marlatt, S. L. 1984. History and management recommendations for the interior least tern in New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
567) Marsh, P. C. 1987. Food of adult razorback sucker in Lake Mohave, Arizona-Nevada. Transactions of the American Fisheries Society 116:117–119.

568) Marti, C. D. 1976. A review of prey selection by the long-eared owl. Condor 78:331-336.
569) Martin, A. P. 2010. The conservation genetics of Ash Meadows pupfish populations. Part I: the Warm Springs pupfish *Cyprinodon nevadensis pectoralis*. Conservation Genetics 11(5):1847-1857.
570) Martin, T. E., and P. M. Barber 2020. Red-faced warbler (*Cardellina rubrifrons*). *In* Birds of the world, version 1.0. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.refwar.01>
571) Marvil, R. E., and A. Cruz. 1989. Impact of brown-headed cowbird parasitism on the reproductive success of the solitary vireo. Auk 106:476-480.
572) Maser, C., R. F. Tarrant, J. M. Trappe, and J. F. Franklin, editors. 1988. From the forest to the sea: a story of fallen trees. U.S. Department of Agriculture, U.S. Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-229, Portland, Oregon, USA.
573) Mathis, V. L., M. S. Hafner and D. J. Hafner. 2014. Evolution and phylogeography of the *Thomomys umbrinus* species complex (Rodentia: Geomyidae). Journal of Mammalogy 95(4):754-771.
574) Matthews, T. C. 1971. Genetic changes in a population of boreal chorus frogs (*Pseudacris triseriata*) polymorphic for color. American Midland Naturalist 85:208-221.
575) Maxson, K. A., L. E. Solomon, T. A. Bookout, S. A. DeLain, A. D. Bartels, M. C. Bowler, E. J. Gittinger, E. N. Ratcliff, J. L. West, S. A. Love, and J. A. DeBoer. 2024. Smallmouth buffalo (*Ictiobus bubalus* Rafinesque) population trends and demographics in the upper Mississippi River system. Environmental Biology of Fishes 1-25.
576) McAllister, D. E. 1987. Status of the central stoneroller, *Campostoma anomalum*, in Canada. Canadian Field-Naturalist 101:213-218.
577) McCallum, D. A. 1994. Review of technical knowledge: flammulated owls. Pages 14-46 *in* G. D. Hayward and J. Verner, editors. Flammulated, boreal, and great gray owls in the United States: a technical conservation assessment. U.S. Department of Agriculture, U.S. Forest Service, General Technical Report RM-253, Fort Collins, Colorado, USA.
578) McCallum, D. A., W. Graul, and R. Zaccagnini. 1977. The breeding status of the long-billed curlew. Auk 94:599-601.
579) McCarley, H. 1966. Annual cycle, population dynamics and adaptive behavior of *Citellus tridecemlineatus*. Journal of Mammalogy 47(2):294-316.
580) McComb, W. C., W. H. Davis, and P. N. Allaire. 1987. Excluding starlings from a slot-entrance bluebird nest box. Wildlife Society Bulletin 15:204-207.
581) McGrath, P. 2010. The life history of longnose gar, *Lepisosteus osseus*, an apex predator in the tidal waters of Virginia. Dissertation, College of William and Mary, School of Marine Science, Williamsburg, Virginia, USA.
582) McGuire, B., L. L. Getz, J. E. Hofmann, T. Pizzuto, and B. Frase. 1993. Natal dispersal and philopatry in prairie voles (*Microtus ochrogaster*) in relation to population density, season, and natal social environment. Behavioral Ecology and Sociobiology 32:293-302.
583) McIntyre, J. 2010. Personal communication. U.S. Department of the Interior, U. S. Fish and Wildlife Service, Pollinator Biologist, Albuquerque, New Mexico, USA.

584) McIntyre, J. 2017. Protecting pollinators: laws, policies, and action: presentation. New Mexico Bar Association Meeting, U.S. Department of the Interior, U.S. Fish and Wildlife Service, Santa Fe, New Mexico, USA.
585) McKee, P. M., and B. J. Parker. 1982. The distribution, biology, and status of the fishes *Campostoma anomalum*, *Clinostomus elongatus*, *Notropis photogenis* (Cyprinidae), and *Fundulus n*otatus (Cyprinodontidae) in Canada. Canadian Journal of Zoology 60:1347-1358.
586) McKibben, F. E. 2022. An investigation of niche breadth of the Peñasco least chipmunk: removing false positive detection error and modeling multiscale habitat selection. Thesis, New Mexico State University, Las Cruces, New Mexico, USA.
587) McKibben, F. E., F. A. Gebreselassie, and J. K. Frey. 2021. Life history and activity of the Peñasco least chipmunk (*Neotamias minimus atristriatus*). New Mexico Department of Game and Fish, Share with Wildlife Program, Agreement 1910302, Santa Fe, New Mexico, USA.
588) McKibben, F. E., and J. Frey. 2020. Distribution and habitat selection by the Peñasco least chipmunk (*Neotamias minimus atristriatus*). New Mexico Department of Game and Fish, Share with Wildlife Program, Agreement 181022, Santa Fe, New Mexico, USA.
589) McKinney, A. M., P. J. CaraDonna, D. W. Inouye, B. Barr, C. C. Bertelsen, and N. M. Waser. 2012. Asynchronous changes in phenology of migratory broad-tailed hummingbirds and their early-season nectar resources. Ecology 93:1987–1993.
590) Meehan T. D., A. H. Hurlbert, and C. Gratton. 2010. Bird communities in future bioenergy landscapes of the upper Midwest. Proceedings of the National Academy of Sciences 107(43):18533-18538.
591) Meffe, G. K. 1985. Predation and species replacement in American southwestern fishes: a case study. Southwestern Naturalist 30:173-187.
592) Merchant, H. 1972. Estimated population size and home range of the salamanders *Plethodon jordani* and *Plethodon glutinosus*. Journal of The Washington Academy of Sciences 62:248–257.
593) Merkle, J. A., P. R. Krausman, D. W. Stark, J. K. Oakleaf, and W. B. Ballard. 2009. Summer diet of the Mexican gray wolf (*Canis lupus baileyi*). Southwestern Naturalist 54:480-485.
594) Merritt, J. F. 1981. *Clethrionomys gapperi.* Mammalian Species 146:1-9.
595) Merritt, J. F., and J. M. Merritt. 1978. Population ecology and energy relationships of *Clethrionomys gapperi* in a Colorado subalpine forest. Journal of Mammalogy 59(3):576-598.
596) Metzke, B. 2023. Species planning document template for mottled sculpin. Mottled Sculpin Recovery Team and Illinois Department of Natural Resources, Chicago, Illinois, USA.
597) Middleton, A. L. 1998. Chipping sparrow (*Spizella passerina*). *In* P. G. Rodewald, editor. The birds of North America, version 2.0. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bna.334>
598) Millar, J. S. 1973. Evolution of litter-size in the pika, *Ochotona princeps* (Richardson). Evolution 27(1):134-143.

599) Millar, J. S., and F.C. Zwickel. 1972. Determination of age, age structure, and mortality of the pika, *Ochotona princeps* (Richardson). Canadian Journal of Zoology 50(2):229-232.
600) Miller, P. H. 1977. A demographic study of the chorus frog, *Pseudacris triseriata*. Thesis, Colorado State University, Fort Collins, Colorado, USA.
601) Miller, R. R. 1946. *Gila cypha*, a remarkable new species of cyprinid fish from the lower Colorado River basin, Arizona. Journal Washington Academy Science 36:206-212.
602) Miller, R. R. 1961. Man and the changing fish fauna of the American southwest. Papers of the Michigan Academy of Science, Arts, and Letters 46:365-404.
603) Miller, R. R., and A. A. Echelle. 1975. *Cyprinodon tularosa*, a new cyprinodontid fish from the Tularosa basin, New Mexico. The Southwestern Naturalist 19(4):365-377.
604) Miller, R. R., and B. Chernoff. 1979. Status of populations of the endangered Chihuahua chub, *Gila nigrescens*, in New Mexico and Mexico. Proceedings of the Desert Fishes Council 11:74-84.
605) Miller, R. R., and C. H. Lowe. 1964. Part 2: an annotated check-list of the fishes of Arizona. Pages 133-151 *in* C. H. Lowe, editor. The vertebrates of Arizona. University of Arizona Press, Tuscon, Arizona, USA.
606) Miller, R. R., W. L. Minckley, and S. M. Norris. 2005. Freshwater fishes of Mexico. University of Chicago Press, Chicago, Illinois, USA.
607) Miller, S. D., and J. F. Cully Jr. 2001. Conservation of black-tailed prairie dogs (*Cynomys ludovicianus*). Journal of Mammalogy 82:889-893.
608) Minckley, W. L. 1969. Native Arizona fishes part I: livebearers. Arizona Game and Fish Department Wildlife Views 16(3):6-8.
609) Minckley, W. L. 1973. Fishes of Arizona. Arizona Game and Fish Department, Phoenix, Arizona, USA.
610) Minckley, W. L. 1981. Ecological studies of Aravaipa Creek, central Arizona, relative to past, present, and future uses. U.S Department of the Interior, U.S. Bureau of Land Management, Safford, Arizona, USA.
611) Minckley, W. L., and B. D. DeMarais. 2000. Taxonomy of chubs (Teleostei, Cyprinidae, Genus *Gila*) in the American southwest with comments on conservation. Copeia 251-256.
612) Minckley, W. L., and J. E. Deacon. 1968. Southwestern fishes and the enigma of "Endangered species." Science 159:1424-32.
613) Minckley, W. L., J. N. Rinne, and J. E. Johnson. 1977. Status of the Gila topminnow and its cooccurrence with mosquitofish. U.S. Department of Agriculture, U.S. Forest Service Research Paper RM-198, Fort Collins, Colorado, USA.
614) Minckley, W. L., and P. C. Marsh. 2009. Inland fishes of the greater southwest: chronicle of a vanishing biota. University of Arizona Press, Tucson, Arizona, USA.
615) Mineau, P., and M. Whiteside. 2013. Pesticide acute toxicity is a better correlate of U.S. grassland bird declines than agricultural intensification. PLoS One 8(2):e57457.
616) Mitchell, J. C., M. D. Cardwell, and A. H. Price. 2020. *Crotalus scutulatus*, Mohave rattlesnake. Pages 600-611 *in* A. T. Holycross and M. J. Mitchell, editors. Snakes of Arizona. ECO Publishing, Rodeo, New Mexico, USA.

617) Mitchell, W. A. 1988. Songbird nest boxes. *In* U.S. Army Corps of Engineers wildlife resources management manual. Department of the Army, Technical Report EL-88-19, Vicksburg, Mississippi, USA.
618) [MNMB] Monitoring Neotropical Migratory Birds. 1992. Prepared by participants at the monitoring working group meeting, Arlington, Virginia, USA.
619) Moffat, K. 2017. Restoration of Gila trout. New Mexico Wildlife, New Mexico Department of Game and Wildlife, Santa Fe, New Mexico, USA. <https://magazine.wildlife.state.nm.us/restoration-gila-trout/>
620) Mohseni, O., H. G. Stefan, and J. G. Eaton. 2003. Global warming and potential changes in fish habitat in U.S. streams. Climate Change 59:389–409.
621) Moir, W. H., B. Geils, M. A. Benoit, and D. Scurlock. 1997. Ecology of southwestern ponderosa pine forests. *In* W. M. Block and D. M. Finch, editors. Songbird ecology in southwestern ponderosa pine forests: a literature review. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-GTR-292, Fort Collins, Colorado, USA.
622) Monday, C. D., editor. 1993. Bats of Arizona. Arizona Wildlife Views: Special Heritage Edition 36(8):1-36.
623) Mopame, M. 1981. Parasites of some fishes native to Arizona and New Mexico, with ecological notes. Dissertation, Arizona State University, Tempe, Arizona, USA.
624) Morafka, D. J. 1982. The status and distribution of the Bolson tortoise (*Gopherus flavomarginatus*). Pages 71-94 *in* R. B. Bury, editor. North American tortoises: conservation and ecology. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Wildlife Research Report, 12, Washington, D.C., USA.
625) Morafka, D. J., G. Aguirre, and G. A. Adest. 1989. *Gopherus flavomarginatus* (Bolson tortoise). Pages 10-13 *in* I. R. Swingland and M. W. Klemens, editors. The conservation biology of tortoises. Occasional Papers, International Union for Conservation of Nature Species Survival Commission, Washington, D.C., USA.
626) Morgan, R. 2021. River otters find a new home on the Rio Grande. New Mexico Wildlife 26.
627) Moses, M. R., J. K. Frey, and G. W. Roemer. 2012. Elevated surface temperature depresses survival of banner-tailed kangaroo rats: will climate change cook a desert icon? Oecologia 168:257-268.
628) Moyle, P. B. 2002. Inland fishes of California: revised and expanded. University of California Press, Berkeley, California, USA.
629) [NABCI] North American Bird Conservation Initiative. 2022. The state of the birds: United States of America. Cornell University, Ithaca, New York, USA. <https://www.stateofthebirds.org/2022/>.
630) NatureServe. 2024. NatureServe network biodiversity location data. NatureServe, Arlington, Virginia. <https://explorer.natureserve.org/>.
631) [NAU] Northern Arizona University. 2019. NAU student researchers contribute to discovery of emerging snake pathogen in Arizona. NAU News, Flagstaff, Arizona, USA.

632) Nelson, B. 1993. Spawning characteristics of Gila chub (*Gila intennedia*) in Cienega Creek, Pima County, Arizona. U.S. Department of the Interior, U.S. Bureau of Land Management, Tucson, Arizona, USA.
633) Nelson, J. S. 1984. Fishes of the world. Second edition. John Wiley and Sons, New York, New York, USA.
634) Nelson, J. S., E. J. Crossman, H. Espinosa-Perez, L. T. Findley, C. R. Gilbert, R. N. Lea, and J. D. Williams. 2004. Common and scientific names of fishes from the United States, Canada, and Mexico. American Fisheries Society, Special Publication 29, Bethesda, Maryland, USA.
635) Neve, L. L. 1976. The life history of the roundtail chub, *Gila robusta grahami*, at Fossil Creek, Arizona. Thesis, Northern Arizona University, Flagstaff, Arizona, USA.
636) [NMDGF] New Mexico Department of Game and Fish. 1985. Handbook of species Endangered in New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
637) [NMDGF] New Mexico Department of Game and Fish. 1988. Handbook of species Endangered in New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
638) [NMDGF] New Mexico Department of Game and Fish. 1990a. Checklist of the native mammals of New Mexico. New Mexico Department of Game and Fish, Endangered Species Program, Santa Fe, New Mexico, USA.
639) [NMDGF] New Mexico Department of Game and Fish. 1990b. November 1990 amendments, handbook of species Endangered in New Mexico, 1988. State Game Commission, New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
640) [NMDGF] New Mexico Department of Game and Fish. 1991. Checklist of the extinct, extirpated, and vanishing wildlife of New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
641) [NMDGF] New Mexico Department of Game and Fish. 1994. Endangered species of New Mexico: 1994 biennial review and recommendations, New Mexico Wildlife Conservation Act (NMSA 17-2-37, 1978). New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
642) [NMDGF] New Mexico Department of Game and Fish. 1995. Recommended changes: list of Endangered species in New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
643) [NMDGF] New Mexico Department of Game and Fish. 1996. Threatened and Endangered species of New Mexico: 1996 biennial review and recommendations, Wildlife Conservation Act. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
644) [NMDGF] New Mexico Department of Game and Fish. 2002. Long range plan for the management of the Rio Grande cutthroat trout in New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
645) [NMDGF] New Mexico Department of Game and Fish. 2004. Status of endemic New Mexico salamanders. Performance report (E-22-12) to the U.S. Department of the Interior, U.S. Fish and Wildlife Service. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

646) [NMDGF] New Mexico Department of Game and Fish. 2006a. Colorado River basin chubs (roundtail chub *Gila robusta*, Gila chub *Gila intermedia*, headwater chub *Gila nigra*) recovery plan. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
647) [NMDGF] New Mexico Department of Game and Fish. 2006b. Comprehensive Wildlife Conservation Strategy for New Mexico. New Mexico Department of Game and Fish. Santa Fe, New Mexico, USA.
648) [NMDGF] New Mexico Department of Game and Fish. 2006c. Threatened and Endangered species of New Mexico: 2006 biennial review. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
649) [NMDGF] New Mexico Department of Game and Fish. 2007. Wildlife notes. New Mexico Department of Game and Fish, Contract 07-516.0000.3599, Santa Fe, New Mexico, USA.
650) [NMDGF] New Mexico Department of Game and Fish. 2015a. New Mexico wildlife and fisheries resource potentially affected by the Gold King Mine toxic liquid release. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
651) [NMDGF] New Mexico Department of Game and Fish. 2015b. State Wildlife Action Plan for New Mexico access database Species of Greatest Conservation Need comments. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
652) [NMDGF] New Mexico Department of Game and Fish. 2016. State Wildlife Action Plan for New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
653) [NMDGF] New Mexico Department of Game and Fish. 2017a. Gould's wild turkey (*Meleagris gallopavo mexicana*) recovery plan. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
654) [NMDGF] New Mexico Department of Game and Fish. 2017b. Habitat restoration and management of native and non-native trees in southwestern riparian ecosystems. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
655) [NMDGF] New Mexico Department of Game and Fish. 2017c. White-tailed ptarmigan (*Lagopus leucura*) recovery plan. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
656) [NMDGF] New Mexico Department of Game and Fish. 2017d. Gila monster (*Heloderma suspectum*) recovery plan. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
657) [NMDGF] New Mexico Department of Game and Fish. 2018a. Out of range: white-nosed coatis heading north or just heading home? New Mexico Wildlife Magazine 61(1):24-25.
658) [NMDGF] New Mexico Department of Game and Fish. 2018b. Threatened and Endangered species of New Mexico: 2018 biennial review. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
659) [NMDGF] New Mexico Department of Game and Fish. 2019. Black-footed ferrets reintroduced to New Mexico once again. New Mexico Wildlife Magazine 62(1):6-8.
660) [NMDGF] New Mexico Department of Game and Fish. 2020. Threatened and Endangered species of New Mexico: 2020 biennial review. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

661) [NMDGF] New Mexico Department of Game and Fish. 2020a. Four additional black-footed ferrets released at Wagon Mound Ranch. New Mexico Wildlife Magazine 62(2):2.
662) [NMDGF] New Mexico Department of Game and Fish. 2020b. Threatened and Endangered species of New Mexico: 2020 biennial review. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
663) [NMDGF] New Mexico Department of Game and Fish. 2022. Threatened and Endangered species of New Mexico. 2022 biennial report. New Mexico Game and Fish Department, Santa Fe, New Mexico, USA.
664) [NMDGF] New Mexico Department of Game and Fish. 2023. White-nose syndrome detected in New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
665) [NMDGF] New Mexico Department of Game and Fish. 2024. Biota Information System of New Mexico (BISON-M). Species accounts for various species. <https://bison-m.org/SuperSearch.aspx>.
666) [NMEST] New Mexico Endemic Salamander Team. 2000. Cooperative management plan for the Jemez Mountains salamander on lands administered by the Forest Service. New Mexico Department of Game and Fish, U.S. Department of the Interior, U.S. Fish and Wildlife Service, U.S. Geological Survey, U.S. Department of Agriculture, U.S. Forest Service, Santa Fe, New Mexico, USA.
667) Newman, G. A. 1970. Cowbird parasitism and nesting success of lark sparrows in southern Oklahoma. Wilson Bulletin 82:304-309.
668) Niemela, S. A. 2002. Influences of habitat heterogeneity and seed distribution on a Chihuahuan Desert avifauna. Thesis, New Mexico State University, Las Cruces, New Mexico, USA.
669) Norris, R. A. 1958. Comparative biosystematics and life history of the nuthatches *Sitta pygmaea* and *Sitta pusilla*. Zoology Publication 56:119-130.
670) Nowak, E. M., M. Amarello, and J. J. Smith. 2020. *Crotalus cerberus*, Arizona black rattlesnake. Pages 511-528 *in* A. T. Holycross and M. J. Mitchell, editors. Snakes of Arizona. ECO Publishing, Rodeo, New Mexico, USA.
671) Nowak, R. M. 1999. Walker's mammals of the world. Sixth edition. Johns Hopkins University Press, Baltimore, Maryland, USA.
672) [NPS] National Park Service. 2024. Channel Islands National Park: peregrine falcon. <https://www.nps.gov/places/000/peregrine-falcon.htm>.
673) Oberholser, H. C. 1974. The bird life of Texas. Volume 2. University of Texas Press, Austin, Texas, USA.
674) [ODWC] Oklahoma Department of Wildlife Conservation. 1993. Endangered and Threatened species of Oklahoma. Oklahoma Department of Wildlife Conservation, Oklahoma City, Oklahoma, USA.
675) O'Gara, B. W. 1994. Eagles. Pages 41-48 in Prevention and control of wildlife damage. University of Nebraska-Lincoln, Institute of Agriculture and Natural Resources, Lincoln, Nebraska, USA.
676) Ohlendorf, H. M. 1974. Competitive relationships among kingbirds (*Tyrannus*) in Trans-Pecos Texas. Wilson Bulletin 86-357-373.

677) Ohmart, R. D. 1994. The effects of human-induced changes on the avifauna of western riparian habitats. Studies in Avian Biology 15:273-285.
678) O'Keefe, J. M., S. C. Loeb, J. D. Lanham, and H. S. Hill Jr. 2009. Macrohabitat factors affect day roost selection by eastern red bats and eastern pipistrelles in the southern Appalachian Mountains, USA. Forest Ecology and Management 257:1757-1763.
679) Olden, J. D., and N. L. Poff. 2005. Long-term trends of native and non-native fish faunas in the American southwest. Animal Biodiversity and Conservation 28(1):75-89.
680) Oring, L. W., and S. J. Maxson. 1978. Instances of simultaneous polyandry by a spotted sandpiper *Actitis macularia*. Ibis 120(3):349-353.
681) Ortega, A., and R. Barbault. 1986. Reproduction in the high elevation Mexican lizard *Sceloporus scalaris*. Journal of Herpetology 20:111-114.
682) Ortega, C., and G. E. Hill. 2010. Black-headed grosbeak (*Pheucticus melanocephalus*). *In* P. G. Rodewald, editor. The birds of North America, version 2.0. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bna.143>
683) Osborne, M., and T. Turner. 2006. Baseline genetic survey of the threatened Pecos bluntnose shiner (*Notropis simus pecosensis*). New Mexico Department of Game and Fish, Albuquerque, New Mexico, USA.
684) Osborne, M., and T. Turner. 2009. Genetic monitoring in a threatened freshwater fish, the Pecos bluntnose shiner (*Notropis simus pecosensis*). New Mexico Department of Game and Fish, Albuquerque, New Mexico, USA.
685) Osborne, M. J. 2013. Genetic status of the Rio Grande shiner and speckled chub in the Pecos River. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.
686) Osborne, M. J. 2017. Identification of hybridization between pond slider (*Trachemys scripta elegans*) and Big Bend slider (*Trachemys gaigeae*) in New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
687) Osborne, M. J., J. L. Hatt, E. I. Gilbert, and S. R. Davenport. 2021. Still time for action: genetic conservation of imperiled South Canadian River fishes, Arkansas River shiner (*Notropis girardi*), peppered chub (*Macrhybopsis tetranema*) and plains minnow (*Hybognathus placitus*). Conservation Genetics 22(6):927-945.
688) Osborne, M. J., T. A. Diver, and T. F. Turner. 2010. Genetic status of the Arkansas River shiner and evaluation of hybridization among cyprinid fish in the Pecos River, New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
689) O'Shea, T. J., P. M. Cryan, D. T. Hayman, R. K. Plowright, and D. G. Streicker. 2016. Multiple mortality events in bats: a global review. Mammal review 46(3):175-190.
690) Overpeck, J. T., and B. Udall. 2020. Climate change and the aridification of North America. Proceedings of the National Academy of Sciences 117(22):11856–11858.
691) Oxley, D. J., M. B. Fenton and G. R. Carmody. 1974. The effects of roads on populations of small mammals. Journal of Applied Ecology 11:51-59.
692) Ozgul, A., L. L. Getz, and M. K. Oli. 2004. Demography of fluctuating populations: temporal and phase-related changes in vital rates of *Microtus ochrogaster*. Journal of Animal Ecology 73:201-215.

693) Pace, A. E. 1974. Systematic and biological studies of the leopard frogs (*Rana pipiens* complex) of the United States. 148. University of Michigan, Ann Arbor, Michigan, USA.
694) Page, G. W., L. E. Stenzel, and C. A. Ribic. 1985. Nest site selection and clutch predation in the snowy plover. Auk 102:347-353.
695) Page, G. W., L. E. Stenzel, J. S. Warriner, J. C. Warriner and P. W. Paton. 2009. Snowy plover (*Charadrius nivosus*). *In* The birds of North America, version 2.0. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bna.154>
696) Page, G. W., L. E. Stenzel, W. D. Shuford, and C. R. Bruce. 1991. Distribution and abundance of the snowy plover on its western North American breeding grounds. Journal of Field Ornithology 62:245-255.
697) Page, G. W., N. Warnock, T. L. Tibbitts, D. Jorgensen, C. A. Hartman, and L. E. Stenzel. 2014. Annual migratory patterns of long-billed curlews in the American West. The Condor 116:50-61.
698) Page, L. M. 1983. Handbook of darters. T. F. H. Publications, Inc., Neptune City, New Jersey, USA.
699) Page, L. M., and B. M. Burr. 2011. Peterson field guide to freshwater fishes of North America north of Mexico. Second edition. Houghton Mifflin Harcourt, Boston, Massachusetts, USA.
700) Page, L. M., C. C. Baldwin, H. Espinosa-Perez, C. R. Gilbert, K. E. Hartel, R. N. Lea, N. E. Mandrak, J. J. Schmitter-Soto, and H. J. Walker. 2016. AFS/ASIH Joint Committee report on the names of fishes on the taxonomy of *Gila* in the lower Colorado River basin of Arizona and New Mexico: final report. Arizona Game and Fish Department, Phoenix, Arizona, USA.
701) Page, L. M., C. C. Baldwin, H. Espinosa-Pérez, L. T. Findley, C. R. Gilbert, K. E. Hartel, R. N. Lea, N. E., Mandrak, J. J. Schmitter-Soto, H. J. Walker. 2017. Taxonomy of *Gila* in the lower Colorado River basin of Arizona and New Mexico. Fisheries 42(9):456–460.
702) Page, L. M., H. Espinosa-Pérez, L. T. Findley, C. R. Gilbert, R. N. Lea, N. E. Mandrak, R. L. Mayden, and J. S. Nelson. 2013. Common and scientific names of fishes from the United States, Canada, and Mexico. Seventh edition. American Fisheries Society, Special Publication 34, Bethesda, Maryland, USA.
703) Paige, C., and S. A. Ritter. 1999. Birds in a sagebrush sea: managing sagebrush habitats for bird communities. Partners in Flight Western Working Group, Boise, Idaho, USA.
704) Painter, C. W. 1985. Herpetology of the Gila and San Francisco River drainages of southwestern New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
705) Painter, C. W. 1991. Interim report for the results of the 1990 survey for the gray-checkered whiptail (*Cnemidophorus dixoni*) on Bureau of Land Management (BLM) lands in southwestern New Mexico. U.S. Department of the Interior, U.S. Bureau of Land Management and U.S. Fish and Wildlife Service, Santa Fe, New Mexico, USA.
706) Painter, C. W. 1995. Status of the gray-checkered whiptail (*Cnemidophorus dixoni*) on BLM lands in southwestern New Mexico. U.S. Department of the Interior, U.S. Bureau of Land Management and U.S. Fish and Wildlife Service, Santa Fe, New Mexico, USA.
707) Painter, C. W. 1996. Conserving the New Mexico ridge-nosed rattlesnake. Bajada 4(2).

708) Painter, C. W. 2004. Conservation of the sand dune lizard in New Mexico: recommendations based on the management plan for the sand dune lizard. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
709) Painter, C. W., C. L. Hayes, and J. N. Stuart. 2002. Recovery and conservation of the gray-banded kingsnake: final plan. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
710) Painter, C. W., J. N. Stuart, J. T. Giermakowski, and L. J. S. Pierce. 2017. Checklist of the amphibians and reptiles of New Mexico, USA, with notes on taxonomy, status, and distribution. Western Wildlife 4:29-60.
711) Painter, C. W., and W. G. Degenhardt. 1997. Review of GAP vegetation: herp associations for New Mexico Department of Game and Fish BISON-M project. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
712) Palmer, R. S., editor. 1988. Handbook of North American birds. Volume 4. Yale University Press, New Haven, Connecticut, USA.
713) Panaram, K., and R. Borowsky. 2005. Gene flow and genetic variability in cave and surface populations of the Mexican tetra, *Astyanax mexicanus* (Teleostei: Characidae). Copeia 2005(2):409-416.
714) Pandey, R., and M. Papes. 2017. Changes in future potential distributions of apex predator and mesopredator mammals in North America. Regional Environmental Change 18:1223-1233.
715) Parody, J. M. 2001. Bird-habitat relationships and the utility of multiscale methods. New Mexico Department of Game and Fish, Share with Wildlife Program, Contract 2000-516.03, Santa Fe, New Mexico, USA.
716) Paroz, Y., and D. Propst. 2006. Long-term monitoring of fish assemblages in the Gila River drainage, New Mexico 1988-2005. U.S. Department of the Interior, U.S. Fish and Wildlife Service and U.S. Bureau of Reclamation, Washington, D.C, USA.
717) Paroz, Y., and D. Propst. 2007. Distribution of spikedace, loach minnow, and chub species in the Gila River basin, New Mexico 1988 to 2007. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
718) Patterson, M. E., J. D. Fraser and J. W. Roggenbuck. 1990. Piping plover ecology, management and research needs. Virginia Journal of Science 41(4A):419-426.
719) Patterson, M. E., J. P. Loegering, and J. D. Fraser. 1992. Piping plover breeding biology and foraging ecology on Assateague Island National Seashore, Maryland: abstract. 6th Annual Meeting of the Society for Conservation Biology, Blacksburg, Virginia, USA.
720) Peacock, M. M. 1997. Determining natal dispersal patterns in a population of North American pikas (*Ochotona princeps*) using direct mark-resight and indirect genetic methods. Behavioral Ecology 8:340-350.
721) Peale, M., B. Long, and J. Klingel. 2022. American mink (*Neogale vison*) habitat and population survey in northern New Mexico. New Mexico Department of Game and Fish, Contract 21-516.0000.00025, Santa Fe, New Mexico, USA.
722) Peden, A. E., and G. W. Hughes. 1984. Status of the shorthead sculpin, *Cottus confusus*, in the Flathead River, British Columbia. Canada Field Naturalist 98:127-133.

723) Pederson, J., and C. Painter. 1990. Poster of rattlesnakes of New Mexico. New Mexico Department of Game and Fish. Santa Fe, New Mexico, USA.
724) Perkins-Taylor, I. E., and J. K. Frey. 2018. Ecological factors associated with site occupancy of an endemic chipmunk. The Journal of Wildlife Management 82(7):1466–1477.
725) Persons, T. B., and C. A. Drost. 2020. *Coluber constrictor*, North American racer. Pages 126-142 *in* A. T. Holycross and M. J. Mitchell, editors. Snakes of Arizona. ECO Publishing, Rodeo, New Mexico, USA.
726) Peters, H. S. 1936. A list of external parasites from birds of the eastern part of the United States. Bird Banding 7:9-28.
727) Peters, R, W. J. Ripple, C. Wolf, M. Moskwik, G. Carreon-Arroyo, G. Ceballos, A. Cordova, R. Dirzo, P. R. Ehrlich, A. D. Flesch, R. List, T. E. Lovejoy, R. F. Noss, J. Pacheco, J. K. Sarukhan, M. E. Soule, E. O. Wilson, and J. R. B. Miller. 2018. Nature divided, scientists united: U.S.-Mexico border wall threatens biodiversity and binational conservation. BioScience 68(10):740-743.
728) Peterson, R. T. 1990. A field guide to western birds. Third edition. Houghton Mifflin Co., Boston, Massachusetts, USA.
729) Pflieger, W. L. 1980. *Hybognathus nuchalis* (Agassiz). Atlas of North American freshwater fishes. Volume 177. North Carolina State, Museum of Natural History, Raleigh, North Carolina, USA.
730) Pflieger, W. L. 1997. The fishes of Missouri. Revised edition. Missouri Department of Conservation, Jefferson City, Missouri, USA.
731) Pierce, L. J. S., J. N. Stuart, J. P. Ward, and C. W. Painter. 2016. *Pseudemys gorzugi* (Ward) 1984 - Rio Grande cooter, western river cooter, Tortuga de Oreja Amarilla, Jicotea del Rio Bravo. Pages 1-12 *in* A. G. J. Rhodin, J. B. Iverson, P. P. van Dijk, R. A. Saumure, K. A. Buhlmann, P. C. H. Pritchard, and R. A. Mittermeier, editors. Conservation biology of freshwater turtles and tortoises: a compilation project of the International Union for Conservation of Nature Species Survival Commission tortoise and freshwater turtle specialist group. Chelonian Research Monographs 5(100).
732) [PIF] Partners in Flight. 2024. Avian conservation assessment database. <https://pif.birdconservancy.org/avian-conservation-assessment-database-scores>.
733) Pittenger, J. S. 2015. White Sands pupfish conservation plan. Submitted to U.S. Department of Defense, White Sands Missile Range and Holloman Air Force Base. Blue Earth Ecological Consultants, Inc., Santa Fe, New Mexico, USA.
734) Pittenger, J. S., and C. L. Springer. 1999. Native range and conservation of the White Sands pupfish (*Cyprinodon tularosa*). Southwestern Naturalist 44:157-165.
735) Pizzimenti, J. J., and R. S. Hoffman. 1973. *Cynomys gunnisoni*. Mammalian Species 25:1-4.
736) Platania, S. P. 1990. The ichthyofauna of the Rio Grande drainage, Texas and Mexico, from Boquillas to San Ygnacio. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA.
737) Platania, S. P. 1991. Fishes of the Rio Chama and upper Rio Grande, New Mexico, with preliminary comments on their longitudinal distribution. The Southwestern Naturalist 36(2):186.

738) Platania, S. P. 1993. Pecos bluntnose shiner (*Notropis simus pecosensis*) research; 1992 annual progress report. University of New Mexico Annual Research Report to U.S. Department of the Interior, U.S. Bureau of Reclamation, Albuquerque, New Mexico, USA.
739) Platania, S. P., and M. Farrington. 2015. Life history study of the roundnose minnow. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.
740) Platis, N. M., Y. Kanno, B. M. Johnson, and B. P. Rose. 2024. Seasonal trophic niche width and overlap of mottled sculpin and brown trout in a regulated high-elevation river. Ecology of Freshwater Fish 33(4):e12793.
741) Platt, D. R., J. T. Collins, and R. E. Ashton. 1974. Rare, Endangered and extirpated species in Kansas. Part II: amphibians and reptiles. Transactions of the Kansas Academy of Science 76(3):185-192.
742) Platz, J. E., and J. S. Mecham. 1984. *Rana chiricahuensis*. Catalogue of American Amphibians and Reptiles (347):1-2.
743) Pollock, M. M., G. M. Lewallen, K. Woodruff, C. E. Jordan, and J. M. Castro, editors. 2017. The beaver restoration guidebook: working with beaver to restore streams, wetlands, and floodplains, version 2.0. U.S Department of the Interior, U.S. Fish and Wildlife Service, Portland, Oregon, USA.
744) Pool, D. B., A. O. Panjabi, A. Macias-Duarte, and D. M. Solhjem. 2014. Rapid expansion of croplands in Chihuahua, Mexico threatens declining North American grassland bird species. Biological Conservation 170:274–281.
745) Post, D. D. 1972. Species differentiation in the *Rana pipiens* complex. Dissertation, Colorado State University, Fort Collins, Colorado, USA.
746) Pounds, A., M. R. Bustamante, L. A. Coloma, J. A. Consuegra, M. P. Fogden, P. N. Foster, E. La Marca, K. L. Masters, A. Merino-Viteri, R. Puschendorf, and S. R. Ron. 2006. Widespread amphibian extinctions from epidemic disease driven by global warming. Nature 439(7073):161-167.
747) Price, A. H. 1985. Roadriding as a herpetofaunal collecting technique and its impact upon the herpetofauna of New Mexico. New Mexico Department of Game and Fish, Contract 519-72-07, Santa Fe, New Mexico, USA.
748) Price, J. P. 2002. Global warming and songbirds: New Mexico. American Bird Conservancy, Boulder, Colorado, USA.
749) Propst, D. L., A. L. Hobbes, and T. L. Stroh. 2001. Distribution and notes on Zuni bluehead sucker, *Catostomus discobolus yarrowi*, in New Mexico. Southwestern Naturalist 46:158-170.
750) Propst, D. L., and J. A. Stefferud. 1994. Distribution and status of the Chihuahua chub (Teleostei: Cyprinidae: *Gila nigrescens*), with notes on its ecology and associated species. Southwestern Naturalist 39:224-234.
751) Propst, D. L., and J. A. Stefferud. 1997. Population dynamics of Gila trout in the Gila River drainage of the southwestern United States. Journal of Fish Biology 51:1137-1154.
752) Propst, D. L., and K. R. Bestgen. 1991. Habitat and biology of the loach minnow, *Tiaroga cobitis*, in New Mexico. Copeia 1991:29-38.

753) Propst, D. L., K. R. Bestgen, and C. W. Painter. 1986. Distribution, status, biology, and conservation of the spikedace (*Meda fulgida*) in New Mexico. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Endangered Species Report 15, Albuquerque, New Mexico, USA.
754) Propst, D. L., K. R. Bestgen, and C. W. Painter. 1988. Distribution, status, biology, and conservation of the loach minnow (*Tiaroga cobitis*) in New Mexico. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Endangered Species Report 17, Albuquerque, New Mexico, USA.
755) Propst, D. L., W. H. Brandenburg, A. L. Hobbes, and P. C. Marsh, editors. 1999. Threatened and Endangered fishes of New Mexico. New Mexico Department of Game and Fish, Technical Report 1, Santa Fe, New Mexico, USA.
756) Ptacek, J. A., D. E. Rees, and W. J. Miller. 2005. Bluehead sucker (*Catostomus discobolus*): a technical conservation assessment. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Region, Lakewood, Colorado, USA.
757) Puckett, E. E., S. Murphy, and G. Bradburd. 2019. A population genomic assessment of subspecies status and range stability of Peñasco least chipmunk within the context of range-wide demographic history. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
758) Puckett, S. L., and C. van Riper III. 2014. Influences of the tamarisk leaf beetle (*Diorhabda carinulata*) on the diet of insectivorous birds along the Dolores River in southwestern Colorado. U.S. Department of the Interior, U.S. Geological Survey, Reston, Virginia, USA.
759) Quigley, H., R. Foster, L. Petracca, E. Payan, R. Salom, and B. Harmsen. 2017. *Panthera onca*. The International Union of Conservation of Nature redllist of Threatened species. <https://www.iucnredlist.org/species/>
760) Racey P. A. 1972. Aspects of reproduction in some heterothermic bats. Dissertation, University of London, London, GBR.
761) Racey P. A. 1973. Environmental factors affecting the length of gestation in heterothermic bats. Journal of Reproductive Fertility 19:175–189.
762) Racey P. A., and S. M. Swift. 1981. Variations in gestation length in a colony of pipistrelle bats (*Pipistrellus pipistrellus*) from year to year. Journal of Reproductive Fertility 61:123–129.
763) Radke, M. F. 2001. Ecology of the barking frog (*Eleutherodactylus augusti*) at Bitter Lake National Wildlife Refuge, New Mexico. New Mexico Department of Game and Fish, Share with Wildlife Program, Contract 98-516.53, Santa Fe, New Mexico, USA.
764) Rahel, F. J., B. Bierwagen, and Y. Taniguchi. 2008. Managing aquatic species of conservation concern in the face of climate change and invasive species. Conservation Biology 22(3):551–561.
765) Rahel, F. J., and J. D. Olden. 2008. Assessing the effects of climate change on aquatic invasive species. Conservation Biology 22(3):521-533.
766) Ramotnik, C. A. 1986. Status report *Plethodon neomexicanus* (Stebbins and Reimer) Jemez Mountains salamander. U.S. Department of the Interior, U.S. Fish and Wildlife Service, National Ecology Center, Fort Collins, Colorado, USA.

767) Ramsey, M., and R. D. Jennings. 1998. Bat inventory of the Black Range, Mimbres Mountains and Mogollon Mountains, New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
768) Rayner, L. S. 1985. Dynamics of a plague outbreak in Gunnison's prairie dog. Journal of Mammalogy 66:194-196.
769) Rayor, L. S., A. K. Brody, and C. Gilbert. 1987. Hibernation in the Gunnison's prairie dog. Journal of Mammalogy 68(1):147–50.
770) Redder, A. J., C. K. Dodd Jr., and D. Keinath. 2006. Ornate box turtle (*Terrapene ornata ornata*): a technical conservation assessment. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Region, Fort Collins, Colorado, USA.
771) Reed, R. N., and J. W. Gibbons. 2003. Conservation status of live U.S. nonmarine turtles in domestic and international trade. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Fort Collins, Colorado, USA.
772) Rees, D. E., R. J. Carr, and W. J. Miller. 2005a. Plains minnow (*Hybognathus placitus*): a technical conservation assessment. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Region, Fort Collins, Colorado, USA.
773) Rees, D. E., R. J. Carr, and W. J. Miller. 2005b. Rio Grande chub (*Gila pandora*): a technical conservation assessment. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Region, Fort Collins, Colorado, USA.
774) Rees, D. E., and W. J. Miller. 2005. Rio Grande sucker (*Catostomus plebius*): a technical conservation assessment. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Region, Fort Collins, Colorado, USA.
775) Regan, G. T. 1972. Natural and man-made conditions determining the ranges of *Acris crepitans* in the Missouri River basin. Dissertation, University of Kansas, Lawrence, Kansas, USA.
776) Reynolds, M. C., and P. R. Krausman. 1998. Effects of winter burning on birds in mesquite grassland. Wildlife Society Bulletin 26(4):867-876.
777) Reynolds, R. T., and B. D. Linkhart. 1998. Flammulated owl (*Otus flammeolus*). Pages 140-144 *in* R. L. Glinski, editor. Raptors of Arizona. University of Tucson Press, Tucson, Arizona, USA.
778) Reynolds, R. T., R. T. Graham, M. H. Reiser, R. L. Bassett, P. L. Kennedy, D. A. Boyce Jr., G. Goodwin, R. Smith, and E. L. Fisher. 1992. Management recommendations for the Northern goshawk in the southwestern United States. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-217, Fort Collins, Colorado, USA.
779) Reynolds, T. D., T. D. Rich, and D. A. Stephens. 2020. Sage thrasher (*Oreoscoptes montanus*), version 1.0. *In* Birds of the world. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.sagthr.01>
780) [RGC and RGS] Rio Grande Chub and Rio Grande Sucker Conservation Team. 2018. Conservation agreement for Rio Grande chub and Rio Grande sucker. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

781) Richgels, K. L., R. E. Russell, M. J. Adams, C. L. White, and E. H. C. Grant. 2016. Spatial variation in risk and consequence of *Batrachochytrium salamandrivorans* introduction in the USA. Royal Society Open Science 3(2):150616.
782) Riedle, J. D., P. C. Rosen, R. T. Kazmaier, P. Holm, and C. A. Jones. 2012. Conservation status of an endemic kinosternid, *Kinosternon sonoriense longifemorale*, in Arizona. Chelonian Conservation and Biology 11(2):182-189.
783) Rinne, J. N. 1976. Cyprinid fishes of the genus *Gila* from the lower Colorado River basin. Wassman Journal of Biology 34:65-107.
784) Rinne, J. N. 1989. Physical habitat use by loach minnow, *Tiaroga cobitus* (Pisces: Cyprinidae), in southwestern desert streams. Southwestern Naturalist 34:109-17.
785) Rinne, J. N. 1992. Physical habitat utilization of fish in a Sonoran Desert stream, Arizona, southwestern United States. Ecology of Freshwater Fish 1(1):35-41.
786) Rinne, J. N. 1995. Rio Grande cutthroat trout. Pages 24-27 *in* M. K. Young, editor. Conservation assessment for inland cutthroat trout. U.S. Department of Agriculture, U.S. Forest Service, General Technical Report RM-GTR-256, Fort Collins, Colorado, USA.
787) Rinne, J. N. 2004. Forests, fish and fire: relationships and management implications for fishes in the southwestern USA. Pages 151-156 *in* G. J. Scrimgeour, G. Eisler, B. McCulloch, U. Silins, and M. Monita, editors. Forest land–fish conference II: ecosystem stewardship through collaboration. Edmonton, Alberta, CAN.
788) Rinne, J. N., and C. D. Carter. 2008. Short-term effects of wildfires on fishes in the southwestern United States, 2002: management implications. *In* Proceedings of the 2002 fire conference: managing fire and fuels in the remaining wildlands and open spaces of the southwestern United States. U.S. Department of Agriculture, U.S. Forest Service, General Technical Report PSW-GTR-189, Albany, California, USA.
789) Rinne, J. N., and W. L. Minckley. 1991. Native fishes of arid lands: a dwindling resource of the desert southwest. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, USA.
790) Rödder D, M. Veith, and S. Lötters. 2008. Environmental gradients explaining the prevalence and intensity of infection with the amphibian chytrid fungus: the host's perspective. Animal Conservation 11:513–517.
791) Rogowitz, G. L. 1992. Reproduction of white-tailed jackrabbits on semi-arid range. Journal of Wildlife Management 56(4):676-684.
792) Rogowski, D., and C. A. Stockwell. 2006a. Assessment of the potential impacts of exotic species on populations of White Sands pupfish, *Cyprinodon tularosa*. Biological Invasions 18:79-87.
793) Rogowski, D., and C. A. Stockwell. 2006b. Parasites and salinity: costly tradeoffs in a threatened species. Oecologia 146:615-622.
794) Romero, A. 2001. Scientists prefer them blind: the history of hypogean fish research. Environmental Biology of Fishes 62(1-3):43-71.
795) Rongstad, O. J. 1965. A life history study of thirteen-lined ground squirrels in southern Wisconsin. Journal of Mammalogy 46(1):76-87.

796) Rorabaugh, J. C. 2020. *Tantilla yaquia*, Yaqui black-headed snake. Pages 383-387 *in* A. T. Holycross and M. J. Mitchell, editors. Snakes of Arizona. ECO Publishing, Rodeo, New Mexico, USA.
797) Rorabaugh, J. C., and J. A. Lemos Espinal. 2016. A field guide to the amphibians and reptiles of Sonora, Mexico. ECO Herpetological Publishing and Distribution, Rodeo, New Mexico, USA.
798) Rosen, P. C. 1991. Comparative ecology and life history of the racer (*Coluber constrictor*) in Michigan. Copeia 1991(4):897-909.
799) Rosen, P. C., and C. R. Schwalbe. 1988. Status of the Mexican and narrow-headed garter snakes (*Thamnophis eques megalops* and *Thamnophis rufipunctatus rufipunctatus*) in Arizona. Arizona Game and Fish Department, Phoenix, Arizona, USA.
800) Rosen, P. C., S. S. Sartorius, C. R. Schwalbe, P. A. Holm, and C. H. Lowe. 1996. Herpetology of the Sulphur Springs valley, Cochise County, Arizona. Pages 65-80 *in* B. Tellman, D. M. Finch, C. Edminster and R. Hamre, editors. The future of arid grasslands: identifying issues, seeking solutions. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Field Station, Fort Collins, Colorado, USA.
801) Rosenberg, K. V, A. M. Dokter, P. J. Blancher, J. R. Sauer, A. C. Smith, P. A. Smith, J. C. Stanton, A. Panjabi, L. Helft, M. Parr, P. P. Marra. 2019. Decline of the North American avifauna. Science 366:120-124.
802) Rosenberg, K. V., J. A. Kennedy, R. Dettmers, R. P. Ford, D. Reynolds, J. D. Alexander, C. J. Beardmore, P. J. Blancher, R. E. Bogart, G. S. Butcher, A. F. Camfield, A. Couturier, D. W. Demarest, W.E. Easton, J. J. Giocomo, R. H. Keller, A. E. Mini, A. O. Panjabi, D. N. Pashley, T. D. Rich, J. M. Ruth, H. Stabins, J. Stanton, and T. Will. 2016. Partners in Flight landbird conservation plan: 2016 revision for Canada and continental United States. Partners in Flight Science Committee. Ithaca, New York, USA.
803) Rossman, D. A., N. B. Ford, and R. A. Seigel. 1996. The garter snakes: evolution and ecology. University of Oklahoma Press, Norman, Oklahoma, USA.
804) Rotenberry, J. T., M. A. Patten, and K. L. Preston. 1999. Brewer's sparrow (*Spizella breweri*). *In* A. Poole and F. Gill, editors. The birds of North America 390. Philadelphia, Pennsylvania, USA. <https://doi.org/10.2173/bna.390>
805) Russell, A., and J. Harden. 2009. The RAVEN Project. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.
806) Russell, R. E., D. W. Tripp, and T. E. Rocke. 2019. Differential plague susceptibility in species and populations of prairie dogs. Ecology and evolution 9(20):11962-11971.
807) Ryan, M. J., I. M. Latella, J. T. Giermakowski, B. Christman, R. D. Jennings, and J. L. Voyles. 2015a. First record of *Batrachochytrium dendrobatidis* in the Arizona toad (*Anaxyrus microscaphus*) in southwestern New Mexico, USA. Herpetological Review 45:606-618.
808) Ryan, M. J., I. M. Latella, J. T. Giermakowski, and H. L. Snell. 2014. Current status of the Arizona toad (*Anaxyrus microscaphus*) in New Mexico: identification and evaluation of potential threats to its persistence. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

809) Ryan, M. J., I. M. Latella, J. T. Giermakowski, and H. L. Snell. 2015b. Status of barking frog (*Craugastor augusti*) in New Mexico: final report. New Mexico Department of Game and Fish, Share with Wildlife Program, Contract 150422, Santa Fe, New Mexico, USA.
810) Ryan, M. J., J. T. Giermakowski, I. M. Latella, and H. L. Snell. 2017. Status of the Arizona toad (*Anaxyrus microscaphus*) in New Mexico. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.
811) Ryberg, W. A., J. A. Harvey, A. Blick, T. J. Hibbitts, and G. Voelker. 2015. Genetic structure is inconsistent with subspecies designations in the western massasauga (*Sistrurus tergeminus*). Journal of Fish and Wildlife Management 6(2):350-359.
812) Ryberg, W. A., M. T. Hill, C. W. Painter, and L. A. Fitzgerald. 2014. Linking irreplaceable landforms in a self-organizing landscape to sensitivity of population vital rates for an ecological specialist. Conservation Biology 29(3):888-898.
813) Ryder, R. A., D. A. Palmer, and J. J. Rawinski. 1987. Distribution and status of boreal owl in Colorado. Pages 169-173 *in* R.W. Nero, R. J. Clark, R. J. Knapton, and R. H. Hamre, editors. Biology and conservation of northern forest owls: symposium proceedings, Manitoba, Canada. U.S. Department of Agriculture, U.S. Forest Service, General Technical Report RM-142, Fort Collins, Colorado, USA.
814) Ryser, F. A. 1985. Birds of the Great Basin: a natural history. University of Nevada Press, Reno, Nevada, USA.
815) Saab, V. A., and J. G. Dudley. 1998. Responses of cavity-nesting birds to stand-replacement fire and salvage logging in ponderosa pine/Douglas-fir forests of southwestern Idaho. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountains Research Station, Fort Collins, Colorado, USA.
816) Sabath, M. 1960. *Sceloporus g. graciosus* in southern New Mexico and Texas. Herpetologica 16(1):22.
817) Sackett, L. C, S. K. Collinge, and A. P. Martin. 2013. Do pathogens reduce genetic diversity of their hosts? Variable effects of sylvatic plague in black tailed prairie dogs. Molecular Ecology 22(9):2441-2445.
818) Sadoti, G. 2008. Nest-site selection by common black-hawks. Journal of Field Ornithology 79(1):11-19.
819) Salas, A., and M. Desmond. 2019. Bendire's thrasher and juvenile survival in relation to vegetation characteristics in the southwest United States. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.
820) Salas, E. A. L., V. A. Seamster, N. M. Harings, K. G. Boykin, G. Alvarez, and K. W. Dixon. 2017a. Projected future bioclimate-envelope suitability for reptile and amphibian species of concern in south central USA. Herpetological Conservation and Biology 12(2):522-547.
821) Salas, E. A., V. A. Seamster, K. G. Boykin, N. M. Harings, and K. W. Dixon. 2017b. Modeling the impacts of climate change on species of concern (birds) in south central U.S. based on bioclimatic variables. AIMS Environmental Science 4(2):358-385.
822) Sallabanks, R., and J. D. McIver. 1998. Response of breeding bird communities to wildfire in the Oregon Blue Mountains: the first three years following the Twin Lakes fire, 1995–1997. Pages 85-89 *in* Fire and wildlife in the Pacific northwest: research, policy and

management, proceedings of the annual meeting of the northwest section of The Wildlife Society. Oregon State University Printing, Corvallis, Oregon, USA.
823) Salt, G. W. 1952. Relation of metabolism to climate and distribution in finches. Ecological Monographs 22:121-152.
824) Samson, F. B. 1976. Territory, breeding density, and fall departure in Cassin's finch. The Auk 93(3):477-497.
825) Sanders, T. A., and R. L. Jarvis. 2000. Do band-tailed pigeons seek a calcium supplement at mineral sites? Condor 102:855-863.
826) Sanderson, G. C., editor. 1977. Management of migratory shore and upland game birds in North America. International Association of Fish and Wildlife Agencies, Washington, D.C., USA.
827) Sands, J. L. 1968. Status of the lesser prairie chicken. Audubon Field Notes 22(3):454-456.
828) Sauer, J. R., and S. Droege. 1992. Geographical patterns in population trends of neotropical migrants in North America. Pages 26-42 *in* J. M. Hagan III and D. W. Johnston, editors. Ecology and conservation of neotropical migrant landbirds. Smithsonian Institution Press, Washington, D.C., USA.
829) Sauer, J. R., D. K. Niven, J. E. Hines, D. J. Ziolkowski Jr., K. L. Pardieck, J. E. Fallon, and W. A. Link. 2017. The North American breeding bird survey, results and analysis 1966 to 2015, version 2.07.2017. U.S. Department of the Interior, U.S. Geological Survey, Patuxent Wildlife Research Center, Laurel, Maryland, USA.
830) Sauer, J. R., D. K. Niven, J. E. Hines, D. J. Ziolkowski Jr., K. L. Pardieck, J. E. Fallon, and W. A. Link. 2019. The North American breeding bird survey, results and analysis 1966–2019, version 2.07.2019. U.S. Department of the Interior, U.S. Geological Survey, Patuxent Wildlife Research Center, Laurel, Maryland, USA.
831) Sauer, J. R., J. E. Hines, G. Gough, I. Thomas, and B. G. Peterjohn. 1997. The North American breeding bird survey results and analysis, version 96.3. U.S. Department of the Interior, U.S. Geological Survey, Patuxent Wildlife Research Center, Laurel, Maryland, USA.
832) Sauer, J. R., J. E. Hines, and J. Fallon. 2003. The North American breeding bird survey, results and analysis 1966 - 2002, version 2003.1. U.S. Department of the Interior, U.S. Geological Survey, Patuxent Wildlife Research Center, Laurel, Maryland, USA.
833) Sauer, J. R., J. E. Hines, and J. Fallon. 2006. The North American breeding bird survey: results and analysis 1966-2005, version 6.2.2006. U.S. Department of the Interior, U.S. Geological Survey, Patuxent Wildlife Research Center, Laurel, Maryland, USA.
834) Sauer, J. R., W. A. Link, and J. E. Hines. 2020. The North American breeding bird survey, analysis results 1966 to 2019: U.S. Geological Survey data release. U.S. Department of the Interior, U.S. Geological Survey, Patuxent Wildlife Research Center, Laurel, Maryland, USA.
835) Savage, A. E., M. J. Sredl, and K. R. Zamudio. 2011. Disease dynamics vary spatially and temporally in a North American amphibian. Biological Conservation 144:1910-1915.
836) Scheurer, J. A., K. R. Bestgen, and K. D. Fausch. 2003. Resolving taxonomy and historic distribution for conservation of rare Great Plains fishes: *Hybognathus* (Teleostei: Cyprinidae) in eastern Colorado basins. Copeia 2003:1-12.

837) Schloss, C. A., T. A. Nuñez, and J. J. Lawler. 2012. Dispersal will limit ability of mammals to track climate change in the western Hemisphere. Proceedings of the National Academy of Sciences 109(22):8606-8611.
838) Schmidly, D. J. 1977. The mammals of the Trans-Pecos Texas including Big Bend National Park and Guadalupe Mountains National Park. Texas A&M University Press, College Station, Texas, USA.
839) Schmidly, D. J., and R. D. Bradley, editors. 2016. The mammals of Texas. Seventh edition. University of Texas Press, Austin, Texas, USA.
840) Schmidt, J. O. 1989. Special biotic relationships in the arid southwest. University of New Mexico Press, Albuquerque, New Mexico, USA.
841) Schmidt, K. P., and D. D. Davis. 1941. Field book of snakes of the United States and Canada. G. P. Putnam's Sons, New York, New York, USA.
842) Schmitt, C. G. 1976. Summer birds of the San Juan Valley, New Mexico. New Mexico Ornithological Society Publication 4.
843) Schmitt, G. 1997. Personal communication. New Mexico Department of Game and Fish, Endangered Species Biologist, Santa Fe, New Mexico, USA.
844) Schönhuth, S., A. Perdices, L. Lozano-Vilano, F. J. García-de-León, H. Espinosa, and R. L. Mayden. 2014. Phylogenetic relationships of North American western chubs of the genus *Gila* (Cyprinidae, Teleostei), with emphasis on southern species. Molecular Phylogenetics and Evolution 70:210-230.
845) Schönhuth, S., D. M. Hillis, D. A. Neely, L. Lozano-Vilano, A. Perdices, and R. L. Mayden. 2012. Phylogeny, diversity, and species delimitation of the North American round-nosed minnows (Teleostei: Dionda), as inferred from mitochondrial and nuclear DNA sequences. Molecular Phylogenetics and Evolution 62:427-446.
846) Schroeder, M. H., and D. L. Sturges. 1975. The effect on the Brewer's sparrow of spraying big sagebrush. Journal of Range Management 28:294-297.
847) Schwalbe, C. R., and P. C. Rosen. 1988. Preliminary report on effect of bullfrogs on wetland herpetofaunas in southeastern Arizona. Pages 166-173 *in* Management of amphibians, reptiles, and small mammals in North America: symposium proceedings. U.S. Fish and Wildlife Service, Western Ecological Research Center, Flagstaff, Arizona, USA.
848) Schwarz, H. R. 1995. Birds of the Sandia and Manzanita Mountains: checklist. U.S. Department of Agriculture, U.S. Forest Service, Cibola National Forest, Sandia Ranger District, Albuquerque, New Mexico, USA.
849) Schweiger, B. R., and J. K. Frey. 2021. Weather determines daily activity pattern of an endemic chipmunk with predictions for climate change. Climate Change Ecology 2:100027.
850) Schweiger, B. R., J. K. Frey, and J. W. Cain III. 2021. A case for multiscale habitat selection studies of small mammals. Journal of Mammalogy 102(5):1249–1265.
851) Scott, V. E., K. E. Evans, D. R. Patton and C. P. Stone. 1977. Cavity-nesting birds of North American forests. U.S. Department of Agriculture U.S. Forest Service Agriculture Handbook 511. U.S. Government Printing Office, Washington, D.C., USA.
852) Scott, W. B., and E. J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin 184.

853) Seager, R., M. Ting, I. Held, Y. Kushnir, J. Lu, G. Vecchi, H. Huang, N. Harnik, A. Leetmaa, N. Lau, C. Li, J. Velez, and N. Naik. 2007. Model projections of an imminent transition to a more arid climate in southwestern North America. Science 10:1126.
854) Sena, A. P. 1978. Temperature relations and the critical thermal maximum of *Holbrookia maculata maculata* (Reptilia: Iguanidae). The Southwestern Naturalist 23(1):41-50.
855) Sena, A. P. 1984. The distribution and reproductive ecology of *Sceloporus raciosus arenicolous* in southeastern New Mexico. Dissertation, University of New Mexico, Albuquerque, New Mexico, USA.
856) Shenk, T. M. 2007. Wildlife research report: post release monitoring of lynx (*Lynx canadensis*) reintroduced to Colorado. Colorado Division of Wildlife, Denver, Colorado, USA.
857) Shook, R. 2017. The Gila River bird habitat management unit: an analysis of avian populations mid-May 1996 through August 2016. U.S. Department of Agriculture, U.S. Forest Service, Gila National Forest, Silver City, New Mexico, USA.
858) Shuster. C. 1990. Report for research on genetic and historical biogeographic relationships among western peripheral populations of the least shrew (*Cryptotis parva*). New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
859) Sias, D. S. 1996. Personal communication. University of New Mexico, Herpetologist. Albuquerque, New Mexico, USA.
860) Sibley, D. A. 2014. The Sibley guide to birds. Second edition. Alfred A. Knopf, New York, New York, USA.
861) Sievert, N., C. Paukert, J. Whittier, W. Daniel, D. Infante, and J. Stewart. 2022. Projected stream fish community risk to climate impacts in the northeastern and midwestern United States. Ecological Indicators 144:109493.
862) Sievert, P. R., and L. B. Keith. 1985. Survival of snowshoe hares at a geographic range boundary. Journal of Wildlife Management 49(4):854-866.
863) Sigler, W. F., and J. W. Sigler. 1996. Fishes of Utah: a natural history. University of Utah Press, Salt Lake City, Utah, USA.
864) Simms, D. A. 1979. Studies of an ermine population in southern Ontario. Canadian Journal of Zoology 57(4):Ryan et al. 2017-832.
865) Simpson, M. B., Jr. 1978. Ecological factors contributing to the decline of Bewick's wren as a breeding species in the southern Blue Ridge Mountain province. Chat 42:25-28.
866) Sinervo, B., F. Mendez-De-La-Cruz, D. B. Miles, B. Heulin, E. Bastiaans, M. Villagrán-Santa Cruz, R. Lara-Resendiz, N. Martínez-Méndez, M. L. Calderón-Espinosa, R. N. Meza-Lázaro, and H. Gadsden. 2010. Erosion of lizard diversity by climate change and altered thermal niches. Science 328(5980):894-899.
867) Skaggs, R. W. 1996. The common black-hawk (*Buteogallus anthracinus*) in southwestern New Mexico, 1994-95 inventories. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
868) Small, B. A., J. K. Frey, and C. C. Gard. 2016. Livestock grazing limits beaver restoration in northern New Mexico. Restoration Ecology 24(5):646-655.

869) Smallwood, J. A., M. Woodrey, N. J. Smallwood, and M. A. Kettler. 1982. Foraging by cattle egrets and American kestrels at a fire's edge. Journal of Field Ornithologists 53(2):171-172.
870) Smith, A. T. 1974. The distribution and dispersal of pikas: influences of behavior and climate. Ecology 55(6):1368-1776.
871) Smith, D. M., and D. M. Finch. 2017. Climate change and wildfire effects in aridland riparian ecosystems: an examination of current and future conditions. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado, USA.
872) Smith, G. R. 1966. Distribution and evolution of the North American Catostomid fishes of the subgenus *Pantosteus*, Genus *Catostomus*. Miscellaneous Publications, University of Michigan, Museum of Zoology129:140.
873) Smith, H. M., C. E. Bock, and J. H. Bock. 1990. Notes on reproduction and coloration in the bunchgrass lizard, *Sceloporus scalaris*, in southeastern Arizona. Bulletin of the Maryland Herpetological Society 26(2):64-67.
874) Snell, H. L., and A. Landwer. 1991. Results of preliminary research on the effect of shinnery oak removal on the sand dune lizard, *Sceloporus graciosus arenicolous*, in New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
875) Snow, C. 1973. Habitat management series for Endangered species: golden eagle. U.S. Department of the Interior, U.S. Bureau of Land Management, Report 7, Washington, D.C., USA.
876) Snow, C. 1974. Ferruginous hawk. U.S. Department of the Interior, U.S. Bureau of Land Management, Technical Report 14. Denver, Colorado, USA.
877) Snow, T. K., S. V. Castner, and D. C. Noel. 1993. Bat inventory of abandoned mines: U.S. Bureau of Land Management, Phoenix District. Arizona Game and Fish Department, Phoenix, Arizona, USA.
878) Snyderman, D. 1995. Element conservation plan for *Rana chiricahuensis*, the Chiricahua leopard frog. Nature Conservancy, Santa Fe Chapter, Santa Fe, New Mexico, USA.
879) Somershoe, S. G. 2018. A full annual-cycle conservation strategy for Sprague’s pipit, chestnut-collared and McCown’s longspurs, and Baird’s sparrow. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Washington, D.C., USA.
880) Spencer, A. W. 1964. The relationship of dispersal and migration to gene flow in the boreal chorus frog. Dissertation, Colorado State University, Fort Collins, Colorado, USA.
881) Spofford, W. R. 1971. The golden eagle: rediscovered. Conservationist 26(1):6-8.
882) Squires, J., J. Holbrook, L. Olson, J. Ivan, and R. Ghormley. 2017. Response of Canada lynx and snowshoe hares to spruce-beetle tree mortality and wildfire in spruce-fir forests of southern Colorado: progress report. U.S. Department of Agriculture, U.S. Forest Service, Rio Grande National Forest, Monte Vista, Colorado, USA.
883) Stahlecker, D. W., P. L. Kennedy, A. C. Cully, and C. B. Kuykendall. 1989. Breeding bird assemblages in the Rio Grande Wild and Scenic River Recreation Area, New Mexico. The Southwestern Naturalist 34(4):487-498.
884) Stahlecker, D. W., and R. B. Duncan. 1996. The boreal owl at the southern terminus of the Rocky Mountains: undocumented longtime resident or recent arrival? Condor 98:153-161.

885) Stalling, D. T. 1990. *Microtus ochrogaster*. Mammalian Species 355:1-9.
886) Stanek, J. E., S. E. McNeil, D. Tracy, J. R. Stanek, J. A. Manning, and M. D. Halterman. 2021. Western yellow-billed cuckoo nest site selection and success in restored and natural riparian forests. The Journal of Wildlife Management. 85(4):782-793.
887) Stanford, K. M., and R. B. King. 2004. Growth, survival, and reproduction in a northern Illinois population of the plains gartersnake, *Thamnophis radix*. Copeia 2004:465-478.
888) Starnes, W. C. 1995. Taxonomic validation for fish species on the U.S. Fish and Wildlife Service category 2 species list. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Washington, D.C., USA
889) Starrett, W. C. 1951. Some factors affecting the abundance of minnows in the Des Moines River, Iowa. Ecology 32(1):13-27.
890) Stebbins, R. C. 1985. A field guide to western reptiles and amphibians. Second edition. Houghton Mifflin Company, Boston, Massachusetts, USA.
891) Stebbins, R. C. 2003. A field guide to western reptiles and amphibians. Third edition. Houghton Mifflin Company, Boston, Massachusetts, USA.
892) Steenhof, K. 2020. Prairie falcon (*Falco mexicanus*). *In* A. F. Poole, editor. Birds of the world, version 1.0. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.prafal.02>
893) Stewart, R. M., R. P. Henderson, and K. Darling. 1978. Breeding ecology of the Wilson's warbler in the high Sierra Nevada, California. Living Bird 16:83-102.
894) Stickel, L. 1978. Changes in a box turtle population during three decades. Copeia 1978(2):221-225.
895) Stille, W. T. 1954. Observations on the reproductions and distribution of the green snake, *Opheodrys vernalis* (Harlan). Natural History Miscellanea 127:1-111.
896) Stinson, N., Jr. 1977. Home range of the western jumping mouse, *Zapus princeps*, in the Colorado Rocky Mountains. Great Basin Naturalist 37:87-90.
897) Stockrahm, D. M., L. E. Schmitz, J. R. Gerads, D. E. Welberg Canfield, and K. L. Andrew. 1995. Ecology of the northern grasshopper mouse (*Onychomys leucogaster*) and prairie vole (*Microtis ochrogaster*) in Clay County, Minnesota. Minnesota Department of Natural Resources, Wildlife Populations and Research Unit, St. Paul, Minnesota, USA.
898) Stockwell, C., and M. Mulvey. 1996. Genetic population structure of the White Sands pupfish (*Cyprinodon tularosa*). Report to Holloman Air Force Base and the White Sands Pupfish Conservation Team. University of Georgia, Savanna River Ecology Laboratory, Aiken, South Carolina, USA.
899) Stoddard, H. L., Sr. 1963. Bird habitat and fire. Pages 163-175 *in* Proceedings, 2nd annual Tall Timbers fire ecology conference. Tall Timbers Research Station, Tallahassee, Florida, USA.
900) Stone, P. A., M. E. Babb, B. D. Stanila, G. W. Kersey, and Z. S. Stone. 2005a. Sonoran mud turtle (*Kinosternon sonoriense*). Diet. Herpetological Review 36(2):167-168.
901) Stone, P. A., J. D. Congdon, M. E. B. Stone, J. N. Stuart, J. B. Iverson, and P. C. Rosen. 2022. *Kinosternon sonoriense* (LeConte 1854): Sonora mud turtle, desert mud turtle, Sonoyta mud turtle, Casquito de Sonora. Pages 1-22 i*n* A. G. J. Rhodin, J. B. Iverson, P. P. van Dijk, C. B. Stanford, E. V. Goode, K. A. Buhlmann, and R. A. Mittermeier, editors. Conservation

biology of freshwater turtles and tortoises: a compilation project of the International Union for Conservation of Nature/Species Survival Commission tortoise and freshwater turtle specialist group. Chelonian Research Foundation and Turtle Conservancy, Arlington, Vermont, USA.

902) Stone, P. A., M. E. Babb, B. D. Stanila, G. W. Kersey, and Z. S. Stone. 2005b. Sonoran mud turtle (*Kinosternon sonoriense*). Diet. Herpetological Review 36(3):312.

903) Storer, R. W. 1961. A hybrid between the painted and varied buntings. Wilson Bulletin 73:209.

904) Streubel, D. P., and L. P. Fitzgerald. 1978. *Spermophilus tridecemlineatus*. Mammalian Species 103:1-5.

905) Strickland, M. A., C. W. Douglas, M. Novak, and N. P. Hunziger. 1982. Marten (*Martes americana*). Pages 599-612 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, editors. Wild mammals of North America: biology, management, and conservation. First edition. Johns Hopkins University Press, Baltimore, Maryland, USA.

906) Stuart, J. N. 1992. Preliminary status survey of the Great Plains narrowmouth toad (*Gastrophryne olivacea*) in New Mexico: final report. New Mexico Department of Game and Fish, Contract 80-519-40, Santa Fe, New Mexico, USA.

907) Stuart, J. N. 1993. Progress report of surveys of state Endangered amphibians in New Mexico, II: the Great Plains narrowmouth toad, *Gastrophryne olivacea*. New Mexico Department of Game and Fish, Contract 94-516-4, Santa Fe, New Mexico, USA.

908) Stuart, J. N. 1996. Review of species account. The University of New Mexico, Museum of Southwestern Biology, Albuquerque, New Mexico, USA.

909) Stuart, J. N. 1998. Natural history aspects of the Big Bend slider, *Trachemys gaigeae*, in New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA and U.S. Department of the Interior, U.S. Fish and Wildlife Service, Bosque del Apache National Wildlife Refuge, Socorro, New Mexico, USA.

910) Stuart, J. N., and J. P. Ward. 2009. *Trachemys gaigeae* (Hartweg 1939): Big Bend slider, Mexican plateau slider, Jicotea de la Meseta Mexicana. Pages 32.1-32.12 in A. G. J. Rhodin, P. C. H. Pritchard, P. P. van Dijk, R. A. Sumure, K. A. Buhlmann, J. B. Iverson, and R. A. Mittermeier, editors. Conservation biology of freshwater turtles and tortoises: a compilation project of the International Union of Conservation of Nature/Species Survival Commission tortoise and freshwater turtle specialist group. Chelonion Research Monographs 5.

911) Sublette, J. E., M. D Hatch, and M. Sublette. 1990. The fishes of New Mexico. University New Mexico Press, Albuquerque, New Mexico, USA.

912) Sullivan, B. K., and K. B. Malmos. 1994. Call variation in the Colorado River toad (*Bufo alvarius*): behavioral and phylogenetic implications. Herpetologica 50(2):146-156.

913) Sullivan, K. A. 1989. Predation and starvation: age-specific mortality in juvenile juncos (*Junco phaenotus).* Journal of Animal Ecology 58:275-286.

914) Sullivan, K. A. 2020. Yellow-eyed Junco (*Junco phaeonotus*). *In* P. G. Rodewald, editor. Birds of the world, version 1.0. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.yeejun.01>

915) Sullivan, R. M. 1996. Genetics, ecology and conservation of montane populations of Colorado chipmunks (*Tamias quadrivittatus*). Journal of Mammalogy 77(4):951-975.

916) Suminski, R. R. 1977. Life history of the White Sands pupfish and distribution of *Cyprinodon* in New Mexico. Thesis, New Mexico State University, Las Cruces, New Mexico, USA.
917) Suriyamongkol, T., and I. Mali. 2019. Aspects of the reproductive biology of the Rio Grande cooter (*Pseudemys gorzugi*) on the Black River, New Mexico. Chelonian Conservation and Biology 18(2):187-194.
918) Swaim, K., and W. Boeing. 2008. Relating fish abundance and condition to environmental factors in desert sinkholes: final report. New Mexico State University, Las Cruces, New Mexico, USA.
919) Swain, T. A., and H. M. Smith. 1978. Communal nesting in *Coluber constrictor* in Colorado (Reptilia: Serpentes). Herpetologica 34(2):175-177.
920) Sweitzer, R. A., S. H. Jenkins, and J. Berger. 1997. Near-extinction of porcupines by mountain lions and consequences of ecosystem change in the Great Basin Desert. Conservation Biology 11(6):1407-1417.
921) Swinford, G. 1991. Progress report on the status of the mottled rock rattlesnake (*Crotalus lepidus lepidus*) in southeastern New Mexico. New Mexico Department of Game and Fish, Contract 80-516.6-04, Santa Fe, New Mexico, USA.
922) Sydeman, W. J., M. Guntert, and R. J. Balda. 1988. Annual reproductive yield in the cooperative pygmy nuthatch (*Sitta pygmaea*). Auk 105:70-77.
923) Szaro, R. C. 1989. Riparian forest and scrubland community types of Arizona and New Mexico. Desert Plants 9(3-4):70-138.
924) Szaro, R. C., and R. P. Balda. 1979a. Bird community dynamics in a ponderosa pine forest: studies in avian biology: number 3. Cooper Ornithological Society, Allen Press, Lawrence, Kansas, USA.
925) Szaro, R. C., and R. P. Balda. 1979b. Effects of harvesting ponderosa pine on nongame bird populations. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, USA.
926) Tanner, W. W. 1987. Lizards and turtles of western Chihuahua. Great Basin Naturalist 47:383-421.
927) Tatschl, J. L. 1967. Breeding birds of the Sandia Mountains and their ecological distributions. The Condor 69:479-490.
928) Taylor, D. 2011. Landscape level habitat assessments for bats and water resources on the Lincoln National Forest. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.
929) Taylor, D. A. R., and M. D. Tuttle. 2007. Water for wildlife: a handbook for ranchers and range managers. Bat Conservation International, Austin, Texas, USA, and U.S. Department of Agriculture, Washington, D.C., USA.
930) Taylor, M. A., and F. S. Guthery. 1980. Fall-winter movement and habitat use of lesser prairie chickens. Journal of Wildlife Management 44:521-524.
931) Tebaldi, C., D. Adams-Smith, and N. Heller. 2012. The heat is on: U.S. temperature trends. Climate Central, Princeton, New Jersey, USA.
932) Tennant, A. 1984. The snakes of Texas. Texas Monthly Press, Austin, Texas, USA.

933) Tenney, C. R. 1997. Black-chinned sparrow (*Spizella atrogularis*). Pages 1-20 i*n* A. Poole and F. Gill, editors. The birds of North America 270. Academy of Natural Sciences, Philadelphia, Pennsylvania, USA and American Ornithologists' Union, Washington, D.C., USA.
934) Terres, J. K. 1980. The Audubon Society encyclopedia of North American birds. A. A. Knopf, Inc., New York, New York, USA.
935) Texas Natural History Collections. 1997. North American freshwater fishes index (images, maps and information). University of Texas at Austin, Austin, Texas, USA.
936) Thomas, J. W. 1979. Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington. U.S. Department of Agriculture Agricultural Handbook 553. U.S. Department of Agriculture, U.S. Forest Service, Portland, Oregon, USA.
937) Thomsen, L. 1971. Behavior and ecology of burrowing owls on the Oakland Municipal Airport. The Condor 73(2):177-192.
938) Thut, R. N. 1970. Feeding habits of the dipper in southwestern Washington. The Condor 72:234-235.
939) Tipton, B. L. 2005. Snakes of the Americas: checklist and lexicon. Krieger Publishing Co., Malabar, Florida, USA.
940) Tobalske, B. W. 1997. Lewis' woodpecker (*Melanerpes lewisi*). Pages 1-28 i*n* A. Poole and F. Gill, editors. The birds of North America 284. Academy of Natural Sciences, Philadelphia, Pennsylvania, USA and American Ornithologists' Union, Washington, D.C., USA.
941) Tordoff, W. 1971. Environmental factors affecting gene frequencies in montane populations of the chorus frog, *Pseudacris triseriata*. Dissertation, Colorado State University, Fort Collins, Colorado, USA.
942) Torgersen, T. R., R. R. Mason, and R.W. Campbell. 1990. Predation by birds and ants on two forest insect pests in the Pacific northwest. Studies in Avian Biology 13:14-19.
943) Traphagen, M. 2011. Status of the white-sided jackrabbit of New Mexico. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.
944) Trost, C. H. 2020. Black-billed magpie (*Pica hudsonia*). *In* S. M. Billerman, editor. Birds of the world, version 1.0. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.bkbmag1.01>.
945) Truett, J., and M. Phillips. 2009. Beyond historic baselines: restoring Bolson tortoises to Pleistocene range. Ecological Restoration 27(2):144-151.
946) Turner, T. F., and W. D. Wilson. 2009. Conservation genetics of Zuni bluehead sucker (*Catostomus discobolus yarrowi*) in New Mexico. New Mexico Department of Game and Fish, Albuquerque, New Mexico, USA.
947) Tuttle, M. 1996. Responses from Bat Conservation International (BCI) to USFS Region 3. Report to U.S. Department of Agriculture, U.S. Forest Service, Region 3, Albuquerque, New Mexico, USA.
948) Twedt, D. J., and R. D. Crawford. 2020. Yellow-headed blackbird (*Xanthocephalus xanthocephalus*). *In* A. F. Poole and F. B. Gill, editors. Birds of the world, version 1.0. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.yehbla.01>.

949) Tweit, R. C., and C. W. Thompson. 2020. Pyrrhuloxia (*Cardinalis sinuatus*). *In* Birds of the world, version 1.0. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.pyrrhu.01>
950) Tweit, R. C., and J. C. Tweit. 2020. Cassin's kingbird (*Tyrannus vociferans*). *In* A. F. Poole and F. B. Gill, editors. Birds of the world, version 1.0. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.caskin.01>
951) [TWS] The Wildlife Society. 2023a. Highly pathogenic bird flu and unprecedented threat to wildlife. The Wildlife Society, Baltimore, Maryland, USA.
952) [TWS] The Wildlife Society. 2023b. White-nose syndrome discovered in Colorado. The Wildlife Society, Baltimore, Maryland, USA.
953) [TWS] The Wildlife Society. 2024. Bolson tortoise introduction boosted by federal agreement. The Wildlife Professional 18(1):11.
954) Tye, S. P., and K. Geluso. 2019. Day roosts of myotis (Mammalia: Chiroptera) in an arid riparian corridor in southwestern New Mexico. Western North American Naturalist 79(4):515-522.
955) [UDWR] Utah Division of Wildlife Resources. 1997. Utah sensitive species list. Utah Division of Wildlife Resources, Salt Lake City, Utah, USA.
956) [UDWR] Utah Division of Wildlife Resources. 2024. Utah Natural Heritage Program field guide. Utah Division of Wildlife Resources, Salt Lake City, Utah, USA.
957) Unmack, P. J., T. E. Dowling, N. J. Laitinen, C. L. Secor, R. L. Mayden, D. K. Shiozawa, and G. R. Smith. 2014. Influence of introgression and geological processes on phylogenetic relationships of western North American mountain suckers (*Pantosteus*, Catostomidae). PLOS ONE 9(3):e90061.
958) Ureña-Aranda, C. A., and A. E. de los Monteros. 2012. The genetic crisis of the Mexican Bolson tortoise (*Gopherus flavomarginatus*: Testudinidae). Amphibia-Reptilia 33(1):45-53.
959) Ureña-Aranda, C. A., O. Rojas-Soto, E. Martínez-Meyer, C. Yáñez-Arenas, R. Landgrave, R. Ramírez, and A. E. de los Monteros. 2015. Using range-wide abundance modeling to identify key conservation areas for the micro-endemic Bolson tortoise (*Gopherus flavomarginatus*). PLoS One 10(6):e0131452.
960) [USBR] U.S. Bureau of Reclamation. 2011. SECURE water act section 9503(c): reclamation climate change and water, report to congress. U.S. Department of the Interior, U.S. Bureau of Reclamation, Washington D.C., USA.
961) [USBR] U.S. Bureau of Reclamation. 2021. Calendar year 2020 report to the Pecos River commission. U.S. Department of the Interior, U.S. Bureau of Reclamation, Interior Region 7, Upper Colorado Basin, Albuquerque Area Office, Albuquerque, New Mexico, USA.
962) [USFS] U.S. Forest Service. 1981. Wildlife and fish habitat relationships. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Region, Denver, Colorado. USA.
963) [USFS] U.S. Forest Service. 1982. Wildlife and fish habitat relationships. U.S. Department of Agriculture, U.S. Forest Service, Denver, Colorado, USA.
964) [USFS] U.S. Forest Service. 1995. Bats of the Lincoln National Forest: a checklist. U.S. Department of Agriculture, U.S. Forest Service, Southwest Region, Albuquerque, New Mexico, USA.

965) [USFS] U.S. Forest Service. 2006. Birds of the Sandia and Manzano Mountains including the Manzanitas and the Gallinas Mountains. U.S. Department of Agriculture, U.S. Forest Service, Albuquerque, New Mexico, USA.
966) [USFS] U.S. Forest Service. 2017. Maintaining and improving habitat for hummingbirds in Arizona and New Mexico: a land manager's guide. U.S. Department of Agriculture, U.S. Forest Service, Southwest Region, Alburquerque, New Mexico, USA.
967) [USFS] U.S. Forest Service. 2020. Potential species of conservation concern, Carson National Forest, New Mexico. U.S. Department of Agriculture, U.S. Forest Service, Taos, New Mexico, USA.
968) [USFWS] U.S. Fish and Wildlife Service. 1967. Native fish and wildlife: Endangered species. Federal Register 32:4001.
969) [USFWS] U.S. Fish and Wildlife Service. 1980a. Biological inventory Zuni project: McKinley County, New Mexico. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA.
970) [USFWS] U.S. Fish and Wildlife Service. 1980b. Selected vertebrate Endangered species of the seacoast of the United States: the jaguar. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Washington, D.C., USA.
971) [USFWS] U.S. Fish and Wildlife Service. 1983. Endangered and Threatened wildlife and plants; Threatened status for *Gila nigrescens* (Chihuahua chub); final rule. Federal Register 48:46053-46057.
972) [USFWS] U.S. Fish and Wildlife Service. 1986a. Endangered and Threatened wildlife and plants; determination of Threatened status for the spikedace. Federal Register 51:23769-23781.
973) [USFWS] U.S. Fish and Wildlife Service. 1986b. Endangered and Threatened wildlife and plants; determination of Threatened status for the loach minnow. Federal Register 51:39468-39478.
974) [USFWS] U.S. Fish and Wildlife Service. 1987. Endangered and Threatened wildlife and plants; determination of Threatened status for the Pecos bluntnose shiner and designation of its critical habitat. Federal Register 52:5295-5303.
975) [USFWS] U.S. Fish and Wildlife Service. 1990. Endangered and Threatened wildlife and plants; proposal to determine the razorback sucker (*Xyrauchen texanus*) to be an Endangered species; proposed rule. Federal Register 55:21154-21161.
976) [USFWS] U.S. Fish and Wildlife Service. 1991. Endangered and Threatened wildlife and plants; animal candidate review for listing as Endangered or Threatened species; proposed rule. Federal Register 56(2):202-233.
977) [USFWS] U.S. Fish and Wildlife Service. 1993. Status report on blue sucker (*Cycleptus elongatus*), a candidate Endangered or Threatened species. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Ecological Services, North Dakota State Office, Bismarck, North Dakota, USA.
978) [USFWS] U.S. Fish and Wildlife Service. 1994a. Endangered and Threatened wildlife and plants; animal candidate review for listing as Endangered or Threatened species; proposed rule. Federal Register 59:58982-59028.

979) [USFWS] U.S. Fish and Wildlife Service. 1994b. Endangered and Threatened wildlife and plants; designation of critical habitat for the Colorado River Endangered fishes: razorback sucker, Colorado squawfish, humpback chub, and bonytail chub; final rule. Federal Register 59:13374-13400.
980) [USFWS] U.S. Fish and Wildlife Service. 1995a. Endangered and Threatened wildlife and plants; final rule determining Endangered status for the southwestern willow flycatcher. Federal Register 60(38):10694-10715.
981) [USFWS] U.S. Fish and Wildlife Service. 1995b. Mexican spotted owl recovery plan. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Endangered Species Division, Albuquerque, New Mexico, USA.
982) [USFWS] U.S. Fish and Wildlife Service. 1997. Endangered and Threatened wildlife and plants; review of plant and animal taxa that are candidates for listing as Endangered or Threatened species; final rule to extend Endangered status for the jaguar in the United States. Federal Register 62(140):39147-39157.
983) [USFWS] U.S. Fish and Wildlife Service. 1998a. Canada lynx would be proposed for Endangered list under lawsuit settlement with 15 plaintiffs. News Release, U.S. Department of the Interior, U.S. Fish and Wildlife Service, Washington, D.C., USA.
984) [USFWS] U.S. Fish and Wildlife Service. 1998b. Endangered and Threatened wildlife and plants; 12-month finding for a petition to list the lesser prairie-chicken as Threatened and designate critical habitat. Federal Register 63(110):31400-31406.
985) [USFWS] U.S. Fish and Wildlife Service. 1998c. Endangered and Threatened wildlife and plants; final rule to list the Arkansas River basin population of the Arkansas River shiner (*Notropis girardi*) as Threatened. Federal Register 63(225):64777-64799.
986) [USFWS] U.S. Fish and Wildlife Service. 1998d. Endangered and Threatened wildlife and plants; proposal to determine the Pecos pupfish (*Cyprinodon pecosensis*) to be an Endangered species; proposed rule. Federal Register 63:4608-4613.
987) [USFWS] U.S. Fish and Wildlife Service. 2000. Endangered and Threatened wildlife and plants; withdrawal of proposed rule to list the Pecos pupfish (*Cyprinodon pecosensis*) as Endangered; proposed rule. Federal Register 65:14513-14518.
988) [USFWS] U.S. Fish and Wildlife Service. 2002a. Endangered and Threatened wildlife and plants; candidate status review for Rio Grande cutthroat trout. Federal Register 67:39936-39947.
989) [USFWS] U.S. Fish and Wildlife Service. 2002b. Razorback sucker (*Xyrauchen texanus*) recovery goals: amendment and supplement to the razorback Sucker recovery plan. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Mountain-Prairie Region, Denver, Colorado, USA.
990) [USFWS] U.S. Fish and Wildlife Service. 2003a. Endangered and Threatened wildlife and plants; designation of critical habitat for the Rio Grande silvery minnow. Federal Register 68(33):8088-8135.
991) [USFWS] U.S. Fish and Wildlife Service. 2003b. Gila trout recovery plan, third revision. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA.

992) [USFWS] U.S. Fish and Wildlife Service. 2004. Finding for the resubmitted petition to list the black-tailed prairie dog as Threatened. Federal Register 69(159):51217-51226.
993) [USFWS] U.S. Fish and Wildlife Service. 2005a. Endangered and Threatened wildlife and plants; final designation of critical habitat for the Arkansas River basin population of the Arkansas River shiner (*Notropis girardi*). Federal Register 70:59808-59846.
994) [USFWS] U.S. Fish and Wildlife Service. 2005b. Endangered and Threatened wildlife and plants; listing Gila Chub as Endangered with critical habitat; final rule. Federal Register 70:66664-66721.
995) [USFWS] U.S. Fish and Wildlife Service. 2007a. Chiricahua leopard frog (*Rana chiricahuensis*) recovery plan. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Southwest Region, Albuquerque, New Mexico, USA.
996) [USFWS] U.S. Fish and Wildlife Service. 2007b. Rio Grande silvery minnow (*Hybognathus amarus*) draft revised recovery plan. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA.
997) [USFWS] U.S. Fish and Wildlife Service. 2008a. Candidate notice of review. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Washington, D.C., USA.
998) [USFWS] U.S. Fish and Wildlife Service. 2008b. Endangered and Threatened wildlife and plants; establishment of a nonessential experimental population of Rio Grande silvery minnow in the Big Bend reach of the Rio Grande in Texas; final rule. Federal Register 73:74357-74372.
999) [USFWS] U.S. Fish and Wildlife Service. 2008c. Endangered and Threatened wildlife and plants; review of native species that are candidates for listing as Endangered or Threatened; annual notice of findings on resubmitted petitions; annual description of progress on listing actions; proposed rule. Federal Register 73:75176-75244.
1000) [USFWS] U.S. Fish and Wildlife Service. 2009a. Endangered and Threatened wildlife and plants; 12-month finding on a petition to change the final listing of the distinct population segment of the Canada lynx to include New Mexico. Federal Register 74(241):66937-66950.
1001) [USFWS] U.S. Fish and Wildlife Service. 2009b. Endangered and Threatened wildlife and plants; partial 90-day finding on a petition to list 475 species in the southwestern United States as Threatened or Endangered with critical habitat. Federal Register 74:66866-66905.
1002) [USFWS] U.S. Fish and Wildlife Service. 2009c. Endangered and Threatened wildlife and plants; removal of the brown pelican (*Pelecanus occidentalis*) from the federal list of Endangered and Threatened wildlife. Federal Register 74(220):5944459472.
1003) [USFWS] U.S. Fish and Wildlife Service. 2009d. Endangered and Threatened wildlife and plants; review of native species that are candidates for listing as Endangered or Threatened; annual notice of findings on resubmitted petitions; annual description of progress on listing actions. Federal Register 74:57804-57878.
1004) [USFWS] U.S. Fish and Wildlife Service. 2010a. Endangered and Threatened wildlife and plants; Endangered status for dunes sagebrush lizard. Federal Register 75(239):77801-77817.
1005) [USFWS] U.S. Fish and Wildlife Service. 2010b. Lesser prairie-chicken species assessment and listing priority assignment form. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Washington, D.C., USA.

1006) [USFWS] U.S. Fish and Wildlife Service. 2010c. Pecos bluntnose shiner (*Notropis simus pecosensis*) 5-year review: summary and evaluation. U.S. Department of the Interior, U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Albuquerque, New Mexico, USA.
1007) [USFWS] U.S. Fish and Wildlife Service. 2010d. Rio Grande silvery minnow (*Hybognathus amarus*) recovery plan, first revision. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA.
1008) [USFWS] U.S. Fish and Wildlife Service. 2011a. A national plan for assisting states, federal agencies, and tribes in managing white-nose syndrome in bats. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Northeast Regional Office, Hadley, Massachusetts, USA.
1009) [USFWS] U.S. Fish and Wildlife Service. 2011b. *Catostomus discobolus yarrow* [sic] species assessment and listing priority assignment form. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Southwest Region, Albuquerque, New Mexico, USA.
1010) [USFWS] U.S. Fish and Wildlife Service. 2011c. Chiricahua leopard frog (*Lithobates* [=*Rana*] *chiricahuensis*) 5-year review: summary and evaluation. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Arizona Ecological Services Office, Phoenix, Arizona, USA.
1011) [USFWS] U.S. Fish and Wildlife Service. 2011d. Colorado pikeminnow (*Ptychocheilus lucius*) 5-year review: summary and evaluation. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Upper Colorado River Endangered Fish Recovery Program, Denver, Colorado, USA.
1012) [USFWS] U.S. Fish and Wildlife Service. 2012a. Endangered and Threatened wildlife and plants; Endangered status and designations of critical habitat for spikedace and loach minnow. Federal Register 77:10810-10932.
1013) [USFWS] U.S. Fish and Wildlife Service. 2012b. Species assessment and listing priority assignment form for *Gila nigra*. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Washington, D.C., USA.
1014) [USFWS] U.S. Fish and Wildlife Service. 2013a. Conserving the Mexican gray wolf. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA. <https://www.fws.gov/program/conserving-mexican-wolf>.
1015) [USFWS] U.S. Fish and Wildlife Service. 2013b. Endangered and Threatened wildlife and plants; determination of Endangered species status for Jemez Mountains salamander (*Plethodon neomexicanus*) throughout its range. Federal Register 78(175):55600-55627.
1016) [USFWS] U.S. Fish and Wildlife Service. 2013c. Endangered and Threatened wildlife and plants; proposed designation of critical habitat for the Zuni bluehead sucker. Federal Register 78(17):5351-5369.
1017) [USFWS] U.S. Fish and Wildlife Service. 2013d. Endangered and Threatened wildlife and plants; proposed Endangered status for the Zuni bluehead sucker. Federal Register 78(17):5369-5385.
1018) [USFWS] U.S. Fish and Wildlife Service. 2013e. Endangered and Threatened wildlife and plants; proposed Threatened status for the western distinct population segment of the yellow-billed cuckoo (*Coccyzus americanus*). Federal Register 78:61622-61666.

1019) [USFWS] U.S. Fish and Wildlife Service. 2013f. Endangered and Threatened wildlife and plants; Threatened status for the northern Mexican gartersnake and narrow-headed gartersnake. Federal Register 78:41500-41547.

1020) [USFWS] U.S. Fish and Wildlife Service. 2014a. Endangered and Threatened wildlife and plants; revised designation of critical habitat for the contiguous United States distinct population segment of the Canada lynx and revised distinct population segment boundary; final rule. Federal Register 99(177):54782–54846.

1021) [USFWS] U.S. Fish and Wildlife Service. 2014b. Endangered and Threatened wildlife and plants; Threatened status for the northern Mexican gartersnake and narrow-headed gartersnake. Federal Register 79(130): 38678-38746.

1022) [USFWS] U.S. Fish and Wildlife Service. 2014c. Species status assessment report New Mexico meadow jumping mouse (*Zapus hudsonius luteus*). U.S. Department of the Interior, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA.

1023) [USFWS] U.S. Fish and Wildlife Service. 2014d. Species status assessment report for the Rio Grande cutthroat trout. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA.

1024) [USFWS] U.S. Fish and Wildlife Service. 2015. Endangered and Threatened wildlife and plants; Gila chub draft recovery plan; notice of availability; request for comment. Federal Register 80:65793-65795.

1025) [USFWS] U.S. Fish and Wildlife Service. 2016. Species status assessment for the lesser long-nosed bat (*Leptonycteris yerbabuenae*). U.S. Department of the Interior, U.S. Fish and Wildlife Service, Arizona Ecological Services Office, Phoenix, Arizona, USA and U.S. Department of the Interior, U.S. Fish and Wildlife Service, Southwest Region, Albuquerque, New Mexico, USA.

1026) [USFWS] U.S. Fish and Wildlife Service. 2017a. Endangered and Threatened wildlife and plants; Threatened species status for the headwater chub and roundtail chub distinct population segment; proposed rule; withdrawal. Federal Register 82:16981-16988.

1027) [USFWS] U.S. Fish and Wildlife Service. 2017b. Final biological opinion for the Carlsbad project water operations and water supply conservation, 2016-2026. U.S. Department of the Interior, U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Consultation 02ENNM00-2016-F-0506, Albuquerque, New Mexico, USA.

1028) [USFWS] U.S. Fish and Wildlife Service. 2017c. Species status assessment for the humpback chub (*Gila cypha*). U.S. Department of the Interior, U.S. Fish and Wildlife Service, Mountain-Prairie Region, Denver, Colorado, USA.

1029) [USFWS] U.S. Fish and Wildlife Service. 2018a. Pecos gambusia (*Gambusia nobilis*) 5-year review: summary and evaluation. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Austin Ecological Services Field Office, Austin, Texas, USA.

1030) [USFWS] U.S. Fish and Wildlife Service. 2018b. Species status assessment report for the Arkansas River shiner (*Notropis girardi*) and peppered chub (*Macrhybopsis tetranema*), version 1.0, with appendices. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA.

1031) [USFWS] U.S. Fish and Wildlife Service. 2018c. Species status assessment for the lesser long-nosed bat. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Southwest Region, Albuquerque, New Mexico, USA.
1032) [USFWS] U.S. Fish and Wildlife Service. 2018d. Species status assessment report for the Mexican long-nosed bat (*Leptonycteris nivalis*). U.S. Department of the Interior, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA.
1033) [USFWS] U.S. Fish and Wildlife Service. 2018e. Species status assessment report for the Peñasco least chipmunk (*Neotamias minimus atristriatus*). U.S. Department of the Interior, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA.
1034) [USFWS] U.S. Fish and Wildlife Service. 2018f. Species status assessment report for the razorback sucker *Xyrauchen t*exanus. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Mountain-Prairie Region, Denver, Colorado, USA.
1035) [USFWS] U.S. Fish and Wildlife Service. 2019. Endangered and Threatened wildlife and plants; 90-day findings for three species; notice of petition findings and initiation of status reviews. Federal Register 84:41691-41694.
1036) [USFWS] U.S. Fish and Wildlife Service. 2020a. Gila trout *(Oncorhynchus gilae)* 5-year review: summary and evaluation. U.S. Department of the Interior, U.S. Fish and Wildlife Service, New Mexico Ecological Field Office, Albuquerque, New Mexico.
1037) [USFWS] U.S. Fish and Wildlife Service. 2020b. Pecos bluntnose shiner (*Notropis simus pecosensis*): 5-year review: summary and evaluation. U.S. Department of the Interior, U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Albuquerque, New Mexico, USA.
1038) [USFWS] U.S. Fish and Wildlife Service. 2020c. Species status assessment report for the New Mexico meadow jumping mouse (*Zapus hudsonius luteus*), first revision. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA.
1039) [USFWS] U.S. Fish and Wildlife Service. 2020d. Zuni bluehead sucker (*Catostomus discobolus yarrowi*) 5-year review: summary and evaluation. U.S. Department of the Interior, U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Albuquerque, New Mexico, USA.
1040) [USFWS] U.S. Fish and Wildlife Service. 2021a. 90-day finding petition review form; listing as Threatened or Endangered and uplisting to Endangered: 90-day finding on a petition to list the Rio Grande shiner (*Notropis jemezanus*) under the Endangered Species Act and concurrently designate critical habitat. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Federal Docket FWS–R2–ES–2020–0054, Albuquerque, New Mexico, USA.
1041) [USFWS] U.S. Fish and Wildlife Service. 2021b. Birds of conservation concern 2021: migratory bird program. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Falls Church, Virginia, USA.
1042) [USFWS] U.S. Fish and Wildlife Service. 2021c. Endangered and Threatened wildlife and plants; Endangered species status for the Peñasco least chipmunk and designation of critical habitat. Federal Register 86(185):53583-53609.

1043) [USFWS] U.S. Fish and Wildlife Service. 2021d. Endangered and Threatened wildlife and plants; reclassification of the razorback sucker from Endangered to Threatened with a section 4(d) rule; proposed rule. Federal Register 86:35708-35728.
1044) [USFWS] U.S. Fish and Wildlife Service. 2022a. Endangered and Threatened wildlife and plants; Endangered species status for peppered chub and designation of critical habitat; final rule. Federal Register 87:11188-11220.
1045) [USFWS] U.S. Fish and Wildlife Service. 2022b. Endangered and Threatened wildlife and plants; lesser prairie-chicken; Threatened status with section 4(d) rule for the northern distinct population segment and Endangered status for the southern distinct population segment. Federal Register 87(226):72674-72755.
1046) [USFWS] U.S. Fish and Wildlife Service. 2022c. Endangered and Threatened wildlife and plants; lower Colorado River distinct population segment of roundtail chub (*Gila robusta*); Gila chub (*Gila intermedia*); notification of petition finding; advance notice of proposed rulemaking. Federal Register 87:19657-19660.
1047) [USFWS] U.S. Fish and Wildlife Service. 2022d. Species status assessment and listing priority assignment form for the Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*). U.S. Department of the Interior, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA.
1048) [USFWS] U.S. Fish and Wildlife Service. 2022e. Species status assessment report for the Colorado pikeminnow *Ptychocheilus lucius,* version 1.1. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Mountain-Prairie Region, Denver, Colorado, USA.
1049) [USFWS] U.S. Fish and Wildlife Service. 2022f. Species status assessment report for the roundtail chub (*Gila robusta*) in the lower Colorado River basin, version 2.1. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Arizona Ecological Services Field Office, Phoenix, Arizona, USA.
1050) [USFWS] U.S. Fish and Wildlife Service. 2022g. Revised recovery plan for Gila trout (*Oncorhynchus gilae*). U.S. Department of the Interior, U.S. Fish and Wildlife Service, Southwest Region, Albuquerque, New Mexico, USA.
1051) [USFWS] U.S. Fish and Wildlife Service. 2023a. Chihuahua chub 5-year review: summary and evaluation. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA.
1052) [USFWS] U.S. Fish and Wildlife Service. 2023b. Endangered and Threatened wildlife and plants; review of species that are candidates for listing as Endangered or Threatened; annual notification of findings on resubmitted petitions; annual description of progress on listing actions; notification of review. Federal Register 88:41560-41585.
1053) [USFWS] U.S. Fish and Wildlife Service. 2023c. Loach minnow (*Tiaroga cobitis*) 5-year review: summary and evaluation. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Arizona Ecological Services Office, Phoenix, Arizona, USA.
1054) [USFWS] U.S. Fish and Wildlife Service. 2023d. Mexican wolf numbers soar past 200 in latest count. U.S. Fish and Wildlife Service Press Release, U.S. Department of the Interior, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA.
1055) [USFWS] U.S. Fish and Wildlife Service. 2023e. N.M. Ranch properties, Inc. (Armendaris Ranch) Bolson tortoise safe harbor agreement. U.S. Department of the Interior,

U.S. Fish and Wildlife Service, New Mexico Ecological Services Office, Albuquerque, New Mexico, USA.
1056) [USFWS] U.S. Fish and Wildlife Service. 2023f. Recovery plan for the Arkansas River shiner (*Notropis girardi*). U.S. Department of the Interior, U.S. Fish and Wildlife Service, Oklahoma Ecological Services Field Office, Tulsa, Oklahoma, USA.
1057) [USFWS] U.S. Fish and Wildlife Service. 2023g. Recovery plan for Colorado pikeminnow (*Ptychocheilus lucius*). U.S. Department of the Interior, U.S. Fish and Wildlife Service, Mountain-Prairie Region, Denver, Colorado, USA.
1058) [USFWS] U.S. Fish and Wildlife Service. 2023h. Rio Grande silvery minnow *(Hybognathus amarus)*; 5-year status review: summary and evaluation. U.S. Department of the Interior, U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Albuquerque, New Mexico, USA.
1059) [USFWS] U.S. Fish and Wildlife Service. 2024a. Endangered and Threatened wildlife and plants; three species not warranted for listing as Endangered or Threatened species. Federal Register 89(119):51864-51869.
1060) [USFWS] U.S. Fish and Wildlife Service. 2024b. Species assessment and listing priority assignment form for the Rio Grande sucker (*Pantosteus plebeius*). U.S. Department of the Interior, U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Albuquerque, New Mexico, USA.
1061) [USFWS] U.S. Fish and Wildlife Service. 2024c. Species status assessment for the Rio Grande chub, version 1.2. U.S. Department of the Interior, U.S. Fish and Wildlife Service, New Mexico Ecological Services Office, New Mexico Fish and Wildlife Conservation Office, and Southwest Regional Office, Albuquerque, New Mexico, USA.
1062) [USFWS] U.S. Fish and Wildlife Service. 2024d. Species status assessment for the Rio Grande sucker, version 1.2. U.S. Department of the Interior, U.S. Fish and Wildlife Service, New Mexico Ecological Services Office, New Mexico Fish and Wildlife Conservation Office, and Southwest Regional Office, Albuquerque, New Mexico, USA.
1063) [USGS] U.S. Geological Survey. 2020a. Continued expansion of rabbit hemorrhagic disease virus 2 in North America and additional instructions regarding mortality event investigations. U.S. Department of the Interior, U.S. Geological Survey, National Wildlife Health Center, Wildlife Health Bulletin 2020-05, Madison, Wisconsin, USA.
1064) [USGS] U.S. Geological Survey. 2020b. Winter 2020 update on highly pathogenic avian influenza viruses circulating globally in wild birds. U.S. Department of the Interior, U.S. Geological Survey, National Wildlife Health Center, Wildlife Health Bulletin 2020-07, Madison, Wisconsin, USA.
1065) Valdez, E. W., K. Geluso, J. Foote, G. Allison-Kosior, and D. M. Roemer. 2009. Spring and winter records of the eastern pipistrelle (*Perimyotis subflavus*) in southeastern New Mexico. Western North American Naturalist 69:396-398.
1066) Valone, T. J., J. H. Brown, and C. L. Jacobi. 1995. Catastrophic decline of a desert rodent, *Dipodomys spectabilis*: insights from a long-term study. Journal of Mammalogy 76:428-436.
1067) VanderWall, S. B. 1988. Foraging of Clark's nutcrackers on rapidly changing pine seed resources. The Condor 90:621-631.

1068) VanderWall, S. B., and R. P. Balda. 1977. Coadaptation's of the Clark's nutcracker and the piñon pine for efficient seed harvest and dispersal. Ecological monographs 47(1):89-111.
1069) Van Eimeren, P. A. 1988. Comparative food habits of Gila trout and speckled dace in a southwestern headwater stream. Thesis, New Mexico State University, Las Cruces, New Mexico, USA.
1070) van Riper, C., III, J. R. Hatten, J. T. Giermakowski, D. Mattson, J. A. Holmes, M. J. Johnson, E. M. Nowak, K. Ironside, M. Peters, P. Heinrich, K. L. Cole, C. Truettner, and C. R. Schwalbe. 2014. Projecting climate effects on birds and reptiles of the southwestern United States. U.S. Department of the Interior, U.S. Geological Survey Open-File Report 2014 1050, Reston, Virginia, USA.
1071) Varela-Romero, A., C. Galindo-Duarte, E. Saucedo-Monarque, L.S. Anderson, P. Warren, S. Stefferud, J. Stefferud, S. Rutman, T. Tibbits and J. Malusa. 1990. Re-discovery of *Gila intermedia* and *Gila purpurea* in northern Sonora, Mexico. Proceedings of the Desert Fishes Council 22:33.
1072) Verner, J., and A. S. Boss. 1980. California wildlife and their habitats: western Sierra Nevada. U.S. Department of Agriculture, U.S. Forest Service, Pacific Southwest Research Station, General Technical Report PSW-37, Albany, California, USA.
1073) Voeltz, J. B. 2002. Roundtail chub (*Gila robusta*) status survey of the Lower Colorado River basin. Arizona Game and Fish Department, Technical Report 186, Phoenix, Arizona, USA.
1074) Vogel, M. E., S. Demarais, and J. M. Mueller. 1996. Effects of range fire on reptile populations at McGregor Range, Fort Bliss. Texas Tech University, Lubbock, Texas, USA.
1075) Voyles, J. 2014. Effect of *Batrachochytrium dendrobatidis* on amphibian communities in New Mexico. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.
1076) Voyles, J. 2015. Effects of *Batrachochytrium dendrobatidis* on amphibian communities in New Mexico. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.
1077) Walker, J. M., H. L. Taylor, and J. E. Cordes. 1994. Hybrid *Cnemidophorus* (Sauria: Teiidae) in Ninemile Valley of the Purgatoire River, Colorado. Southwestern Naturalist 39:235-240.
1078) Walker, R. H., C. E. Girard, S. L. Alford, and A. W. Walters. 2019. Anthropogenic land-use change intensifies the effect of low flows on stream fishes. Journal of Applied Ecology 57:149–159.
1079) Walkup, D. K., W. A. Ryberg, L. A. Fitzgerald, and T. J. Hibbitts. 2018. Occupancy and detection of an endemic habitat specialist, the dunes sagebrush lizard (*Sceloporus arenicolus*). Herpetological Conservation and Biology 13(3):497-506.
1080) Wallach, V., and J. C. Mitchell. 2020. *Rena humilis*, Western threadsnake. Pages 69-77 *in* A. T. Holycross and M. J. Mitchell, editors. Snakes of Arizona. ECO Publishing, Rodeo, New Mexico, USA.
1081) Walters, E. L., E. H. Miller, and P. E. Lowther 2020. Red-naped sapsucker (*Sphyrapicus nuchalis*). *In* A. F. Poole, editor. Birds of the world, version 1.0. Cornell Lab of Ornithology, Ithaca, New York, USA. <https://doi.org/10.2173/bow.rensap.01>.

1082) Ward, J. P. 1978. *Terrapene ornata*. Catalog of American Amphibians and Reptiles 217: 1-4.
1083) Waser, P. M., and J. M. Ayers. 2003. Microhabitat use and population decline in banner-tailed kangaroo rats. Journal of Mammalogy 84:1031-1043.
1084) Wasserman, T. N., S. A. Cushman, A. S. Shirk, E. L. Landguth, and J. S. Littell. 2012. Simulating the effects of climate change on population connectivity of American marten (*Martes americana*) in the northern Rocky Mountains, USA. Landscape Ecology 27(2):211-225.
1085) Watkins-Colwell, G. J., H. M. Smith, and D. Chiszar. 2003. *Sceloporus sleveni*. Catalogue of American Amphibians and Reptiles 771:1-6.
1086) Watson, M. L. 2017. Double E Ranch management plan. New Mexico Department of Game and Fish, Gila, New Mexico, USA.
1087) Watson, M. L., and W. M. Gruber. 2006. Wildlife, habitat, and hunting: New Mexico's roadless areas. New Mexico Department of Game and Fish. Santa Fe, New Mexico, USA.
1088) Watson, W., A. Lawson, C. Borgman, and S. Cox. 2024. Inferring brown-capped rosy-finch demography and breeding distribution trends from long-term wintering data in New Mexico. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.
1089) Wauer, R. H. 1964. Ecological distribution of the birds of the Panamint Mountains, California. The Condor 66:287-301.
1090) Webb, B. E. 1982. Distribution and nesting requirements of montane forest owls in Colorado. Thesis, University of Colorado, Boulder, Colorado, USA.
1091) Webb, E. A. and C. E. Bock. 1996. Botteri's sparrow (*Aimophila botteri*). *In* A. Poole and F. Gill, editors. The birds of North America, No. 216. The Academy of Natural Sciences, Philadelphia, Pennsylvani, USA and The American Ornithologist' Union, Washington, D.C, USA. <https://doi.org/10.2173/bna.216>
1092) Weedman, D. A. 1998. Gila topminnow, *Poeciliopsis occidentalis occidentalis*; revised recovery plan. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA.
1093) Weedman, D. A., A. L. Girmendonk, and K. L. Young. 1996. Status review of Gila chub, *Gila intermedia*, in the United States and Mexico. Arizona Game and Fish Department, Technical Report 91, Phoenix, Arizona, USA.
1094) Werler, J. E., and J. R. Dixon. 2000. Texas snakes: identification, distribution, and natural history. University of Texas Press, Austin, Texas, USA.
1095) Westworth, D. A., and E. S. Telfer. 1993. Summer and winter bird populations associated with five age-classes of aspen forest in Alberta. Canadian Journal of Forest Research 23:1830-1836.
1096) Whitaker, J. O., Jr. 1972. *Zapus Hudsonius*. Mammalian Species 11:1-7.
1097) White, G. C., A. B. Franklin, and J. P. Ward Jr. 1995. Population biology. Pages 1-25 *in* Mexican spotted owl recovery plan. Volume 2. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA.

1098) White, J., P. Moosman Jr., C. Kilgore, and T. Best. 2006. First record of the eastern pipistrelle (*Pipistrellus subflavus*) from southern New Mexico. The Southwestern Naturalist 51(3):420-422.
1099) Wick, J. 2023. Personal communication. New Mexico Department of Game and Fish, Native Fish Program Manager, Santa Fe, New Mexico, USA.
1100) Wilde, G. R., and K. G. Ostrand. 1999. Changes in the fish assemblage of an intermittent prairie stream upstream from a Texas impoundment. Texas Journal of Science 51:203-210.
1101) Wild Earth Guardians. 2020. Petition to list the Rio Grande shiner (*Notropis jemezanus*) under the Endangered Species Act. WildEarth Guardians, Denver, Colorado, USA.
1102) Williams, S. L., and H. H. Genoways. 1978. Review of the desert pocket gopher, *Geomys arenarius* (Mammalia: Rodentia). Annals of the Carnegie Museum 47(23).
1103) Williams, S. O. III. 1993. Preliminary listing and status assessment of neotropical migrant birds in New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.
1104) Williams, S. R. 1978. Comparative reproduction of the endemic New Mexico plethodontid salamanders, *Plethodon neomexicanus* and *Aneides hardii* (Amphibia, Urodela, Plethodontidae). Journal of Herpetology 12(4):471-476
1105) Wilsey, C., B. Bateman, L. Taylor, J. X. Wu, G. LeBaron, R. Shepherd, C. Koseff, S. Friedman, and R. Stone. 2019a. Survival by degrees: 389 bird species on the brink. National Audubon Society, New York, New York, USA.
1106) Wilsey, C. B., J. Grand, J. Wu, N. Michel, J. Grogan-Brown, and B. Trusty. 2019b. North American grasslands and birds report. National Audubon Society, New York, New York, USA.
1107) Wilson, D. E., and D. M. Reeder, editors. 2005. Mammal species of the world: a taxonomic and geographic reference. Third edition. Volume 2. The Johns Hopkins University Press, Baltimore, Maryland, USA.
1108) Winhold, L., A. Kurta, and R. Foster. 2008. Long-term change in an assemblage of North American bats: are eastern red bats declining? Acta Chiropterologica 10:359-366.
1109) Winston, M. R. 2002. Spatial and temporal species associations with the Topeka shiner (*Notropis topeka*) in Missouri. Journal of Freshwater Ecology 17:249-261.
1110) With, K. A. 1994. The hazards of nesting near shrubs for a grassland bird, the McCown's longspur. Condor 96:1009-1019.
1111) [WNTI] Western Native Trout Initiative. 2016. Gila trout (Oncorhynchus gilae) data: Gila trout recovery plan 2003. Western Native Trout Initiative, Boise, Idaho, USA. <http://www.westernnativetrout.org/media/trout/wnti-gila-trout-2016-status-report.pdf>.
1112) Worthington, T. A., A. A. Echelle, J. S. Perkin, R. Mollenhauer, N. Farless, J. J. Dyer, D. Logue, and S. K. Brewer. 2018. The emblematic minnows of the North American Great Plains: a synthesis of threats and conservation opportunities. Fish and Fisheries 19(2):271-307.
1113) [WRI] Wildlife Rescue, Inc. 2010. The 2010 RAVEN pilot project: analysis of New Mexico's statewide rehabilitation data: final report. New Mexico Department of Game and Fish, Share with Wildlife Program, Contract 09-516-0000-00022, Santa Fe, New Mexico, USA.

1114) Wright, G., and Frey, J. 2010. Cool season activity of the meadow jumping mouse in the middle Rio Grande. New Mexico Department of Game and Fish, Share with Wildlife Program, Santa Fe, New Mexico, USA.
1115) Wright, H. A., and A. W. Bailey. 1982. Fire ecology: United States and southern Canada. John Wiley and Sons, New York, New York, USA.
1116) Wright, J. W., and C. H. Lowe. 1993. Synopsis of the subspecies of the little striped whiptail lizard, *Cnemidophorus inornatus*. Journal of the Arizona-Nevada Academy of Science 1(27):129-157.
1117) Yosef, R., and T. C. Grubb Jr. 1994. Resource dependence and territory size in loggerhead shrikes (*Lanius ludovicianus*). Auk 111:465-469.
1118) Zabriskie, J. E., P. L. Cutler, and J. N. Stuart. 2019. Range extension of the western yellow bat (*Dasypterus xanthinus*) in New Mexico. Western Wildlife 6:1-4.
1119) Zeigler, M. P., A. S. Todd, and C. A. Caldwell. 2012. Evidence of recent climate change within the historic range of Rio Grande cutthroat trout: implications for management and future persistence. Transactions of the American Fisheries Society 141:1045-1059.
1120) Zeigler, M. P., and M. E. Ruhl. 2016. Small-bodied fishes monitoring in the San Juan River: 2015. U.S. Department of the Interior, U.S. Fish and Wildlife Service, San Juan River Basin Recovery Implementation Program, Albuquerque, New Mexico, USA.
1121) Zeigler, M. P., S. F. Brinkman, C. A. Caldwell, A. S. Todd, M. S. Recsetar, and S. A. Bonar. 2013. Upper thermal tolerance of Rio Grande cutthroat trout under constant and fluctuating temperatures. Transactions of the American Fisheries Society 142:1395-1405.
1122) Zimova, M., L. S. Mills, and J. J. Nowak. 2016. High fitness costs of climate change-induced camouflage mismatch. Ecological Letters 19(3):299–307.

APPENDIX 7. Table of adaptive capacity and Climate Change Vulnerability Index scores for the Representative Concentration Pathways (RCPs) 4.5 and 8.5 and literature cited for 295 vertebrate Species of Greatest Conservation Need.

Common Name	*Scientific Name*	Family	Adaptive Capacity	RCP 4.5 Score	RCP 8.5 Score	Literature
Arizona Toad	*Anaxyrus microscaphus microscaphus*	Amphibians	Moderately High	Moderately Vulnerable	Highly Vulnerable	163, 363, 652, 704, 807, 808, 810, 1076
Arizona Treefrog	*Hyla wrightorum*	Amphibians	Moderately High	Moderately Vulnerable	Moderately Vulnerable	4, 346, 363, 519, 649
Blanchard's Cricket Frog	*Acris blanchardi*	Amphibians	Moderately High	Less Vulnerable	Moderately Vulnerable	235, 365, 387, 363, 383, 441, 519, 710, 775
Boreal Chorus Frog	*Pseudacris maculata*	Amphibians	Moderately High	Less Vulnerable	Moderately Vulnerable	14, 363, 519, 574, 600, 880, 941, 1075, 1076
Boreal Toad	*Anaxyrus boreas boreas*	Amphibians	Moderately Low	Moderately Vulnerable	Extremely Vulnerable	141, 162, 284, 363, 385, 637, 658, 662, 710, 746, 790, 967
Chiricahua Leopard Frog	*Lithobates chiricahuensis*	Amphibians	Moderately Low	Highly Vulnerable	Highly Vulnerable	163, 235, 326, 363, 462, 463, 466, 652, 742, 878, 906, 995, 1010, 1086
Eastern Barking Frog	*Craugastor augusti latrans*	Amphibians	Moderately High	Moderately Vulnerable	Extremely Vulnerable	235, 333, 363, 519, 560, 763, 809
Jemez Mountains Salamander	*Plethodon neomexicanus*	Amphibians	Moderately High	Highly Vulnerable	Highly Vulnerable	214, 215, 217, 218, 235, 363, 507, 519, 592, 648, 666,766, 1015
Lowland Leopard Frog	*Lithobates yavapaiensis*	Amphibians	Low	Moderately Vulnerable	Extremely Vulnerable	163, 196, 363, 461, 464, 466, 519, 637, 704, 710, 835, 847
Northern Leopard Frog	*Lithobates pipiens*	Amphibians	Moderately Low	Moderately Vulnerable	Moderately Vulnerable	2, 4, 146, 163, 280, 284, 329, 363, 464, 1075, 1076
Plains Leopard Frog	*Lithobates blairi*	Amphibians	High	Less Vulnerable	Less Vulnerable	4, 163, 196, 329, 355, 363, 383, 464, 519, 693, 745
Rio Grande Leopard Frog	*Lithobates berlandieri*	Amphibians	Moderately High	Less Vulnerable	Less Vulnerable	329, 363, 466, 519, 652, 710
Sacramento Mountain Salamander	*Aneides hardii*	Amphibians	Low	Highly Vulnerable	Highly Vulnerable	194, 195, 232, 363, 546, 637, 645, 658, 781, 1087, 1104
Sonoran Desert Toad	*Incilius alvarius*	Amphibians	Moderately Low	Moderately Vulnerable	Moderately Vulnerable	363, 485, 519, 637, 641, 637, 643, 890, 912
Western Narrow-mouthed Toad	*Gastrophryne olivacea*	Amphibians	Moderately Low	Moderately Vulnerable	Extremely Vulnerable	363, 383, 519, 637, 643, 906, 907
Abert's Towhee	*Melozone aberti aberti*	Birds	High	Less Vulnerable	Less Vulnerable	236, 283, 637, 643, 652, 662, 871, 1105
American Bittern	*Botaurus lentiginosus*	Birds	High	Less Vulnerable	Less Vulnerable	4, 284, 439, 652, 1105
American Dipper	*Cinclus mexicanus unicolor*	Birds	High	Less Vulnerable	Less Vulnerable	78, 236, 389, 439, 802, 883, 938, 1105
American Kestrel	*Falco sparverius sparverius*	Birds	High	Less Vulnerable	Less Vulnerable	45, 236, 327, 712, 802, 869
American Pipit	*Anthus rubescens*	Birds	High	Moderately Vulnerable	Moderately Vulnerable	45, 93, 439, 802, 1105
American Tree Sparrow	*Spizelloides arborea ochracea*	Birds	High	Less Vulnerable	Less Vulnerable	58, 197, 332, 481, 802, 931, 934, 1105
Aplomado Falcon	*Falco femoarlis septentrionalis*	Birds	Moderately High	Moderately Vulnerable	Highly Vulnerable	405, 640, 641, 652, 662, 1105, 1106
Arizona Grasshopper Sparrow	*Ammodramus savannarum ammolegus*	Birds	High	Moderately Vulnerable	Moderately Vulnerable	381, 615, 639, 641, 643, 652, 662, 732, 802, 1103, 1105

Common Name	*Scientific Name*	Family	Adaptive Capacity	RCP 4.5 Score	RCP 8.5 Score	Literature
Arizona Woodpecker	*Dryobates arizonae*	Birds	High	Less Vulnerable	Less Vulnerable	93, 236, 641, 802, 1105
Baird's Sparrow	*Centronyx bairdii*	Birds	High	Moderately Vulnerable	Moderately Vulnerable	260, 366, 381, 629, 637, 802, 879, 1106
Bald Eagle	*Haliaeetus leucocephalus*	Birds	High	Less Vulnerable	Less Vulnerable	2, 197, 368, 405, 641, 643, 650, 951, 1105
Band-tailed Pigeon	*Patagioenas fasciata*	Birds	High	Moderately Vulnerable	Moderately Vulnerable	103, 457,637, 802, 825, 1105
Bank Swallow	*Riparia riparia riparia*	Birds	Moderately High	Less Vulnerable	Moderately Vulnerable	260, 327, 381, 627, 934, 1105
Bell's Vireo	*Vireo belli*	Birds	High	Less Vulnerable	Less Vulnerable	52, 381, 643, 649, 652, 715, 1105
Bendire's Thrasher	*Toxostoma bendirei*	Birds	High	Less Vulnerable	Less Vulnerable	236, 237, 629, 748, 802, 819
Bewick's Wren	*Thryomanes bewickii*	Birds	High	Less Vulnerable	Less Vulnerable	78, 236, 327, 748, 802, 842, 851, 865
Black Rosy-finch	*Leucosticte atrata*	Birds	Moderately High	Moderately Vulnerable	Highly Vulnerable	81, 411, 439, 539, 629, 802, 967
Black Swift	*Cypseloides niger*	Birds	Moderately High	Highly Vulnerable	Highly Vulnerable	381, 437, 447, 511, 538, 629, 641, 802, 955, 1105
Black-billed Magpie	*Pica hudsonia*	Birds	High	Less Vulnerable	Less Vulnerable	4, 236, 263, 380, 830, 944, 1105
Black-chinned Sparrow	*Spizella atrogularis evura*	Birds	High	Moderately Vulnerable	Moderately Vulnerable	236, 629, 802, 933, 1086
Black-headed Grosbeak	*Pheucticus melanocephalus*	Birds	High	Less Vulnerable	Less Vulnerable	80, 94, 236, 260, 297, 682, 758, 802, 830, 942, 1105
Black-throated Gray Warbler	*Setophaga nigrescens*	Birds	High	Less Vulnerable	Less Vulnerable	39, 251, 260, 353, 381, 802, 833
Black-throated Sparrow	*Amphispiza bilineata*	Birds	High	Less Vulnerable	Less Vulnerable	9, 236, 399, 478, 802, 1070
Boreal Owl	*Aegolius funereus*	Birds	Moderately Low	Highly Vulnerable	Extremely Vulnerable	274, 284, 407, 516, 545, 550, 662, 813, 884, 1099, 1105
Botteri's Sparrow	*Peucaea botteri arizonae*	Birds	High	Less Vulnerable	Less Vulnerable	97, 652, 1091, 1105, 1106
Brewer's Sparrow	*Spizella breweri*	Birds	High	Moderately Vulnerable	Moderately Vulnerable	9, 92, 97, 399, 439, 748, 802, 804, 846, 883, 969, 1103, 1106
Broad-billed Hummingbird	*Cynanthus latirostris magicus*	Birds	High	Less Vulnerable	Less Vulnerable	44, 236, 637, 641, 643, 647, 802
Broad-tailed Hummingbird	*Selasphorus platycercus platycercus*	Birds	High	Less Vulnerable	Less Vulnerable	37, 136, 236, 589, 732, 802, 966
Brown Pelican	*Pelecanus occidentalis carolinensis*	Birds	High	Less Vulnerable	Less Vulnerable	16, 17, 425, 437, 637, 643, 644, 1002, 1105
Brown-capped Rosy Finch	*Leucosticte australis*	Birds	Moderately Low	Highly Vulnerable	Highly Vulnerable	411, 539, 629, 802, 814, 1041, 1088
Buff-breasted Flycatcher	*Empidonax fulvifrons pygmaeus*	Birds	High	Less Vulnerable	Less Vulnerable	100, 236, 439, 860
Bullock's Oriole	*Icterus bullockii*	Birds	High	Less Vulnerable	Less Vulnerable	294, 748, 802, 857
Burrowing Owl	*Athene cunicularia hyupgaea*	Birds	High	Less Vulnerable	Moderately Vulnerable	74, 260, 476, 508, 647, 652, 802, 934, 937, 1105, 1115
Cactus Wren	*Campylorhyncus brunneicapillus couesi*	Birds	High	Less Vulnerable	Less Vulnerable	54, 236, 439, 652, 748, 802, 1106
Canyon Towhee	*Melozone fusca*	Birds	High	Less Vulnerable	Less Vulnerable	81, 236, 480, 748, 830, 1105
Canyon Wren	*Catherpes mexicanus conspersus*	Birds	High	Less Vulnerable	Less Vulnerable	78, 236, 491, 732, 839

Common Name	*Scientific Name*	Family	Adaptive Capacity	RCP 4.5 Score	RCP 8.5 Score	Literature
Cassin's Finch	*Haemorhous cassinii*	Birds	Moderately High	Moderately Vulnerable	Highly Vulnerable	81, 410, 439, 652, 748, 802, 823, 824
Cassin's Kingbird	*Tyrannus vociferans vociferans*	Birds	High	Less Vulnerable	Less Vulnerable	437, 748, 802, 829, 950
Cassin's Sparrow	*Peucaea cassinii*	Birds	High	Less Vulnerable	Less Vulnerable	97, 381, 506, 615, 748, 1106
Chestnut-collared Longspur	*Calcarius ornatus*	Birds	High	Moderately Vulnerable	Highly Vulnerable	97, 249, 381, 392, 417, 615, 629, 802, 833, 879, 1105, 1106
Chihuahuan Meadowlark	*Sturnella lilianae*	Birds	High	Less Vulnerable	Less Vulnerable	9, 93, 159, 260, 381, 615, 748, 802, 1106
Chihuahuan Raven	*Corvus cryptoleucus*	Birds	High	Less Vulnerable	Less Vulnerable	236, 254, 649, 748
Chipping Sparrow	*Spizella passerina arizonae*	Birds	High	Less Vulnerable	Less Vulnerable	236, 297, 353, 564, 597, 668, 748, 830, 1103
Clark's Grebe	*Aechmorphorus clarkii*	Birds	High	Less Vulnerable	Less Vulnerable	4, 284, 629, 652, 801, 1105
Clark's Nutcracker	*Nucifraga columbiana*	Birds	Moderately High	Moderately Vulnerable	Highly Vulnerable	39, 239, 381, 473, 557, 652, 801, 1105, 1106, 1067, 1068
Cliff Swallow	*Petrochelidon pyrrhonota*	Birds	High	Less Vulnerable	Less Vulnerable	110, 113, 236, 260, 327, 381, 748, 802, 1103
Common Black Hawk	*Buteogallus anthracinus anthracinus*	Birds	Moderately Low	Highly Vulnerable	Highly Vulnerable	439, 637, 641, 643, 673, 677, 818, 867, 871
Common Ground Dove	*Columbina passerina pallescense*	Birds	High	Less Vulnerable	Less Vulnerable	640, 643, 652, 662, 1195
Common Nighthawk	*Chordeiles minor*	Birds	High	Less Vulnerable	Less Vulnerable	9, 45, 381, 439, 801, 842, 1105
Costa's Hummingbird	*Calypte costae*	Birds	High	Less Vulnerable	Less Vulnerable	435, 495, 643, 652, 662, 802, 966
Eastern Bluebird	*Sialis sialis*	Birds	High	Less Vulnerable	Less Vulnerable	9, 241, 327, 381, 437, 580, 802, 899, 965, 1105
Elegant Trogon	*Trogon elegans conescense*	Birds	Moderately High	Less Vulnerable	Moderately Vulnerable	93, 641, 643, 649, 652, 662, 802
Elf Owl	*Micrathene whitneyi whitneyi*	Birds	Moderately High	Less Vulnerable	Less Vulnerable	236, 382, 413, 414, 439, 851, 1086, 1105
Evening Grosbeak	*Coccothraustes vespertinus*	Birds	High	Moderately Vulnerable	Moderately Vulnerable	81, 98, 236, 381, 629, 652, 802, 848, 1105, 1106, 1113
Ferruginous Hawk	*Buteo regalis*	Birds	High	Less Vulnerable	Less Vulnerable	4, 9, 236, 284, 400, 353, 876, 1105, 1106
Field Sparrow	*Spizella pusilla arenacea*	Birds	High	Moderately Vulnerable	Moderately Vulnerable	21, 142, 437, 439, 590, 802, 1105
Flammulated Owl	*Psilocops flammeolus*	Birds	High	Less Vulnerable	Less Vulnerable	399, 403, 410, 439, 472, 541, 577, 777
Gila Woodpecker	*Melanerpes uropygialis uropygialis*	Birds	Moderately High	Less Vulnerable	Moderately Vulnerable	637, 641, 643, 654, 802, 923
Golden Eagle	*Aquila chrysaetos canadensis*	Birds	High	Less Vulnerable	Less Vulnerable	236, 277, 335, 439, 515, 527, 650, 675, 802, 875, 881, 1105
Grace's Warbler	*Setophaga graciae*	Birds	High	Moderately Vulnerable	Moderately Vulnerable	222, 236, 267, 381, 482, 621, 652, 802, 1105
Grasshopper Sparrow	*Ammodramus savannarum perpallidus*	Birds	Moderately High	Moderately Vulnerable	Highly Vulnerable	381, 437, 439, 590, 615, 639, 652, 662, 732, 802, 1105
Gray Vireo	*Vireo vicinior*	Birds	Moderately High	Less Vulnerable	Moderately Vulnerable	53, 79, 288, 325, 353, 399, 637, 662, 802
Gray-crowned Rosy Finch	*Leucosticte tephorcotis*	Birds	Moderately High	Moderately Vulnerable	Highly Vulnerable	81, 360, 381, 411, 479, 539, 965, 1088, 1105
Greater Pewee	*Contopus pertinax pallidiventris*	Birds	High	Less Vulnerable	Less Vulnerable	197, 236, 381, 437, 652, 732, 801, 802, 1103, 1105
Greater Yellowlegs	*Tringa melanoleuca*	Birds	High	Less Vulnerable	Less Vulnerable	45, 437, 732, 1105

Common Name	*Scientific Name*	Family	Adaptive Capacity	RCP 4.5 Score	RCP 8.5 Score	Literature
Green-tailed Towhee	*Pipilo chlorurus*	Birds	High	Moderately Vulnerable	Moderately Vulnerable	72, 96, 236, 243, 381, 439, 802, 1105, 1106
Harris's Hawk	*Parabuteo unicinctus harrisi*	Birds	High	Less Vulnerable	Less Vulnerable	63, 229, 253, 437, 439, 712, 1105
Horned Lark	*Eremophila alpestris*	Birds	High	Less Vulnerable	Less Vulnerable	9, 97, 172, 177, 236, 238, 381, 437, 802, 1005, 1106
Juniper Titmouse	*Baeolophus ridgwayi*	Birds	Moderately High	Less Vulnerable	Less Vulnerable	170, 353, 652, 802, 1105
Killdeer	*Charadrius vociferus vociferus*	Birds	High	Less Vulnerable	Less Vulnerable	45, 97, 264, 437, 522, 776, 834, 857, 1105
Lapland Longspur	*Calcarius lapponicus alascensis*	Birds	Moderately High	Moderately Vulnerable	Moderately Vulnerable	219, 381, 437, 802, 1105
Lark Bunting	*Calamospiza melanocorys*	Birds	High	Moderately Vulnerable	Moderately Vulnerable	260, 284, 381, 439, 615, 732, 802, 1105, 1106
Lark Sparrow	*Chondestes grammacus strigatus*	Birds	High	Less Vulnerable	Less Vulnerable	9, 260, 381, 419, 437, 497, 667, 703, 802, 1103, 1105, 1106
Lazuli Bunting	*Passerina amoena*	Birds	High	Less Vulnerable	Less Vulnerable	236, 282, 439, 652, 802, 1105
Least Tern	*Sternula antillarum athalassos*	Birds	Moderately Low	Highly Vulnerable	Highly Vulnerable	124, 373, 566, 640, 641, 652, 662, 732, 984, 997, 1005, 1045, 1105, 1106
Lesser Prairie Chicken	*Tympanuchus pallidicinctus*	Birds	Low	Highly Vulnerable	Highly Vulnerable	34, 99, 351, 376, 439, 474, 629, 802, 827, 930, 984, 997, 1005, 1045, 1105, 1106
Lewis's Woodpecker	*Melanerpes lewisi*	Birds	Moderately High	Less Vulnerable	Moderately Vulnerable	75, 95, 439, 572, 815, 652, 802, 940, 955, 1105
Loggerhead Shrike	*Lanius ludovicianus*	Birds	High	Less Vulnerable	Less Vulnerable	19, 130, 132, 236, 284, 381, 439, 518, 590, 748, 802, 1106, 1117
Long-billed Curlew	*Numenius americanus americanus*	Birds	Moderately High	Less Vulnerable	Moderately Vulnerable	153, 179, 278, 260, 284, 505, 578, 615, 652, 697, 744, 1105, 1106
Long-billed Dowitcher	*Limnodromus scolopaceus*	Birds	High	Less Vulnerable	Less Vulnerable	45, 197, 435, 629, 1105
Long-eared Owl	*Asio otus*	Birds	Moderately High	Less Vulnerable	Less Vulnerable	121, 236, 264, 439, 496, 565, 568, 802, 1105
Lucifer's Hummingbird	*Calothorax lucifer*	Birds	High	Less Vulnerable	Less Vulnerable	584, 637, 644, 652, 662, 966
Lucy's Warbler	*Leiothlypis luciae*	Birds	High	Less Vulnerable	Less Vulnerable	9, 236, 381, 641, 652, 662, 802, 851, 1105
Mexican Chickadee	*Poecile sclateri eidos*	Birds	High	Less Vulnerable	Less Vulnerable	93, 439, 653, 802, 851
Mexican Spotted Owl	*Strix occidentalis lucida*	Birds	Moderately Low	Highly Vulnerable	Highly Vulnerable	55, 149, 369, 371, 410, 652, 805, 967, 981, 1097
Mexican Whip-poor-will	*Anostomus arizonae arizonae*	Birds	High	Less Vulnerable	Less Vulnerable	236, 381, 439, 540, 652, 802
Mountain Bluebird	*Sialia currucoides*	Birds	High	Less Vulnerable	Less Vulnerable	353, 381, 448, 617, 652, 802, 1095, 1105
Mountain Chickadee	*Poecile gambeli gambeli*	Birds	High	Less Vulnerable	Less Vulnerable	236, 300, 381, 439, 802, 822, 883, 925, 1105
Mountain Plover	*Charadrius montanus*	Birds	High	Moderately Vulnerable	Moderately Vulnerable	510, 532, 615, 629, 641, 652, 732, 955, 1004, 1105, 1106
Neotropic Cormorant	*Nannopterum brasilianum*	Birds	Moderately High	Less Vulnerable	Less Vulnerable	439, 637, 643, 652, 662, 1105
Northern Beardless-Tyrannulet	*Campostoma omberbe ridgwayi*	Birds	High	Less Vulnerable	Less Vulnerable	381, 439, 641, 643, 652, 662, 1105
Northern Harrier	*Circus hudsonius*	Birds	High	Less Vulnerable	Less Vulnerable	9, 97, 236, 284, 381, 415, 437, 439, 520, 802, 1105, 1106
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	Birds	High	Less Vulnerable	Less Vulnerable	260, 327, 381, 394, 437, 934, 1105

Common Name	*Scientific Name*	Family	Adaptive Capacity	RCP 4.5 Score	RCP 8.5 Score	Literature
Olive Warbler	*Peucedramus taeniatus arizonae*	Birds	High	Less Vulnerable	Less Vulnerable	381, 437, 439, 934, 1105
Olive-sided Flycatcher	*Contopus cooperi*	Birds	High	Less Vulnerable	Less Vulnerable	11, 12, 39, 284, 381, 437, 438, 652, 802, 927, 1072, 1105
Peregrine Falcon	*Falco peregrinus*	Birds	High	Less Vulnerable	Less Vulnerable	236, 405, 483, 637, 642, 652, 672, 674, 802, 967, 1064
Phainopepla	*Phainopepla nitens lepida*	Birds	High	Less Vulnerable	Less Vulnerable	197, 236, 327, 381, 439, 805, 1105
Pine Grosbeak	*Pinicola enucleator montana*	Birds	High	Moderately Vulnerable	Moderately Vulnerable	236, 437, 439, 802, 1105
Pine Siskin	*Spinus pinus*	Birds	High	Moderately Vulnerable	Moderately Vulnerable	381, 439, 802, 965, 1105
Pinyon Jay	*Gymnorhinus cyanocephalus*	Birds	Moderately Low	Moderately Vulnerable	Highly Vulnerable	231, 236, 353, 475, 477, 557, 652, 802, 927, 1070
Piping Plover	*Charadrius melodus circumcinctus*	Birds	Moderately High	Moderately Vulnerable	Moderately Vulnerable	101, 124, 425, 437, 637, 718, 719, 1105
Plumbeous Vireo	*Vireo plumbeus*	Birds	High	Less Vulnerable	Less Vulnerable	236, 325, 571, 802, 883, 924, 1105
Prairie Falcon	*Falco mexicanus*	Birds	High	Less Vulnerable	Less Vulnerable	236, 238, 402, 422, 802, 892, 965
Purple Martin	*Progne subis*	Birds	Moderately High	Moderately Vulnerable	Moderately Vulnerable	111, 236, 260, 284, 381, 802, 1105
Pygmy Nuthatch	*Sitta pygmaea melanotis*	Birds	High	Moderately Vulnerable	Moderately Vulnerable	236, 301, 381, 437, 669, 802, 851, 922, 925, 1070, 1105
Pyrrhuxolia	*Cardinalis sinuatus sinuatus*	Birds	High	Less Vulnerable	Less Vulnerable	236, 742, 802, 949, 965
Red-faced Warbler	*Cardellina rubrifrons*	Birds	High	Less Vulnerable	Less Vulnerable	268, 570, 652, 802, 1103
Red-headed Woodpecker	*Melanerpes erythrocephalus caurinus*	Birds	High	Less Vulnerable	Less Vulnerable	303, 437, 451, 652, 802, 860
Red-naped Sapsucker	*Sphyrapicus nuchalis*	Birds	High	Moderately Vulnerable	Moderately Vulnerable	220, 236, 259, 778, 802, 860, 965, 1081, 1103, 1113
Rock Wren	*Salpinctes obsoletus obsoletus*	Birds	High	Less Vulnerable	Less Vulnerable	71, 78, 381, 439, 549, 748, 802, 934, 965, 1089, 1106
Sage Thrasher	*Oreoscoptes montanus*	Birds	High	Less Vulnerable	Less Vulnerable	104, 260, 399, 779, 802, 1070, 1106
Sagebrush Sparrow	*Artemisiospiza nevadensis*	Birds	High	Less Vulnerable	Less Vulnerable	177, 236, 381, 399, 404, 652, 748, 802, 860, 883, 965, 1103
Savannah Sparrow	*Passerculus sandwichensis*	Birds	High	Moderately Vulnerable	Moderately Vulnerable	260, 381, 439, 615, 732, 802, 1105, 1106
Scott's Oriole	*Icterus parisorum*	Birds	High	Less Vulnerable	Less Vulnerable	236, 353, 381, 517, 748, 802, 1103
Short-eared Owl	*Asio flammeus flammeus*	Birds	High	Less Vulnerable	Less Vulnerable	97, 173, 200, 615, 802, 955, 1064, 1103, 1106
Snowy Plover	*Charadrius nivosus*	Birds	High	Less Vulnerable	Less Vulnerable	284, 425, 439, 652, 694, 695, 696, 728, 802, 860, 976
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	Birds	Moderately High	Moderately Vulnerable	Moderately Vulnerable	4, 7, 108, 199, 326, 425, 439, 480, 509, 637, 652, 662, 802, 980, 1103
Spotted Sandpiper	*Actitis macularius*	Birds	High	Less Vulnerable	Less Vulnerable	236, 393, 437, 680, 826, 1105
Spotted Towhee	*Pipilo maculatus*	Birds	High	Less Vulnerable	Less Vulnerable	236, 297, 327, 401, 748, 758, 802, 1103. 1113
Sprague's Pipit	*Anthus spragueii*	Birds	High	Moderately Vulnerable	Moderately Vulnerable	381, 629, 652, 802, 879, 1103, 1105
Steller's Jay	*Cyanocitta stelleri macrolopha*	Birds	High	Less Vulnerable	Less Vulnerable	77, 351, 361, 381, 438, 557, 778
Thick-billed Kingbird	*Tyrannus crassirostris*	Birds	High	Less Vulnerable	Less Vulnerable	3, 260, 637, 641, 652, 802
Thick-billed Longspur	*Rhynchophanes mccownii*	Birds	High	Moderately Vulnerable	Moderately Vulnerable	236, 260, 629, 802, 832, 879, 1041, 1106, 1110

Common Name	*Scientific Name*	Family	Adaptive Capacity	RCP 4.5 Score	RCP 8.5 Score	Literature
Varied Bunting	*Passerina versicolor*	Birds	High	Less Vulnerable	Less Vulnerable	236, 282, 439, 637, 641, 643, 652, 660, 802, 903, 1041
Verdin	*Auriparus flaviceps ornatus*	Birds	High	Less Vulnerable	Less Vulnerable	45, 236, 802, 1105
Vesper Sparrow	*Pooecetes gramineus*	Birds	High	Less Vulnerable	Less Vulnerable	9, 260, 439, 652, 748, 802
Violet-crowned Hummingbird	*Leucolia violiceps ellioti*	Birds	High	Less Vulnerable	Less Vulnerable	404, 583, 637, 641, 643, 662, 802
Violet-green Swallow	*Tachycineta thalassina lepida*	Birds	High	Less Vulnerable	Less Vulnerable	236, 381, 564, 748, 802, 829, 883, 1103
Virginia's Warbler	*Leiothlypis virginiae*	Birds	High	Less Vulnerable	Less Vulnerable	236, 353, 651, 652, 802, 831, 934, 1103, 1105
Western Bluebird	*Sialia mexicana bairdi*	Birds	High	Less Vulnerable	Less Vulnerable	9, 236, 353, 381, 617, 652, 1105
Western Grebe	*Aechmophorus occidentalis*	Birds	High	Less Vulnerable	Less Vulnerable	73, 197, 470, 934, 802, 1041, 1105
Western Kingbird	*Tyrannus verticalus*	Birds	High	Less Vulnerable	Less Vulnerable	40, 76, 439, 676, 726, 802, 828, 871, 934, 9631103, 1106
Western Meadowlark	*Sturnella neglecta*	Birds	High	Less Vulnerable	Less Vulnerable	9, 260, 748, 802, 840, 1106
Western Sandpiper	*Calidris mauri*	Birds	High	Moderately Vulnerable	Moderately Vulnerable	45, 299, 437, 439, 1105
Western Wood-Pewee	*Contopus sordidulus*	Birds	High	Less Vulnerable	Less Vulnerable	76, 153, 260, 439, 440, 802, 822, 857, 934
Whiskered Screech-Owl	*Megascops trichopsis asperus*	Birds	High	Less Vulnerable	Less Vulnerable	236641, 643, 652, 802, 851
White-eared Hummingbird	*Basilinna leucotis borealis*	Birds	High	Less Vulnerable	Less Vulnerable	584, 637, 643, 662, 802
White-tailed Ptarmigan	*Lagopus leucura altipetens*	Birds	Moderately High	Highly Vulnerable	Highly Vulnerable	104, 105, 637, 652, 654, 821
White-throated Swift	*Aeronautes saxatalis saxatalis*	Birds	High	Less Vulnerable	Less Vulnerable	45, 236, 802, 936, 962
Williamson's Sapsucker	*Sphyrapicus thyroideus nataliae*	Birds	High	Less Vulnerable	Less Vulnerable	75, 205, 372, 437, 439, 652, 1070, 1105
Wilson's Warbler	*Cardellina pusilla*	Birds	High	Less Vulnerable	Less Vulnerable	22, 236, 401, 802, 893, 934, 963, 967
Woodhouse's Scrub Jay	*Aphelocoma woodhouseii*	Birds	High	Less Vulnerable	Less Vulnerable	158, 236, 277, 297, 353, 748
Yellow-billed Cuckoo (Eastern population)	*Coccyzus americanus americanus*	Birds	Moderately Low	Moderately Vulnerable	Extremely Vulnerable	153, 284, 436, 802, 1103
Yellow-billed Cuckoo (Western Population)	*Coccyzus americanus occidentalis*	Birds	Moderately Low	Moderately Vulnerable	Extremely Vulnerable	2, 284, 398, 436, 618, 654, 802, 886, 1003, 1018
Yellow-eyed Junco	*Junco phaeonotus palliatus*	Birds	High	Less Vulnerable	Less Vulnerable	236, 637, 652, 913, 914
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	Birds	High	Less Vulnerable	Less Vulnerable	45, 236, 287, 381, 748, 802, 948
Arkansas River Shiner	*Notropis girardi*	Fish	Low	Highly Vulnerable	Highly Vulnerable	49, 89,637, 687, 688, 911, 985, 993, 1030, 1056,
Bigscale Logperch	*Percina macrolepida*	Fish	High	Less Vulnerable	Less Vulnerable	120, 148, 206, 331, 534, 628, 652, 662, 699, 861, 911
Blue Sucker	*Cycleptus elongatus*	Fish	Moderately High	Moderately Vulnerable	Moderately Vulnerable	127, 458, 82, 137, 637, 662, 729, 861, 911, 977, 978
Central Stoneroller	*Campostoma anomalum*	Fish	High	Less Vulnerable	Less Vulnerable	424, 460, 576, 585, 665, 699, 861, 911
Chihuahua Chub	*Gila nigrescens*	Fish	Low	Extremely Vulnerable	Extremely Vulnerable	604, 606, 662, 699, 750, 755, 911, 971, 1051
Colorado Pikeminnow	*Ptychocheilus lucius*	Fish	Moderately Low	Highly Vulnerable	Highly Vulnerable	239, 637, 911, 968, 979, 1011, 1048, 1057
Desert Sucker	*Catostomus clarkii*	Fish	Moderately High	Highly Vulnerable	Extremely Vulnerable	230, 548, 606, 609, 614, 652, 679, 699, 861, 863, 911, 935
Gila Chub	*Gila intermedia*	Fish	Low	Highly Vulnerable	Highly Vulnerable	367, 453, 601, 605, 620, 623, 630, 632, 646, 658, 699, 717, 765, 783, 789, 853, 994, 1024, 1026, 1028, 1046, 1071, 1093

Common Name	*Scientific Name*	Family	Adaptive Capacity	RCP 4.5 Score	RCP 8.5 Score	Literature
Gila Topminnow	*Poeciliopsis occidentalis occidentalis*	Fish	Low	Extremely Vulnerable	Extremely Vulnerable	405, 409, 453, 534, 608, 609, 613, 861, 911, 968, 1035, 1092
Gila Trout	*Oncorhynchus gilae*	Fish	Low	Highly Vulnerable	Highly Vulnerable	114, 240, 326, 619, 751, 755, 991, 1036, 1050, 1069, 1111
Gray Redhorse	*Moxostoma congestum*	Fish	Low	Extremely Vulnerable	Extremely Vulnerable	201, 444, 459, 630, 637, 663, 755, 861, 911
Greenthroat Darter	*Etheostoma lepidum*	Fish	Moderately Low	Extremely Vulnerable	Extremely Vulnerable	223, 643, 698, 699, 861, 911, 935
Headwater Catfish	*Ictalurus lupus*	Fish	Low	Extremely Vulnerable	Extremely Vulnerable	257, 391, 446, 501, 502, 544, 699, 736, 861, 911
Headwater Chub	*Gila nigra*	Fish	Low	Extremely Vulnerable	Extremely Vulnerable	7, 85, 86, 147, 453, 611, 620, 634, 646, 665, 699, 700, 702, 765, 787, 789, 853, 1013, 1073
Loach Minnow	*Rhinichthys cobitis*	Fish	Low	Extremely Vulnerable	Extremely Vulnerable	620, 752, 754, 765, 784, 853, 911, 973, 1012, 1053
Longnose Gar	*Lepisosteus osseus*	Fish	High	Less Vulnerable	Less Vulnerable	60, 109, 135, 191, 581, 699, 765, 853, 911
Mexican Tetra	*Astyanax mexicanus*	Fish	Moderately High	Less Vulnerable	Moderately Vulnerable	630, 633, 702, 713, 755, 765, 794, 853, 911606,
Mottled Sculpin	*Cottus bairdii*	Fish	Low	Extremely Vulnerable	Extremely Vulnerable	49, 60, 246, 326, 449, 534, 596, 630, 699, 722, 740, 852, 911, 1078, 1120
Pecos Bluntnose Shiner	*Notropis simus pecosensis*	Fish	Low	Extremely Vulnerable	Extremely Vulnerable	26, 87, 156, 298, 326, 336, 396, 683, 684, 738, 911, 961, 974, 1006, 1027, 1037
Pecos Gambusia	*Gambusia nobilis*	Fish	Low	Extremely Vulnerable	Extremely Vulnerable	62, 255, 256, 326, 443, 445, 534, 699, 918, 1029
Pecos Pupfish	*Cyprinodon pecosensis*	Fish	Low	Extremely Vulnerable	Extremely Vulnerable	266, 326, 630, 642, 911, 986, 987, 1001, 1032, 1034
Peppered Chub	*Macrhybopsis tetranema*	Fish	Low	Extremely Vulnerale	Extremely Vulnerable	184, 188, 262, 551, 1030, 1032, 1034, 1044
Plains Minnow	*Hybognathus placitus*	Fish	Moderately Low	Moderately Vulnerable	Highly Vulnerable	188, 207, 537, 630, 687, 699, 772, 836, 911, 1030, 1100, 1109, 1112
Razorback Sucker	*Xyrauchen texanus*	Fish	Moderately High	Less Vulnerable	Moderately Vulnerable	567, 630, 699, 773, 975, 979, 989, 1034, 1043
Rio Grande Chub	*Gila pandora*	Fish	Moderately High	Less Vulnerable	Moderately Vulnerable	69, 90, 133, 630, 737, 764, 844, 1059, 1061, 1062
Rio Grande Cutthroat Trout	*Oncorhynchus clarkii virginalis*	Fish	Low	Extremely Vulnerable	Extremely Vulnerable	13, 67, 68, 133, 334, 390, 644, 786, 911, 988, 1020, 1023, 1047, 1119, 1121
Rio Grande Shiner	*Notropis jemezanus*	Fish	Moderately Low	Moderately Vulnerable	Extremely Vulnerable	154, 250, 412, 421, 529,534, 630, 685, 699, 911, 960, 1040, 1101
Rio Grande Silvery Minnow	*Hybognathus amarus*	Fish	Low	Highly Vulnerable	Highly Vulnerable	10, 24, 25, 88, 258, 450, 536, 630, 637, 662, 665, 687, 690, 729, 911, 990, 996, 998, 1007, 1058
Rio Grande Sucker	*Catostomus plebeius*	Fish	Low	Highly Vulnerable	Highly Vulnerable	36, 47, 134, 204, 453, 534, 606, 630, 699, 774, 780, 872, 911, 957, 1059, 1060, 1062
Roundnose Minnow	*Dionda episcopa*	Fish	Moderately High	Moderately Vulnerable	Moderately Vulnerable	699, 739, 844, 911
Roundtail Chub	*Gila robusta*	Fish	Moderately High	Less Vulnerable	Moderately Vulnerable	86, 91, 143, 152, 275, 442, 453, 591, 602, 612, 630, 635, 665, 701, 765, 853, 911, 1049, 1073

Common Name	*Scientific Name*	Family	Adaptive Capacity	RCP 4.5 Score	RCP 8.5 Score	Literature
Smallmouth Buffalo	*Ictiobus bubalus*	Fish	High	Less Vulnerable	Less Vulnerable	60, 134, 221, 468, 575, 699, 911, 1099
Sonora Sucker	*Catostomus insignis*	Fish	High	Less Vulnerable	Less Vulnerable	6, 178, 350, 530, 534, 606, 652, 785, 788, 911, 1013
Southern Redbelly Dace	*Chrosomus erythrogaster*	Fish	Moderately Low	Moderately Vulnerable	Moderately Vulnerable	35, 362, 410, 534, 637, 652, 662, 699, 755, 911
Speckled Chub	*Macrhybopsis aestivallis*	Fish	Moderately High	Less Vulnerable	Moderately Vulnerable	48, 97, 207, 262, 637, 685, 730, 889, 911
Spikedace	*Meda fulgida*	Fish	Low	Highly Vulnerable	Highly Vulnerable	609, 610, 716, 753, 755, 911, 972, 999, 1012, 1013
Suckermouth Minnow	*Phenacobius mirabilis*	Fish	High	Less Vulnerable	Less Vulnerable	637, 641, 643, 658, 699, 911
White Sands Pupfish	*Cyprinodon tularosa*	Fish	Moderately Low	Moderately Vulnerable	Highly Vulnerable	5, 51, 144, 469, 569, 603, 641, 643, 699, 733, 734, 792, 793, 898, 916
Zuni Bluehead Sucker	*Catostomus discobolus yarrowi*	Fish	Low	Moderately Vulnerable	Extremely Vulnerable	352, 458, 637, 641, 749, 755, 756, 888, 911, 946, 999, 1009, 1016, 1017, 1039
Allen's Big-eared Bat	*Idionycteris phyllotis*	Mammals	Moderately High	Less Vulnerable	Less Vulnerable	1, 117, 168, 423, 426, 488, 760, 761, 762, 929
American Beaver	*Castor canadensis*	Mammals	Moderately High	Less Vulnerable	Moderately Vulnerable	286, 473, 500, 504, 553, 650, 654, 742, 868, 1115
American Mink	*Neogale vison*	Mammals	Moderately High	Less Vulnerable	Moderately Vulnerable	277, 292, 441, 640, 721,
American Pika	*Ochotona princeps*	Mammals	Moderately Low	Moderately Vulnerable	Highly Vulnerable	30, 65, 150, 292, 410, 471, 552, 598, 599, 720, 870,
Arizona Gray Squirrel	*Sciurus arizonensis arizonensis*	Mammals	High	Less Vulnerable	Less Vulnerable	210, 211, 319, 423, 473
Arizona Montane Vole	*Microtus montanus arizonensis*	Mammals	Moderately High	Moderately Vulnerable	Moderately Vulnerable	312, 630, 637, 652, 662
Arizona Shrew	*Sorex arizonae*	Mammals	Moderately High	Less Vulnerable	Moderately Vulnerable	2, 4, 637, 837, 843
Banner-tailed Kangaroo Rat	*Dipodomys spectabilis*	Mammals	Moderately Low	Moderately Vulnerable	Highly Vulnerable	131, 198, 473, 488, 627, 649, 1066, 1083
Big Free-tailed Bat	*Nyctinomops macrotis*	Mammals	Moderately High	Less Vulnerable	Moderately Vulnerable	192, 305, 423, 426, 488, 760, 761, 762, 929
Black-footed Ferret	*Mustela nigripes*	Mammals	Low	Extremely Vulnerable	Extremely Vulnerable	286, 306, 324, 441, 473, 486, 659, 660
Black-tailed Prairie Dog	*Cynomys ludovicianus*	Mammals	Moderately High	Moderately Vulnerable	Moderately Vulnerable	157, 176, 177, 284, 285, 286, 423, 441, 607, 652, 843, 992
Canada Lynx	*Lynx canadensis*	Mammals	Moderately Low	Highly Vulnerable	Highly Vulnerable	171, 289, 324, 473, 514, 638, 714, 856, 882, 951, 967, 983, 1000, 1020
Cave Myotis	*Myotis velifer*	Mammals	Moderately High	Less Vulnerable	Less Vulnerable	20, 286, 292, 423, 426, 488, 512, 563, 760, 761, 762, 928
Common Porcupine	*Erethizon dorsatum*	Mammals	High	Less Vulnerable	Less Vulnerable	23, 286, 292, 327, 543, 920
Desert Pocket Gopher	*Geomys arenarius*	Mammals	Moderately High	Less Vulnerable	Moderately Vulnerable	46. 227, 245, 286, 374, 375, 473, 671, 691, 1002
Eastern Red Bat	*Lasiurus borealis*	Mammals	High	Less Vulnerable	Less Vulnerable	32, 265, 428, 488, 515, 678, 760, 761, 762, 928, 929, 1008, 1108
Ermine Weasel	*Mustela richardsonii*	Mammals	High	Less Vulnerable	Less Vulnerable	276, 285, 307, 473, 320, 321, 864

Common Name	*Scientific Name*	Family	Adaptive Capacity	RCP 4.5 Score	RCP 8.5 Score	Literature
Fringed Myotis	*Myotis thysanodes thysanodes*	Mammals	High	Less Vulnerable	Less Vulnerable	168, 190, 284, 397, 426, 488, 664, 760, 761, 762, 947, 964
Gray-collared Chipmunk	*Neotamias cinereicollis cinereicollis*	Mammals	High	Less Vulnerable	Less Vulnerable	102, 307, 378, 420, 484, 525
Gray-footed Chipmunk	*Neotamias canipes*	Mammals	High	Less Vulnerable	Less Vulnerable	84, 307, 839
Gunnison's Prairie Dog	*Cynomys gunnisoni*	Mammals	Moderately High	Moderately Vulnerable	Extremely Vulnerable	176, 212, 213, 284, 286, 305, 328, 423, 533, 735, 768, 769, 806, 817, 843
Heather Vole	*Phenacomys intermedius intermedius*	Mammals	High	Less Vulnerable	Less Vulnerable	286, 307, 651
Hoary Bat	*Aeorestes cinereus cinereus*	Mammals	High	Moderately Vulnerable	Moderately Vulnerable	32, 41, 168, 292, 426, 488, 515, 760, 761, 762, 838, 928
Holzner's Cottontail Rabbit	*Sylvilagus holzneri*	Mammals	High	Less Vulnerable	Less Vulnerable	277, 286, 305, 349, 969, 1063
Hooded Skunk	*Mephitis macroura milleri*	Mammals	High	Less Vulnerable	Less Vulnerable	171, 190, 263, 286, 473
Jaguar	*Panthera onca arizonensis*	Mammals	High	Less Vulnerable	Less Vulnerable	33, 112, 171, 356, 513, 640, 652, 727, 759, 970, 982
Least Shrew	*Cryptotis parvus*	Mammals	High	Less Vulnerable	Moderately Vulnerable	637, 643, 837, 843, 858
Lesser Long-nosed Bat	*Leptonycteris yerbabuenae*	Mammals	Moderately High	Less Vulnerable	Moderately Vulnerable	38, 181, 284, 423, 426, 488, 515, 531, 643, 689, 760, 761, 762, 876, 1025, 1031
Mexican Gray Wolf	*Canis lupus baileyi*	Mammals	Moderately Low	Moderately Vulnerable	Extremely Vulnerable	2, 408, 593, 652, 1014, 1054, 1087
Mexican Long-nosed Bat	*Leptonycteris nivalis*	Mammals	Moderately High	Less Vulnerable	Moderately Vulnerable	15, 27, 426, 488, 639, 643, 652, 760, 761, 762, 838, 1032
Mexican Long-tongued Bat	*Choeronycteris mexicana*	Mammals	Moderately Low	Highly Vulnerable	Highly Vulnerable	209, 426, 488, 622, 652, 760, 761, 762, 947
New Mexico Jumping Mouse	*Zapus hudsonius luteus (=Zapus luteus luteus)*	Mammals	Moderately Low	Moderately Vulnerable	Extremely Vulnerable	284, 308, 309, 310, 326, 398, 423, 1014, 1022, 1038, 1096, 1114
North American River Otter	*Lontra canadensis*	Mammals	Moderately High	Less Vulnerable	Moderately Vulnerable	9, 187, 202, 203, 247, 324, 626, 652
Northern Pygmy Mouse	*Baiomys taylori ater*	Mammals	High	Less Vulnerable	Less Vulnerable	160, 273, 286, 342, 406, 423, 493, 503, 555
Organ Mountains Colorado Chipmunk	*Neotamias quadrivittatus australis*	Mammals	Moderately Low	Highly Vulnerable	Highly Vulnerable	84, 312, 313, 455, 637, 849, 850, 915
Oscura Mountains Colorado Chipmunk	*Neotamias quadrivittatus oscuraensis*	Mammals	Moderately Low	Moderately Vulnerable	Highly Vulnerable	84, 637, 643, 724, 757, 849, 850, 915
Pacific Marten	*Martes caurina*	Mammals	Moderately High	Less Vulnerable	Moderately Vulnerable	286, 292, 542, 643, 662, 905, 1084
Peñasco Least Chipmunk	*Neotamias minimus atristriatus*	Mammals	Moderately Low	Extremely Vulnerable	Extremely Vulnerable	315, 218, 323, 357, 454, 586, 587, 588, 652, 757, 1033, 1042
Pocketed Free-tailed Bat	*Nyctinomops femorosaccus*	Mammals	High	Less Vulnerable	Less Vulnerable	307, 423, 426, 488, 760, 761, 762, 947
Prairie Vole	*Microtus ochrogaster haydenii*	Mammals	Moderately High	Less Vulnerable	Moderately Vulnerable	228, 304, 307, 347, 348, 404, 473, 582, 692, 885, 897
Snowshoe Hare	*Lepus americanus bairdii*	Mammals	Moderately High	Less Vulnerable	Moderately Vulnerable	128, 285, 317, 523, 556, 862, 1122
Southern Pocket Gopher	*Thomomys umbrinus*	Mammals	High	Less Vulnerable	Less Vulnerable	41, 190, 286, 423, 435, 473, 573, 637, 662, 671
Southern Red-backed Vole	*Myodes gapperi*	Mammals	High	Less Vulnerable	Less Vulnerable	70, 304, 354, 370, 473, 487, 499, 521, 594, 595
Southwestern Little Brown Myotis	*Myotis occultus*	Mammals	High	Less Vulnerable	Less Vulnerable	151, 169, 286, 426, 488, 760, 761, 762, 777, 928

Common Name	*Scientific Name*	Family	Adaptive Capacity	RCP 4.5 Score	RCP 8.5 Score	Literature
Spotted Bat	*Euderma maculatum*	Mammals	High	Less Vulnerable	Less Vulnerable	286, 305, 337, 338, 426, 488, 760, 761, 762, 967
Thirteen-lined Ground Squirrel	*Ictidomys tridecemlineatus*	Mammals	High	Less Vulnerable	Less Vulnerable	292, 434, 493, 579, 795, 904
Tricolored Bat	*Perimyotis subflavus*	Mammals	Moderately High	Highly Vulnerable	Highly Vulnerable	43, 155, 330, 343, 426, 488, 515, 524, 760, 761, 762, 1008, 1065, 1098
Western Jumping Mouse	*Zapus princeps princeps*	Mammals	High	Less Vulnerable	Less Vulnerable	116, 164, 175, 286, 309, 473, 896
Western Red Bat	*Lasiurus blossevillii*	Mammals	High	Less Vulnerable	Less Vulnerable	190, 286, 340, 426, 488, 760, 761, 762
Western Water Shrew	*Sorex navigator*	Mammals	Moderately High	Moderately Vulnerable	Moderately Vulnerable	186, 286, 322, 423, 837, 967
Western Yellow Bat	*Dasypterus xanthinus*	Mammals	Moderately High	Less Vulnerable	Moderately Vulnerable	32, 190, 286, 307, 423, 426, 488, 515, 643, 662, 760, 761, 762, 929, 1118
White-nosed Coati	*Nasua narica*	Mammals	High	Less Vulnerable	Less Vulnerable	316, 395, 441, 498, 657
White-sided Jackrabbit	*Lepus callotis gaillardi*	Mammals	High	Less Vulnerable	Less Vulnerable	61, 64, 115, 326, 637, 643, 643, 652, 662, 943,
White-tailed Jackrabbit	*Lepus townsendii campanius*	Mammals	High	Less Vulnerable	Less Vulnerable	113, 115, 118, 252, 281, 286, 324, 791, 967,
Yellow-bellied Marmot	*Marmota flaviventris*	Mammals	Moderately High	Less Vulnerable	Less Vulnerable	28, 29, 31, 286, 302, 314, 370, 388
Yellow-nosed Cotton Rat	*Sigmodon ochrognathus*	Mammals	High	Less Vulnerable	Less Vulnerable	138, 190, 227, 339, 341, 493
Yuma Myotis	*Myotis yumanensis yumanensis*	Mammals	High	Less Vulnerable	Less Vulnerable	43, 106, 104, 168, 286, 426, 488, 760, 761, 762, 952, 954
Arid Land Ribbonsnake	*Thamnophis proximus diabolicus*	Reptiles	High	Less Vulnerable	Less Vulnerable	57, 270, 363, 637, 641, 652, 803
Arizona Black Rattlesnake	*Crotalus cerberus*	Reptiles	High	Less Vulnerable	Less Vulnerable	166, 167, 244, 363, 399, 670, 1070
Banded Rock Rattlesnake	*Crotalus lepidus klauberi*	Reptiles	High	Less Vulnerable	Less Vulnerable	399, 430, 649
Big Bend Slider	*Trachemys gaigeae*	Reptiles	Moderately High	Moderately Vulnerable	Moderately Vulnerable	295, 327, 333, 686, 909, 910
Bleached Earless Lizard	*Holbrookia maculata ruthveni*	Reptiles	Moderately Low	Moderately Vulnerable	Moderately Vulnerable	66, 344, 345, 379, 383, 561, 854, 866
Bolson's Tortoise	*Gopherus flavomarginatus*	Reptiles	Low	Extremely Vulnerable	Extremely Vulnerable	56, 129, 624, 625, 945, 953, 958, 959, 1055
Dunes Sagebrush Lizard	*Sceloporus arenicolus*	Reptiles	Moderately Low	Moderately Vulnerable	Highly Vulnerable	234, 235, 279, 293, 418, 637, 649, 655, 708, 812, 816, 855, 859, 866, 874, 1004, 1079
Giant Spotted Whiptail	*Aspidoscelis stictogramma*	Reptiles	Moderately Low	Moderately Vulnerable	Highly Vulnerable	44, 107, 235, 637, 642, 643, 649, 652, 710, 797, 866, 891
Gray-banded Kingsnake	*Lampropeltis alterna*	Reptiles	High	Less Vulnerable	Less Vulnerable	235, 363, 377, 641m 652, 709, 891, 932, 1094
Gray-checkered Whiptail	*Aspidoscelis dixoni*	Reptiles	Moderately Low	Moderately Vulnerable	Highly Vulnerable	6, 180, 193, 208, 235, 637, 652, 662, 705, 706, 866, 890, 1077
Green Rat Snake	*Senticolis triaspis intermedia*	Reptiles	High	Less Vulnerable	Less Vulnerable	66, 235, 652,662, 890,891
Knobloch's Mountain Kingsnake	*Lampropeltis knoblochi*	Reptiles	High	Less Vulnerable	Less Vulnerable	122, 363, 428, 452, 891
Little White Whiptail	*Aspidoscelis inornata gypsi*	Reptiles	High	Less Vulnerable	Less Vulnerable	125, 235, 242, 261, 386, 561, 890, 1116
Mexican Gartersnake	*Thamnophis eques megalops*	Reptiles	Moderately Low	Extremely Vulnerable	Extremely Vulnerable	3, 363, 554, 562, 637, 643, 662, 799, 939, 1003, 1021
Midland Smooth Softshell Turtle	*Apalone mutica mutica*	Reptiles	Moderately Low	Moderately Vulnerable	Moderately Vulnerable	24, 183, 333, 441, 710, 771, 890
Mojave Rattlesnake	*Crotalus scutulatus scutulatus*	Reptiles	High	Less Vulnerable	Less Vulnerable	139, 235, 269, 363, 616, 649, 723, 747

Common Name	*Scientific Name*	Family	Adaptive Capacity	RCP 4.5 Score	RCP 8.5 Score	Literature
Mottled Rock Rattlesnake	*Crotalus lepidus lepidus*	Reptiles	High	Less Vulnerable	Less Vulnerable	139, 363, 399, 430, 641, 643, 649, 921, 932
Mountain Skink	*Plestiodon callicephalus*	Reptiles	High	Less Vulnerable	Less Vulnerable	235, 290, 291, 637, 641, 890, 926
Narrow-headed Gartersnake	*Thamnophis rufipunctatus*	Reptiles	High	Less Vulnerable	Less Vulnerable	165, 235, 280, 357, 363, 465, 631, 637, 641, 643, 890, 1019
New Mexico Ridge-nosed Rattlesnake	*Crotalus willardi obscurus*	Reptiles	High	Less Vulnerable	Less Vulnerable	50, 140, 225, 226, 431, 432, 433, 637, 643, 649, 707
North American Racer	*Coluber constrictor*	Reptiles	High	Less Vulnerable	Less Vulnerable	118,119, 183, 235, 327, 363, 383, 725, 798, 919, 932
Ornate Box Turtle	*Terrapene ornata*	Reptiles	Moderately Low	Highly Vulnerable	Extremely Vulnerable	333, 363,399, 410, 535, 710, 770, 894, 1082
Plain-bellied Water Snake	*Nerodia erythrogaster transversa*	Reptiles	High	Less Vulnerable	Less Vulnerable	164, 235, 637, 643, 932
Plains Gartersnake	*Thamnophis radix*	Reptiles	High	Less Vulnerable	Less Vulnerable	235, 363, 383, 887, 890, 1074
Pyro Mountain Kingsnake	*Lampropeltis pyromelana*	Reptiles	High	Less Vulnerable	Less Vulnerable	54, 122, 235, 359, 429, 631, 891, 956
Reticulate Gila Monster	*Heloderma suspectum suspectum*	Reptiles	High	Less Vulnerable	Less Vulnerable	139, 360, 399, 485, 637, 643, 649, 656, 1087
Slevin's Bunchgrass Lizard	*Sceloporus slevini*	Reptiles	Moderately High	Moderately Vulnerable	Moderately Vulnerable	42, 261, 326, 636, 637, 641, 642, 643, 652, 681, 866, 873, 891, 1085
Smooth Greensnake	*Opheodrys vernalis blanchardi*	Reptiles	High	Less Vulnerable	Less Vulnerable	145, 182, 185, 189, 284, 296, 363, 384, 410, 494, 741, 895,
Sonoran Lyresnake	*Trimorphodon lambda*	Reptiles	High	Less Vulnerable	Less Vulnerable	54, 107, 235, 270, 63, 526, 891, 932
Sonoran Mud Turtle	*Kinosternon sonoriense sonoriense*	Reptiles	Moderately High	Less Vulnerable	Moderately Vulnerable	234, 248, 271, 364, 630, 782, 890, 901, 902
Texas Lyresnake	*Trimorphodon vilkinsonii*	Reptiles	High	Less Vulnerable	Less Vulnerable	107, 235, 363, 528, 711, 841, 932
Texas Spotted Whiptail	*Aspidoscelis gularis gularis*	Reptiles	High	Less Vulnerable	Less Vulnerable	18, 83, 126, 261, 285, 333, 710, 711, 866
Trans-Pecos Rat Snake	*Bogertophis subocularis subocularis*	Reptiles	High	Less Vulnerable	Less Vulnerable	54, 185, 235, 363, 710, 747, 890, 932, 1094
Western Blind Snake	*Rena humilis segregus*	Reptiles	High	Less Vulnerable	Less Vulnerable	54, 235, 891, 1080, 1094
Western Massasauga	*Sistrurus tergeminus*	Reptiles	High	Less Vulnerable	Less Vulnerable	2, 174, 284, 427, 649, 723, 800, 811
Western Painted Turtle	*Chrysemys picta bellii*	Reptiles	High	Less Vulnerable	Less Vulnerable	161, 235, 327, 333, 379, 383, 650, 416, 771
Western River Cooter	*Pseudemys gorzugi*	Reptiles	Moderately High	Moderately Vulnerable	Highly Vulnerable	154, 466, 558, 559, 637, 731, 820, 917
Yaqui Black-headed Snake	*Tantilla yaquia*	Reptiles	High	Less Vulnerable	Less Vulnerable	235, 641, 796, 891
Yarrow's Spiny Lizard	*Sceloporus jarrovii jarrovii*	Reptiles	Moderately High	Less Vulnerable	Moderately Vulnerable	59, 358, 547, 630, 866, 891

APPENDIX 8. Table of categories that impact each Climate Change Vulnerability Index score for 295 vertebrate Species of Greatest Conservation Need.

Orange signifies “shift in space” factors. Purple signifies “persist in place” factors. Blue signifies a factor that can influence a species’ ability to “shift in space” and “persist in place”. Within the “threat multipliers” column: B signifies a topographic (e.g., mountain, lake) or anthropogenic (e.g., road, dam) barrier, C signifies changes in land-use (e.g., urbanization, agricultural development), O signifies other anthropogenic threats (e.g., harvest, collection), and D signifies biologic threats (e.g., disease, invasive species). The “Response” column refers to any documented or modeled response to climate change for that particular species.

Common Name	*Scientific Name*	Family	Distribution	Movement	Demography	Life History	Ecological Role	Evolutionary Potential	Abiotic Niche	Threat multipliers	Response
Arizona Toad	*Anaxyrus microscaphus microscaphus*	Amphibians		x	x				x	B, C, D	x
Arizona Treefrog	*Hyla wrightorum*	Amphibians	x	x					x	C	
Blanchard's Cricket Frog	*Acris blanchardi*	Amphibians		x		x			x		
Boreal Chorus Frog	*Pseudacris maculata*	Amphibians		x		x			x	B, C, D	
Boreal Toad	*Anaxyrus boreas boreas*	Amphibians	x	x		x		x	x		
Chiricahua Leopard Frog	*Lithobates chiricahuensis*	Amphibians	x	x					x	B, C, D	
Eastern Barking Frog	*Craugastor augusti latrans*	Amphibians	x	x					x		
Jemez Mountains Salamander	*Plethodon neomexicanus*	Amphibians	x	x				x	x	B, C, D	
Lowland Leopard Frog	*Lithobates yavapaiensis*	Amphibians	x	x				x	x		
Northern Leopard Frog	*Lithobates pipiens*	Amphibians		x	x		x	x	x		
Plains Leopard Frog	*Lithobates blairi*	Amphibians		x					x		
Rio Grande Leopard Frog	*Lithobates berlandieri*	Amphibians		x					x		
Sacramento Mountain Salamander	*Aneides hardii*	Amphibians	x	x	x	x			x		
Sonoran Desert Toad	*Incilius alvarius*	Amphibians		x	x	x			x		
Western Narrow-mouthed Toad	*Gastrophryne olivacea*	Amphibians	x			x			x		
Abert's Towhee	*Melozone aberti aberti*	Birds						x	x	O, D	
American Bittern	*Botaurus lentiginosus*	Birds		x		x			x		x
American Dipper	*Cinclus mexicanus unicolor*	Birds		x		x			x		x

Common Name	*Scientific Name*	Family	Distribution	Movement	Demography	Life History	Ecological Role	Evolutionary Potential	Abiotic Niche	Threat multipliers	Response
American Kestrel	*Falco sparverius sparverius*	Birds		x		x					
American Pipit	*Anthus rubescens*	Birds		x					x		x
American Tree Sparrow	*Spizelloides arborea ochracea*	Birds		x					x		x
Aplomado Falcon	*Falco femoarlis septentrionalis*	Birds		x	x	x		x			x
Arizona Grasshopper Sparrow	*Ammodramus savannarum ammolegus*	Birds	x								x
Arizona Woodpecker	*Dryobates arizonae*	Birds	x			x					x
Baird's Sparrow	*Centronyx bairdii*	Birds	x	x		x					x
Bald Eagle	*Haliaeetus leucocephalus*	Birds		x	x	x					x
Band-tailed Pigeon	*Patagioenas fasciata*	Birds		x	x	x					x
Bank Swallow	*Riparia riparia riparia*	Birds	x	x		x			x		
Bell's Vireo	*Vireo belli*	Birds		x		x					
Bendire's Thrasher	*Toxostoma bendirei*	Birds		x		x					x
Bewick's Wren	*Thryomanes bewickii*	Birds		x		x					
Black Rosy-finch	*Leucosticte atrata*	Birds	x	x		x			x		x
Black Swift	*Cypseloides niger*	Birds	x	x					x		x
Black-billed Magpie	*Pica hudsonia*	Birds				x					x
Black-chinned Sparrow	*Spizella atrogularis evura*	Birds		x		x					x
Black-headed Grosbeak	*Pheucticus melanocephalus*	Birds		x		x			x		
Black-throated Gray Warbler	*Setophaga nigrescens*	Birds		x		x					x
Black-throated Sparrow	*Amphispiza bilineata*	Birds		x							
Boreal Owl	*Aegolius funereus*	Birds	x	x		x			x		x
Brewer's Sparrow	*Spizella breweri*	Birds		x		x					x
Broad-billed Hummingbird	*Cynanthus latirostris magicus*	Birds		x							
Broad-tailed Hummingbird	*Selasphorus platycercus platycercus*	Birds		x							x
Brown Pelican	*Pelecanus occidentalis carolinensis*	Birds		x		x			x		
Brown-capped Rosy Finch	*Leucosticte australis*	Birds	x	x				x	x		x
Buff-breasted Flycatcher	*Empidonax fulvifrons pygmaeus*	Birds		x		x		x			
Bullock's Oriole	*Icterus bullockii*	Birds		x							
Burrowing Owl	*Athene cunicularia hyupgaea*	Birds	x	x		x					

Common Name	*Scientific Name*	Family	Distribution	Movement	Demography	Life History	Ecological Role	Evolutionary Potential	Abiotic Niche	Threat multipliers	Response
Cactus Wren	*Campylorhyncus brunneicapillus couesi*	Birds		x		x					
Canyon Towhee	*Melozone fusca*	Birds				x					
Canyon Wren	*Catherpes mexicanus conspersus*	Birds				x					
Cassin's Finch	*Haemorhous cassinii*	Birds		x		x			x		x
Cassin's Kingbird	*Tyrannus vociferans vociferans*	Birds				x					
Cassin's Sparrow	*Peucaea cassinii*	Birds		x					x		
Chestnut-collared Longspur	*Calcarius ornatus*	Birds	x	x		x					x
Chihuahuan Meadowlark	*Sturnella lilianae*	Birds	x	x							
Chihuahuan Raven	*Corvus cryptoleucus*	Birds		x							
Chipping Sparrow	*Spizella passerina arizonae*	Birds		x						B, C, O, D	
Clark's Grebe	*Aechmorphorus clarkii*	Birds	x	x					x		x
Clark's Nutcracker	*Nucifraga columbiana*	Birds	x	x		x			x		x
Cliff Swallow	*Petrochelidon pyrrhonota*	Birds		x		x					
Common Black Hawk	*Buteogallus anthracinus anthracinus*	Birds	x	x					x		x
Common Ground Dove	*Columbina passerina pallescense*	Birds		x		x					
Common Nighthawk	*Chordeiles minor*	Birds		x							
Costa's Hummingbird	*Calypte costae*	Birds		x				x	x		
Eastern Bluebird	*Sialis sialis*	Birds		x		x					
Elegant Trogon	*Trogon elegans conescense*	Birds	x	x		x			x		
Elf Owl	*Micrathene whitneyi whitneyi*	Birds		x		x					
Evening Grosbeak	*Coccothraustes vespertinus*	Birds		x		x					x
Ferruginous Hawk	*Buteo regalis*	Birds		x		x					x
Field Sparrow	*Spizella pusilla arenacea*	Birds		x		x					x
Flammulated Owl	*Psilocops flammeolus*	Birds		x		x					
Gila Woodpecker	*Melanerpes uropygialis uropygialis*	Birds	x	x		x		x			
Golden Eagle	*Aquila chrysaetos canadensis*	Birds		x		x					
Grace's Warbler	*Setophaga graciae*	Birds		x		x					x
Grasshopper Sparrow	*Ammodramus savannarum perpallidus*	Birds		x		x					x

Common Name	*Scientific Name*	Family	Distribution	Movement	Demography	Life History	Ecological Role	Evolutionary Potential	Abiotic Niche	Threat multipliers	Response
Gray Vireo	*Vireo vicinior*	Birds	x	x					x	C, D	
Gray-crowned Rosy Finch	*Leucosticte tephorcotis*	Birds	x	x		x			x		x
Greater Pewee	*Contopus pertinax pallidiventris*	Birds	x	x		x					
Greater Yellowlegs	*Tringa melanoleuca*	Birds	x	x					x		x
Green-tailed Towhee	*Pipilo chlorurus*	Birds		x		x					x
Harris's Hawk	*Parabuteo unicinctus harrisi*	Birds		x	x						
Horned Lark	*Eremophila alpestris*	Birds		x		x					
Juniper Titmouse	*Baeolophus ridgwayi*	Birds	x	x		x					
Killdeer	*Charadrius vociferus vociferus*	Birds		x		x					
Lapland Longspur	*Calcarius lapponicus alascensis*	Birds		x		x			x		x
Lark Bunting	*Calamospiza melanocorys*	Birds		x		x					x
Lark Sparrow	*Chondestes grammacus strigatus*	Birds		x		x					
Lazuli Bunting	*Passerina amoena*	Birds		x		x					
Least Tern	*Sternula antillarum athalassos*	Birds	x	x							x
Lesser Prairie Chicken	*Tympanuchus pallidicinctus*	Birds	x	x					x		x
Lewis's Woodpecker	*Melanerpes lewisi*	Birds	x	x		x			x		
Loggerhead Shrike	*Lanius ludovicianus*	Birds		x		x					x
Long-billed Curlew	*Numenius americanus americanus*	Birds	x	x					x	C, O, D	
Long-billed Dowitcher	*Limnodromus scolopaceus*	Birds	x	x							
Long-eared Owl	*Asio otus*	Birds	x	x		x					
Lucifer's Hummingbird	*Calothorax lucifer*	Birds		x				x			
Lucy's Warbler	*Leiothlypis luciae*	Birds		x							
Mexican Chickadee	*Poecile sclateri eidos*	Birds		x		x		x			
Mexican Spotted Owl	*Strix occidentalis lucida*	Birds	x	x		x			x		x
Mexican Whip-poor-will	*Anostomus arizonae arizonae*	Birds	x	x							
Mountain Bluebird	*Sialia currucoides*	Birds		x		x					
Mountain Chickadee	*Poecile gambeli gambeli*	Birds		x		x					x
Mountain Plover	*Charadrius montanus*	Birds		x							x
Neotropic Cormorant	*Nannopterum brasilianum*	Birds		x		x			x		

Common Name	*Scientific Name*	Family	Distribution	Movement	Demography	Life History	Ecological Role	Evolutionary Potential	Abiotic Niche	Threat multipliers	Response
Northern Beardless-Tyrannulet	*Campostoma omberbe ridgwayi*	Birds		x		x					
Northern Harrier	*Circus hudsonius*	Birds		x	x						x
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	Birds		x		x					
Olive Warbler	*Peucedramus taeniatus arizonae*	Birds	x	x		x					x
Olive-sided Flycatcher	*Contopus cooperi*	Birds		x		x					x
Peregrine Falcon	*Falco peregrinus*	Birds		x		x					
Phainopepla	*Phainopepla nitens lepida*	Birds				x			x		
Pine Grosbeak	*Pinicola enucleator montana*	Birds		x					x		x
Pine Siskin	*Spinus pinus*	Birds		x		x					x
Pinyon Jay	*Gymnorhinus cyanocephalus*	Birds				x	x		x		x
Piping Plover	*Charadrius melodus circumcinctus*	Birds	x	x							x
Plumbeous Vireo	*Vireo plumbeus*	Birds		x		x					
Prairie Falcon	*Falco mexicanus*	Birds			x	x					
Purple Martin	*Progne subis*	Birds		x		x			x		
Pygmy Nuthatch	*Sitta pygmaea melanotis*	Birds				x			x		x
Pyrrhuxolia	*Cardinalis sinuatus sinuatus*	Birds				x				B, D	
Red-faced Warbler	*Cardellina rubrifrons*	Birds	x	x					x		
Red-headed Woodpecker	*Melanerpes erythrocephalus caurinus*	Birds		x							
Red-naped Sapsucker	*Sphyrapicus nuchalis*	Birds		x		x					
Rock Wren	*Salpinctes obsoletus obsoletus*	Birds		x		x					
Sage Thrasher	*Oreoscoptes montanus*	Birds		x		x		x			x
Sagebrush Sparrow	*Artemisiospiza nevadensis*	Birds		x		x	x				
Savannah Sparrow	*Passerculus sandwichensis*	Birds		x		x					x
Scott's Oriole	*Icterus parisorum*	Birds		x		x					
Short-eared Owl	*Asio flammeus flammeus*	Birds		x				x	x		
Snowy Plover	*Charadrius nivosus*	Birds		x				x	x	B, C, O	
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	Birds		x				x	x	B, D	

Common Name	*Scientific Name*	Family	Distribution	Movement	Demography	Life History	Ecological Role	Evolutionary Potential	Abiotic Niche	Threat multipliers	Response
Spotted Sandpiper	*Actitis macularius*	Birds							x		x
Spotted Towhee	*Pipilo maculatus*	Birds		x		x					
Sprague's Pipit	*Anthus spragueii*	Birds		x				x	x		
Steller's Jay	*Cyanocitta stelleri macrolopha*	Birds				x	x				
Thick-billed Kingbird	*Tyrannus crassirostris*	Birds		x		x			x		
Thick-billed Longspur	*Rhynchophanes mccownii*	Birds		x		x		x			
Varied Bunting	*Passerina versicolor*	Birds	x	x							
Verdin	*Auriparus flaviceps ornatus*	Birds		x					x		
Vesper Sparrow	*Pooecetes gramineus*	Birds									
Violet-crowned Hummingbird	*Leucolia violiceps ellioti*	Birds		x					x		
Violet-green Swallow	*Tachycineta thalassina lepida*	Birds		x		x			x		
Virginia's Warbler	*Leiothlypis virginiae*	Birds		x		x					
Western Bluebird	*Sialia mexicana bairdi*	Birds		x		x					
Western Grebe	*Aechmophorus occidentalis*	Birds		x		x			x		
Western Kingbird	*Tyrannus verticalus*	Birds		x		x					
Western Meadowlark	*Sturnella neglecta*	Birds		x				x			
Western Sandpiper	*Calidris mauri*	Birds		x					x		x
Western Wood-Pewee	*Contopus sordidulus*	Birds		x		x		x			
Whiskered Screech-Owl	*Megascops trichopsis asperus*	Birds				x			x		
White-eared Hummingbird	*Basilinna leucotis borealis*	Birds							x	B, D	
White-tailed Ptarmigan	*Lagopus leucura altipetens*	Birds	x					x	x		x
White-throated Swift	*Aeronautes saxatalis saxatalis*	Birds		x							
Williamson's Sapsucker	*Sphyrapicus thyroideus nataliae*	Birds	x	x							x
Wilson's Warbler	*Cardellina pusilla*	Birds		x		x					
Woodhouse's Scrub Jay	*Aphelocoma woodhouseii*	Birds		x		x		x			
Yellow-billed Cuckoo (Eastern population)	*Coccyzus americanus americanus*	Birds		x			x		x		
Yellow-billed Cuckoo (Western Population)	*Coccyzus americanus occidentalis*	Birds		x			x	x	x		

Common Name	*Scientific Name*	Family	Distribution	Movement	Demography	Life History	Ecological Role	Evolutionary Potential	Abiotic Niche	Threat multipliers	Response
Yellow-eyed Junco	*Junco phaeonotus palliatus*	Birds		x		x					
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	Birds		x					x		x
Arkansas River Shiner	*Notropis girardi*	Fish	x	x				x	x	B, C, O,D	
Bigscale Logperch	*Percina macrolepida*	Fish								B, D	
Blue Sucker	*Cycleptus elongatus*	Fish		x	x	x					
Central Stoneroller	*Campostoma anomalum*	Fish								B, C, O, D	x
Chihuahua Chub	*Gila nigrescens*	Fish	x					x	x	B, C, O, D	
Colorado Pikeminnow	*Ptychocheilus lucius*	Fish		x	x					B, C, O, D	x
Desert Sucker	*Catostomus clarkii*	Fish	x						x	B, C, O, D	x
Gila Chub	*Gila intermedia*	Fish	x						x	B, C, O, D	x
Gila Topminnow	*Poeciliopsis occidentalis occidentalis*	Fish	x	x				x		B, C, O, D	
Gila Trout	*Oncorhynchus gilae*	Fish	x						x	B, D	
Gray Redhorse	*Moxostoma congestum*	Fish	x						x		
Greenthroat Darter	*Etheostoma lepidum*	Fish	x						x		
Headwater Catfish	*Ictalurus lupus*	Fish	x					x		B, C, O, D	
Headwater Chub	*Gila nigra*	Fish	x						x	B, C, O, D	
Loach Minnow	*Rhinichthys cobitis*	Fish	x			x			x	B, C, O, D	
Longnose Gar	*Lepisosteus osseus*	Fish				x		x			
Mexican Tetra	*Astyanax mexicanus*	Fish		x		x		x			
Mottled Sculpin	*Cottus bairdii*	Fish			x	x		x	x	B, C, O, D	
Pecos Bluntnose Shiner	*Notropis simus pecosensis*	Fish	x	x		x		x	x	B, C, O, D	
Pecos Gambusia	*Gambusia nobilis*	Fish	x			x		x	x	B, C, O, D	
Pecos Pupfish	*Cyprinodon pecosensis*	Fish	x			x		x	x	B, C, O, D	
Peppered Chub	*Macrhybopsis tetranema*	Fish	x			x		x	x		
Plains Minnow	*Hybognathus placitus*	Fish				x			x	B, C, O, D	
Razorback Sucker	*Xyrauchen texanus*	Fish		x	x	x			x		
Rio Grande Chub	*Gila pandora*	Fish				x		x	x	B, O, D	
Rio Grande Cutthroat Trout	*Oncorhynchus clarkii virginalis*	Fish	x			x		x	x	B, O, D	x
Rio Grande Shiner	*Notropis jemezanus*	Fish	x			x			x	B, C, O, D	
Rio Grande Silvery Minnow	*Hybognathus amarus*	Fish	x			x		x	x	B, C, O, D	
Rio Grande Sucker	*Catostomus plebeius*	Fish	x			x	x		x	B, O, D	
Roundnose Minnow	*Dionda episcopa*	Fish	x			x					
Roundtail Chub	*Gila robusta*	Fish		x					x		
Smallmouth Buffalo	*Ictiobus bubalus*	Fish			x	x					

Common Name	*Scientific Name*	Family	Distribution	Movement	Demography	Life History	Ecological Role	Evolutionary Potential	Abiotic Niche	Threat multipliers	Response
Sonora Sucker	*Catostomus insignis*	Fish	x			x					
Southern Redbelly Dace	*Chrosomus erythrogaster*	Fish	x	x					x		
Speckled Chub	*Macrhybopsis aestivallis*	Fish			x	x			x		
Spikedace	*Meda fulgida*	Fish	x	x		x		x	x		
Suckermouth Minnow	*Phenacobius mirabilis*	Fish				x					
White Sands Pupfish	*Cyprinodon tularosa*	Fish	x						x		
Zuni Bluehead Sucker	*Catostomus discobolus yarrowi*	Fish	x	x		x		x	x		
Allen's Big-eared Bat	*Idionycteris phyllotis*	Mammals		x					x		
American Beaver	*Castor canadensis*	Mammals		x				x	x		
American Mink	*Neogale vison*	Mammals						x	x		
American Pika	*Ochotona princeps*	Mammals	x	x					x	B	x
Arizona Gray Squirrel	*Sciurus arizonensis arizonensis*	Mammals	x						x	B, C, O,D	
Arizona Montane Vole	*Microtus montanus arizonensis*	Mammals	x					x		B, C, O,D	
Arizona Shrew	*Sorex arizonae*	Mammals	x						x	B, C, O	
Banner-tailed Kangaroo Rat	*Dipodomys spectabilis*	Mammals	x	x					x		x
Big Free-tailed Bat	*Nyctinomops macrotis*	Mammals		x		x			x		
Black-footed Ferret	*Mustela nigripes*	Mammals	x				x	x			
Black-tailed Prairie Dog	*Cynomys ludovicianus*	Mammals		x				x	x	B, D	
Canada Lynx	*Lynx canadensis*	Mammals	x					x	x		x
Cave Myotis	*Myotis velifer*	Mammals		x		x			x		
Common Porcupine	*Erethizon dorsatum*	Mammals				x					
Desert Pocket Gopher	*Geomys arenarius*	Mammals	x	x					x		
Eastern Red Bat	*Lasiurus borealis*	Mammals		x		x			x		
Ermine Weasel	*Mustela richardsonii*	Mammals							x		x
Fringed Myotis	*Myotis thysanodes thysanodes*	Mammals		x	x	x			x		
Gray-collared Chipmunk	*Neotamias cinereicollis cinereicollis*	Mammals	x						x		
Gray-footed Chipmunk	*Neotamias canipes*	Mammals	x						x		
Gunnison's Prairie Dog	*Cynomys gunnisoni*	Mammals	x	x				x	x	B, D	
Heather Vole	*Phenacomys intermedius intermedius*	Mammals	x						x		

Common Name	*Scientific Name*	Family	Distribution	Movement	Demography	Life History	Ecological Role	Evolutionary Potential	Abiotic Niche	Threat multipliers	Response
Hoary Bat	*Aeorestes cinereus cinereus*	Mammals		x					x		x
Holzner's Cottontail Rabbit	*Sylvilagus holzneri*	Mammals	x								
Hooded Skunk	*Mephitis macroura milleri*	Mammals				x					
Jaguar	*Panthera onca arizonensis*	Mammals	x	x				x			
Least Shrew	*Cryptotis parvus*	Mammals			x				x	B, C, O, D	
Lesser Long-nosed Bat	*Leptonycteris yerbabuenae*	Mammals		x					x		
Mexican Gray Wolf	*Canis lupus baileyi*	Mammals	x					x		B, C, D	
Mexican Long-nosed Bat	*Leptonycteris nivalis*	Mammals	x	x		x			x		
Mexican Long-tongued Bat	*Choeronycteris mexicana*	Mammals	x	x					x		x
New Mexico Jumping Mouse	*Zapus hudsonius luteus (=Zapus luteus luteus)*	Mammals	x					x	x	B, C, O, D	
North American River Otter	*Lontra canadensis*	Mammals		x		x		x	x		
Northern Pygmy Mouse	*Baiomys taylori ater*	Mammals	x	x							
Organ Mountains Colorado Chipmunk	*Neotamias quadrivittatus australis*	Mammals	x	x		x			x		
Oscura Mountains Colorado Chipmunk	*Neotamias quadrivittatus oscuraensis*	Mammals	x	x					x		
Pacific Marten	*Martes caurina*	Mammals	x					x	x		
Peñasco Least Chipmunk	*Neotamias minimus atristriatus*	Mammals	x						x	B, C, D	x
Pocketed Free-tailed Bat	*Nyctinomops femorosaccus*	Mammals			x				x		
Prairie Vole	*Microtus ochrogaster haydenii*	Mammals		x					x		
Snowshoe Hare	*Lepus americanus bairdii*	Mammals	x	x					x		
Southern Pocket Gopher	*Thomomys umbrinus*	Mammals	x	x		x					
Southern Red-backed Vole	*Myodes gapperi*	Mammals		x					x		
Southwestern Little Brown Myotis	*Myotis occultus*	Mammals	x						x		
Spotted Bat	*Euderma maculatum*	Mammals		x					x		
Thirteen-lined Ground Squirrel	*Ictidomys tridecemlineatus*	Mammals				x			x		

Common Name	*Scientific Name*	Family	Distribution	Movement	Demography	Life History	Ecological Role	Evolutionary Potential	Abiotic Niche	Threat multipliers	Response
Tricolored Bat	*Perimyotis subflavus*	Mammals						x	x	C, O, D	x
Western Jumping Mouse	*Zapus princeps princeps*	Mammals	x						x		
Western Red Bat	*Lasiurus blossevillii*	Mammals		x					x		
Western Water Shrew	*Sorex navigator*	Mammals	x	x		x			x		
Western Yellow Bat	*Dasypterus xanthinus*	Mammals		x				x	x		
White-nosed Coati	*Nasua narica*	Mammals		x		x					
White-sided Jackrabbit	*Lepus callotis gaillardi*	Mammals	x			x					
White-tailed Jackrabbit	*Lepus townsendii campanius*	Mammals	x						x		
Yellow-bellied Marmot	*Marmota flaviventris*	Mammals				x			x		
Yellow-nosed Cotton Rat	*Sigmodon ochrognathus*	Mammals		x							
Yuma Myotis	*Myotis yumanensis yumanensis*	Mammals		x					x		
Arid Land Ribbonsnake	*Thamnophis proximus diabolicus*	Reptiles	x						x	B,C,O,D	
Arizona Black Rattlesnake	*Crotalus cerberus*	Reptiles	x		x				x	B,C,O,D	x
Banded Rock Rattlesnake	*Crotalus lepidus klauberi*	Reptiles			x					B,C,D	
Big Bend Slider	*Trachemys gaigeae*	Reptiles	x		x			x	x	B,C,O,D	
Bleached Earless Lizard	*Holbrookia maculata ruthveni*	Reptiles	x		x			x	x		x
Bolson's Tortoise	*Gopherus flavomarginatus*	Reptiles	x	x	x	x		x	x	B,C,O,D	
Dunes Sagebrush Lizard	*Sceloporus arenicolus*	Reptiles	x			x	x		x		x
Giant Spotted Whiptail	*Aspidoscelis stictogramma*	Reptiles	x					x	x		x
Gray-banded Kingsnake	*Lampropeltis alterna*	Reptiles	x		x				x		
Gray-checkered Whiptail	*Aspidoscelis dixoni*	Reptiles	x		x	x		x	x	B, C, O, D	x
Green Rat Snake	*Senticolis triaspis intermedia*	Reptiles			x			x	x		
Knobloch's Mountain Kingsnake	*Lampropeltis knoblochi*	Reptiles			x				x		
Little White Whiptail	*Aspidoscelis inornata gypsi*	Reptiles	x		x				x		
Mexican Gartersnake	*Thamnophis eques megalops*	Reptiles	x		x			x	x	B, C, O, D	

Common Name	*Scientific Name*	Family	Distribution	Movement	Demography	Life History	Ecological Role	Evolutionary Potential	Abiotic Niche	Threat multipliers	Response
Midland Smooth Softshell Turtle	*Apalone mutica mutica*	Reptiles	x		x	x		x	x		
Mojave Rattlesnake	*Crotalus scutulatus scutulatus*	Reptiles	x		x				x		
Mottled Rock Rattlesnake	*Crotalus lepidus lepidus*	Reptiles	x		x				x		
Mountain Skink	*Plestiodon callicephalus*	Reptiles	x						x		
Narrow-headed Gartersnake	*Thamnophis rufipunctatus*	Reptiles	x		x				x	B, C, D	
New Mexico Ridge-nosed Rattlesnake	*Crotalus willardi obscurus*	Reptiles	x		x			x	x	B, C, O	x
North American Racer	*Coluber constrictor*	Reptiles							x		
Ornate Box Turtle	*Terrapene ornata*	Reptiles			x	x			x	B, C, O, D	x
Plain-bellied Water Snake	*Nerodia erythrogaster transversa*	Reptiles	x					x	x		
Plains Gartersnake	*Thamnophis radix*	Reptiles			x				x		
Pyro Mountain Kingsnake	*Lampropeltis pyromelana*	Reptiles			x				x		
Reticulate Gila Monster	*Heloderma suspectum suspectum*	Reptiles	x		x				x	B, C, O	x
Slevin's Bunchgrass Lizard	*Sceloporus slevini*	Reptiles	x		x	x			x	B, C, O	x
Smooth Greensnake	*Opheodrys vernalis blanchardi*	Reptiles							x		x
Sonoran Lyresnake	*Trimorphodon lambda*	Reptiles		x					x		
Sonoran Mud Turtle	*Kinosternon sonoriense sonoriense*	Reptiles	x	x	x	x			x		
Texas Lyresnake	*Trimorphodon vilkinsonii*	Reptiles							x		
Texas Spotted Whiptail	*Aspidoscelis gularis gularis*	Reptiles							x		x
Trans-Pecos Rat Snake	*Bogertophis subocularis subocularis*	Reptiles			x				x		
Western Blind Snake	*Rena humilis segregus*	Reptiles							x		
Western Massasauga	*Sistrurus tergeminus*	Reptiles		x	x				x	B, C, O	
Western Painted Turtle	*Chrysemys picta bellii*	Reptiles			x	x			x		x
Western River Cooter	*Pseudemys gorzugi*	Reptiles			x	x		x	x		x
Yaqui Black-headed Snake	*Tantilla yaquia*	Reptiles	x					x	x		

Common Name	*Scientific Name*	Family	Distribution	Movement	Demography	Life History	Ecological Role	Evolutionary Potential	Abiotic Niche	Threat multipliers	Response
Yarrow's Spiny Lizard	*Sceloporus jarrovii jarrovii*	Reptiles	x			x			x		x