2022

NEVADA STATE WILDLIFE ACTION PLAN

NEVADA DEPARTMENT OF WILDLIFE




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Source: NDOW

Table of Contents

Volume I

Volume II

Volume III

Executive Summary

The 2022 Nevada State Wildlife Action Plan (SWAP) is intended to be a comprehensive, statewide plan for conserving the state's wildlife and habitat resources and is designed to address the eight required elements to fulfill the State Wildlife Grant legislative requirements. The last Nevada Wildlife Action Plan was submitted to the U.S. Fish and Wildlife Service on September 6, 2012 and approved on March 1, 2013. For almost two years, internal Nevada Department of Wildlife (NDOW) staff as well as an external team of experts and agencies comprehensively reviewed and updated the 2012 SWAP. Key components of this comprehensive revision include evaluating over 600 species as potential Species of Greatest Conservation Need (SGCN) and expanding on efforts to connect citizens to nature through nature tourism, citizen science, and education. New content was also developed and added to the SWAP for the first time, including terrestrial pollinators as part of the SGCN, newly delineated habitats, and considerations for regional coordination.

Chapter Overview

The Nevada SWAP is organized into seven chapters. An overview of each chapter is provided below.

Chapter 1 - Introduction

This chapter explains the purpose and scope of the SWAP, describes how the eight required elements are met in the plan, shares how the plan will be reviewed and revised, and provides an overview of how the public and partners were involved in the development of the SWAP. Additionally, this chapter summarizes the changes from the 2012 to the 2022 plan.

Chapter 2 – Nevada Overview

Nevada is the seventh largest state in the nation and home to a broad array of flora and fauna. This chapter provides an overview of Nevada's natural heritage including the wildlife and landform diversity and biophysical regions. Additionally, the chapter addresses land and resource management, human demographics and impacts facing Nevada, and includes a discussion on climate change and expected impacts in Nevada.

Chapter 3 – Species of Greatest Conservation Need

The SWAP identifies 367 Species of Greatest Conservation Need (SGCN). This chapter describes the approach and methods used to identify Nevada's SGCN list. The full SGCN list is also included in the chapter. Species accounts detail additional information about each SGCN species and can be found as an appendix to the SWAP. This chapter also describes the threats impacting Nevada's wildlife and actions to address these threats. The top actions for each SGCN species are outlined in a species action table in this chapter. Lastly, this chapter includes a new subsection on terrestrial invertebrates which were not included in the 2012 Nevada Wildlife Action Plan.

Chapter 4 – Key Habitats

Across Nevada, 20 key habitats were identified for Nevada based on terrestrial vegetation assemblages or aquatic characteristics. This chapter provides an overview of each of these key habitats including predicted climate change effects, threats, and conservation strategies. This chapter also uses a Resist, Accept, Direct framework to consider conservation and management actions based on future anticipated conditions rather than historical baseline conditions alone.

Chapter 5 – Implementation and Monitoring

This chapter describes how Nevada will develop and deploy effective conservation actions through research and monitoring. This chapter outlines a process for adaptive management based on monitoring and provides an overview of the tools and methodologies NDOW currently uses to monitor species and habitats. Lastly, the chapter describes partnering opportunities and ways to leverage existing management plans.

Chapter 6 – Regional Coordination

To better implement cross-jurisdictional approaches to conservation in the West, the state of Nevada partnered with the state of Arizona to develop a pilot project for coordinating during each state's respective SWAP revision process. Both states moved forward on a path that meets their individual state needs while considering and incorporating needs that extend beyond state boundaries. This chapter describes the cross-state coordination effort, its results, and proposed next steps.

Chapter 7 – Conservation Education and Watchable Wildlife

Connecting citizens to Nevada's wildlife resources and viewing opportunities is essential for conserving wildlife and habitats. To meet the goals of the SWAP, citizens of Nevada need to be engaged and informed about wildlife conservation. This chapter describes four key areas NDOW will focus on including K-12 wildlife education, interpretive centers and wildlife education for all ages, urban wildlife and living with wildlife, and wildlife viewing and nature tourism. The chapter also explains how these objectives will be implemented and their effectiveness will be monitored.

Collaborating to Conserve Nevada's Wildlife and Habitats

Although NDOW is the lead agency for the Nevada Wildlife Action Plan, the SWAP is not a single-agency strategy. Ultimately, success in preserving and managing Nevada's fish, wildlife, and habitats depends on many organizations working together across borders and jurisdictions. Numerous partnerships, collaboratives, and initiatives exist across Nevada to manage, protect, and restore these vital habitats. These efforts are critical for accomplishing shared goals and keeping Nevada's landscape ecologically functional. As such, it is important to continue to expand on these partnerships and maintain regular coordination between agencies, NGOs, and various other conservation and research groups to realize the most effective and efficient conservation of Nevada's wildlife.


Source: NDOW

Chapter 1

Introduction

Purpose and Scope of the Nevada Wildlife Action Plan

Nevada's State Wildlife Action Plan (SWAP) is intended to be a comprehensive, statewide plan for conserving the state's wildlife and habitat resources. This endeavor is part of a larger nationwide effort by all 50 states and U.S. territories to develop conservation plans and participate in the federally authorized State and Tribal Wildlife Grants (SWG) Program. This SWAP is also intended to aid in wildlife management through other federally authorized grant programs providing resources to help advance wildlife and landscape conservation. The purpose of these programs is to support state actions that broadly benefit wildlife and habitats, but particularly the Species of Greatest Conservation Need (SGCN) identified by the individual states.

The objectives of the Nevada SWAP are to:

- Maintain and strive for healthy populations of Nevada's wildlife.
- Reduce the need for future federal Endangered Species Act listings.
- Recover imperiled populations of wildlife.
- Maintain and work toward intact healthy habitat conditions across the state.
- Provide for routine assessment of SGCN and habitat monitoring and restoration projects to evaluate the successful implementation and revise strategies as needed.
- Engage citizens of Nevada to become more involved and aware of the conservation of Nevada's wildlife and ecosystems.
- Increase public involvement in wildlife management and decision-making.
- Encourage responsible stewardship of Nevada's wildlife from members of the public, industry, the agricultural sector, and advocacy groups.
- Build on regional coordination across state borders to streamline efforts and maximize conservation effectiveness.

National Requirements and Guidance

Each state is charged with preparing a SWAP that assesses the overall conditions of the state's individual species and habitats, identifies the challenges and threats they face, and outlines the actions needed to conserve them. Nevada's most recent SWAP was completed and approved by the U.S. Fish and Wildlife Service in 2012. While each state has broad latitude to write a conservation plan that meets the needs of the individual state, states are required to address eight elements:

1. Information about the distribution and abundance of priority wildlife species.

2. Descriptions of locations and relative condition of key habitats and communities essential to the conservation of priority species.
3. Descriptions of challenges and threats that may affect identified species and research and survey efforts needed to address challenges and threats.
4. Descriptions of proposed strategies and actions for the conservation of identified wildlife and their habitats.
5. Descriptions of proposed monitoring plans for identified species and their habitats as well as the effectiveness of conservation actions.
6. Descriptions of how the SWAP will be reviewed and updated periodically.
7. Coordination with federal, state, local agencies, and Indian tribes in the development, implementation, review, and revision of the plan.
8. Broad public participation in the development and implementation of the plan.

In addition to the required elements, the SWAP team also reviewed the "State Wildlife Action Plan Best Practices" document developed by the Association of Fish and Wildlife Agencies (AFWA, 2012) and has incorporated many of the proposed best practices into this plan revision.

Review and Revision

The Nevada SWAP is designed to be a 10-year strategic plan, so complete evaluation and revision are scheduled to occur on a 10-year rotation with a full revision planned for 2032. This plan is intended to be the guiding document providing programmatic structure

Table 1: Roadmap of the 8 Required Elements in the 2022 SWAP.

ELEMENT	SECTIONS ADDRESSING THIS ELEMENT
1	Chapter 3: Species of Greatest Conservation Need (p. 32-47; 64-65) Appendix E: Species Accounts
2	Chapter 3: Species of Greatest Conservation Need (p. 65) Chapter 4: Major Habitats of Nevada (p. 70-74; Individual habitats: p. 85-232)
3	Chapter 2: Nevada Overview (p. 27-30) Chapter 3: Species of Greatest Conservation Need (p. 47-52; 62-66) Chapter 4: Major Habitats of Nevada (p. 74-78; Individual habitats: p. 85-232) Appendix E: Species Accounts
4	Chapter 3: Species of Greatest Conservation Need (p. 66-68) Chapter 4: Major Habitats of Nevada (p. 79; 93; 99; 117; 125; 143; 151; 161; 169; 175; 185; 196; 206; 213; 221; 228) Chapter 5: Implementation and Monitoring (p. 234-250)
5	Chapter 5: Implementation and Monitoring
6	Chapter 1: Introduction (p. 6)
7	Chapter 1: Introduction (p. 11-12) Chapter 5: Implementation and Monitoring (p. 241-249) Chapter 6: Regional Coordination
8	Chapter 1: Introduction (p. 11-12) Chapter 5: Implementation & Monitoring (p. 249) Chapter 7: Enhancing Conservation of SGCN & their Habitats Through Citizen Science (p. 260-265)

and guidance as projects and conservation actions are developed. While the Nevada 2022 SWAP will provide the framework and overall goals and actions for the next ten years, it is important to note that adaptive management is critical to improving conservation outcomes. Actions to address the most pressing threats and conservation needs of species and habitats will be adapted to reflect new information and the development of new tools and technology. This type of adaptive management within the framework of the overall conservation goals and actions of the 2022 SWAP will ensure that conservation outcomes are maximized. Additionally, key components of the SWAP can and should serve as foundational building blocks for further conservation planning and the development of more specific actions at the local level. Overall conservation goals for SGCN and their habitats within the plan will guide annual planning and periodic review as projects are completed. There is no clear timeline for such review due to on-the-ground project variability, fluctuations in emerging technology and other considerations that would guide adaptive management actions, but typically the Department will initiate a more formal review processes several years before the scheduled full major revision in 2032. Emerging conservation issues and/or SGCN species status changes will be addressed utilizing the guidance from the Fish and Wildlife Service for Minor Revisions.

As part of the revision process, we reviewed conservation actions that NDOW and our conservation partners took for our terrestrial and aquatic 2012 SGCN (defined as Species of Conservation Priority in 2012). Table 2 presents a compiled list of those actions, as understood to the best of our knowledge. While it is impossible to capture every conservation action taken in the prior ten years, this table attempts to capture major implementation actions from the 2012 SWAP. The table includes the following categories:

(solid green)	Actions taken by NDOW
(hatched green)	Actions taken by NDOW with strong partner participation
(solid blue)	Actions taken by others in the conservation community
(hatched blue)	Actions taken by partners with strong NDOW participation
(solid orange)	Non-targeted actions (solid orange) that may have addressed needs for SGCN that were either part of a broad group of species (i.e., not species-specific actions, but instead an approach with multi-species benefits such as the national Breeding Bird Survey effort) or that benefited SGCN incidentally from actions taken for other species.

The broader conservation community includes groups as disparate as federal, state, county, and municipal agencies, tribes, NGOs, in- and out-of-state universities, independent researchers, and concerned members of the public. Implementation of conservation actions should not be assumed to have fully addressed a conservation need or threat, and some actions will continue while implementing the 2022 SWAP. For example, SGCN managed as game species need ongoing population monitoring efforts, habitat maintenance, disease and contaminant monitoring, and other actions to ensure healthy populations are being conserved into the future. Effective conservation of many of our nongame SGCN can be hampered by a lack of basic knowledge about distribution, habitat requirements, population size and trend, direct threats, and the species' ability to adapt and persist in the face of changing threats and will require ongoing survey and inventory actions. Long-term monitoring datasets such as the Nevada Winter Raptor Survey and the Breeding Bird Survey are valuable for evaluating long-term trends and population fluctuations and these types of surveys are expected to continue.

Table 2: 2012 SGCN Actions (For descriptions of NDOW Actions, see Table 7: Description of NDOW Project Actions with IUCN Conservation Action Equivalents on p.54-56)

2012 SGCN List				ACTIONS																									
				Species Actions							Habitat Actions									Threat Actions									Other
IUCN Conservation Actions				3.1 Species Mgmt	3.1 Species Mgmt	3.1 Species Mgmt	3.1 Species Mgmt	3.3 Species Reintroduction	3.4 *ex situ* Conservation	3.2 Species Recovery 2.3 Habitat & Natural Process Restoration	2.1 Site/area mgmt	1.2 (resource/habitat protection)	2.1 Site/area mgmt	2.3 Habitat & Natural process restoration	2.1 Site/area mgmt	2.1 Site/area mgmt	2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	2.2 Invasive/problematic species control	3.2 Species Recovery	3.2 Species Recovery	3.1 Species Mgmt	No IUCN Equivalent Conservation Action	No IUCN Equivalent Conservation Action	2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	5.1 Legislation 5.2 Policies & Regulations 5.4 Compliance & Enforcement	1.2 (resource/habitat protection)
											Habitat Protection						Habitat Restoration			Disease/Contaminants		Climate Change	Development	Development	Pesticide	Grazing	Toxic Water	Poaching/Direct Take	
NDOW Actions				Inventory	Taxonomic Clarification (spp./subsp)	Monitoring & Population Status	Refine Distribution Knowledge (predictive modeling)			Develop restoration prescriptions/monitor if effective	Maintain Habitat	Legal & acquisition/easements	Mgmt Action (e.g., fencing, gating, etc.)	Maintain connectivity (Corridors, Migration, Full Life Cycle)	Forestry Mgmt (e.g., maintain snags, structure/age mosaic)	Water Mgmt (quality, quantity, timing, shoreline & reservoirs)	Post fire Rehab	Restore degraded habitats		Proactive disease/contaminant (e.g., lead, mercury, PFAS) Surveillance	Disease/Contaminant mitigation & mgmt	Forecast changes due to CC	Develop BMPs for some development	Map areas where development less impactful	Mitigate pesticide effects	Implement proper grazing	Mitigate/ Manage water quality (mines, AG runoff)	Strengthen Regulations, Penalties & LE Enforcement for Protected Species	Acquire Water Rights for Wildlife
Common Name	**Scientific Name**	**Type**	**Species Type**																										
Amargosa toad	*Anaxyrus nelsoni*	toad	Amphibian																										
Arizona toad	*Anaxyrus microscaphus*	toad	Amphibian																										
Columbia spotted frog	*Rana luteiventris*	frog	Amphibian																										
Great Basin spadefoot	*Spea intermontana*	toad	Amphibian																										
Great Plains toad	*Anaxyrus cognatus*	toad	Amphibian																										
northern leopard frog	*Lithobates pipiens*	frog	Amphibian																										
relict leopard frog	*Lithobates onca*	frog	Amphibian																										
Sierra Nevada yellow-legged frog	*Rana sierra*	frog	Amphibian																										
western toad	*Anaxyrus boreas*	toad	Amphibian																										
American avocet	*Recurvirostra americana*	shorebird	Bird																										
American bittern	*Botaurus lentiginosus*	water bird	Bird																										
American white pelican	*Pelecanus erythrorhynchos*	water bird	Bird																										
Arizona Bell's vireo	*Vireo bellii arizonae*	passerine, etc.	Bird																										
bald eagle	*Haliaeetus leucocephalus*	raptor	Bird																										
bank swallow	*Riparia riparia*	passerine, etc.	Bird																										
Bendire's thrasher	*Toxostoma bendirei*	passerine, etc.	Bird																										
black rosy-finch	*Leucosticte atrata*	passerine, etc.	Bird																										
black tern	*Chlidonias niger*	water bird	Bird																										
black-backed woodpecker	*Picoides arcticus*	passerine, etc.	Bird																										
black-chinned sparrow	*Spizella atrogularis*	passerine, etc.	Bird																										
bobolink	*Dolichonyx oryzivorus*	passerine, etc.	Bird																										
brewer's sparrow	*Spizella breweri*	passerine, etc.	Bird																										
California spotted owl	*Strix occidentalis occidentalis*	owl	Bird																										
canvasback	*Aythya valisineria*	migratory	Bird																										
Cassin's finch	*Haemorhous cassinii*	passerine, etc.	Bird																										
Columbian sharp-tailed grouse	*Tympanuchus phasianellus columbianu*	upland game	Bird																										
common loon	*Gavia immer*	water bird	Bird																										
common nighthawk	*Chordeiles minor*	passerine, etc.	Bird																										
dusky grouse	*Dendragapus obscurus*	upland game	Bird																										
ferruginous hawk	*Buteo regalis*	raptor	Bird																										
flammulated owl	*Psiloscops flammeolus*	owl	Bird																										
gilded flicker	*Colaptes chrysoides*	passerine, etc.	Bird																										
golden eagle	*Aquila chrysaetos*	raptor	Bird																										
gray-crowned rosy-finch	*Leucosticte tephrocotis*	passerine, etc.	Bird																										
Great Basin willow flycatcher (E. t. adastus)	*Empidonax traillii adastus*	passerine, etc.	Bird																										
greater sage grouse	*Centrocercus urophasianus*	upland game	Bird																										
greater sandhill crane	*Grus canadensis tabida*	migratory	Bird																										
least bittern	*Ixobrychus exilis*	water bird	Bird																										
LeConte's thrasher	*Toxostoma lecontei*	passerine, etc.	Bird																										
Lewis's woodpecker	*Melanerpes lewis*	passerine, etc.	Bird																										
loggerhead shrike	*Lanius ludovicianus*	passerine, etc.	Bird																										
long-billed curlew	*Numenius americanus*	shorebird	Bird																										
long-billed dowitcher	*Limnodromus scolopaceus*	shorebird	Bird																										
mountain quail	*Oreortyx pictus*	upland game	Bird																										
northern goshawk	*Accipiter gentilis*	raptor	Bird																										
northern pintail	*Anas acuta*	migratory	Bird																										
olive-sided flycatcher	*Contopus cooperi*	passerine, etc.	Bird																										
peregrine falcon	*Falco peregrinus*	raptor	Bird																										
pinyon jay	*Gymnorhinus cyanocephalus*	passerine, etc.	Bird																										
prairie falcon	*Falco mexicanus*	raptor	Bird																										
red-necked phalarope	*Phalaropus lobatus*	shorebird	Bird																										
rufous hummingbird	*Selasphorus rufus*	passerine, etc.	Bird																										
sage thrasher	*Oreoscoptes montanus*	passerine, etc.	Bird																										
sagebrush sparrow	*Artemisiospiza nevadensis*	passerine, etc.	Bird																										
Scott's oriole	*Icterus parisorum*	passerine, etc.	Bird																										
short-eared owl	*Asio flammeus*	owl	Bird																										
Sierra Nevada Mountain willow flycatcher	*Empidonax traillii brewsteri*	passerine, etc.	Bird																										
sooty grouse	*Dendragapus fuliginosus*	upland game	Bird																										
southwestern willow flycatcher	*Empidonax traillii extimus*	passerine, etc.	Bird																										
tricolored blackbird	*Agelaius tricolor*	passerine, etc.	Bird																										
Virginia's warbler	*Leiothlypis virginiae*	passerine, etc.	Bird																										
western burrowing owl	*Athene cunicularia hypugaea*	owl	Bird																										
western sandpiper	*Calidris mauri*	shorebird	Bird																										
western snowy plover	*Charadrius nivosus*	shorebird	Bird																										
white-faced ibis	*Plegadis chihi*	water bird	Bird																										
white-headed woodpecker	*Dryobates albolarvatus*	passerine, etc.	Bird																										
Wilson's phalarope	*Phalaropus tricolor*	shorebird	Bird																										
yellow-billed cuckoo	*Coccyzus americanus occidentalis* *Toxostoma lecontei*	passerine, etc.	Bird																										
Yuma Ridgway's rail	*Rallus obsoletus yumanensis*	water bird	Bird																										
Alvord chub	*Siphateles alvordensis*	fish	Fish																										
Ash Meadows Amargosa pupfish	*Cyprinodon nevadensis mionectes*	fish	Fish																										

2012 SGCN List				ACTIONS																									
				Species Actions							Habitat Actions									Threat Actions									Other
IUCN Conservation Actions				3.1 Species Mgmt	3.1 Species Mgmt	3.1 Species Mgmt	3.1 Species Mgmt	3.3 Species Reintroduction	3.4 *ex situ* Conservation	3.2 Species Recovery 2.3 Habitat & Natural Process Restoration	2.1 Site/area mgmt	1.2 (resource/habitat protection)	2.1 Site/area mgmt	2.3 Habitat & Natural process restoration	2.1 Site/area mgmt	2.1 Site/area mgmt	2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	2.2 Invasive/problematic species control	3.2 Species Recovery	3.2 Species Recovery	3.1 Species Mgmt	No IUCN Equivalent Conservation Action	No IUCN Equivalent Conservation Action	2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	5.1 Legislation 5.2 Policies & Regulations 5.4 Compliance & Enforcement	1.2 (resource/habitat protection)
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NDOW Actions				Inventory	Taxonomic Clarification (spp./subsp)	Monitoring & Population Status	Refine Distribution Knowledge (predictive modeling)			Develop restoration prescriptions/monitor if effective	Maintain Habitat	Legal & acquisition/easements	Mgmt Action (e.g., fencing, gating, etc.)	Maintain connectivity (Corridors, Migration, Full Life Cycle)	Forestry Mgmt (e.g., maintain snags, structure/age mosaic)	Water Mgmt (quality, quantity, timing, shoreline & reservoirs)	Post fire Rehab	Restore degraded habitats		Proactive disease/contaminant (e.g., lead, mercury, PFAS) Surveillance	Disease/Contaminant mitigation & mgmt	Forecast changes due to CC	Develop BMPs for some development	Map areas where development less impactful	Mitigate pesticide effects	Implement proper grazing	Mitigate/ Manage water quality (mines, AG runoff)	Strengthen Regulations, Penalties & LE Enforcement for Protected Species	Acquire Water Rights for Wildlife
Common Name	**Scientific Name**	**Type**	**Species Type**																										
Ash Meadows speckled dace	*Rhinichthys osculus nevadensis*	fish	Fish																										
Big Smokey Valley speckled dace	*Rhinichthys osculus lariversi*	fish	Fish																										
Big Smokey Valley tui chub	*Siphateles bicolor* ssp. 8	fish	Fish																										
Big Spring spinedace	*Lepidomeda mollispinis pratensis*	fish	Fish																										
Bonneville cutthroat trout	*Oncorhynchus clarkii utah*	fish	Fish																										
bonytail	*Gila elegans*	fish	Fish																										
bull trout	*Salvelinus confluentus* pop. 4	fish	Fish																										
Clover Valley speckled dace	*Rhinichthys osculus oligoporus*	fish	Fish																										
cui-ui	*Chasmistes cujus*	fish	Fish																										
desert dace	*Eremichthys acros*	fish	Fish																										
Devils Hole pupfish	*Cyprinodon diabolis*	fish	Fish																										
Fish Lake Valley tui chub	*Siphateles bicolor* ssp. 4	fish	Fish																										
flannelmouth sucker	*Catostomus latipinnis*	fish	Fish																										
Hiko White River springfish	*Crenichthys baileyi grandis*	fish	Fish																										
Independence Valley speckled dace	*Rhinichthys osculus lethoporus*	fish	Fish																										
Independence Valley tui chub	*Siphateles bicolor isolata*	fish	Fish																										
Inland Columbia Basin redband trout	*Oncorhynchus mykiss gairdneri*	fish	Fish																										
Lahontan cutthroat trout	*Oncorhynchus clarkii henshawi*	fish	Fish																										
Little Fish Lake Valley tui chub	*Siphateles bicolor* ssp. 6	fish	Fish																										
Meadow Valley Wash desert sucker	*Catostomus clarkii* ssp. 2	fish	Fish																										
Meadow Valley Wash speckled dace	*Rhinichthys osculus* ssp. 11	fish	Fish																										
Moapa dace	*Moapa coriacea*	fish	Fish																										
Moapa speckled dace	*Rhinichthys osculus moapae*	fish	Fish																										
Moapa White River springfish	*Crenichthys baileyi moapae*	fish	Fish																										
Monitor Valley speckled dace	*Rhinichthys osculus* ssp. 5	fish	Fish																										
Moorman White River springfish	*Crenichthys baileyi thermophilus*	fish	Fish																										
mountain whitefish	*Prosopium williamsoni*	fish	Fish																										
northern leatherside chub	*Lepdomeda copei*	fish	Fish																										
Oasis Valley speckled dace	*Rhinichthys osculus* ssp. 6	fish	Fish																										
Pahranagat roundtail chub	*Gila robusta jordani*	fish	Fish																										
Pahranagat speckled dace	*Rhinichthys osculus velifer*	fish	Fish																										
Pahrump poolfish	*Empetrichthys latos latos*	fish	Fish																										
Preston White River springfish	*Crenichthys baileyi albivallis*	fish	Fish																										
Railroad Valley springfish	*Crenichthys nevadae*	fish	Fish																										
Railroad Valley tui chub	*Siphateles bicolor* ssp. 7	fish	Fish																										
razorback sucker	*Xyrauchen texanus*	fish	Fish																										
relict dace	*Relictus solitarius*	fish	Fish																										
Sheldon tui chub	*Siphateles bicolor eurysoma*	fish	Fish																										
tui chub in Dixie Valley	*Siphateles bicolor* ssp. 9	fish	Fish																										
Virgin River chub	*Gila seminuda*	fish	Fish																										
Virgin spinedace	*Lepidomeda mollispinis mollispinis*	fish	Fish																										
Wall Canyon sucker	*Catostomus* sp. 1	fish	Fish																										
Warm Springs pupfish	*Cyprinodon nevadensis pectoralis*	fish	Fish																										
Warner sucker	*Catostomus warnerensis*	fish	Fish																										
Warner Valley redband trout	*Oncorhynchus mykiss* pop. 4	fish	Fish																										
White River desert sucker	*Catostomus clarkii intermedius*	fish	Fish																										
White River speckled dace	*Rhinichthys osculus* ssp. 7	fish	Fish																										
White River spinedace	*Lepidomeda albivallis*	fish	Fish																										
White River springfish	*Crenichthys baileyi baileyi*	fish	Fish																										
woundfin	*Plagopterus argentissimus*	fish	Fish																										
Yellowstone cutthroat trout	*Oncorhynchus clarkii bouvieri*	fish	Fish																										
Amargosa tryonia	*Tryonia variegata*	springsnail	Gastropod																										
Antelope Valley pyrg	*Pyrgulopsis pellita*	springsnail	Gastropod																										
Ash Meadows pebblesnail	*Pyrgulopsis erythropoma*	springsnail	Gastropod																										
bifid duct pyrg	*Pyrgulopsis peculiaris*	springsnail	Gastropod																										
Big Warm Spring pyrg	*Pyrgulopsis papillata*	springsnail	Gastropod																										
Blue Point pyrg	*Pyrgulopsis coloradensis*	springsnail	Gastropod																										
Butterfield pyrg	*Pyrgulopsis lata*	springsnail	Gastropod																										
Camp Valley pyrg	*Pyrgulopsis montana*	springsnail	Gastropod																										
Corn Creek pyrg	*Pyrgulopsis fausta*	springsnail	Gastropod																										
Cortez Hills pebblesnail	*Pyrgulopsis bryantwalkeri*	springsnail	Gastropod																										
Crittenden pyrg	*Pyrgulopsis lentiglans*	springsnail	Gastropod																										
Crystal springsnail	*Pyrgulopsis crystalis*	springsnail	Gastropod																										
desert tryonia	*Tryonia porrecta*	springsnail	Gastropod																										
distal-gland springsnail	*Pyrgulopsis nanus*	springsnail	Gastropod																										
Dixie Valley pyrg	*Pyrgulopsis dixensis*	springsnail	Gastropod																										
Duckwater pyrg	*Pyrgulopsis aloba*	springsnail	Gastropod																										
Duckwater Warm Springs pyrg	*Pyrgulopsis villacampae*	springsnail	Gastropod																										
Elko pyrg	*Pyrgulopsis leporina*	springsnail	Gastropod																										
Elongate Cain Spring pyrg	*Pyrgulopsis augustae*	springsnail	Gastropod																										
Elongate Mud Meadows pyrg	*Pyrgulopsis notidicola*	springsnail	Gastropod																										
Elongate-gland springsnail	*Pyrgulopsis isolata*	springsnail	Gastropod																										
Emigrant pyrg	*Pyrgulopsis gracilis*	springsnail	Gastropod																										
Fairbanks springsnail	*Pyrgulopsis fairbanksensis*	springsnail	Gastropod																										
Fish Lake Valley pyrg	*Pyrgulopsis ruinosa*	springsnail	Gastropod																										

2012 SGCN List				ACTIONS																									
				Species Actions							Habitat Actions									Threat Actions									Other
IUCN Conservation Actions				3.1 Species Mgmt	3.1 Species Mgmt	3.1 Species Mgmt	3.1 Species Mgmt	3.3 Species Reintroduction	3.4 *ex situ* Conservation	3.2 Species Recovery 2.3 Habitat & Natural Process Restoration	2.1 Site/area mgmt	1.2 (resource/habitat protection)	2.1 Site/area mgmt	2.3 Habitat & Natural process restoration	2.1 Site/area mgmt	2.1 Site/area mgmt	2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	2.2 Invasive/problematic species control	3.2 Species Recovery	3.2 Species Recovery	3.1 Species Mgmt	No IUCN Equivalent Conservation Action	No IUCN Equivalent Conservation Action	2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	5.1 Legislation 5.2 Policies & Regulations 5.4 Compliance & Enforcement	1.2 (resource/habitat protection)
											Habitat Protection						Habitat Restoration			Disease/Contaminants		Climate Change	Development	Development	Pesticide	Grazing	Toxic Water	Poaching/Direct Take	
NDOW Actions				Inventory	Taxonomic Clarification (spp./subsp)	Monitoring & Population Status	Refine Distribution Knowledge (predictive modeling)			Develop restoration prescriptions/monitor if effective	Maintain Habitat	Legal & acquisition/easements	Mgmt Action (e.g., fencing, gating, etc.)	Maintain connectivity (Corridors, Migration, Full Life Cycle)	Forestry Mgmt (e.g., maintain snags, structure/age mosaic)	Water Mgmt (quality, quantity, timing, shoreline & reservoirs)	Post fire Rehab	Restore degraded habitats		Proactive disease/contaminant (e.g., lead, mercury, PFAS) Surveillance	Disease/Contaminant mitigation & mgmt	Forecast changes due to CC	Develop BMPs for some development	Map areas where development less impactful	Mitigate pesticide effects	Implement proper grazing	Mitigate/ Manage water quality (mines, AG runoff)	Strengthen Regulations, Penalties & LE Enforcement for Protected Species	Acquire Water Rights for Wildlife
Common Name	**Scientific Name**	**Type**	**Species Type**																										
flag pyrg	*Pyrgulopsis breviloba*	springsnail	Gastropod																										
Flat-topped Steptoe pyrg	*Pyrgulopsis planulata*	springsnail	Gastropod																										
Fly Ranch pyrg	*Pyrgulopsis bruesi*	springsnail	Gastropod																										
Grand Wash springsnail	*Pyrgulopsis bacchus*	springsnail	Gastropod																										
grated tryonia	*Tryonia clathrata*	springsnail	Gastropod																										
Hamlin Valley pyrg	*Pyrgulopsis hamlinensis*	springsnail	Gastropod																										
Hardy pyrg	*Pyrgulopsis marcida*	springsnail	Gastropod																										
Hubbs pyrg	*Pyrgulopsis hubbsi*	springsnail	Gastropod																										
Humboldt pyrg	*Pyrgulopsis humboldtensis*	springsnail	Gastropod																										
Kings River pyrg	*Pyrgulopsis imperialis*	springsnail	Gastropod																										
Lake Valley pyrg	*Pyrgulopsis sublata*	springsnail	Gastropod																										
Landyes pyrg	*Pyrgulopsis landyei*	springsnail	Gastropod																										
Large Gland Carico pyrg	*Pyrgulopsis basiglans*	springsnail	Gastropod																										
Lockes pyrg	*Pyrgulopsis lockensis*	springsnail	Gastropod																										
longitudinal gland pyrg	*Pyrgulopsis anguina*	springsnail	Gastropod																										
median-gland springsnail	*Pyrgulopsis pisteri*	springsnail	Gastropod																										
minute tryonia	*Tryonia ericae*	springsnail	Gastropod																										
Moapa pebblesnail	*Pyrgulopsis avernalis*	springsnail	Gastropod																										
Moapa Valley pyrg	*Pyrgulopsis carinifera*	springsnail	Gastropod																										
Monitor Tryonia	*Tryonia monitorae*	springsnail	Gastropod																										
nature pyrg	*Pyrgulopsis cybele*	springsnail	Gastropod																										
Neritiform Steptoe Ranch pyrg	*Pyrgulopsis neritella*	springsnail	Gastropod																										
northern Soldier Meadow pyrg	*Pyrgulopsis militaris*	springsnail	Gastropod																										
northern Steptoe pyrg	*Pyrgulopsis serrata*	springsnail	Gastropod																										
northwest Bonneville pyrg	*Pyrgulopsis variegata*	springsnail	Gastropod																										
Oasis Valley springsnail	*Pyrgulopsis micrococcus*	springsnail	Gastropod																										
Ovate Cain Spring pyrg	*Pyrgulopsis pictilis*	springsnail	Gastropod																										
Pahranagat pebblesnail	*Pyrgulopsis merriami*	springsnail	Gastropod																										
Pleasant Valley pyrg	*Pyrgulopsis aurata*	springsnail	Gastropod																										
Point of Rocks tryonia	*Tryonia elata*	springsnail	Gastropod																										
Pyramid Lake pebblesnail	*Fluminicola dalli*	springsnail	Gastropod																										
Sadas pyrg	*Pyrgulopsis sadai*	springsnail	Gastropod																										
Small Gland Carico pyrg	*Pyrgulopsis bifurcata*	springsnail	Gastropod																										
smooth juga	*Juga acutifilosa*	springsnail	Gastropod																										
southern Duckwater pyrg	*Pyrgulopsis anatina*	springsnail	Gastropod																										
southern Soldier Meadow pyrg	*Pyrgulopsis umbilicata*	springsnail	Gastropod																										
southern Steptoe pyrg	*Pyrgulopsis sulcata*	springsnail	Gastropod																										
southwest Nevada pyrg	*Pyrgulopsis turbatrix*	springsnail	Gastropod																										
sportinggoods tryonia	*Tryonia angulata*	springsnail	Gastropod																										
Spring Mountains pyrg	*Pyrgulopsis deaconi*	springsnail	Gastropod																										
Squat Mud Meadows pyrg	*Pyrgulopsis limaria*	springsnail	Gastropod																										
Steptoe hydrobe	*Eremopyrgus eganensis*	springsnail	Gastropod																										
Sterile Basin pyrg	*Pyrgulopsis sterilis*	springsnail	Gastropod																										
Sub-globose Steptoe Ranch pyrg	*Pyrgulopsis orbiculata*	springsnail	Gastropod																										
Surprise Valley pyrg	*Pyrgulopsis gibba*	springsnail	Gastropod																										
Toquerville springsnail	*Pyrgulopsis kolobensis*	springsnail	Gastropod																										
Transverse Gland pyrg	*Pyrgulopsis cruciglans*	springsnail	Gastropod																										
turban pebblesnail	*Fluminicola turbiniformis*	springsnail	Gastropod																										
Twentyone Mile pyrg	*Pyrgulopsis millenaria*	springsnail	Gastropod																										
Upper Thousand Spring pyrg	*Pyrgulopsis hovinghi*	springsnail	Gastropod																										
Varners pyrg	*Pyrgulopsis varneri*	springsnail	Gastropod																										
Vinyards pyrg	*Pyrgulopsis vinyardi*	springsnail	Gastropod																										
Virginia Mountains pebblesnail	*Fluminicola virginius*	springsnail	Gastropod																										
Western Lahontan pyrg	*Pyrgulopsis longiglans*	springsnail	Gastropod																										
White River Valley pyrg	*Pyrgulopsis sathos*	springsnail	Gastropod																										
Wong's springsnail	*Pyrgulopsis wongi*	springsnail	Gastropod																										
California floater	*Anodonta californiensis*	mussel	Mollusk																										
western pearlshell mussel	*Margaritifera falcata*	mussel	Mollusk																										
western ridged mussel	*Gonidea angulata*	mussel	Mollusk																										
Allen's big-eared bat	*Idionycteris phyllotis*	bat	Mammal																										
Allen's chipmunk	*Neotamias senex*	small mammal	Mammal																										
American pika	*Ochotona princeps*	small mammal	Mammal																										
bighorn sheep	*Ovis canadensis*	big game	Mammal																										
California leaf-nosed bat	*Macrotus californicus*	bat	Mammal																										
cave myotis	*Myotis velifer*	bat	Mammal																										
dark kangaroo mouse	*Microdipodops megacephalus*	small mammal	Mammal																										
desert kangaroo rat	*Dipodomys deserti*	small mammal	Mammal																										
desert pocket mouse	*Chaetodipus penicillatus*	small mammal	Mammal																										
Eastgate pocket gopher	*Thomomys bottae lucrificus*	small mammal	Mammal																										
Fish Springs pocket gopher	*Thomomys bottae abstrusus*	small mammal	Mammal																										
fringed myotis	*Myotis thysanodes*	bat	Mammal																										

2012 SGCN List				ACTIONS																									
				Species Actions							Habitat Actions									Threat Actions									Other
IUCN Conservation Actions				3.1 Species Mgmt	3.1 Species Mgmt	3.1 Species Mgmt	3.1 Species Mgmt	3.3 Species Reintroduction	3.4 *ex situ* Conservation	3.2 Species Recovery 2.3 Habitat & Natural Process Restoration	2.1 Site/area mgmt	1.2 (resource/habit at protection)	2.1 Site/area mgmt	2.3 Habitat & Natural process restoration	2.1 Site/area mgmt	2.1 Site/area mgmt	2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	2.2 Invasive/problematic species control	3.2 Species Recovery	3.2 Species Recovery	3.1 Species Mgmt	No IUCN Equivalent Conservation Action	No IUCN Equivalent Conservation Action	2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	5.1 Legislation 5.2 Policies & Regulations 5.4 Compliance & Enforcement	1.2 (resource/habitat protection)
											Habitat Protection						Habitat Restoration			Disease/Contaminants		Climate Change	Development	Development	Pesticide	Grazing	Toxic Water	Poaching/Direct Take	
NDOW Actions				Inventory	Taxonomic Clarification (spp./subsp)	Monitoring & Population Status	Refine Distribution Knowledge (predictive modeling)			Develop restoration prescriptions/monitor if effective	Maintain Habitat	Legal & acquisition/easements	Mgmt Action (e.g., fencing, gating, etc.)	Maintain connectivity (Corridors, Migration, Full Life Cycle)	Forestry Mgmt (e.g., maintain snags, structure/age mosaic)	Water Mgmt (quality, quantity, timing, shoreline & reservoirs)	Post fire Rehab	Restore degraded habitats		Proactive disease/contaminant (e.g., lead, mercury, PFAS) Surveillance	Disease/Contaminant mitigation & mgmt	Forecast changes due to CC	Develop BMPs for some development	Map areas where development less impactful	Mitigate pesticide effects	Implement proper grazing	Mitigate/ Manage water quality (mines, AG runoff)	Strengthen Regulations, Penalties & LE Enforcement for Protected Species	Acquire Water Rights for Wildlife
Common Name	**Scientific Name**	**Type**	**Species Type**																										
hoary bat	*Lasiurus cinereus*	bat	Mammal																										
Humboldt yellow-pine chipmunk	*Neotamias amoenus celeris*	small mammal	Mammal																										
Humboldt's flying squirrel	*Glaucomys oregonensis*	small mammal	Mammal																										
Inyo shrew	*Sorex tenellus*	small mammal	Mammal																										
little brown myotis	*Myotis lucifugus*	bat	Mammal																										
long-eared myotis	*Myotis volans*	bat	Mammal																										
Merriam's shrew	*Sorex merriami*	small mammal	Mammal																										
Mexican free-tailed bat	*Tadarida brasiliensis*	bat	Mammal																										
montane shrew	*Sorex monticolus*	small mammal	Mammal																										
mountain pocket gopher	*Thomomys monticola*	small mammal	Mammal																										
mule deer	*Odocoileus hemionus*	big game	Mammal																										
northern river otter	*Lontra canadensis*	mammal other	Mammal																										
Pacific marten	*Martes caurina*	mammal other	Mammal																										
Pahranagat Valley Montane vole	*Microtus montanus fucosus*	small mammal	Mammal																										
pale kangaroo mouse	*Microdipodops pallidus*	small mammal	Mammal																										
Palmer's chipmunk	*Neotamias palmeri*	small mammal	Mammal																										
Preble's shrew	*Sorex preblei*	small mammal	Mammal																										
pygmy rabbit	*Brachylagus idahoensis*	upland game	Mammal																										
sagebrush vole	*Lemmiscus curtatus*	small mammal	Mammal																										
San Antonio pocket gopher	*Thomomys bottae curtatus*	small mammal	Mammal																										
Sierra Nevada mountain beaver	*Aplodontia rufa californica*	mammal other	Mammal																										
Sierra Nevada snowshoe hare	*Lepus americanus tahoensis*	mammal other	Mammal																										
silver-haired bat	*Lasionycteris noctivagans*	bat	Mammal																										
spotted bat	*Euderma maculatum*	bat	Mammal																										
Townsend's big-eared bat	*Corynorhinus townsendii*	bat	Mammal																										
western jumping mouse	*Zapus princeps*	small mammal	Mammal																										
western red bat	*Lasiurus blossevillii*	bat	Mammal																										
western small-footed myotis	*Myotis ciliolabrum*	bat	Mammal																										
western water shrew	*Sorex navigator*	small mammal	Mammal																										
Wyoming ground squirrel	*Spermophilus elegans nevadensis*	small mammal	Mammal																										
common chuckwalla	*Sauromalus ater*	reptile	Reptile																										
desert horned lizard	*Phrynosoma platyrhinos*	reptile	Reptile																										
desert iguana	*Dipsosaurus dorsalis*	reptile	Reptile																										
desert night lizard	*Xantusia vigilis*	reptile	Reptile																										
desert rosy boa	*Lichanura orcutti*	reptile	Reptile																										
gila monster	*Heloderma suspectum*	reptile	Reptile																										
Gilbert's skink	*Plestiodon gilberti rubricaudatus*	reptile	Reptile																										
Great Basin collared lizard	*Crotaphytus bicinctores*	reptile	Reptile																										
greater short-horned lizard	*Phrynosoma hernandesi*	reptile	Reptile																										
long-nosed leopard lizard	*Gambelia wislizenii*	reptile	Reptile																										
long-tailed brush lizard	*Urosaurus graciosus*	reptile	Reptile																										
Mojave Desert tortoise	*Gopherus agassizii*	reptile	Reptile																										
Mojave shovel-nosed snake	*Chionactis occipitalis*	reptile	Reptile																										
northern alligator lizard	*Elgaria coerulea*	reptile	Reptile																										
northern rubber boa	*Charina bottae*	reptile	Reptile																										
Panamint alligator lizard	*Elgaria panamintina*	reptile	Reptile																										
pygmy short-horned lizard	*Phrynosoma douglasii*	reptile	Reptile																										
ring-necked snake	*Diadophis punctatus*	reptile	Reptile																										
sidewinder	*Crotalus cerastes*	reptile	Reptile																										
Smith's black-headed snake	*Tantilla hobartsmithi*	reptile	Reptile																										
Sonoran Mountain kingsnake	*Lampropeltis pyromelana*	reptile	Reptile																										
spotted leaf-nosed snake	*Phyllorhynchus decurtatus*	reptile	Reptile																										
western banded gecko	*Coleonyx variegatus*	reptile	Reptile																										
western pond turtle	*Actinemys marmorata*	reptile	Reptile																										
western threadsnake	*Rena humilis*	reptile	Reptile																										

Public and Partner Involvement in the Wildlife Action Plan

In addition to an internal NDOW revision team, an external team of partners, including federal and state agencies, tribes, and non-governmental organizations (see page iv for participants), served as a key component in the revision of the SWAP. This core team reviewed outdated pieces of the 2012 SWAP; identified deficiencies and new scientific literature; reviewed and updated the SGCN list (including reviewing scoring matrices on more than 600 species); provided input to survey and monitoring methods; provided input on assessments of historic, current, and potential threats to individual species and habitats; and identified and/or developed actions for addressing threats. Partners participated in brainstorming sessions, the development of the revised 2022 SWAP, and numerous rounds of review. This core team met nine times throughout this revision to provide strategic guidance and input on key sections. Additional area experts outside of the core team provided topic-specific expertise throughout the SWAP. A full list of contributors is shown on page iii.

NDOW strives to be inclusive of all the citizens the agency serves. Including the public was an important consideration as the SWAPs are intended to reflect the wildlife conservation priorities and values of the citizens of Nevada. To gather input and involve the public, NDOW distributed three surveys to gather input from citizens and other interested stakeholders.

The first survey launched the revision process and collected feedback from over 100 participants about their familiarity and use of the 2012 SWAP and their suggested changes for the 2022 SWAP. The top reported uses of the 2012 SWAP were for planning and National Environmental Policy Act considerations, referencing species and habitat information, and learning about conservation strategies and management actions. Desired improvements included incorporating new threats to species in the evaluation process for determining which species are included as SGCN, creating a web-enabled and more user-friendly document, and adding regional considerations.

In a second survey, NDOW requested feedback on the proposed 2022 SGCN and key habitat list and received input from over 1,500 participants. Over 80% of respondents supported the proposed SGCN list, with comments including support for large mammals and game species and several specific comments related to migratory birds, bats, and mollusks. 90% of respondents supported the newly defined key habitat designations. Comments received highlighted the importance of wetland and riparian habitats and the importance of demonstrating the departure from ideal conditions and tracking changes over time. There was some concern related to habitats being solely focused on vegetative communities as barren lands (i.e., playas, sand dunes, cliffs and canyons, and caves and mines) are also critical habitat features for wildlife. These types of habitats are included in the 2022 SWAP.

The third and final survey was introduced through a public webinar attended by over 70 participants. The survey was taken by 230 participants and collected feedback on the habitat threats and actions, species threats and actions, new inclusion of terrestrial invertebrate species as SGCN, conservation education and watchable wildlife section, and NDOW's approach to species and habitat monitoring. Comments were generally supportive of the direction that NDOW was using to approach conservation actions, with specific feedback provided for certain species that were incorporated as appropriate. Comments on the newly included terrestrial invertebrate components expressed support for the species included but pointed out that there are other important guilds of invertebrates that should be included such as ants, beetles, aquatic invertebrates, and arachnids. These species guilds and others are critical components of fully functioning ecosystems, and while NDOW currently lacks the capacity and the knowledge to adequately address the conservation needs of these guilds, it is recommended they are included in future SWAP revisions. Respondents expressed support for education and connecting citizens to their natural resources and improving the relevancy of the Department, and they brought forward innovative suggestions for programs and initiatives that have been captured in Chapter 7. Finally, there was support for increasing citizen science efforts to allow the public to directly contribute to the conservation of Nevada's wildlife and habitats and support for habitat restoration as a key implementation strategy to address species conservation priorities.

To the greatest extent possible, survey results and input from all three surveys were incorporated and are reflected throughout the 2022 SWAP. Finally, in addition to public surveys, NDOW also presented periodic updates to the Nevada Board of Wildlife Commissioners at meetings, in Department Activity Reports, and through formal presentations throughout the entire revision process.

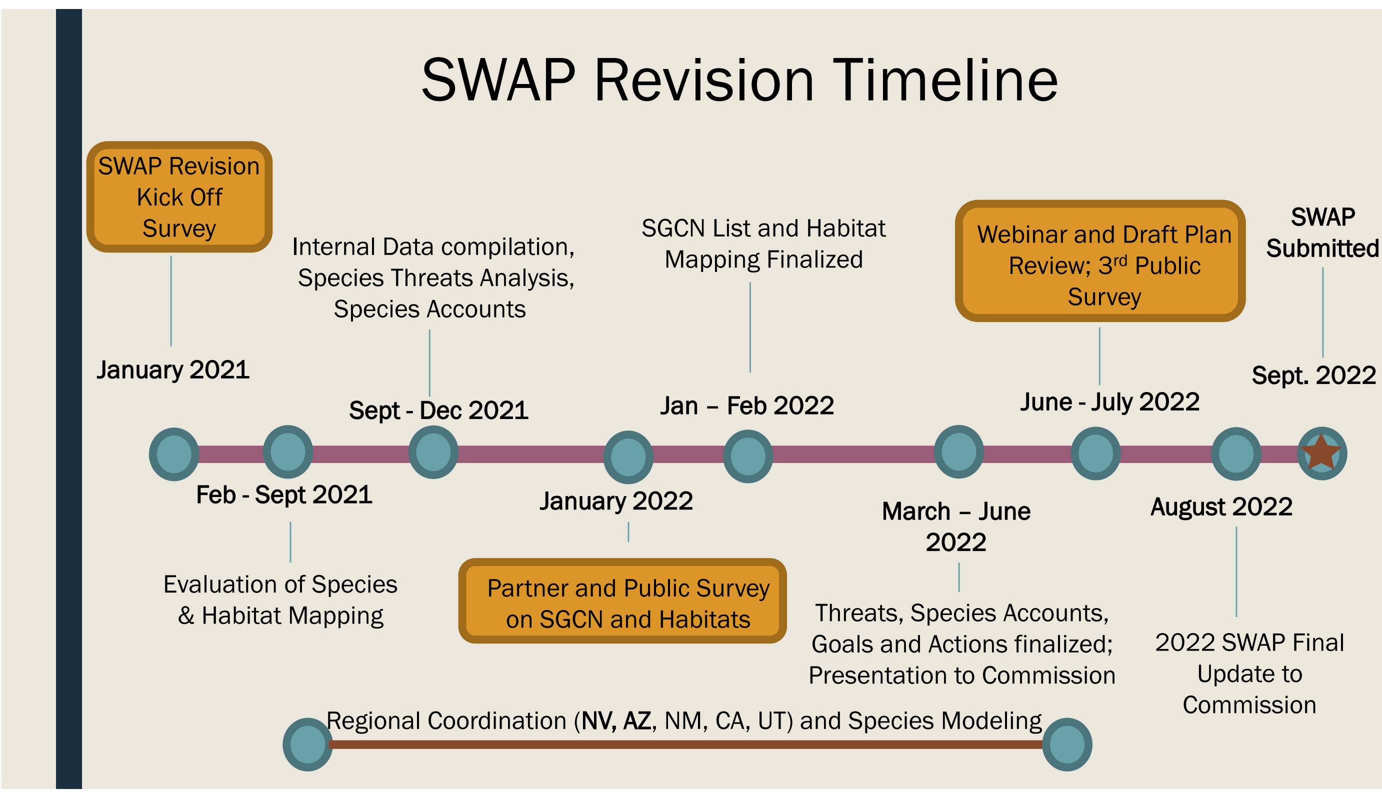


Figure 1. SWAP Revision Timeline.

Table 3: Summary of changes from the 2012 SWAP to the 2022 SWAP

CONTENT	2012 SWAP	2022 SWAP	LOCATION IN 2022 SWAP
Threats Affecting Terrestrial Species and Habits	Expert review of SGCN and habitats was used to determine threats	Ranked threat categories using a standardized threats analysis calculator for each terrestrial SGCN as defined by Salafsky et al. (2008) and the International Union for the Conservation of Nature (IUCN 2021)	Chapters 3 and 4; Appendix E: Species Accounts
Conservation Actions	Expert review of SGCN and habitats was used to develop conservation challenges, research needs, and approach	Prioritized and assigned standardized actions based on key threats as defined by Salafsky et al. (2008) and the IUCN (2021) to each SGCN	Chapters 3, 4, and 7; Appendix E: Species Accounts
SGCN List	257 species, plus five that were added in a 2021 minor revision	367 species, including 66 terrestrial invertebrates	Chapter 3; Appendix E: Species Accounts
SGCN Distribution Mapping	Included statewide range maps based on USGS GAP and expert review	Included statewide range maps based on USGS ReGAP, defined by HUC	Appendix E: Species Accounts
Terrestrial Invertebrate SGCN	Not included	Worked with partners to rank key pollinators using NDOW scoring matrix (66 SGCN identified) and developed threats and conservation actions using expert review	Chapter 3; Appendix E: Species Accounts
Key Habitats	Identified 17 terrestrial key habitats based on the Southwest Regional Gap Analysis Project Identified five aquatic habitats within terrestrial key habitat types based on water flow and associated terrestrial vegetation	Identified 16 terrestrial key habitats of vegetation assemblages based on Landfire (2020) Biophysical Settings Identified three aquatic habitats based on regional and national data sets	Chapter 4

CONTENT	2012 SWAP	2022 SWAP	LOCATION IN 2022 SWAP
Climate Change	Worked with partners to develop a habitat analysis using predictive modeling of Nevada's vegetative communities, calculated an individual Species Vulnerability Analysis for each SGCN, and developed climate change predictions for Nevada's breeding birds	Used outputs from NatureServe Habitat Climate Change Vulnerability Index (HCCVI) to map key terrestrial habitats Carried over Climate Change Vulnerability Index for SGCN calculated in 2012 SWAP Detailed climate change considerations throughout the plan	Chapters 2, 3, 4; Appendix B: Climate Models; Appendix D: HCCVI Analysis
Focal Areas	Identified discrete landscape units using biodiversity and species richness measures at a broad scale (e.g., mountain range, valley, lake, etc.)	Not developed Instead, succession class data from Landfire were used to estimate departure from the baseline condition of each terrestrial key habitat type to assess the relative condition of key habitats	Chapter 4
Regional Coordination	Not included	Coordinated with SWAP revision staff from the Arizona Game and Fish Department with critical support from the USFWS Science Applications program. Predictive models of 47 terrestrial SGCN shared between Nevada and Arizona are in development.	Chapter 6
Conservation Education and Watchable Wildlife	Focused on communication and outreach for key threats, species, or habitats; wildlife education; and watchable wildlife	Focused on connecting citizens to nature and wildlife through citizen science, education, living with wildlife, and nature tourism; NDOW relevancy; and shared stewardship for Nevada's natural resources	Chapter 7


Source: NDOW

Chapter 2

Nevada Overview

Source: NDOW

INTRODUCTION

Nevada contains portions of two great deserts, the Great Basin Desert, and the northern extent of the Mojave Desert. The Great Basin Desert is a cold desert, while the Mojave is the smallest of America's hot deserts. These two physiographic provinces dominate the Nevada landscape and are comprised of basin and range topography with 319 named mountain ranges across the state (Charlet, 2019). The Sierra Nevada dictates much of the state's climate by influencing rainfall patterns and vegetation patterns, which in turn exert selective pressure to direct the distribution of wildlife in the state. The rain shadow created by the Sierra Nevada is recognizable across the state but is most pronounced in a belt from Tonopah to Lovelock (Trimble, 1989).

The climate of the Great Basin-Mojave Desert region is one of the most varied and extreme in the world (Hidy & Klieforth, 1990). Individual mountain ranges can lift air masses, wringing out whatever moisture escaped the Sierra Nevada and creating precipitation at higher elevations. This local orographic effect creates a rainfall gradient, with mountains receiving significantly more precipitation than adjacent basins. Much of the precipitation that falls in the Great Basin arrives outside of the growing season, dictating an evolutionary challenge for plants. Because snowfall occurs outside of the growing season, Great Basin plants must rely largely on water stored in the soil as snow melts. Summer rains in the state are often brief torrents that run off before much moisture can soak into the soil and benefit plants. While winters in the Great Basin are cold, summers are conversely hot and dry.

The Mojave Desert is hotter and drier than the Great Basin. Precipitation in this region falls primarily as rain, is less predictable than in the Great Basin, and is just as likely to experience torrential rainfall and rapid runoff. There is also considerable variation in precipitation in the Mojave region based on the variation within and among seasons. Similar to the Great Basin, higher ranges in the Mojave receive more precipitation. Both the form and timing of precipitation in the Mojave, coupled with warmer temperatures, sustain its markedly different natural communities.

Across the state, cold winters, hot summers, and scant and unpredictable rainfall have resulted in a variety of adaptations by wildlife to survive in Nevada's environment. These climatic forces, along with the influences of geography, have created diverse habitats across the state.

Aquatic habitats are rare and sparsely distributed across Nevada but provide numerous benefits to various species and are often a magnet for year-round residents and migratory species alike. Nevada is home to several major river systems in the Great Basin and Mojave. The Truckee River headwaters begin in the Lake Tahoe Basin in the Sierra Nevada, with tributaries, lakes, and reservoirs contributing to streamflow, before terminating at Pyramid Lake. The Carson River system, also located in northwestern Nevada, begins in the Sierra Nevada, flowing east and terminating in the Carson Sink, outside Fallon, Nevada. The Walker River begins in the Sierra Nevada further south of Lake Tahoe and the Carson River, flowing east and south, terminating at Walker Lake. Both Pyramid and Walker lakes are terminal lakes with no outlets and high evaporation rates, and they contain high amounts of dissolved salt contents. The Humboldt River is an extensive system located in north central Nevada. It flows east to west beginning with headwaters in the Independence, Jarbidge, and Ruby Mountains, and terminating in the Humboldt Sink northeast of Fallon. There are numerous tributaries and reservoirs in the Humboldt River system, similar to the Truckee, Carson, and Walker River systems. Occurring in the Mojave Desert of southern Nevada but originating in the Rocky Mountains of Utah and Colorado, the Colorado River system runs through the southernmost tip of the state, into the manmade reservoirs of lakes Mead and Mohave. Tributaries feeding into the Colorado system in Nevada include the White River, Meadow Valley Wash which flows into the Muddy River, and the Virgin River, all running from north to south. Many smaller creeks and tributaries have perennial or intermittent flows contributing to these systems. Springs dot the entire landscape across Nevada and are comprised of both cold and geothermally active sites. These systems provide critical aquatic and riparian habitat and water for wildlife use, with the complexity of these landscapes giving rise to Nevada's diverse wildlife communities.

In the United States, the primary management authority for most of the wildlife species found within their borders falls to individual states. The US Fish and Wildlife Service (USFWS) manages migratory birds, marine mammals, wildlife within National Wildlife Refuges, and species listed under the Endangered Species Act. Federal agencies regularly partner with state wildlife agencies to protect and manage wildlife resources across the country.

GEOLOGIC HISTORY

With 319 named mountain ranges, Nevada's dominant topographic feature is its basin and range topography (Charlet, 2019). The mountains of the Great Basin are geologically recent, less than 17 million years old, and a product of crustal stretching between the Sierra Nevada to the west and the Wasatch Range of the Rocky Mountains to the east (Wuerthner, 1992). In the intervening millennia, erosion has steadily chipped away at the higher elevations, filling the basins between the ranges with rock and sediment. Crustal stretching and faulting are not uniform, and extensive sections of northwestern and southern Nevada are lower than the central part of the state. These regional differences in elevation, on the order of thousands of feet, have strongly influenced the flora and fauna communities that now occupy these areas.

While the mechanism of mountain formation is consistent across the Great Basin, the underlying bedrock and the resulting composition of the mountains vary. Many granite ranges occur in the west, basalt ranges in the northwest, rhyolite mountains in the center, and limestone and sandstone in the east and southwest (Stewart, 1980). In general, the bedrock in the west and in a central band across the state is igneous in origin, while most of the rest of the state's bedrock is sedimentary in origin (Fiero, 1986). A small fraction of Nevada's bedrock is metamorphic. This variation in bedrock likewise produces variations in soils, which in turn influence plant communities' fundamental structure and ultimately, faunal community composition.

Several periods of volcanic activity deposited extensive lava flows and ash across Nevada. The Owyhee Uplands of the Columbia Plateau in northern Nevada is one of the landscapes shaped by this activity. The presence of this area is significant, because that high plateau country drains north into the Owyhee River, and from there into the Snake River. Scattered across the state is evidence of calderas, lava flows, tuff or welded ash, and other reminders of the natural mechanisms that created the Great Basin (Stewart, 1980).

At various times in its geologic history, extensive parts of the state have been completely submerged. Until approximately 500 million years ago, most of Nevada did not exist, and instead, an ocean stretched westward from what was then the edge of the North American continent. More recently, Pleistocene Lake Lahontan was the largest of several primarily freshwater lakes that covered significant parts of the state. All of these events, whether marine or freshwater in origin, were extensive and lasted long enough to leave sedimentary deposits that are now visible in various parts of the state. Remnants of Lake Lahontan's presence can also be seen in shoreline terraces, now parched and high above valley floors and supporting desert shrubs instead of bulrushes (Scirpoides spp.) and sedges (Carex spp.). The limestones that formed beneath the oceans now form a major regional aquifer beneath much of northeastern, eastern, and southeastern Nevada, and springs flowing from this aquifer are important water sources for species across the state.

During the Pleistocene, Nevada experienced periods of glaciation that altered several mountain landscapes. Over millennia, the shear mass of glaciers, aided by the abrasive quality of rocks and debris entrained in their ice, acted to erode the bedrock beneath them. When the glaciers retreated, they left behind cirques in their headwaters and classic U-shaped valleys that reveal the paths of the ice masses. These distinctive landscapes are evident in the Sierra Nevada, but also in other mountains, including the Ruby, Humboldt, and Snake Ranges. Other Nevada ranges with evidence of glaciation include the Spring Mountains, Toiyabe Range, Carson Range, Toquima Range, Jarbidge Mountains, Santa Rosa Range, Independence Mountains, and the Schell Creek Range (Wuerthner, 1992).

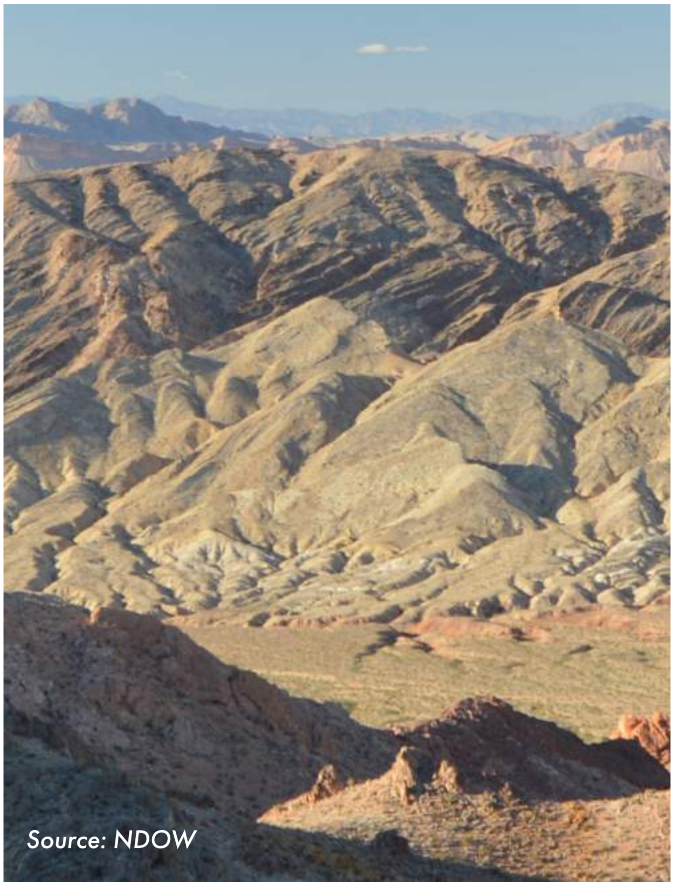
Unique geological conditions, usually in the form of soils, occur in isolated pockets scattered across the state. These conditions have given rise to regionally adapted plants and, at least in some locations, unique species of invertebrates with extremely restricted ranges. Edaphic communities are, by definition, determined by soil conditions. One example of this is the 140 patches of altered andesite scattered across the west-central Great Basin (Billings, 1950, 1990; DeLucia et al., 1988; all in Brussard et al., 1999). These sites, in contrast to the surrounding sagebrush-dominated landscape, are characterized by the presence of Jeffrey (*Pinus jeffreyi*) or ponderosa pine (*Pinus ponderosa*), and many of them harbor an endemic species of buckwheat (*Eriogonum spp.*). Another example is the gypsum-derived soils of the Mojave Desert in southern Nevada that support endemic plant communities adapted to this soil type. Some of these plants, such as the Las Vegas bearpoppy (*Arctomecon californica*), are associated with endemic species of bees.

Biophysical Regions and Major Habitat Types

Although Nevada is defined on the map by its political boundary, its interconnected landscapes are a subset of five ecoregions of the western United States (Wilken et al., 2011). Ecoregions are based on biotic and environmental factors that include climate, physiography, water, soils, air, hydrology, and potential natural vegetation communities (Bailey, 1995). Dinerstein et al. (2000) defined ecoregions as “relatively large areas of land and water that contain geographically distinct assemblages of natural plant communities.” The four primary ecoregions that overlap Nevada include the Northern Basin and Range, Central Basin and Range, Mojave Basin and Range, Sierra Nevada, and a minor inclusion of the Arizona/New Mexico Plateau (1). EPA Level 3 Ecoregions are used for cross-jurisdictional consistency when comparing across regions or state borders.

The Northern Basin and Range is typified by sagebrush steppe and cool season grass-dominated volcanic plains and valleys, tablelands, and intermontane basin and range topography. Higher elevations on the north-south oriented ranges are typically dominated by aspen (*Populus spp.*), firs (*Abies spp.*), and various pine species (*Pinus spp.*). This ecoregion occurs in Oregon, northern Nevada, southern Idaho, and northern Utah and represents the northern portion of the Great Basin. The Northern Basin and Range is an arid cold desert with cold winters and hot summers and a relatively short frost-free growing season.

The Central Basin and Range region covers the central and southern portions of the Great Basin. This semidesert region ranges from the east slope of the Sierra Nevada across much of Nevada to the Wasatch Mountains of the western Rocky Mountains in central Utah. The Great Basin is characterized by salt desert scrub and sagebrush shrublands in the valleys and the lower slopes, and by pinyon-juniper woodlands, mountain sagebrush (*Artemisia tridentata ssp. Vaseyana*), open conifer forests, and alpine areas in the mountain ranges. Remote mountain tops, isolated aquatic habitats in valley bottoms, weathered badlands, and sand dunes highlight the Great Basin’s unique biological diversity. Watersheds within the Central Basin and Range are internally drained leading to a number of sinks and playas and more saline-sodic soils than the cold deserts to the north. This region is warmer and drier than portions of the Great Basin occurring in the Northern Basin and Range ecoregion.


Source: NDOW


Source: NDOW

Desert slopes on the east side of the Sierra Nevada ecoregion partially descend upon Nevada along the western Great Basin border. Vegetation in this part of the ecoregion is characterized by conifer communities mixed with sagebrush (*Artemesia sp.*) and pinyon juniper in the lower elevations and an alpine zone characterized by bare rock, permanent snow fields, and a few grass or forb species. Vegetation diversity in the eastern Sierra Nevada is high, reflecting broad climactic gradients that vary from severe cold, mesic conditions with short frost-free periods at high elevations to mild Mediterranean conditions on mid-lower elevation slopes.

Finally, the Mojave Basin and Range characterizes much of southern Nevada. The Mojave Desert extends from southwestern Utah to southeastern California over to western and northwestern Arizona. Creosote scrub, succulents, and yucca-blackbrush community types dominate the ecoregion. Upper elevation community types, atypical of a desert ecoregion, do occur in the sky island mountains and mountain ranges of the Mojave Desert which contain some of the ecoregion's most isolated communities and species. Climatic conditions are typified by hot summers, warm winters, low precipitation, and relatively long frost-free periods. Minor inclusions of the Arizona/New Mexico Plateau that occur on the eastern edge of the Mojave are largely treated with Mojave Basin and Range systems here.

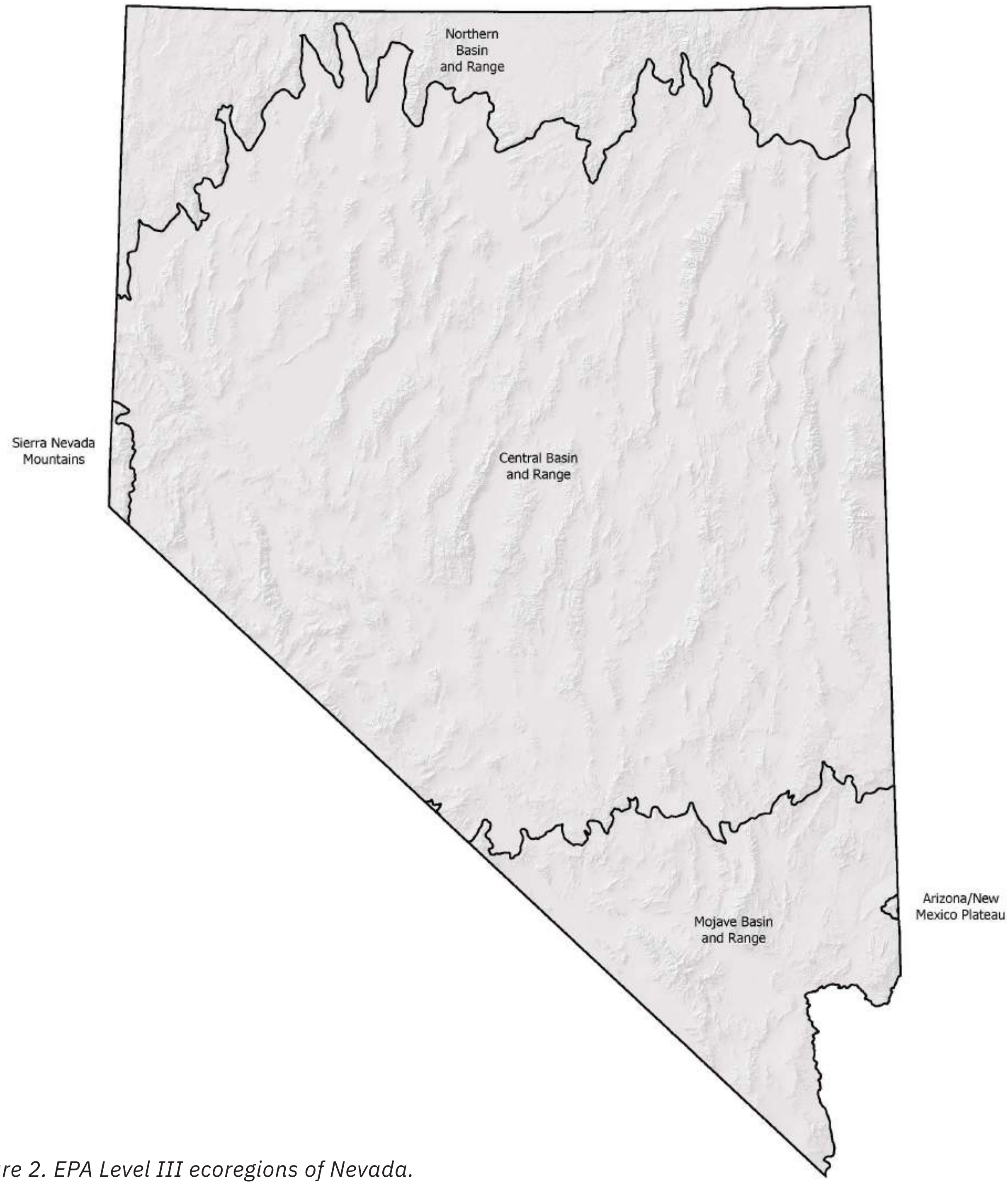


Figure 2. EPA Level III ecoregions of Nevada.

US Department of Agriculture (USDA) Major Land Resource Areas (MLRAs) are at times utilized for reporting metrics within the State Wildlife Action Plan (SWAP) at a finer scale than the Level III Ecoregions as they are, with some exceptions, generally subunits of the Level III ecoregions yet not as finely dissected as Level IV regions. Additionally, many products which are commonly utilized by many resource agencies including Soil Surveys and Ecological Site Descriptions coincide with MLRA boundaries (U.S.D.A., 2022). MLRA used as reporting units within the SWAP, primarily for Habitat Climate Change Vulnerability Analysis, have been split on Level III ecoregional boundaries as there are important ecological gradients represented within the split areas (Figure 3).

Figure 3. USDA MLRAs within Nevada. MLRAs have been further divided on Level III ecoregion boundaries to represent important ecological differences within regions.

Geographic Wildlife Diversity

The broad array of flora and fauna found in Nevada is derived largely from its geography and limited water resources. The high Sierra Nevada range, which began its rise approximately three to five million years ago, efficiently strips water from east-moving storms and creates the pronounced rain shadow that has resulted in the characteristically dry climate in Nevada. The numerous fault-block mountain ranges with winter snowpacks, trees, meadows, and relatively isolated streams are separated from one another by the arid and treeless basins. This juxtaposition of landscapes has effectively created isolated islands of habitat, dubbed sky islands. For the less mobile species of small mammals, reptiles, amphibians, endemic fishes, and some invertebrates, populations have likewise become isolated from one another. Over time, this geographical partitioning and localized adaption have led to the evolution of new species and subspecies.

The principles of island biogeography explain other aspects of the state's diversity of life and the pattern of species across the landscape. Two of the tenets of this branch of ecology state that the number of species on an "island" will decrease with distance from the "mainland" (the source of the species to populate the island); and the smaller the island, the fewer species the island can sustain. The "mainlands" for the Great Basin are the Sierra Nevada and the Rocky Mountains. Moving eastward from the tree-rich Sierra Nevada, the number of tree species declines until, in Central Nevada, mountains such as the Toiyabe and Monitor ranges harbor only a few species (Wuerthner, 1992). A similar pattern occurs in eastern Nevada, where, moving through ranges from east to west, the trees decline in both diversity and their compositional affinity with the Rocky Mountains in Utah. This pattern has been documented in mammal populations in Nevada as well.

While mobile species like birds might be expected to be unaffected by the effects of distance and island size, this is not the case. The reduced number of plant species in the interior mountain ranges translates to lower habitat diversity and fewer available niches, which results in reduced species richness across the central Great Basin with fewer avian species overall.

Another characteristic related to Nevada's geography, prevailing weather patterns, and the rain shadow effect is that critical components necessary for wildlife (e.g., surface water availability and associated vegetative structure) tend to be small, occur in low density, and are scattered broadly across the vast landscape. This is important because the distribution of wildlife tends to reflect the distribution of water resources, available forage, and structural cover, and therefore with few exceptions, wildlife species are not found in high densities across their respective distributions. This creates additional stressors on Nevada's wildlife and particularly impacts species with low dispersal capabilities.

Except for the Colorado River along the southeastern border of the state, and a few tributaries of the Snake River in the north, all of Nevada's watersheds are isolated internally drained endorheic systems without any outflow (Wuerthner, 1992). In general, they originate at springs on the flanks of mountains, capture local precipitation, descend through desert shrubs, and vanish into sinks and playas. Accordingly, the pattern of isolation and divergence has been even more extreme for Nevada's aquatic species. During the Pleistocene, this region of the United States was considerably wetter than it is today, and lakes covered significant parts of the state

(Fiero, 1986). As the Pleistocene waned and the Earth entered a drier, warmer period, the lakes receded and vanished, sometimes completely, sometimes leaving behind only isolated wetlands and remnant springs. Organisms, such as springsnails and pupfish, that once resided in enormous lakes now evolved to persist in tiny seeps and springs, each population cut off from its nearest neighbor, often by miles of desert. Over time, these populations have diverged into separate species, each uniquely adapted to their tiny corner of the world.

Nevada has 370 confirmed endemic (occurring nowhere else in the world) species identified within the state, including six amphibians, nine mammals, 68 insects, two arachnids, 75 mollusks, 156 dicot plant species, two monocot plant species, and 52 endemic species of fishes (NDNH, 2022). With the human reliance on water, nearly all rivers, springs, and aquifers are tapped and to varying degrees dewatered. The natural scarcity of water, coupled with competition for human uses, has left the state with more endangered fish species than any other state. The Devil's Hole pupfish is one famous example of endemism that occurs in southern Nevada, not far from the California border and Death Valley. Devil's Hole is a spring perched on a desolate ledge of black rock, creosote, and cactus. The subsurface spring is located in a defile in the rock and is the only remaining habitat for the Devil's Hole pupfish, which occurs naturally nowhere else in the world. Approximately 20,000 years ago a lake once covered the Amargosa Valley floor, and the pupfish swam freely through hundreds of square miles of water. Now, their entire population is confined to a crack in the bedrock.

Land and Resource Management

Nevada's borders encompass about 110,571 square miles (approximately 71.7 million acres), making it the seventh largest state. The federal government manages approximately 59.9 million acres or 85% of the land base. Of the remaining 15% (approximately 10.8 million acres), privately owned lands comprise approximately 9.2 million acres (approximately 13.0% of the state), Tribal lands comprise approximately 1.1 million acres (approximately 1.5% percent of the state), state-owned lands make up approximately 335,257 acres (approximately 0.5%) and the remaining lands primarily consist of local government holdings. A greater proportion of Nevada's land is owned by the federal government than any other state. Land status is illustrated in 3.

Federal lands in Nevada are primarily managed by the Bureau of Land Management (BLM), US Forest Service (USFS), and Department of Defense/Department of Energy, with a smaller area managed by USFWS. The largest federal land managers, BLM and USFS, manage their land under multiple uses and sustained yield policies as mandated by federal statutes. Multiple use management requires federal agencies to manage the public lands and natural resources for a combination of diverse uses while balancing long-term needs for renewable and non-renewable resources. The BLM and USFS manage multiple-use lands for grazing, mining, outdoor recreation, scientific study, and ecological function. Resources currently receiving considerable attention in USFS Forest Plans, BLM Resource Management Plans, and Regional Ecological Assessments include wetland and riparian resources, biological diversity, forage production, forest health, watershed conditions, wildlife habitat, free-roaming equids populations, motorized recreation, wildfire restoration, fuels management, and noxious and invasive weeds. USFWS manages approximately 1.5 million acres of federally administered lands in Nevada through the National Refuge system for the express benefit of various wildlife species including waterfowl and big game species.

The Department of Energy and Department of Defense together comprise 4.2 million acres, or approximately 6% of land in Nevada, primarily consisting of the Nevada Test and Training Range and adjacent Nevada National Security Site in southern Nevada and Naval Air Station Fallon in northern Nevada. The Bureau of Reclamation (BOR) has jurisdiction over a large area of the Great Basin and a smaller portion in the Mojave within Nevada. The BOR primarily manages land along the Colorado, Walker, Carson, Truckee, and Humboldt River basins, where there are five operating projects and one resource management project.

Similar to the federal land management agencies, state land management agencies are mandated to manage resources according to multiple uses and sustained yield principles, as defined by state law. State lands include 17 wildlife management areas, 28 state parks, and 759 parcels across the state. Tribal lands are distributed across the state, with 27 federally recognized tribes. In 2019, Nevada adopted legislation promoting collaboration between state agencies and Indian tribes, emphasizing effective communication and collaboration, positive government-to-government relations, and cultural competency. Land uses of private lands are predominantly urban and suburban development and agriculture.

With so many land and resource management agencies and interested parties across the state, with varying levels of overlapping interests, coordination and collaboration with these entities is critical to protect, enhance, and manage wildlife and habitats.


Source: NDOW

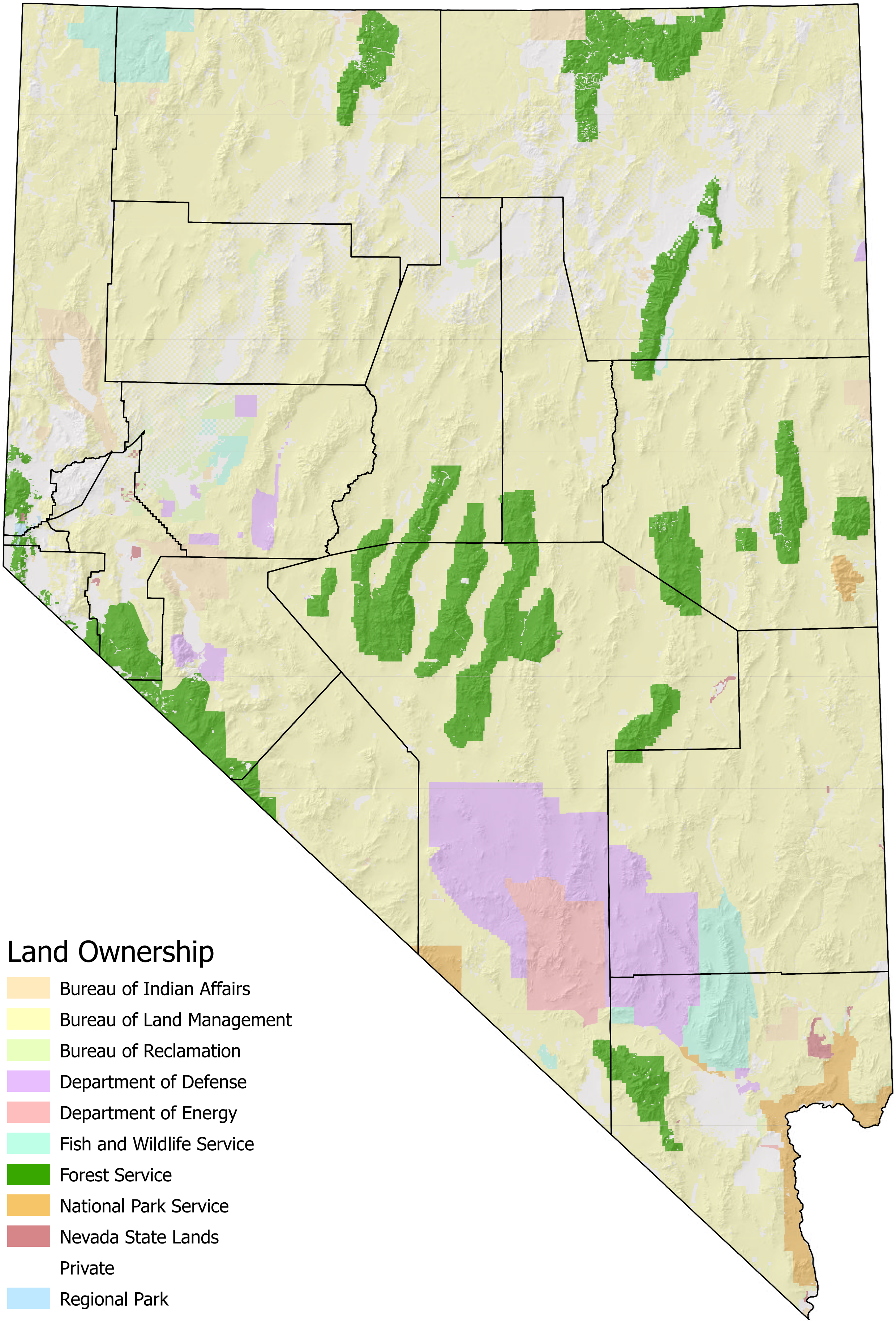


Figure 4. Land status across Nevada.

Human Demographics and Impacts

Based on the 2020 U.S. Census, Nevada experienced a 15% population increase over the previous 10 years. More specifically, Clark County and Washoe County saw 16% and 15% population increases between 2010 and 2020. Nevada is the most urbanized state in the nation, with approximately 89% of its 3.1 million human population associated with the cities of Las Vegas and Henderson in southern Nevada, and Reno and Sparks in northern Nevada (U.S. Census Bureau, 2020).

Even the rural areas of the state have been impacted by population growth. One of the greatest population increases within the state occurred within Nye County with a 17% countywide increase, particularly in the rural communities of Tonopah, Pahrump, and Beatty (U.S. Census Bureau, 2020). Rural communities strain to keep up with the emigration of urban dwellers departing the cities, out-of-state manufacturers moving into a lower tax environment, and energy producers building large-scale projects in previously undeveloped areas or pursuing new technologies. With the influx of people moving to Nevada comes additional stress on natural resources in the state, primarily through the development of previously intact natural systems, increased outdoor recreational pressure, impacts associated with human-caused wildfires, and other extractive uses.

Climate Change in Nevada

The average 30-year-annual precipitation in Nevada is 9.5 inches (WRCC, 2022), making it the driest state in the nation. The average precipitation measure is misleading in that it masks the tremendous amount of variation in precipitation experienced across the state. Precipitation falls primarily as snow in the Great Basin and Columbia Plateau and as rain in the Mojave Desert, one of the principal factors distinguishing these two regions. The Mojave region is also far more likely to receive summer rains as it lies at the northern limit of the region of the American Southwest that consistently receives monsoonal rains generated from weather systems originating in the Gulf of Mexico. Within Nevada's Great Basin, only White Pine County receives about a month's worth of monsoonal weather (Trimble, 1989).

Much of the precipitation that falls in the Great Basin arrives outside of the growing season, during winter months. As such, vegetation communities in the Great Basin rely largely on soil water moisture from snowmelt, rather than precipitation events that occur briefly throughout the year. The Mojave Desert experiences less precipitation and higher temperatures, resulting in overall drier conditions. Riparian areas in the Mojave are typically smaller in size and less frequent across the landscape (Albano et al., 2020). Both the form and timing of precipitation in the Mojave, coupled with warmer temperatures, sustain its markedly different natural communities. Across the state, cold winters, hot summers, and scant and unpredictable rainfall have required a variety of adaptations on behalf of animals to survive in Nevada's environment. These climatic forces, along with the influences of geography, have created a fascinating array of wildlife in an often harsh and beautiful setting of North America.

Climate indicators, including land and water surface temperatures, have increased globally and within the United States with a marked increase in temperature anomalies beginning in the late 1970s to the present (USGCRP, 2017;

EPA, 2022). Average annual temperatures within the Desert Southwest during the period of record from the early 20th Century to the early 21st Century rose throughout the region by roughly 2.89 degrees Celsius with associated increases in the coldest day of year temperatures of 7.81 degrees Celsius (USGCRP 2017 Chpt 25, Vose et al., 2017). Observed decreases in Western snowpacks based on analysis of Natural Resource Conservation Service SnoTel sites are widespread and season long with total Snow Water Equivalent (SWE) losses of 10-20% during 1982-2016 (Fyfe et al., 2017). Both high winter temperatures (preventing accumulation/causing earlier melt) and decreasing precipitation as snow have been implicated in region-wide decreases in the snowpack (Mote et al., 2018).

Changes in primary indicators including maximum and minimum annual temperatures and precipitation are likely to interact in complex ways that exacerbate drought and soil moisture deficits (Overpeck & Udall, 2020). These changes are likely to have widespread and serious implications for Nevada's wildlife and the habitats upon which they depend.

Causal links between human-induced climate changes and changes in fish and wildlife habitats have been well studied and established worldwide, as well as within the Intermountain West in recent decades (Brice et al., 2020; Staudinger et al., 2013; Weiskopf et al., 2020; Prakash, 2021). Recent analysis projects highly variable changes in chronic drought (2070-2100 vs. 1980-2010) across the Intermountain West, particularly within the Basin and Range landscapes of Nevada where the projected number of days of dry topsoil conditions tends to increase in the western Great Basin and decrease in the eastern Great Basin. Potential soil water stress is projected to result, as an example, in vegetation changes within the sagebrush ecosystem including increases in bare ground, decreases in sagebrush, other shrubs, and herbaceous cover, and large declines in perennial cool season grass species accompanied by an increase in perennial warm season grass species (Palmquist et al., 2021; Homer et al., 2015). Warming and drying trends in the recent past have been linked to increased wildfire within the western United States, leading to an estimated doubling of acres burned over the expected baseline (Abatzoglou & Williams, 2016). Multi-year extreme droughts and evaporative stress are expected to cause further future increases in fire danger with implications for changing ecological filters for vegetation communities and the wildlife they support (McEvoy et al., 2020).

Climate change impacts on aquatic ecosystems within the state also are likely to have profound effects on wildlife species. For example, deep temperature mixing within Lake Tahoe, which impacts nutrient availability, may cease to fully occur under future scenarios leading to increases in algal growth, decreases in lake clarity, and impacts throughout the trophic chain (Sahoo et al., 2013). Also, alterations in the timing and type of precipitation, decreases in snowpack and changes in the timing of snowmelt, potential increased groundwater withdrawals from human activity to compensate for reduced surface water availability, and other stressors are all expected to negatively impact aquatic and groundwater dependent ecosystems throughout the state (Fyfe et al., 2017; Meixner et al., 2016; Saito et al., 2022).

Statistically downscaled climate data for Nevada for historical (1960-1991) and medium (future 2035-2064) timescales are presented here to compare forecast climate scenarios for the State. Medium (RCP4.5) and high (RCP8.5) scenarios are used to compare observed historical data to future forecast indicators for primary climate variables (annual average maximum and minimum temperature and precipitation). RCP4.5 and 8.5 were chosen based on scenarios used in the 4th National Climate Assessment (Vose et al., 2017). Data were obtained from Cal-Adapt summaries of CMIP5 (Coupled Model Intercomparison Project Phase 5 Localized Constructed Analogs (LOCA) downscaled products and represent a suite of 10 models expected to perform well regionally (Abatzoglou & Brown, 2012; Cal-Adapt, 2018; Pierce et al., 2018). Data details and model selection details are available from Pierce et al. (2018) and www.loca.ucsd.edu. Please see Appendix B for a full list of models and originating institutions.

Forecast changes in mean maximum annual temperature and mean minimum annual temperatures are higher under RCP8.5 emission scenarios than RCP4.5 scenarios, with both scenarios showing increased temperatures over historical baselines (Table 4, Appendix A). While spatial and interannual variability and a range of model outputs exist within the forecasts, maximum and minimum annual mean temperatures are expected to increase in the medium term throughout the state.

Forecast precipitation futures are highly variable and overlap current precipitation at a state-wide level; however, model means generally indicate the likelihood of drying in southern portions of the state with potential increases in the northern, eastern, and higher elevation portions of the state (Table 4, Figure 4, Appendix A). Interannual trends in precipitation coupled with other complicating factors are known to make forecasts of precipitation trends particularly challenging (see Prein et al., 2016). More complex modeling shows an expected soil water deficit for the Southwest that will likely impact species distributions and cover (Bradford et al. 2020). While projected accumulated precipitation trends remain difficult to model, it is expected that there will be a shift toward increasing rain with decreasing annual snowfall (McEvoy et al., 2020; Rhoades et al., 2018).

Biologically, Nevada is a landscape of enormous diversity and subtlety. The following chapters will describe the specific Species of Greatest Conservation Need, as well as the key habitats delineated in Nevada. These chapters will include a discussion of the threats and conservation actions unique to each species and habitat, as well as identify influences on these resources as a result of a changing climate, and priority research needs.


Source: NDOW

Table 4: Annual mean maximum and minimum temperatures and accumulated precipitation for historic (1960-1991) and medium future (2035-2064) periods based on 10 Global Circulation Model outputs of CMIP5 LOCA data obtained from Cal-Adapt. Please see Appendix C for model details.

	ANNUAL TIME PERIOD VARIABLES		
PERIOD	MEAN MAXIMUM TEMPERATURE, C	MEAN MINIMUM TEMPERATURE, C	ACCUMULATED PRECIPITATION, CM
1960-1991	17.6 C	0.6 C	27.7 cm
RCP4.5 (all models)	20.5 C	3.03 C	28.1 cm
Range of expected annual average	18.5 - 23.0 C	0.7 - 4.9 C	12.2 - 50.0 cm
RCP8.5 (all models)	21.2 C	3.72 C	28.8 cm
Range of expected annual average	18.2 - 24.1 C	0.9 - 6.5 C	14.1 - 54.0 cm

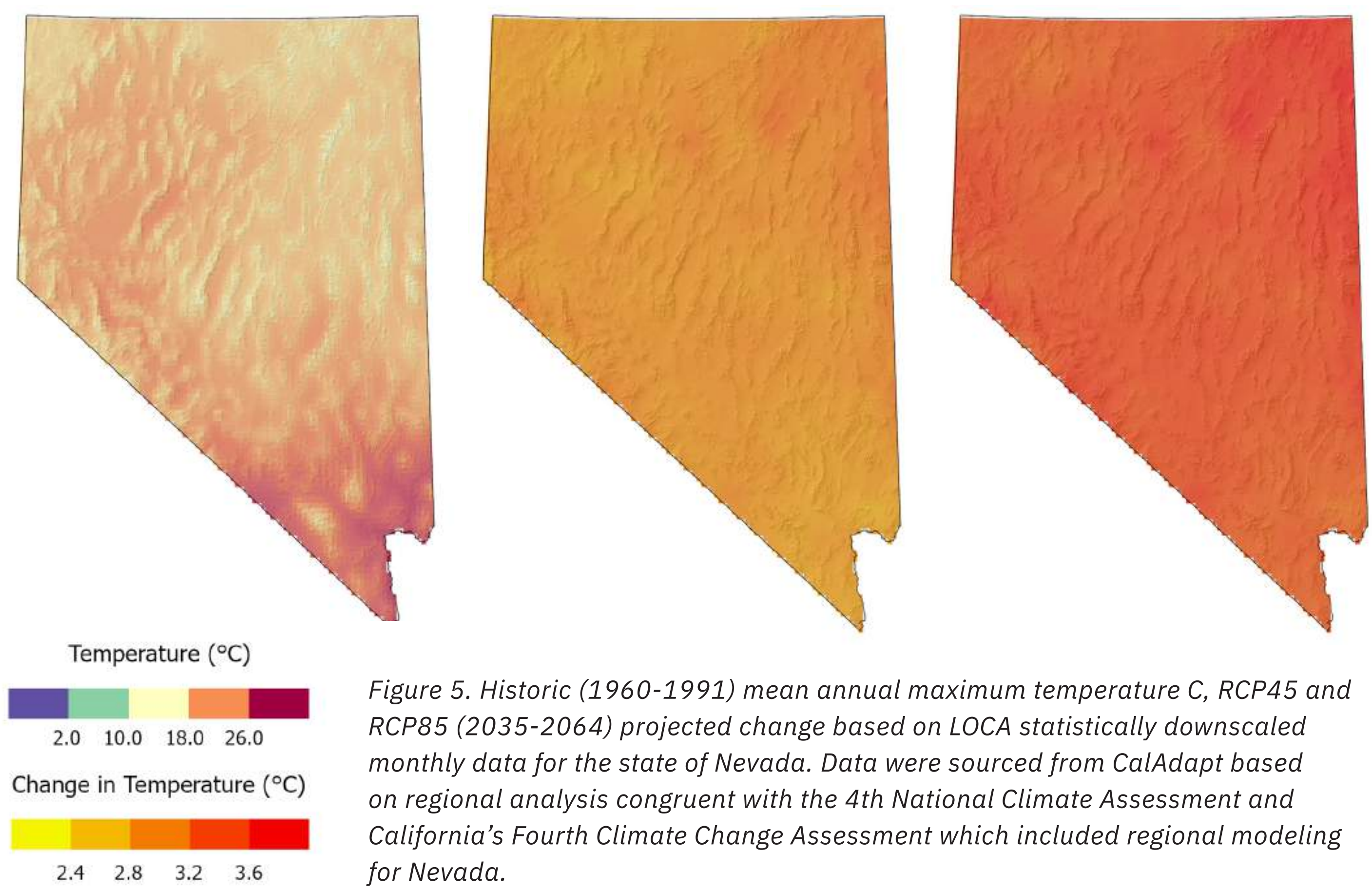


Figure 5. Historic (1960-1991) mean annual maximum temperature C, RCP45 and RCP85 (2035-2064) projected change based on LOCA statistically downscaled monthly data for the state of Nevada. Data were sourced from CalAdapt based on regional analysis congruent with the 4th National Climate Assessment and California's Fourth Climate Change Assessment which included regional modeling for Nevada.

Chapter 3

Species of Greatest Conservation Need

Source: NDOW

Identification of Species of Greatest Conservation Need

Approach and Methods: Revising the Species of Greatest Conservation Need List

Nevada is a state high in species diversity, with over 890 regularly occurring taxa that NDOW has regulatory authority to manage. This does not include the thousands of unique plants and invertebrate species that also call Nevada home – many of which are not fully described and for which very little information exists. NDOW's overarching goal and mission are to conserve all wildlife for current and future generations and to ensure that ecosystems and habitats are intact and fully functioning. With such incredible diversity in the state, it is necessary to prioritize species that need management attention to prevent declines and loss, are keystone or indicator species for various ecosystems, or are common species that the state has a disproportionate responsibility for their global conservation.

Species identified as most in need of conservation actions are referred to as the Species of Greatest Conservation Need (SGCN; identified as Species of Conservation Priority in our 2012 SWAP). States are required to include information on the distribution and abundance and status of their SGCN. It is important to note that identifying a species as an SGCN does not change any regulations regarding the species; it is a prioritization tool that Nevada wildlife managers can use to guide conservation actions.

As we began the process of developing a current SGCN list, we chose to evaluate terrestrial invertebrates (primarily pollinators) in addition to the broad taxonomic groups considered previously of amphibians, aquatic invertebrates (gastropods and other mollusks), birds, fishes, mammals, and reptiles. Factors that were considered in evaluations included indicator or umbrella species concepts, cultural sensitivities, and traditional resource use, in addition to population status, rarity on the landscape, threat exposure, knowledge gaps, or other strictly ecological concerns.

New to the 2022 SWAP are identified terrestrial invertebrate SGCN. Regulatory authority for this group is somewhat complex, with no single entity solely responsible. This gap in management authority creates concern that certain groups of species may be declining in the absence of quantifiable status assessments, and these knowledge gaps will prevent the conservation and stewardship of the species. For this reason, the 2022 SWAP includes invertebrates with an emphasis on pollinating bees and butterflies due to their critical role in maintaining healthy habitat. It is acknowledged that there are several other important guilds of invertebrates, including beetles and ants, that are critical to healthy and functioning ecosystems. There is a significant lack of information for many of these species, and as resources allow, future prioritization should be expanded to include these guilds.

Similarly, it is recognized that plants play a pivotal role in fully functional ecosystems. The regulatory oversight for plants is well defined in Nevada with the Nevada Division of Forestry (NDF) designating and regulating protected flora under revised Nevada Statutes. NDF coordinates with the Nevada Division of Natural Heritage (NDNH) as the "Competent Authority" defined under Nevada Revised Statute for botanical verification and inquiry related to permitting. NDNH regularly assesses extirpation risk for individual plant species using a standard methodology consistent with other taxa. Broader conservation of protected, threatened, and rare plant species in Nevada relies on collaborative partnerships between multiple contributing organizations, with representatives from federal, state, and local governments as well as non-profit groups, corporations, and private landowners. The 2022 SWAP currently does not include identified SGCN plants, but it is a recognized need. Adding identified plant SGCN to the SWAP can be done as resources are available using the tools and methodology described below for terrestrial species.

Using expertise from NDNH, we include consideration of threats that impact plants in a broad sense in the threats section below, as many of these stressors impact species across taxonomic and geographic areas. In addition, both NDNH and NDF have identified updating distribution knowledge, population size and trend assessments, and maintaining current information in accessible databases as program priorities that will be key actions for plant conservation. Finally, understanding and projecting future impacts of climate change on the range, distribution, and habitats of protected and other threatened plants will likely be a priority.

For our 2022 update, and similar to our 2012 SWAP, we scored Nevada's species of native wildlife based on various elements such as perceived threats to populations, Nevada's stewardship role based on the proportion of species' global population occurring within the state, population status and trend, and opportunity to engage partners. While each NDOW division with direct species management authority (i.e., Fisheries, Game, and Wildlife Diversity) considered all of these elements, there were differences in how these elements were applied depending on the species group. Individual scoring methodologies are described below by the appropriate group.

Table 5: Overview of SGCN Changes from the 2012 to 2022 Plans by Taxonomical Groups

SPECIES TYPE	TOTAL SPECIES 2012	TOTAL SPECIES 2022	CHANGES
Mammals	40	47	5 bats, 2 nonvolant small mammals, and 1 lagomorph were added; 1 species was subdivided into 3 separate subspecies; 2 nonvolant small mammals and 1 mustelid removed
Birds	60	75	15 passerine/near passerines, 2 owls, 2 raptors, 1 shorebird, and 2 waterfowl added; 1 passerine was subdivided taxonomically with only 1 of the newly designated species retained; 2 shorebirds, 1 hummingbird, 2 water birds, 1 waterfowl, and 1 crane removed
Reptiles	26	24	2 snakes and 2 lizards were added; 3 snakes, 1 lizard, and 1 gecko were removed; 2 lizard subspecies were collapsed into a single species
Fish	52	55	5 species added (3 in 2021 minor revision); 1 species removed; 2 subpopulations collapsed to 1 species
Amphibians	9	12	4 species were added; 1 removed
Aquatic Invertebrates	70	88	16 springsnails added; 2 mussels added in minor 2021 revision
Terrestrial Invertebrates	Not included	66	42 butterflies, 23 bees, and 1 beetle added
TOTAL	**257**	**367**	

Each scoring effort to assess which species would be included as an SGCN began with the consideration of the broader list of species occurring in Nevada, as opposed to basing evaluations on species that had been prioritized in our earlier SWAP versions. As such, while scoring methods were similar and there are certainly commonalities between revisions, our 2022 list of SGCN should be viewed as an independently selected list of prioritized species rather than simply an update of previous lists. Overall, NDOW evaluated over 600 species for inclusion as an SGCN and 367 species were selected as SGCN for the 2022 SWAP. See Table 5 for an overview of SGCN changes from our 2012 to 2022 plans by taxonomical groups and Table 6 for the full 2022 SGCN list.

SGCN Selection Process

Aquatic Species Ranking Methods

The means for developing the 2012 aquatic Species of Greatest Conservation Need list was a collaborative process and evolved from pre-existing ranking mechanisms including Nevada Division of Natural Heritage information, Endangered Species Act listing criteria, IUCN World Conservation Union Red List, protected status under Nevada Administrative Code, and an internal matrix developed to rank NDOW's terrestrial non-game species. Aquatic species are linked to aquatic systems, which in Nevada tend to be isolated habitats more sensitive to local threats and stressors, and the distribution characteristics of aquatic species are a much larger contributing factor to their conservation need.

The process for evaluating and updating the current list of aquatic SGCN consisted of a comprehensive review of all native fish and amphibians using updated information and based on expert opinion, endemism, population size/distribution, fragmentation, population trend, and threats. All springsnail and amphibian species occurring in Nevada were carried forward as SGCN, while other species were scored using an internal scoring matrix to determine SGCN based on a minimum scoring threshold (68 species were scored; those with a score of 13 and above were included as SGCN). More specifically, the aquatic species scoring matrix consisted of:

- **Endemism (scored 1–5):** Is the species/subspecies endemic to Nevada or does it have a regional/broad-based natural distribution? For species that also occur outside of Nevada, do Nevada populations represent a significant focus of species distribution for conservation purposes?
- **Population Size/Distribution (scored 1–5):** How limited/restricted is the distribution?
- **Fragmentation (scored 1 or 2):** 1 = distribution characterized by connectivity between populations or abundant in multiple expansive habitats; 2 = a disjunct or fragmented distribution
- **Population Trend (scored 1–4):** An assessment of whether populations are increasing, stable, decreasing, or unknown based on available information.
- **Threats (scored 1–5):** What is the severity of identified threats, and how immediate might those threats be realized? Threats include conditions relating to habitat quality and quantity, the potential for habitat disturbance or deterioration, disease or predation risk, competition with invasive species, and environmental contaminants.

Game Species Ranking Methods

All species classified as game animals in the Nevada Administrative Code were evaluated for SGCN consideration and scored by NDOW Game Division biologists. Species rankings were calculated for inclusion based on whether or not they historically have occurred naturally in Nevada, have recently dispersed into the state, or if active management actions have established populations locally. Species were scored using an internal scoring matrix to determine SGCN status based on a minimum scoring threshold (55 species were scored; those with a score of 21 and above were included as SGCN). The Game species scoring matrix consisted of:

- **Population Status (scored 1–5):** A continuum scoring with 1 being population status is at/exceeding carrying capacity to 5 being the population is well below carrying capacity and urgent remedial action is needed to assure retention within most or all of its range.
- **Population Trend (scored 1–5):** A continuum scoring with 1 being populations are increasing through natural recruitment to 5 being populations are declining rapidly and are likely to disappear over much or all of their range without profound intervention.

- **Distribution in Nevada (scored 1–5):** A continuum scoring with 1 being the species is distributed across all suitable habitat in Nevada to 5 being distribution is greatly diminishing and urgent remedial action is needed to restore the species to its former range.
- **Distribution—Species' Global Range (scored 1–5):** A continuum scoring of 1 being the species is not endemic to Nevada to 5 being its existence in Nevada represents a significant portion of its global range.
- **Habitat Quality in Nevada (scored 1–5):**
    - 1 = Habitat quality has been diminished to the extent that nothing can be done to restore it, or the species is non-native and only exists in Nevada through human intervention
    - 2 = All or a majority of the habitat is in poor ecological condition but can be improved through human intervention
    - 3 = Habitat is not imperiled by human action, but conditions can vary widely as a result of natural influences
    - 4 = Occupied habitat can easily support the species, but can also be improved through human intervention
    - 5 = Habitat is ecologically sound throughout all or a majority of its range
- **Habitat Trend (scored 1–5):** A continuum scoring with 1 being the habitat status is stable or not likely to decline in quality to 5 being urgent and significant remedial action is necessary to prevent species extirpation throughout the remaining habitat.
- **Planning (scored 1–5):** A continuum scoring of 1 being the species can continue to exist in good numbers independent of human intervention, to 5 being the protection of the species under Endangered Species Act listing appears imminent without actions to prevent further decline.
- **Data Needs (scored 1–5):** A continuum scoring with 1 being data sufficient for confident assessments of the species' status and trend to 5 being little to no species status information is known about this species in Nevada.

Terrestrial Nongame Species Ranking Methods

Based on the large number of nongame terrestrial vertebrates documented as occurring in Nevada for at least part of their life cycle, the list of species assessed was not exhaustive. To pare down the evaluation list, we excluded nonnative species; used expert opinion, internal NDOW data, NDNH records, and NatureServe Explorer (NatureServe, 2022) to focus on species thought to currently occur in Nevada; and prioritized species that regularly occur in Nevada or can be found for a substantial part of their annual life cycle within the state (i.e., species only occurring during very brief migratory fly-throughs, unpredictable irruptive species, or species with only a few substantiated records in the state were not always included). Species were scored using an internal scoring matrix to determine SGCN status based on a minimum scoring threshold (401 species were scored; those with a score of 13 and above were included as SGCN). The nongame terrestrial species scoring matrix consisted of:

- **Federal/State Status:** Species with Endangered, Threatened, or Candidate status under federal or Nevada law received a score of 1, all others were 0.
- **State Rank:** Each species was assigned an inverted NDNH State Rank score (scored 1–5). If state (S-rank) levels were

not available, then NatureServe national (N-rank) or range (G-rank) levels were used as appropriate.

- **Threats (scored 1–5):** A continuum scoring with 1 being future conditions are expected to remain stable with no known threats to 5 being future conditions are expected to experience extreme deterioration with immediate action required or the species would be at risk of extirpation or significant range contraction.
- **Area Importance (scored 1–3):** A categorical scoring of Nevada's stewardship role based on the proportion of the species' range found in Nevada. This was a subjective evaluation based on low, moderate, or high responsibility.
- **Current Knowledge (scored 1–3):** A categorical approach with 3 representing species with relatively little scientific knowledge available, 2 representing a moderate level of knowledge, and 1 representing species already benefiting from long-term historical study and accumulation of knowledge. While types of information vary by taxa, the types of species knowledge most heavily weighted for this element were information useful from a species management perspective (e.g., distribution, population size, population status, population trend, dispersal potential, density, etc.).
- **Opportunity (scored 1–3):** A categorical approach with 1 representing relatively low opportunity and 3 representing relatively high opportunity with an emphasis on existing partnerships (e.g., state, federal, NGO, and volunteer-based partnerships), partnership-building opportunities, and existing management plans and conservation strategies. While considered during our 2012 SWAP revision, we attempted to solely prioritize partnering opportunities within the broader Nevada conservation community and avoided penalizing cryptic species with low detection rates by not considering species detectability in this matrix element.

Terrestrial Invertebrate Species Ranking Methods

The inclusion of this taxonomic group is new to the development of our 2022 SWAP. We used the Terrestrial Nongame Species Matrix for evaluating this group, with the exception that federal listing under the ESA was an automatic SGCN inclusion (four species). NDOW has little taxonomical expertise with this species group, so we engaged with regional experts from the Xerces Society for Invertebrate Conservation and NDNH to run our matrix scoring exercise. Terrestrial invertebrates are a key component of Nevada's landscapes, serving as native plant and crop pollinators; as prey for countless fish, amphibian, reptile, bird, and mammal species; and as herbivore communities in natural ecosystems. To prioritize ecosystem benefits, we chose to restrict our analysis to pollinator species of bees (*Hymenoptera*) and butterflies (*Lepidoptera*). While only the top 42 butterfly taxa and 23 bee taxa were formally ranked, many additional species from each group were evaluated. These taxa represent the bees and butterflies most in need of conservation attention in Nevada based on the minimum scoring threshold (those with a score of 13 and above were included).

Table 6: 2022 Species of Greatest Conservation Need List. Species in bold are newly included in the 2022 SGCN List (except for Terrestrial Invertebrates, all of which are a new addition to the 2022 SWAP). Species in bold with asterisk indicates species added in 2021 as a minor revision to the 2012 SWAP.

AMPHIBIANS	
COMMON NAME	SCIENTIFIC NAME
Amargosa toad	*Anaxyrus nelsoni*
Arizona toad	*Anaxyrus microscaphus*
Columbia spotted frog	*Rana luteiventris*
Dixie Valley toad	***Anaxyrus williamsi***
Great Basin spadefoot	*Spea intermontana*
Great Plains toad	*Anaxyrus cognatus*
Hot Creek toad	***Anaxyrus monfontanus***
northern leopard frog	*Lithobates pipiens*
Railroad Valley toad	***Anaxyrus nevadensis***
red-spotted toad	***Anaxyrus punctatus***
relict leopard frog	*Lithobates onca*
western toad	*Anaxyrus boreas*

BIRDS	
COMMON NAME	SCIENTIFIC NAME
American Avocet	*Recurvirostra americana*
American Kestrel	***Falco sparverius***
American White Pelican	*Pelecanus erythrorhynchos*
Arizona Bell's Vireo	*Vireo bellii arizonae*
Bald Eagle	*Haliaeetus leucocephalus*
Band-tailed Pigeon	***Patagioenas fasciata***
Bank Swallow	*Riparia riparia*
Bendire's Thrasher	*Toxostoma bendirei*
Black Rosy-Finch	*Leucosticte atrata*
Black Tern	*Chlidonias niger*
Black-backed Woodpecker	***Picoides arcticus***
Black-chinned Sparrow	*Spizella atrogularis*
Black-necked Stilt	***Himantopus mexicanus***
Black-throated Gray Warbler	***Setophaga nigrescens***
Bobolink	*Dolichonyx oryzivorus*
Brewer's Sparrow	*Spizella breweri*
California Spotted Owl	*Strix occidentalis occidentalis*
Canvasback	*Aythya valisineria*
Cassin's Finch	*Haemorhous cassinii*

BIRDS	
COMMON NAME	SCIENTIFIC NAME
Cinnamon Teal	***Spatula cyanoptera***
Clark's Nutcracker	***Nucifraga columbiana***
Columbian Sharp-tailed Grouse	*Tympanuchus phasianellus columbianus*
Common Nighthawk	*Chordeiles minor*
Costa's Hummingbird	***Calypte costae***
Crissal Thrasher	***Toxostoma crissale***
Dusky Flycatcher	***Empidonax oberholseri***
Dusky Grouse	*Dendragapus obscurus*
Ferruginous Hawk	*Buteo regalis*
Flammulated Owl	*Psiloscops flammeolus*
Gambel's Quail	***Callipepla gambelii***
Gilded Flicker	*Colaptes chrysoides*
Golden Eagle	*Aquila chrysaetos*
Grace's Warbler	***Setophaga graciae***
Gray Vireo	***Vireo vicinior***
Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*
Great Basin Willow Flycatcher	***Empidonax traillii adastus***
Greater Sage Grouse	*Centrocercus urophasianus*
Hermit Warbler	***Setophaga occidentalis***
Least Bittern	*Ixobrychus exilis*
LeConte's Thrasher	*Toxostoma lecontei*
Lewis's Woodpecker	*Melanerpes lewis*
Lincoln's Sparrow	***Melospiza lincolnii***
Loggerhead Shrike	*Lanius ludovicianus*
Long-billed Curlew	*Numenius americanus*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Long-eared Owl	***Asio otus***
Lucy's Warbler	***Leiothlypis luciae***
Mountain Quail	*Oreortyx pictus*
Northern Goshawk	*Accipiter gentilis*
Northern Pintail	*Anas acuta*
Northern Pygmy-Owl	***Glaucidium gnoma***
Olive-sided Flycatcher	*Contopus cooperi*
Peregrine Falcon	*Falco peregrinus*
Pinyon Jay	*Gymnorhinus cyanocephalus*
Prairie Falcon	*Falco mexicanus*
Sage Thrasher	*Oreoscoptes montanus*
Sagebrush Sparrow	*Artemisiospiza nevadensis*

BIRDS	
COMMON NAME	**SCIENTIFIC NAME**
Scott's Oriole	*Icterus parisorum*
Short-eared Owl	*Asio flammeus*
Sierra Nevada Mountain Willow Flycatcher	*Empidonax traillii brewsteri*
Sooty Grouse	*Dendragapus fuliginosus*
Southwestern Willow Flycatcher	*Empidonax traillii extimus*
Swainson's Hawk	***Buteo swainsoni***
Tricolored Blackbird	*Agelaius tricolor*
Trumpeter Swan	***Cygnus buccinator***
Virginia's Warbler	*Leiothlypis virginiae*
Western Burrowing Owl	*Athene cunicularia hypugaea*
Western Snowy Plover	*Charadrius nivosus*
Western Yellow-billed Cuckoo	*Coccyzus americanus occidentalis*
White-faced Ibis	*Plegadis chihi*
White-headed Woodpecker	*Dryobates albolarvatus*
White-throated Swift	***Aeronautes saxatilis***
Williamson's Sapsucker	***Sphyrapicus thyroideus***
Wilson's Phalarope	*Phalaropus tricolor*
Yuma Ridgway's Rail	*Rallus obsoletus yumanensis*

FISH	
COMMON NAME	**SCIENTIFIC NAME**
Alvord Chub	*Siphateles alvordensis*
Ash Meadows Amargosa Pupfish	*Cyprinodon nevadensis mionectes*
Ash Meadows Speckled Dace	*Rhinichthys osculus nevadensis*
Big Smokey Valley Speckled Dace	*Rhinichthys osculus lariversi*
Big Smokey Valley Tui Chub	*Siphateles bicolor (ssp. 8)*
Big Spring Spinedace	*Lepidomeda mollispinis pratensis*
Bonneville Cutthroat Trout*	***Oncorhynchus clarkii utah***
Bonytail	*Gila elegans*
Bull Trout	*Salvelinus confluentus (pop. 4)*
Clover Valley Speckled Dace	*Rhinichthys osculus oligoporus*
Columbia Basin Redband Trout*	***Oncorhynchus mykiss gairdneri***
Cui-ui	*Chasmistes cujus*
Desert Dace	*Eremichthys acros*
Devils Hole Pupfish	*Cyprinodon diabolis*
Fish Creek Springs Tui Chub	***Siphateles bicolor euchila***
Fish Lake Valley Tui Chub	*Siphateles bicolor (ssp. 4)*
Flannelmouth Sucker	*Catostomus latipinnis*
Hiko White River Springfish	*Crenichthys baileyi grandis*
Independence Valley Speckled Dace	*Rhinichthys osculus lethoporus*

FISH	
COMMON NAME	**SCIENTIFIC NAME**
Independence Valley Tui Chub	*Siphateles bicolor isolata*
Lahontan Cutthroat Trout	*Oncorhynchus clarkii henshawi*
Little Fish Lake Valley Tui Chub	*Siphateles bicolor (ssp. 6)*
Meadow Valley Wash Desert Sucker	*Catostomus clarkii (ssp. 2)*
Meadow Valley Wash Speckled Dace	*Rhinichthys osculus (ssp. 11)*
Moapa Dace	*Moapa coriacea*
Moapa Speckled Dace	*Rhinichthys osculus moapae*
Moapa White River Springfish	*Crenichthys baileyi moapae*
Monitor Valley Speckled Dace	*Rhinichthys osculus (ssp. 5)*
Moorman White River Springfish	*Crenichthys baileyi thermophilus*
Mountain Whitefish	*Prosopium williamsoni*
Northern Leatherside Chub*	***Lepdomeda copei***
Oasis Valley Speckled Dace	*Rhinichthys osculus (ssp. 6)*
Pahranagat Roundtail Chub	*Gila robusta jordani*
Pahranagat Speckled Dace	*Rhinichthys osculus velifer*
Pahrump Poolfish	*Empetrichthys latos latos*
Paiute Sculpin	***Cottus beldingii***
Preston White River Springfish	*Crenichthys baileyi albivallis*
Railroad Valley Springfish	*Crenichthys nevadae*
Railroad Valley Tui Chub	*Siphateles bicolor (ssp. 7)*
Razorback Sucker	*Xyrauchen texanus*
Relict Dace	*Relictus solitarius*
Sheldon Tui Chub	*Siphateles bicolor eurysoma*
Tui Chub in Dixie Valley	*Siphateles bicolor (ssp. 9)*
Virgin River Chub	*Gila seminuda*
Virgin Spinedace	*Lepidomeda mollispinis mollispinis*
Wall Canyon Sucker	*Catostomus (sp. 1)*
Warm Springs Pupfish	*Cyprinodon nevadensis pectoralis*
Warner Sucker	*Catostomus warnerensis*
Warner Valley Redband Trout	*Oncorhynchus mykiss (pop. 4)*
White River Desert Sucker	*Catostomus clarkii intermedius*
White River Speckled Dace	*Rhinichthys osculus (ssp. 7)*
White River Spinedace	*Lepidomeda albivallis*
White River Springfish	*Crenichthys baileyi baileyi*
Woundfin	*Plagopterus argentissimus*
Yellowstone Cutthroat Trout	*Oncorhynchus clarkii bouvieri*

GASTROPODS	
COMMON NAME	**SCIENTIFIC NAME**
curved filament snail	***Pyrgulopsis licina***
Sanchez pyrg	***Pyrgulopsis sanchezi***

GASTROPODS	
COMMON NAME	SCIENTIFIC NAME
Shasta pebblesnail	***Pyrgulopsis licina***
Amargosa tryonia	*Tryonia variegata*
Antelope Valley pyrg	*Pyrgulopsis pellita*
Ash Meadows pebblesnail	*Pyrgulopsis erythropoma*
bifid duct pyrg	*Pyrgulopsis peculiaris*
Big Warm Spring pyrg	*Pyrgulopsis papillata*
Blue Point pyrg	*Pyrgulopsis coloradensis*
Blue Point Springs tryonia	***Tryonia infernalis***
Butterfield pyrg	*Pyrgulopsis lata*
Camp Valley pyrg	*Pyrgulopsis montana*
carinate Duckwater pyrg	***Pyrgulopsis carinata***
Corn Creek pyrg	*Pyrgulopsis fausta*
Cortez Hills pebblesnail	***Pyrgulopsis bryantwalkeri***
Crittenden pyrg	***Pyrgulopsis lentiglans***
crystal springsnail	*Pyrgulopsis crystalis*
desert tryonia	***Tryonia porrecta***
distal-gland springsnail	*Pyrgulopsis nanus*
Dixie Valley pyrg	*Pyrgulopsis dixensis*
Duckwater pyrg	*Pyrgulopsis aloba*
Duckwater Warm Springs pyrg	*Pyrgulopsis villacampae*
Elko pyrg	*Pyrgulopsis leporina*
elongate Cain Spring pyrg	*Pyrgulopsis augustae*
elongate Mud Meadows pyrg	*Pyrgulopsis notidicola*
elongate-gland springsnail	*Pyrgulopsis isolata*
emigrant pyrg	*Pyrgulopsis gracilis*
Fairbanks springsnail	*Pyrgulopsis fairbanksensis*
Fish Lake Valley pyrg	***Pyrgulopsis ruinosa***
flag pyrg	*Pyrgulopsis breviloba*
flat-topped Steptoe pyrg	*Pyrgulopsis planulata*
Fly Ranch pyrg	*Pyrgulopsis bruesi*
Grand Wash springsnail	***Pyrgulopsis bacchus***
grated tryonia	*Tryonia clathrata*
Hamlin Valley pyrg	***Pyrgulopsis hamlinensis***
Hardy pyrg	*Pyrgulopsis marcida*
Hubbs pyrg	*Pyrgulopsis hubbsi*
Humboldt pyrg	*Pyrgulopsis humboldtensis*
Kings River pyrg	*Pyrgulopsis imperialis*
Lake Valley pyrg	*Pyrgulopsis sublata*
Landyes Pyrg	*Pyrgulopsis landyei*
large gland Carico pyrg	*Pyrgulopsis basiglans*

GASTROPODS	
COMMON NAME	SCIENTIFIC NAME
Lockes pyrg	*Pyrgulopsis lockensis*
longitudinal gland pyrg	*Pyrgulopsis anguina*
median-gland springsnail	*Pyrgulopsis pisteri*
minute tryonia	*Tryonia ericae*
Moapa pebblesnail	*Pyrgulopsis avernalis*
Moapa Valley pyrg	*Pyrgulopsis carinifera*
Monitor tryonia	*Tryonia monitorae*
nature pyrg	***Pyrgulopsis cybele***
neritiform Steptoe Ranch pyrg	*Pyrgulopsis neritella*
northern Soldier Meadow pyrg	*Pyrgulopsis militaris*
northern Steptoe pyrg	*Pyrgulopsis serrata*
northwest Bonneville pyrg	*Pyrgulopsis variegata*
Oasis Valley springsnail	*Pyrgulopsis micrococcus*
Ovate Cain Spring pyrg	*Pyrgulopsis pictilis*
Pahranagat pebblesnail	*Pyrgulopsis merriami*
Pleasant Valley pyrg	*Pyrgulopsis aurata*
Point of Rocks tryonia	*Tryonia elata*
Pyramid Lake pebblesnail	*Fluminicola dalli*
Sadas pyrg	*Pyrgulopsis sadai*
small gland Carico pyrg	*Pyrgulopsis bifurcata*
smooth juga	*Juga acutifilosa*
southern Duckwater pyrg	*Pyrgulopsis anatina*
southern Soldier Meadow pyrg	*Pyrgulopsis umbilicata*
southern Steptoe pyrg	*Pyrgulopsis sulcata*
southwest Nevada pyrg	*Pyrgulopsis turbatrix*
sportinggoods tryonia	*Tryonia angulata*
Spring Mountains pyrg	*Pyrgulopsis deaconi*
squat Mud Meadows pyrg	*Pyrgulopsis limaria*
Steptoe hydrobe	*Eremopyrgus eganensis*
Sterile Basin pyrg	*Pyrgulopsis sterilis*
sub-globose Steptoe Ranch pyrg	*Pyrgulopsis orbiculata*
Surprise Valley pyrg	***Pyrgulopsis gibba***
Toquerville springsnail	***Pyrgulopsis kolobensis***
transverse gland pyrg	*Pyrgulopsis cruciglans*
turban pebblesnail	*Fluminicola turbiniformis*
Twentyone Mile pyrg	*Pyrgulopsis millenaria*
Upper Thousand Spring pyrg	*Pyrgulopsis hovinghi*
Varners pyrg	***Pyrgulopsis varneri***
Vinyards pyrg	*Pyrgulopsis vinyardi*
Virginia Mountains pebblesnail	*Fluminicola virginius*

GASTROPODS	
COMMON NAME	SCIENTIFIC NAME
Western Lahontan pyrg	***Pyrgulopsis longiglans***
White River Valley pyrg	*Pyrgulopsis sathos*
Wong's springsnail	Pyrgulopsis wongi

MOLLUSKS	
COMMON NAME	SCIENTIFIC NAME
California Floater	*Anodonta californiensis*
western pearlshell mussel*	***Margaritifera falcata***
western ridged mussel*	***Gonidea angulata***

MAMMALS	
COMMON NAME	SCIENTIFIC NAME
Allen's big-eared bat	*Idionycteris phyllotis*
Allen's chipmunk	*Neotamias senex*
American pika	*Ochotona princeps*
big free-tailed bat	***Nyctinomops macrotis***
bighorn sheep	*Ovis canadensis*
California leaf-nosed bat	*Macrotus californicus*
canyon bat	***Parastrellus hesperus***
cave myotis	*Myotis velifer*
dark kangaroo mouse	*Microdipodops megacephalus*
desert kangaroo rat	*Dipodomys deserti*
desert pocket mouse	*Chaetodipus penicillatus*
Eastgate pocket gopher	***Thomomys bottae lucrificus***
Fish Springs pocket gopher	***Thomomys bottae abstrusus***
fringed myotis	*Myotis thysanodes*
greater bonneted bat	***Eumops perotis***
hoary bat	*Lasiurus cinereus*
Humboldt yellow-pine chipmunk	*Neotamias amoenus celeris*
Humboldt's flying squirrel	*Glaucomys oregonensis*
Inyo shrew	*Sorex tenellus*
little brown myotis	*Myotis lucifugus*
long-eared myotis	*Myotis evotis*
Merriam's shrew	*Sorex merriami*
Mexican free-tailed bat	*Tadarida brasiliensis*
montane shrew	*Sorex monticolus*
mountain pocket gopher	*Thomomys monticola*
mule deer	*Odocoileus hemionus*
Pacific marten	*Martes caurina*

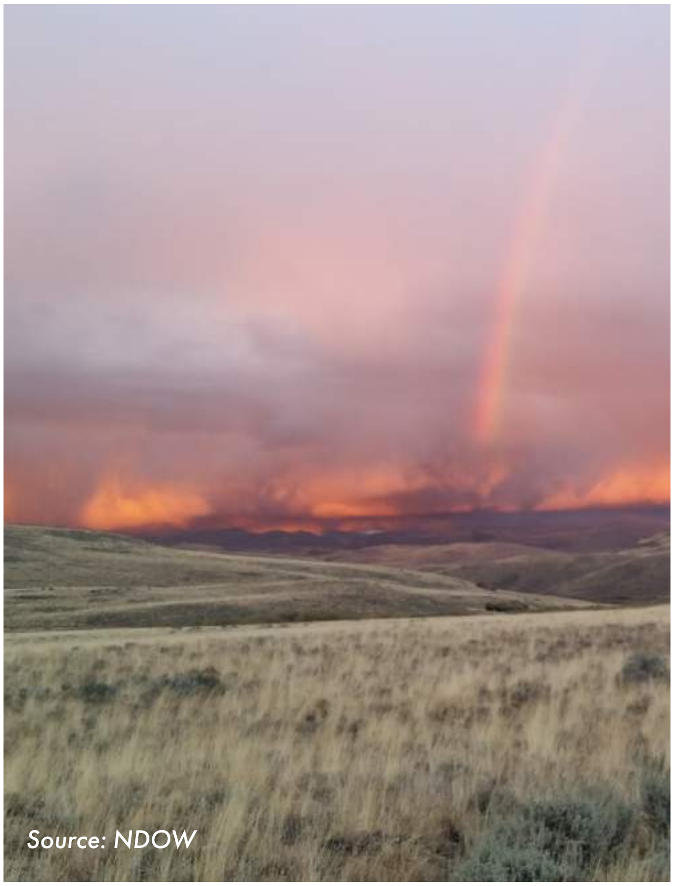
MAMMALS	
COMMON NAME	SCIENTIFIC NAME
Pahranagat Valley montane vole	*Microtus montanus fucosus*
pale kangaroo mouse	*Microdipodops pallidus*
pallid bat	***Antrozous pallidus***
Palmer's chipmunk	*Neotamias palmeri*
Panamint kangaroo rat	***Dipodomys panamintinus***
Preble's shrew	*Sorex preblei*
pygmy rabbit	*Brachylagus idahoensis*
San Antonio pocket gopher	***Thomomys bottae curtatus***
Sierra Nevada mountain beaver	Aplodontia rufa californica
Sierra Nevada snowshoe hare	Lepus americanus tahoensis
silver-haired bat	Lasionycteris noctivagans
spotted bat	Euderma maculatum
Townsend's big-eared bat	Corynorhinus townsendii
Trowbridge's shrew	***Sorex trowbridgii***
western jumping mouse	Zapus princeps
western red bat	Lasiurus blossevillii
western small-footed myotis	Myotis ciliolabrum
western water shrew	Sorex navigator
white-tailed jackrabbit	***Lepus townsendii***
Yuma myotis	***Myotis yumanensis***

REPTILES	
COMMON NAME	SCIENTIFIC NAME
common chuckwalla	*Sauromalus ater*
desert horned lizard	*Phrynosoma platyrhinos*
desert iguana	*Dipsosaurus dorsalis*
desert night lizard	*Xantusia vigilis*
desert rosy boa	*Lichanura orcutti*
Gila monster	*Heloderma suspectum*
Gilbert's skink	*Plestiodon gilberti rubricaudatus*
glossy snake	***Arizona elegans***
Great Basin collared lizard	*Crotaphytus bicinctores*
greater short-horned lizard	*Phrynosoma hernandesi*
long-tailed brush lizard	*Urosaurus graciosus*
Mojave Desert tortoise	*Gopherus agassizii*
Mojave fringe-toed lizard	***Uma scoparia***
Mojave shovel-nosed snake	*Chionactis occipitalis*
northern alligator lizard	*Elgaria coerulea*
northern rubber boa	*Charina bottae*

REPTILES	
COMMON NAME	**SCIENTIFIC NAME**
Panamint alligator lizard	*Elgaria panamintina*
Panamint rattlesnake	***Crotalus stephensi***
pygmy short-horned lizard	*Phrynosoma douglasii*
ring-necked snake	*Diadophis punctatus*
sidewinder	*Crotalus cerastes*
Sonoran mountain kingsnake	*Lampropeltis pyromelana*
western pond turtle	*Actinemys marmorata*
western skink	***Plestiodon skiltonianus***

TERRESTRIAL INVERTEBRATES		
COMMON NAME	**SCIENTIFIC NAME**	**POLLINATOR GROUP**
Ash Meadows Naucorid	*Ambrysus amargosus*	Coleoptera
a digger bee	*Anthophora mortuaria*	Hymenoptera
a digger bee	*Anthophora forbesi*	Hymenoptera
a digger bee	*Anthophora signata*	Hymenoptera
a digger bee	*Anthophora cockerelli*	Hymenoptera
a leaf cutter bee	*Megachile browni*	Hymenoptera
a leaf cutter bee	*Megachile bruneri*	Hymenoptera
a miner bee	*Perdita stephanomeriae*	Hymenoptera
a wool-carder bee	*Anthidium rodecki*	Hymenoptera
American bumble bee	*Bombus pensylvanicus*	Hymenoptera
big-headed perdita	*Perdita cephalotes*	Hymenoptera
Crotch's bumble bee	*Bombus crotchii*	Hymenoptera
Indiscriminate cuckoo bumble bee	*Bombus insularis*	Hymenoptera
Moapa perdita	*Perdita fulvescens*	Hymenoptera
Mojave gypsum bee	*Andrena balsamorhizae*	Hymenoptera
Mojave poppy bee	*Perdita meconis*	Hymenoptera
Morrison's bumble bee	*Bombus morrisoni*	Hymenoptera
red-tailed blazing star bee	*Megandrena mentzeliae*	Hymenoptera
spurge-loving perdita	*Perdita euphorbiae*	Hymenoptera
Virgin River perdita	*Perdita crotonis caerulea*	Hymenoptera
Virgin River twilight bee	*Perdita vespertina*	Hymenoptera
western bumble bee	*Bombus occidentalis*	Hymenoptera
white-shouldered bumble-bee	*Bombus appositus*	Hymenoptera
yellow bumble bee	*Bombus fervidus*	Hymenoptera
Arizona powdered-skipper	*Systasea zampa*	Lepidoptera
arrowhead blue	*Glaucopsyche piasus*	Lepidoptera
Baking Powder Flat blue	*Euphilotes bernardino minuta*	Lepidoptera
bleached sandhill skipper	*Polites sabuleti sinemaculata*	Lepidoptera
Carson Valley wood nymph	*Cercyonis pegala carsonensis*	Lepidoptera

TERRESTRIAL INVERTEBRATES		
COMMON NAME	**SCIENTIFIC NAME**	**POLLINATOR GROUP**
Carson Wandering Skipper	*Pseudocopaeodes eunus obscurus*	Lepidoptera
Checkered White	*Pontia protodice*	Lepidoptera
Common Sootywing	*Pholisora catullus*	Lepidoptera
Dotted Blue	*Euphilotes enoptes primavera*	Lepidoptera
Dotted Blue	*Euphilotes enoptes aridorum*	Lepidoptera
Eunus Skipper	*Pseudocopaeodes eunus alinea*	Lepidoptera
Eunus Skipper	*Pseudocopaeodes eunus flavus*	Lepidoptera
Golden Hairstreak	*Habrodais grunus*	Lepidoptera
Honey Lake Blue	*Euphilotes pallescens calneva*	Lepidoptera
Indra Swallowtail	*Papilio indra*	Lepidoptera
Large Marble	*Euchloe ausonides*	Lepidoptera
Lupine Blue	*Icaricia lupini*	Lepidoptera
Marine Blue	*Leptotes marina*	Lepidoptera
Mattoni's Blue	*Euphilotes pallescens mattonii*	Lepidoptera
Melissa Blue	*Plebejus melissa*	Lepidoptera
Mojave Blue	*Euphilotes mojave virginensis*	Lepidoptera
Western Monarch	*Danaus plexippus plexippus*	Lepidoptera
Mt. Charleston Blue	*Icaricia shasta charlestonensis*	Lepidoptera
Nevada Skipper	*Hesperia nevada*	Lepidoptera
Nokomis Fritillary	*Argynnis nokomis carsonensis*	Lepidoptera
Northern Crescent	*Phyciodes cocyta arenacolor*	Lepidoptera
Railroad Valley Skipper	*Hesperia uncas fulvapalla*	Lepidoptera
Rice's Blue	*Euphilotes pallescens ricei*	Lepidoptera
Ruddy Copper	*Tharsalea rubidus*	Lepidoptera
Sachem	*Atalopedes campestris*	Lepidoptera
Sand Mountain Blue	*Euphilotes pallescens arenamontana*	Lepidoptera
Sandhill Skipper	*Polites sabuleti*	Lepidoptera
Sara Orangetip	*Anthocharis sara*	Lepidoptera
Small Blue	*Philotiella speciosa septentrionalis*	Lepidoptera
Small Wood-nymph	*Cercyonis oetus alkalorum*	Lepidoptera
Small Wood-nymph	*Cercyonis oetus pallescens*	Lepidoptera
Square Dotted Blue	*Euphilotes battoides fusimaculata*	Lepidoptera
Tailed Copper	*Tharsalea arota*	Lepidoptera
Uncas Skipper	*Hesperia uncas grandiosa*	Lepidoptera
West Coast Lady	*Vanessa annabella*	Lepidoptera
Western Tailed-blue	*Cupido amyntula*	Lepidoptera
White Mountains Skipper	*Hesperia miriamae longaevicola*	Lepidoptera



Threats Impacting Nevada's Wildlife

Approach and Methods: Identifying a Comprehensive List of Threats

Threats and Conservation Actions Framework

Threats to Nevada's wildlife and habitats and conservation actions for the preservation of Nevada's Wildlife and Habitats have broadly been calculated and classified using the International Union for Conservation of Nature (IUCN) Threats Classification and Conservation Actions Classification Schemes. These tools provide a standardized global structure for assessing, discussing, and prioritizing high-level threats and conservation actions and are commonly used to inform species assessments including developing lists of SGCN (Salafsky et al., 2008; IUCN, 2022). Threats and actions used in the 2022 SWAP revision are designated under a three-level hierarchy. Level 1 threats and actions are overarching categories (described below). Level 2 threats and actions are more specific and nested within the Level 1 categories; these are described in Chapter 3 for species and Chapter 4 for key habitats. Level 3 threats are highly specific to individual habitats, and therefore are detailed and addressed within the habitat narratives of Chapter 4. Threats as addressed here and as defined under the IUCN framework may have occurred historically, may be occurring currently, or may be anticipated in the future.

For terrestrial vertebrate species, NDOW used a standardized threat calculator to help assess the scope, severity, and pervasiveness of individual threats to a species. This calculator is based on IUCN and NatureServe methodologies, with a third tier of more specific threats assessed. Direct threats (i.e., threats perceived as most consequential) are those that ranked medium to high, although some species had a suite of low-level threats that lead to concerns about cumulative impacts. The most consequential threats were then carried over to the species accounts and were used to influence the selection of IUCN-based conservation actions. The following are Level 1 IUCN threats, as described by Salafsky et al. (2008) with broad descriptions on a Level 2 tier detailing conditions in Nevada and categorical summaries of direct threats:

1. Residential and Commercial Development

Residential and Commercial Development refers to threats from human settlements or other non-agricultural land uses with a substantial footprint. Development impacts are most prevalent in Clark, Washoe, Carson City, Douglas, and Storey counties. Residential and commercial development replaces natural habitats with impervious surfaces and non-native landscaping plants and exacerbates associated stressors in the form of expanded road and power grid networks. In addition to habitat loss, fragmentation, and degradation, residential and commercial development often results in increases in local recreational activities; increases in impacts from free-roaming pets, feral animals, and human-associated species; and generally results in expanded landfill operations that all pose elevated risks to less tolerant native wildlife and associated habitat.

2. Agriculture and Aquaculture

Agriculture and Aquaculture refer to threats from farming and ranching as a result of agricultural expansion and intensification, including silviculture and aquaculture, and the impacts of any fencing around such areas. Farming impacts primarily valley habitats and generally results in the complete removal of all native vegetation and alteration of soil and groundwater systems. Ranching often extends to higher elevations along foothills and mid-elevation slopes, and activities alter vegetation communities over large areas with grazing and trampling impacts on rare and other native plants. Potential agricultural impacts can include the conversion of native systems to cropland or pasture, conversion from flood to sprinkler irrigation, grain and hay harvest, improper grazing practices, and the creation of water developments or modifications of existing springs or streams.

3. Energy Production and Mining

Energy Production and Mining refer to threats from the production and extraction of non-biological resources. Oil and gas resources are limited in Nevada but solar, geothermal, and to a lesser degree, wind energy production are increasing rapidly. Industrial-scale solar energy projects can be expansive, are sometimes sited in areas with significant impacts on wildlife, and can involve the complete removal of native vegetation and soil surface. Recent practices have been emphasizing the retention of native vegetation in southern Nevada with the ability of fauna to persist or recolonize sites. Geothermal energy plants cause local impacts and can disrupt groundwater flows that sustain rare and other native plants and aquatic wildlife that exist in nearby wetland habitats. Mining operations are highly variable in size but can be quite expansive. Mining impacts occur throughout Nevada and can result in permanent habitat loss. Many rare plants can be particularly vulnerable as they are adapted to survive on soils with high metals or other elements that are toxic to most plants. Many mines have associated settling ponds and heap leach pads with concentrated levels of toxic chemicals and elements, which can pose additional risks to wildlife beyond habitat loss and an increase in disturbance and noise generation.

4. Transportation and Service Corridors

Transportation and Service Corridors refer to threats from linear transport corridors and associated vehicles, as well as utility and service lines and pipelines. Roads, powerlines, and pipelines have direct impacts during construction and maintenance. They also increase habitat fragmentation, the risk of wildfires, the spread of invasive plants, and other human disturbance and increase waste and collision risk from vehicles and fences along roadways.

5. Biological Resource Use

Biological Resource Use refers to threats from consumptive use of biological resources including deliberate and unintentional harvesting effects of flora and fauna. Regulated hunting and various other forms of 'take' of species can have local impacts on fauna that is generally planned for and managed, but there can be unintended consequences from illegal harvest and incidental poisoning (e.g., secondary lead poisoning of predators and scavengers of dead or injured animals remaining on the landscape from hunting activities). Timber harvest in Nevada is limited in scope and well managed, although forest management strategies related to riparian systems and woodland restoration and edge treatments can have impacts on wildlife and key habitats. Some terrestrial plants are impacted by collecting and the harvest of pinyon pine nuts, cacti, and other succulents can impact habitat quality and wildlife populations.

6. Human Intrusions and Disturbance

Human Intrusions and Disturbance refers to threats from nonconsumptive human activities that may disturb, destroy, or otherwise alter habitats and wildlife. Our vast public lands are a great asset to Nevada and outdoor recreation is increasing rapidly. Many of Nevada's public lands lack adequate infrastructure to meet demands and guide users to appropriate places to minimize impacts on key habitats, wildlife, and rare plants. While most motorized and nonmotorized recreational activities can be accommodated with few lasting impacts if dispersed and done responsibly, increased concentrated usage and some niche activities (e.g., cave/mine exploration, rock climbing) can have adverse impacts on vulnerable habitats and habitat-specialist wildlife.

7. Natural Systems Modifications

Natural Systems Modifications refers to threats from the management of natural or seminatural systems, often for human benefit, that may have detrimental consequences to habitats and wildlife. The bulk of these threats experienced within Nevada relate to wildfire and fire suppression activities, surface water and groundwater manipulation and extraction, vegetation treatment/restoration projects, and abandoned mine closures. Areas experiencing high-intensity wildfires are exposed to higher rates of soil erosion, less regeneration of native species, and further establishment of invasive species. Projects to reduce fuel loads may have short-term impacts on habitat, wildlife, and rare plants but long-term intended benefits. Dams, water diversions, spring development, and groundwater extraction can contribute to stream channelization and water quality and quantity alterations, which can have profound impacts on aquatic and terrestrial wildlife and associated habitats.

8. Invasive and Other Problematic Species, Genes and Diseases

Threats can stem from nonnative and out-of-balance native plants, animals, pathogens/microbes, or the introduction of human-modified genes. Invasive plants can be found in nearly every habitat in Nevada, and their impacts include displacing native species, reducing food availability for specialized pollinators, and increasing wildfire frequency and intensity.

Nonnative plants have often been introduced or spread unintentionally and invasive species tend to thrive in disturbed areas (e.g., along roadways, in construction and grazed areas, within previously burned habitat). Historical and current intentional plant introductions (e.g., grazing forage, erosion control, landscaping) may have unintended consequences with profound habitat-altering implications. Nonnative (terrestrial and aquatic) and feral wildlife present elevated risks for native wildlife and vegetation in the form of competition for limited resources, destruction of isolated aquatic systems, displacement, and predation impacts. Native wildlife that is out of ecological balance (e.g., generally human-adapted species like the common raven) can be just as deleterious to a suite of vulnerable species as are nonnative species. Nonnative insects and diseases can be particularly impactful to wildlife and habitat since adaptive responses have often not evolved in local systems; however, even threats from native insects and diseases can be exacerbated by climate change or already stressed systems.

9. Pollution

Pollution refers to threats from point and non-point water-borne and air-borne pollutants (naturally occurring metals and elements or industrial and agricultural chemicals and nutrients) and solid waste, as well as noise and light pollution. Vegetated communities can be impacted by spills from urban, industrial, mining, and agricultural sites, and aquatic systems can be impacted and facilitate the spread of pollutants. Point or non-point source pollutants (including consumption of contaminated prey) can impact wildlife by increasing the risk of neurological or motor function alterations, impacting breeding success, and increasing susceptibility to predation or direct mortality.


Source: NDOW


Source: NDOW

Air-borne pollutants can travel great distances and impact systems through atmospheric deposition, while soot and dust cause snowpack to melt faster, leaving alpine flora and fauna exposed to cold, wind, and summer drought and impacting streamflow and aquatic or terrestrial species dependent on downstream lotic and lentic systems. Noise pollution can increase disturbance to sensitive wildlife, and light pollution can disrupt nocturnal pollinators such as moths with impacts on some rare plants.

10. Geological Events

Even though Nevada is one of the most seismically active states, earthquakes are generally not highly impactful from a habitat or wildlife perspective and volcanic events are not known in recent times. Spring-dependent wildlife and plant species may be vulnerable to local seismic shifts if aquifers are impacted or flows to seeps and springs are altered.

11. Climate Change and Severe Weather

Ongoing and often persistent threats from long-term climate changes are linked to global warming and other severe climatic or weather events outside the range of natural variation or occurring with increased frequency and intensity. Highly localized and endemic species with limited dispersal capabilities are particularly vulnerable. Most climate models predict hotter and drier weather across much of Nevada, with increased summer storm intensity. Habitat shifting, with profound implications for species and communities of flora and fauna, can occur due to increased average temperatures and alterations in precipitation type (i.e., rain vs. snow), and the amount or timing of precipitation. Altered precipitation patterns and prolonged droughts result in reduced soil saturation, perennial aquatic systems becoming ephemeral, and naturally occurring ephemeral lakes and playas losing predictable watering patterns and remaining dry for extended periods, which can have profound impacts on local flora and fauna and migratory birds reliant on stopover locations. Increased soil aridity based on higher temperatures, reduced precipitation, and increased evapotranspiration can impact vegetative communities and associated wildlife. While more localized in nature, increased intensity of storm events can increase erosion, impact vegetation, and present direct risk to less mobile wildlife or nesting birds.

Strategies for Addressing Threats to Species

Conservation actions are often designed and implemented to reduce, reverse, and mitigate the impacts of threats (direct and indirect) to SGCN and key habitats. Certain threats and impediments to ensuring the conservation of wildlife and habitat can be nearly ubiquitous and conservation benefits can be realized from broadly addressing those threats. The following is a list of universal actions that will benefit all species:

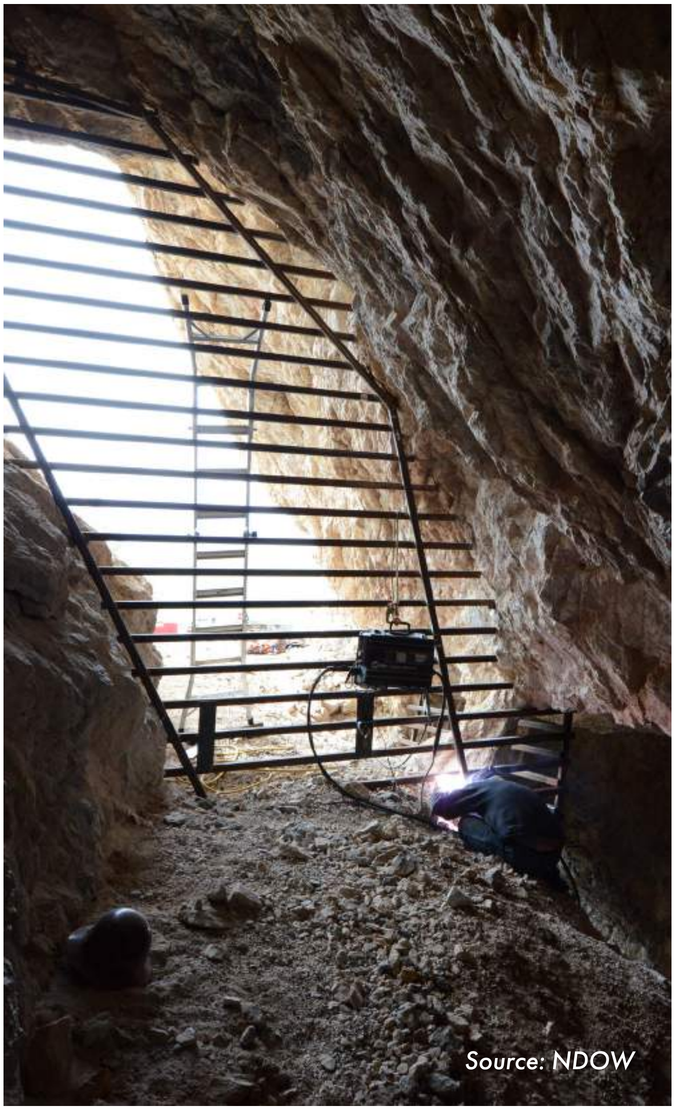
- Restore habitats and address increased fire and invasive annual grasses.
- Create resilient and resistant landscapes to address climate change, including forecasting climate change impacts on species and habitats.
- Increase technical and management training for wildlife management tools to stay on top of the latest technological advances, proper handling methodology, and latest scientific research.
- Support Conservation Easements (CE), Safe Harbor Agreements (SHA), and Candidate Conservation Agreements with Assurances (CCAA) with willing landowners and/or acquire key habitats and water rights.

- Develop and maintain centralized and accessible data and databases.
- Consistently enforce laws, regulations, and protections of SGCN.
- Connect citizens with their wildlife through broad engagement, citizen science, information delivery, education programs, watchable wildlife trails, and nature tourism.
- Utilize wildlife management areas and other state or federally protected lands for broad wildlife values and to educate and connect people with Nevada's wildlife as appropriate.
- Conduct public outreach and education regarding nonnative, problematic native, feral, and invasive aquatic species and other conservation issues affecting SGCN and their habitats.

Terrestrial and Aquatic Species Actions

Other more targeted and prescriptive conservation actions have been considered as either species-specific needs, habitat actions, or threat abatement to varying degrees. In an attempt to maintain consistency and standardization across jurisdictions and with regional states, we used the IUCN Conservation Actions Classification Scheme (Salafsky et al., 2008; IUCN, 2022), which we then linked with NDOW actions that are more detailed and directed toward project development needs (Table 7). For each terrestrial SGCN vertebrate, we then used results from the standardized threats calculator to prioritize the top three NDOW/IUCN actions (green) and 1–4 secondary actions (tan) perceived to be important for addressing those threats over the next ten years (Table 8). Actions for aquatic SGCN are more intertwined with aquatic habitat conditions and so are identified in individual species accounts and within the Key Habitat accounts (Chapter 4). Terrestrial invertebrate SGCN in Nevada have been included for the first time in 2022, and because much less is known about them, they are being treated separately below in terms of threats and associated conservation actions, developed through solicited external expert review.

Prioritized conservation actions represent current thinking on actions that will likely provide the strongest conservation benefits; however, we recognize that new information and technology will likely be available over the next ten years. To assess conservation outcomes and employ adaptive management strategies, the Department will use accepted best practices and incorporate new technology when available.



Source: NDOW

Table 7: Description of NDOW Project Actions with IUCN Conservation Action Equivalents

SPECIES ACTIONS		
NDOW ACTIONS	**DESCRIPTION**	**IUCN EQUIVALENT**
Inventory	The locations and distribution of a species are not well understood.	3.1 Species Management
Taxonomic Clarification	Lack of clarity on species/subspecies/ populations designations hampers management.	3.1 Species Management
Monitoring and population status	Long-term monitoring of a species that documents population status and trend (could be annually recurring or episodic).	3.1 Species Management
Refine Distribution Knowledge (predictive modeling)	Use modeling techniques to better predict where species may occur along with associated critical habitat variables when needed for management.	3.1 Species Management
Species Reintroduction	Actions that reintroduce species to formerly occupied habitat and/or new suitable habitat.	3.3 Species Reintroduction
ex situ Conservation	Management and protection of species in refugia or other sites outside of its native habitat.	3.4 *ex situ* Conservation
Develop restoration prescriptions and monitor effectiveness	Develop plans and restoration techniques to benefit species and improve population status.	3.2 Species Recovery 2.3 Habitat & Natural Process Restoration
HABITAT ACTIONS		
HABITAT PROTECTION		
NDOW ACTIONS	**DESCRIPTION**	**IUCN EQUIVALENT**
Maintain habitat	Maintain existing habitat for a species to increase or stabilize a species trend.	2.1 Site/area management
Legal & Acquisition/ easements/other conservation tools such as CCAAs	Acquire land, apply legal designations and protections, and/or easements to benefit conservation; utilize tools such as CCAAs as appropriate.	1.2 Resource/habitat protection
Management Actions (e.g., fencing, gating, etc.)	Specific management actions that protect species or habitats such as fencing sensitive habitat, installing bat-compatible gates on mines, flagging fencing for sage-grouse, installing and maintaining fish barriers, etc.	2.1 Site/area management

HABITAT ACTIONS		
HABITAT PROTECTION		
NDOW ACTIONS	**DESCRIPTION**	**IUCN EQUIVALENT**
Maintain connectivity (corridors, migration paths, full species lifecycle)	Maintain corridors for full connectivity including genetic connections and migration/movement pathways, as well as potential new corridors due to climate change. Manage for the full lifecycle of the species (e.g., breeding, migration, and nonbreeding grounds).	2.3 Habitat & Natural process restoration
Forestry management (e.g., maintain snags, structure/age mosaic)	Activities that maintain proper forest functioning including snag maintenance, various age classes and structure, and proper forest assemblages.	2.1 Site/area management
Water management (e.g., quality, quantity, timing, shoreline & reservoirs)	Activities that maintain or restore water quality, water quantity, water delivery, shoreline maintenance, and proper reservoir and spring function.	2.1 Site/area management
HABITAT RESTORATION		
NDOW ACTIONS	**DESCRIPTION**	**IUCN EQUIVALENT**
Post Fire Rehabilitation	Large-scale restoration efforts post-fire, specifically targeting reversing fire/annual grass cycles and/or restoring native vegetation.	2.3 Habitat & Natural process restoration
Restore degraded habitats	Restore habitats to proper functioning levels, such as spring restoration, aspen restoration, and OHV use restoration.	2.3 Habitat & Natural process restoration
Invasive, problematic, and feral species control	Engage in nonnative, problematic native, and feral species management. Increase outreach activities.	2.2 Invasive/problematic species control

THREAT ABATEMENT ACTIONS		
DISEASE		
NDOW ACTIONS	**DESCRIPTION**	**IUCN EQUIVALENT**
Proactive disease/contaminant (e.g., lead, mercury,) surveillance	Actively monitoring species/habitat for evidence of disease or contamination, e.g., chronic wasting disease checkpoints, white-nose syndrome sampling, lead and mercury analysis, etc.	3.2 Species Recovery
Disease/contaminant mitigation/management	When disease or contamination is documented, develop actions that isolate, mitigate or address concerns.	3.2 Species Recovery

THREAT ABATEMENT ACTIONS		
CLIMATE CHANGE		
NDOW ACTIONS	**DESCRIPTION**	**IUCN EQUIVALENT**
Forecast changes due to climate change	Project/forecast shifts to species/habitats due to climate change to better understand potential impacts, areas of resistance, and potential range shifts.	3.1 Species Management
DEVELOPMENT		
NDOW ACTIONS	**DESCRIPTION**	**IUCN EQUIVALENT**
Develop BMPs for some development	Develop best management plans for various development /impacts that address species/ habitat needs.	
Map areas where development is least detrimental	Map areas where species/habitat can tolerate some development or other activities to minimize impacts.	
PESTICIDES		
NDOW ACTIONS	**DESCRIPTION**	**IUCN EQUIVALENT**
Mitigate pesticide effects	Actions that minimize, mitigate, or address the effects of pesticides on species.	2.3 Habitat & Natural process restoration
GRAZING		
NDOW ACTIONS	**DESCRIPTION**	**IUCN EQUIVALENT**
Implement proper grazing	Actions that implement proper grazing methods that benefit species.	2.3 Habitat & Natural process restoration
TOXIC WATER		
NDOW ACTIONS	**DESCRIPTION**	**IUCN EQUIVALENT**
Mitigate/manage water quality (mine and agricultural runoff)	Actions that address toxic ponds, water quality, pesticides, or improper nutrient loads in water sources.	2.3 Habitat & Natural process restoration
POACHING/DIRECT TAKE		
NDOW ACTIONS	**DESCRIPTION**	**IUCN EQUIVALENT**
Strengthen regulations, penalties & law enforcement for protected species	Strengthen regulations, penalties, and law enforcement for protected species.	5.1 Legislation 5.2 Policies & Regulations 5.4 Compliance & Enforcement
OTHER		
NDOW ACTIONS	**DESCRIPTION**	**IUCN EQUIVALENT**
Acquire water rights for wildlife	Acquire water rights specifically for the management of species/habitat	1.2 Resource/habitat protection

Table 8: Priority and secondary actions for terrestrial SGCN. Actions cross reference IUCN actions with NDOW actions, with the top perceived threats provided. A more comprehensive list of direct threats can be found in individual species accounts. Green indicates a priority action and yellow indicates a secondary action.

ACTIONS

Action group	IUCN Conservation Actions	NDOW action group	NDOW Actions
Species Actions	3.1 Species Mgmt		Inventory
Species Actions	3.1 Species Mgmt		Taxonomic Clarification (spp./subsp)
Species Actions	3.1 Species Mgmt		Monitoring & Population Status
Species Actions	3.1 Species Mgmt		Refine Distribution Knowledge (predictive modeling)
Species Actions	3.3 Species Reintroduction		
Species Actions	3.4 *ex situ* Conservation		
Species Actions	3.2 Species Recovery 2.3 Habitat & Natural Process Restoration		Develop restoration prescriptions/monitor if effective
Habitat Actions	2.1 Site/area mgmt	Habitat Protection	Maintain Habitat
Habitat Actions	1.2 Resource/habitat protection	Habitat Protection	Legal & acquisition/easements
Habitat Actions	2.1 Site/area mgmt	Habitat Protection	Mgmt Action (e.g., fencing, gating, etc.)
Habitat Actions	2.3 Habitat & Natural process restoration	Habitat Protection	Maintain connectivity (Corridors, Migration, Full Life Cycle)
Habitat Actions	2.1 Site/area mgmt	Habitat Protection	Forestry Mgmt (e.g., maintain snags, structure/age mosaic)
Habitat Actions	2.1 Site/area mgmt	Habitat Protection	Water Mgmt (quality, quantity, timing, shoreline & reservoirs)
Habitat Actions	2.3 Habitat & Natural process restoration	Habitat Restoration	Post fire Rehab
Habitat Actions	2.3 Habitat & Natural process restoration	Habitat Restoration	Restore degraded habitats
Habitat Actions	2.2 Invasive/problematic species control	Habitat Restoration	
Threat Actions	3.2 Species Recovery	Disease/Contaminants	Proactive disease/contaminant (e.g., lead, mercury, PFAS) surveilliance
Threat Actions	3.2 Species Recovery	Disease/Contaminants	Disease/contaminant mitigation & mgmt
Threat Actions	3.1 Species Mgmt	Climate Change	Forecast changes due to CC
Threat Actions		Development	Develop BMPs for some development
Threat Actions		Development	Map areas where development less impactful
Threat Actions	2.3 Habitat & Natural process restoration	Pesticide	Mitigate pesticide effects
Threat Actions	2.3 Habitat & Natural process restoration	Grazing	Implement proper grazing
Threat Actions	2.3 Habitat & Natural process restoration	Toxic Water	Mitigate/Manage water quality (mines, AG runoff)
Threat Actions	5.1 Legislation 5.2 Policies & Regulations 5.4 Compliance & Enforcement	Poaching/Direct Take	Strengthen Regulations, Penalties & LE Enforcement for Protected Species
Other	1.2 (resource/habitat protection)		Acquire Water Rights for Wildlife

2022 Vertebrate SGCN List

Common Name	Scientific Name	Type	Species Type	Top Threats
American Avocet	*Recurvirostra americana*	shorebird	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 9. Pollution
American Kestrel	*Falco sparverius*	raptor	Bird	8. Invasive & Other Problematic Species & Genes; 7. Natural Systems Modifications; 11. Climate Change & Severe Weather; 5. Biological Resource Use; 2. Improper Agriculture & Aquaculture
American White Pelican	*Pelecanus erythrorhynchos*	water bird	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 9. Pollution; 6. Human Intrusions & Disturbance
Arizona Bell's Vireo	*Vireo bellii arizonae*	passerine, etc.	Bird	7. Natural System Modification; 8. Invasive & Other Problematic Species & Genes; 1. Residential & Commercial Development; 2. Improper Agriculture & Aquaculture
Bald Eagle	*Haliaeetus leucocephalus*	raptor	Bird	7. Natural System Modifications; 4. Transportation & Service Corridors; 5. Biological Resource Use
Band-tailed Pigeon	*Patagioenas fasciata*	migratory	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather
Bank Swallow	*Riparia riparia*	passerine, etc.	Bird	7. Natural System Modifications; 3. Energy Production & Mining; 4. Transportation & Service Corridors; 9. Pollution (pesticides)
Bendire's Thrasher	*Toxostoma bendirei*	passerine, etc.	Bird	1. Residential & Commercial Development; 3. Energy Production & Mining; 7. Natural Systems Modification; 8. Invasive & Other Problematic Species & Genes.
Black Rosy-Finch	*Leucosticte atrata*	passerine, etc.	Bird	7. Natural Systems Modifications; 11. Climate Change & Severe Weather
Black Tern	*Chlidonias niger*	water bird	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 9. Pollution; 2. Improper Agriculture & Aquaculture
Black-backed Woodpecker	*Picoides arcticus*	passerine, etc.	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather
Black-chinned Sparrow	*Spizella atrogularis*	passerine, etc.	Bird	8. Invasive & Other Problematic Species & Genes; 7. Natural Systems Modifications; 11. Climate Change
Black-necked Stilt	*Himantopus mexicanus*	shorebird	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 9. Pollution
Black-throated Gray Warbler	*Setophaga nigrescens*	passerine, etc.	Bird	7. Natural System Modifications; 8. Invasive & Other Problematic Species & Genes;
Bobolink	*Dolichonyx oryzivorus*	passerine, etc.	Bird	2. Improper Agriculture & Aquaculture; 7. Natural System Modifications
Brewer's Sparrow	*Spizella breweri*	passerine, etc.	Bird	7. Natural System Modifications; 8. Invasive & Problematic Species & Genes; 3. Energy Production & Mining; 2. Improper Agriculture & Aquaculture
California Spotted Owl	*Strix occidentalis occidentalis*	owl	Bird	5. Biological Resource Use; 7. Natural System Modification; 8. Invasive & Other Problematic Species & Genes; 11. Climate Change & Severe Weather
Canvasback	*Aythya valisineria*	migratory	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 9. Pollution
Cassin's Finch	*Haemorhous cassinii*	passerine, etc.	Bird	7. Natural System Modifications; 5. Biological Resource Use; 8. Invasive & Other Problematic Species & Genes; 11. Climate Change & Severe Weather
Cinnamon Teal	*Spatula cyanoptera*	migratory	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 9. Pollution
Clark's Nutcracker	*Nucifraga columbiana*	passerine, etc.	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 5. Biological Resource Use; 8. invasive & Other Problematic Species & Genes
Columbian Sharp-tailed Grouse	*Tympanuchus phasianellus columbianu*	upland game	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 8. Invasive and Other Problematic Species & Genes; 2. Agriculture & Aquaculture
Common Nighthawk	*Chordeiles minor*	passerine, etc.	Bird	9. Pollution; 4. Transportation; 1. Residential and Commercial Development
Costa's Hummingbird	*Calypte costae*	passerine, etc.	Bird	1. Residential & Commercial Development; 3. Energy Production & Mining; 7. Natural System Modifications
Crissal Thrasher	*Toxostoma crissale*	passerine, etc.	Bird	3. Energy Production & Mining; 8. Invasive & Other Problematic Species & Genes; 1. Residential & Commercial Development 7. Natural System Modifications
Dusky Flycatcher	*Empidonax oberholseri*	passerine, etc.	Bird	7. Natural System Modifications; 2. Improper Agriculture & Aquaculture; 5. Biological Resource Use
Dusky Grouse	*Dendragapus obscurus*	upland game	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 8. Invasive and Other Problematic Species & Genes; 2. Agriculture & Aquaculture
Ferruginous Hawk	*Buteo regalis*	raptor	Bird	7. Natural System Modifications; 8. Invasive & Problematic Species & Genes; 11. Climate Change & Severe Weather; 4. Transportation & service Corridors; 5. Biological Resource Use
Flammulated Owl	*Psiloscops flammeolus*	owl	Bird	5. Biological Resource Use; 7. Natural System Modification; 11. Climate Change & Severe Weather
Gambel's Quail	*Callipepla gambelii*	upland game	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 8. Invasive and Other Problematic Species & Genes
Gilded Flicker	*Colaptes chrysoides*	passerine, etc.	Bird	7. Natural System Modifications; 3. Energy Production & Mining; 1. Residential & Commercial Development

2022 Vertebrate SGCN List				Top Threats	ACTIONS																									
					Species Actions							Habitat Actions									Threat Actions									Other
IUCN Conservation Actions					3.1 Species Mgmt	3.1 Species Mgmt	3.1 Species Mgmt	3.1 Species Mgmt	3.3 Species Reintroduction	3.4 *ex situ* Conservation	3.2 Species Recovery 2.3 Habitat & Natural Process Restoration	2.1 Site/area mgmt	1.2 Resource/habitat protection	2.1 Site/area mgmt	2.3 Habitat & Natural process restoration	2.1 Site/area mgmt	2.1 Site/area mgmt	2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	2.2 Invasive/problematic species control	3.2 Species Recovery	3.2 Species Recovery	3.1 Species Mgmt			2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	5.1 Legislation 5.2 Policies & Regulations 5.4 Compliance & Enforcement	1.2 (resource/habitat protection)
												Habitat Protection						Habitat Restoration			Disease/Contaminants		Climate Change	Development	Development	Pesticide	Grazing	Toxic Water	Poaching/Direct Take	
NDOW Actions					Inventory	Taxonomic Clarification (spp./subsp)	Monitoring & Population Status	Refine Distribution Knowledge (predictive modeling)			Develop restoration prescriptions/monitor if effective	Maintain Habitat	Legal & acquisition/easements	Mgmt Action (e.g., fencing, gating, etc.)	Maintain connectivity (Corridors, Migration, Full Life Cycle)	Forestry Mgmt (e.g., maintain snags, structure/age mosaic)	Water Mgmt (quality, quantity, timing, shoreline & reservoirs)	Post fire Rehab	Restore degraded habitats		Proactive disease/contaminant (e.g., lead, mercury, PFAS) surveilliance	Disease/contaminant mitigation & mgmt	Forecast changes due to CC	Develop BMPs for some development	Map areas where development less impactful	Mitigate pesticide effects	Implement proper grazing	Mitigate/Manage water quality (mines, AG runoff)	Strengthen Regulations, Penalties & LE Enforcement for Protected Species	Acquire Water Rights for Wildlife
Golden Eagle	*Aquila chrysaetos*	raptor	Bird	11. Climate Change & Severe Weather; 8. Invasive & Problematic Species & Genes; 7. Natural System Modifications; 5. Biological Resource Use; 4. Transportation & Service Corridors																										
Grace's Warbler	*Setophaga graciae*	passerine, etc.	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 5. Biological Resource Use																										
Gray Vireo	*Vireo vicinior*	passerine, etc.	Bird	7. Natural System Modifications; 8. Invasive & Other Problematic Species & Genes; 11. Climate Change & Severe Weather																										
Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*	passerine, etc.	Bird	11. Climate Change & Severe Weather; 7. Natural Systems Modificaiton;																										
Great Basin Willow Flycatcher	*Empidonax traillii adastus*	passerine, etc.	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 5. Biological Resource Use																										
Greater Sage Grouse	*Centrocercus urophasianus*	upland game	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 8. Invasive and Other Problematic Species & Genes; 2. Agriculture & Aquaculture; 3. Energy Production & Mining																										
Hermit Warbler	*Setophaga occidentalis*	passerine, etc.	Bird	5. Biological Resource Use; 7. Natural System Modifiations; 8. Invasive & Other Problematic Species & Genes; 11. Climate Change & Severe Weather																										
Least Bittern	*Ixobrychus exilis*	water bird	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 9. Pollution; 2. Improper Agriculture & Aquaculture																										
LeConte's Thrasher	*Toxostoma lecontei*	passerine, etc.	Bird	1. Residential & Commercial Development; 3. Energy Production and Mining; 7. Natural System Modification; 8. Invasive & Other Problematic Species & Genes.																										
Lewis's Woodpecker	*Melanerpes lewis*	passerine, etc.	Bird	5. Biological Resource Use; 7. Natural System Modifications; 11. Climate Change & Severe Weather																										
Lincoln's Sparrow	*Melospiza lincolnii*	passerine, etc.	Bird	7. Natural System Modifications; 8. Invasive & Other Problematic Species & Genes; 11. Climate Change & Severe Weather																										
Loggerhead Shrike	*Lanius ludovicianus*	passerine, etc.	Bird	7. Natural System Modifications; 8. Invasive & Problematic Species & Genes; 3. Energy Production & Mining; 2. Improper Agriculture & Aquaculture																										
Long-billed Curlew	*Numenius americanus*	shorebird	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 9. Pollution; 2. Improper Agriculture & Aquaculture																										
Long-billed Dowitcher	*Limnodromus scolopaceus*	shorebird	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 9. Pollution																										
Long-eared Owl	*Asio otus*	owl	Bird	5. Biological Resource Use; 7. Natural System Modification; 11. Climate Change & Severe Weather																										
Lucy's Warbler	*Leiothlypis luciae*	passerine, etc.	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 1. Residential & Commercial Development																										
Mountain Quail	*Oreortyx pictus*	upland game	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 8. Invasive and Other Problematic Species & Genes; 2. Agriculture & Aquaculture																										
Northern Goshawk	*Accipiter gentilis*	raptor	Bird	11. Climate Change & Severe Weather; 2. Improper Agriculture & Aquaculture; 7. Natural System Modifications; 3. Energy Production & Mining																										
Northern Pintail	*Anas acuta*	migratory	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 9. Pollution																										
Northern Pygmy-Owl	*Glaucidium gnoma*	owl	Bird	5. Biological Resource Use; 7. Natural System Modification; 11. Climate Change & Severe Weather																										
Olive-sided Flycatcher	*Contopus cooperi*	passerine, etc.	Bird	7. Natural Systems Modification; 5. Biological Resource Use																										
Peregrine Falcon	*Falco peregrinus*	raptor	Bird	6. Human Intrusion & Disturbance; 9. Pollution; 4. Transportation & Service Corridors; 3. Energy Production & Mining																										
Pinyon Jay	*Gymnorhinus cyanocephalus*	passerine, etc.	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 8. Invasive & Other Problematic Species & Genes																										
Prairie Falcon	*Falco mexicanus*	raptor	Bird	4. Transportation & Service Corridors; 5. Biological Resource Use; 6. Human Intrusions & Disturbance; 3. Energy Production & Mining																										
Sage Thrasher	*Oreoscoptes montanus*	passerine, etc.	Bird	7. Natural System Modifications; 8. Invasive & Other Problematic Species & Genes; 2. Improper Agriculture and Aquaculture; 3. Energy Production & Mining																										
Sagebrush Sparrow	*Artemisiospiza nevadensis*	passerine, etc.	Bird	7. Natural System Modifications; 8. Invasive & Other Problematic Species & Genes; 2. Improper Agriculture and Aquaculture; 3. Energy Production & Mining.																										
Scott's Oriole	*Icterus parisorum*	passerine, etc.	Bird	1. Residential & Commercial Development; 3. Energy Production & Mining; 7. Natural Systems Modification																										
Short-eared Owl	*Asio flammeus*	owl	Bird	2. Improper Agriculture & Aquaculture; 5. Biological Resource Use; 11. Climate Change & Severe Weather																										
Sierra Nevada Mountain Willow Flycatcher	*Empidonax traillii brewsteri*	passerine, etc.	Bird	1. Residential & Commercial Development; 5. Biological Resource Use; 7. Natural Systems Modifications; 11: Climate Change & Severe Weather																										

2022 Vertebrate SGCN List				Top Threats	ACTIONS																									
					Species Actions							Habitat Actions									Threat Actions									Other
IUCN Conservation Actions					3.1 Species Mgmt	3.1 Species Mgmt	3.1 Species Mgmt	3.1 Species Mgmt	3.3 Species Reintroduction	3.4 *ex situ* Conservation	3.2 Species Recovery 2.3 Habitat & Natural Process Restoration	2.1 Site/area mgmt	1.2 Resource/habitat protection	2.1 Site/area mgmt	2.3 Habitat & Natural process restoration	2.1 Site/area mgmt	2.1 Site/area mgmt	2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	2.2 Invasive/problematic species control	3.2 Species Recovery	3.2 Species Recovery	3.1 Species Mgmt			2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	5.1 Legislation 5.2 Policies & Regulations 5.4 Compliance & Enforcement	1.2 (resource/habitat protection)
												Habitat Protection						Habitat Restoration			Disease/Contaminants		Climate Change	Development	Development	Pesticide	Grazing	Toxic Water	Poaching/Direct Take	
NDOW Actions					Inventory	Taxonomic Clarification (spp./subsp)	Monitoring & Population Status	Refine Distribution Knowledge (predictive modeling)			Develop restoration prescriptions/monit or if effective	Maintain Habitat	Legal & acquisition/easements	Mgmt Action (e.g., fencing, gating, etc.)	Maintain connectivity (Corridors, Migration, Full Life Cycle)	Forestry Mgmt (e.g., maintain snags, structure/age mosaic)	Water Mgmt (quality, quantity, timing, shoreline & reservoirs)	Post fire Rehab	Restore degraded habitats		Proactive disease/contaminant (e.g., lead, mercury, PFAS) surveilliance	Disease/contaminant mitigation & mgmt	Forecast changes due to CC	Develop BMPs for some development	Map areas where development less impactful	Mitigate pesticide effects	Implement proper grazing	Mitigate/Manage water quality (mines, AG runoff)	Strengthen Regulations, Penalties & LE Enforcement for Protected Species	Acquire Water Rights for Wildlife
Sooty Grouse	*Dendragapus fuliginosus*	upland game	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 8. Invasive and Other Problematic Species & Genes																										
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	passerine, etc.	Bird	8. Invasive & Other Problematic Species & Genes; 7. Natural Systems Modifications; 6. Human Intrusion & Disturbance; 11. Climate Change & Severe Weather																										
Swainson's Hawk	*Buteo swainsoni*	raptor	Bird	2. Improper Agriculture & Aquaculture; 5. Biological Resources Use; 4. Transportation & Service Corridors																										
Tricolored Blackbird	*Agelaius tricolor*	passerine, etc.	Bird	2. Improper Agriculture & Aquaculture; 7. Natural System Modifications; 1. Residential & Commercial Development																										
Trumpeter Swan	*Cygnus buccinator*	migratory	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 9. Pollution																										
Virginia's Warbler	*Leiothlypis virginiae*	passerine, etc.	Bird	7. Natural System Modifications; 8. Invasive & Other Problematic Species & Genes; 11. Climate Change & Severe Weather																										
Western Burrowing Owl	*Athene cunicularia hypugaea*	owl	Bird	1. Residential & Commerical Development; 3. Energy Production & Mining; 5. Biological Resource Use																										
Western Snowy Plover	*Charadrius nivosus*	shorebird	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 9. Pollution																										
White-faced Ibis	*Plegadis chihi*	water bird	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 9. Pollution; 2. Improper Agriculture & Aquaculture																										
White-headed Woodpecker	*Dryobates albolarvatus*	passerine, etc.	Bird	5. Biological Resource Use; 7. Natural System Modifications; 11. Climate Change & Severe Weather																										
White-throated Swift	*Aeronautes saxatilis*	passerine,	Bird	3. Energy Production & Mining; 9. Pollution																										
Williamson's Sapsucker	*Sphyrapicus thyroideus*	passerine, etc.	Bird	5. Biolgoical Resource Use; 7. Natural System Modification; 11. Climate Change & Severe Weather																										
Wilson's Phalarope	*Phalaropus tricolor*	shorebird	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 9. Pollution																										
Yellow-billed Cuckoo	*Coccyzus americanus occidentalis*	passerine, etc.	Bird	7. Natural Systems Modifications; 11. Climate Change & Severe Weather																										
Yuma Ridgway's Rail	*Rallus obsoletus yumanensis*	water bird	Bird	7. Natural System Modifications; 11. Climate Change & Severe Weather; 9. Pollution; 1. Residential & Commercial Development																										
Allen's Big-eared Bat	*Idionycteris phyllotis*	bat	Mammal	5. Biological Resource Use; 7. Natural System Modifications; 6. Human Instrusion & Disturbance																										
Allen's chipmunk	*Neotamias senex*	small mammal	Mammal	7. Natural System Modifications; 11. Climate Change & Severe Weather; 5. Biological Resource Use																										
American Pika	*Ochotona princeps*	small mammal	Mammal	11. Climate Change & Severe Weather; 12. Crucial data gaps in unknown population status and inadequate restoration tools/methods; 8. Problematic Native Species (low dispersal)																										
Big-Free-tailed Bat	*Nyctinomops macrotis*	bat	Mammal	6. Human Intrusion & Disturbance; 9. Pollution; 3. Energy Production & Mining																										
Bighorn Sheep	*Ovis canadensis*	big game	Mammal	8. Invasive & Other Problematic Species & Genes; 7. Natural System Modifications; 11. Climate Change & Severe Weather																										
California Leaf-nosed Bat	*Macrotus californicus*	bat	Mammal	3. Energy Production and Mining; 6. Human Intrusions and Disturbance; 12. Crucial Data Gaps.																										
Canyon Bat	*Parastrellus hesperus*	bat	Mammal	11. Climate Change & Severe Weather; 6. Human Disturbance & Instrusion; 7. Natural Systems Modifications																										
Cave Myotis	*Myotis velifer*	bat	Mammal	7. Natural Systems Modifications; 11. Climate Change & Severe Weather; 6. Human Disturbance & Intrusion																										
Dark Kangaroo Mouse	*Microdipodops megacephalus*	small mammal	Mammal	3. Energy Production & Mining; 8. Invasive & other Problematic Species & Genes. 11. Climate Change & Severe Weather; 6. Human Intrusions & Disturbance																										
Desert Kangaroo Rat	*Dipodomys deserti*	small mammal	Mammal	11. Climate Change & Severe Weather; 3. Energy Production & Mining; 8. Invasive & Other Problematic Species & Genes																										
desert pocket mouse	*Chaetodipus penicillatus*	small mammal	Mammal	11. Climate Change & Severe Weather; 3. Energy Production & Mining; 8. Invasive & Other Problematic Species & Genes																										
Eastgate Pocket Gopher	*Thomomys bottae lucrificus*	small mammal	Mammal	8. Invasive & Problematic Species & Genes; 2. Improper Agriculture & Aquaculture; 5. Biological Resource Use																										
Fish Springs Pocket Gopher	*Thomomys bottae abstrusus*	small mammal	Mammal	8. Invasive & Problematic Species & Genes; 2. Improper Agriculture & Aquaculture; 5. Biological Resource Use																										
Fringed Myotis	*Myotis thysanodes*	bat	Mammal	11. Climate Change & Severe Weather; 6. Human Disturbance & Instrusion; 8. Invasive & Other Problematic Species & Genes; 7. Natural Systems Modifications; 9. Pollution																										
Greater Bonneted Bat	*Eumops perotis*	bat	Mammal	7. Natural System Modifications; 11. Climate Change & Severe Weather; 9. Pollution																										
Hoary Bat	*Lasiurus cinereus*	bat	Mammal	3. Energy Production & Mining; 7. Natural System Modifications; 5. Biological Resource Use; 11. Climate Change & Severe Weather																										
Humboldt yellow-pine chipmunk	*Neotamias amoenus celeris*	small mammal	Mammal	8. Invasive & Problematic Species & Genes (isolated endemic); 11. Climate Change & Severe Weather; 7. Natural System Modifications																										
Humboldt's Flying Squirrel	*Glaucomys oregonensis*	small mammal	Mammal	5. Biological Resources Use; 7. Natural System Modifications; 8. Invasive & Problematic Species & Genes; 11. Climate Change & Severe Weather; 1. Residential & Commercial Development																										

2022 Vertebrate SGCN List				Top Threats	ACTIONS																									
					Species Actions							Habitat Actions									Threat Actions									Other
IUCN Conservation Actions					3.1 Species Mgmt	3.1 Species Mgmt	3.1 Species Mgmt	3.1 Species Mgmt	3.3 Species Reintroduction	3.4 *ex situ* Conservation	3.2 Species Recovery 2.3 Habitat & Natural Process Restoration	2.1 Site/area mgmt	1.2 Resource/habitat protection	2.1 Site/area mgmt	2.3 Habitat & Natural process restoration	2.1 Site/area mgmt	2.1 Site/area mgmt	2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	2.2 Invasive/problematic species control	3.2 Species Recovery	3.2 Species Recovery	3.1 Species Mgmt			2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	5.1 Legislation 5.2 Policies & Regulations 5.4 Compliance & Enforcement	1.2 (resource/habitat protection)
												Habitat Protection						Habitat Restoration			Disease/Contaminants		Climate Change	Development	Development	Pesticide	Grazing	Toxic Water	Poaching/Direct Take	
NDOW Actions					Inventory	Taxonomic Clarification (spp./subsp)	Monitoring & Population Status	Refine Distribution Knowledge (predictive modeling)			Develop restoration prescriptions/monitor if effective	Maintain Habitat	Legal & acquisition/easements	Mgmt Action (e.g., fencing, gating, etc.)	Maintain connectivity (Corridors, Migration, Full Life Cycle)	Forestry Mgmt (e.g., maintain snags, structure/age mosaic)	Water Mgmt (quality, quantity, timing, shoreline & reservoirs)	Post fire Rehab	Restore degraded habitats		Proactive disease/contaminant (e.g., lead, mercury, PFAS) surveilliance	Disease/contaminant mitigation & mgmt	Forecast changes due to CC	Develop BMPs for some development	Map areas where development less impactful	Mitigate pesticide effects	Implement proper grazing	Mitigate/Manage water quality (mines, AG runoff)	Strengthen Regulations, Penalties & LE Enforcement for Protected Species	Acquire Water Rights for Wildlife
Inyo shrew	*Sorex tenellus*	small mammal	Mammal	11. Climate Change & Severe Weather; 7. Natural Systems Modification; 2. Improper Agriculture & Aquaculture; 3. Energy Production & Mining																										
Little Brown Myotis	*Myotis lucifugus*	bat	Mammal	11. Climate Change & Severe Weather; 8. Invasive & Problematic Species & Genes; 3. Energy Production & Mining; 6. Human Intrusion & Distrubance 7. Natural System Modifications																										
Long-eared Myotis	*Myotis evotis*	bat	Mammal	11. Climate Change & Severe Weather; 8. Invasive & Problematic Species & Genes; 7. Natural System Modifications; 5. Biological Resource Use																										
Merriam's shrew	*Sorex merriami*	small mammal	Mammal	11. Climate Change & Severe Weather; 7. Natural Systems Modification; 2. Improper Agriculture & Aquaculture; 3. Energy Production & Mining																										
Mexican Free-tailed Bat	*Tadarida brasiliensis*	bat	Mammal	6. Human Intrusion & Disturbance; 7. Natural System Modifications; 9. Pollution; 3. Energy Production & Mining																										
montane shrew	*Sorex monticolus*	small mammal	Mammal	11. Climate Change & Severe Weather; 7. Natural Systems Modification; 2. Improper Agriculture & Aquaculture; 5. Biological Resource Use; 3. Energy Production & Mining																										
Mountain Pocket Gopher	*Thomomys monticola*	small mammal	Mammal	7. Natural System Modifications; 11. Climate Change & Severe Weather; 5. Biological Resource Use																										
Mule Deer	*Odocoileus hemionus*	big game	Mammal	7. Natural System Modifications; 8. Invasive and Other Problematic Species & Genes; 11. Climate Change & Severe Weather; 2. Agriculture & Aquaculture																										
Pacific Marten	*Martes caurina*	mammal other	Mammal	7. Natural System Modifications; 11. Climate Change & Severe Weather; 5. Biological Resource Use; 1. Residential & Commercial Development																										
Pahranagat Valley Montane Vole	*Microtus montanus fucosus*	small mammal	Mammal	11. Climate Change & Severe Weather; 2. Improper Agriculture & Aquaculture; 7. Natural System Modifications																										
Pale Kangaroo Mouse	*Microdipodops pallidus*	small mammal	Mammal	3. Energy Production & Mining; 8. Invasive & other Problematic Species & Genes. 11. Climate Change & Severe Weather; 6. Human Intrusions & Disturbance																										
Pallid Bat	*Antrozous pallidus*	bat	Mammal	7. Natural System Modifications; 6. Human Intrusion & Disturbance; 3. Energy Production & Mining																										
Palmer's Chipmunk	*Neotamias palmeri*	small mammal	Mammal	7. Natural System Modifications; 8. Invasive & Problematic Species & Genes (isolated, endemic); 11. Climate Change & Severe Weather																										
Panamint Kangaroo Rat	*Dipodomys panamintinus*	small mammal	Mammal	7. Natural System Modifications; 11. Climate Change & Severe Weather; 3. Energy Production & Mining; 6. Human Intrusion & Disturbance																										
Preble's Shrew	*Sorex preblei*	small mammal	Mammal	11. Climate Change & Severe Weather; 7. Natural Systems Modification; 2. Improper Agriculture & Aquaculture; 3. Energy Production & Mining																										
Pygmy Rabbit	*Brachylagus idahoensis*	upland game	Mammal	7. Natural System Modifications; 11. Climate Change & Severe Weather; 8. Invasive and Other Problematic Species & Genes; 2. Agriculture & Aquaculture																										
San Antonio Pocket Gopher	*Thomomys bottae curtatus*	small mammal	Mammal	8. Invasive & Problematic Species & Genes; 2. Improper Agriculture & Aquaculture; 5. Biological Resource Use																										
Sierra Nevada Mountain Beaver	*Aplodontia rufa californica*	mammal other	Mammal	1. Residential & Commercial Development; 11. Climate Change & Severe Weather; 7. Natural System Modifications; 6. Human Intrusion & Disturbance																										
Sierra Nevada Snowshoe Hare	*Lepus americanus tahoensis*	mammal other	Mammal	7. Natural System Modifications; 11. Climate Change & Severe Weather; 5. Biological Resource Use; 1. Residential & Commercial Development																										
Silver-haired Bat	*Lasionycteris noctivagans*	bat	Mammal	11. Climate Change & Severe Weather; 7. Natural System Modifications; 9. Pollution; 3. Energy Production & Mining; 5. Biological Resource Use																										
Spotted Bat	*Euderma maculatum*	bat	Mammal	11. Climate Change & Severe Weather; 9. Pollution; 6. Human Intrusion & Disturbance																										
Townsend's Big-eared Bat	*Corynorhinus townsendii*	bat	Mammal	6. Human Intrusion & Disturbance: 9. Pollution; 7. Natural System Modifications; 8. Invasive & Problematic Species & Genes																										
Trowbridge's Shrew	*Sorex trowbridgii*	small mammal	Mammal	11. Climate Change & Severe Weather; 7. Natural Systems Modification; 2. Improper Agriculture & Aquaculture; 3. Energy Production & Mining																										
Western Jumping Mouse	*Zapus princeps*	small mammal	Mammal	11. Climate Change & Severe Weather; 8. Invasive & Problematic Species & Genes; 7. Natural System Modifications; 2. Improper Agriculture & Aquaculture																										
Western Red Bat	*Lasiurus blossevillii*	bat	Mammal	5. Biological Resource Use; 7. Natural System Modifications; 11. Climate Change & Severe Weather																										
Western Small-footed Myotis	*Myotis ciliolabrum*	bat	Mammal	11. Climate Change & Severe Weather; 8. Invasive & Problematic Species & Genes; 3. Energy Production & Mining; 6. Human Intrusion & Distrubance 7. Natural System Modifications																										
western water shrew	*Sorex navigator*	small mammal	Mammal	11. Climate Change & Severe Weather; 2. Improper Agriculture & Aquaculture; 7. Natural System Modifications																										
White-tailed Jackrabbit	*Lepus townsendii*	upland game	Mammal	11. Climate Change & Severe Weather; 8. Invasive & Other Problematic Species & Genes; 7. Natural System Modifications																										

2022 Vertebrate SGCN List				Top Threats	ACTIONS																									
					Species Actions							Habitat Actions									Threat Actions									Other
IUCN Conservation Actions					3.1 Species Mgmt	3.1 Species Mgmt	3.1 Species Mgmt	3.1 Species Mgmt	3.3 Species Reintroduction	3.4 *ex situ* Conservation	3.2 Species Recovery 2.3 Habitat & Natural Process Restoration	2.1 Site/area mgmt	1.2 Resource/habitat protection	2.1 Site/area mgmt	2.3 Habitat & Natural process restoration	2.1 Site/area mgmt	2.1 Site/area mgmt	2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	2.2 Invasive/problematic species control	3.2 Species Recovery	3.2 Species Recovery	3.1 Species Mgmt			2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	2.3 Habitat & Natural process restoration	5.1 Legislation 5.2 Policies & Regulations 5.4 Compliance & Enforcement	1.2 (resource/habitat protection)
												Habitat Protection						Habitat Restoration			Disease/Contaminants		Climate Change	Development	Development	Pesticide	Grazing	Toxic Water	Poaching/Direct Take	
NDOW Actions					Inventory	Taxonomic Clarification (spp./subsp)	Monitoring & Population Status	Refine Distribution Knowledge (predictive modeling)			Develop restoration prescriptions/monit or if effective	Maintain Habitat	Legal & acquisition/easements	Mgmt Action (e.g., fencing, gating, etc.)	Maintain connectivity (Corridors, Migration, Full Life Cycle)	Forestry Mgmt (e.g., maintain snags, structure/age mosaic)	Water Mgmt (quality, quantity, timing, shoreline & reservoirs)	Post fire Rehab	Restore degraded habitats		Proactive disease/contaminant (e.g., lead, mercury, PFAS) surveilliance	Disease/contaminant mitigation & mgmt	Forecast changes due to CC	Develop BMPs for some development	Map areas where development less impactful	Mitigate pesticide effects	Implement proper grazing	Mitigate/Manage water quality (mines, AG runoff)	Strengthen Regulations, Penalties & LE Enforcement for Protected Species	Acquire Water Rights for Wildlife
Yuma Myotis	*Myotis yumanensis*	bat	Mammal	11. Climate Change & Severe Weather; 9. Pollution; 8. Invasive & Problematic Species & Genes; 7. Natural System Modifications; 6. Human Intrusions & Disturbance																										
Common Chuckwalla	*Sauromalus ater*	reptile	Reptile	5. Biological Resource Use; 1. Residential & Commercial Development; 7. Natural System Modifications																										
Desert Horned Lizard	*Phrynosoma platyrhinos*	reptile	Reptile	7. Natural System Modifications; 8. Invasive & Problematic Species & Genes; 3. Energy Production & Mining; 5. Biological Resource Use																										
Desert Iguana	*Dipsosaurus dorsalis*	reptile	Reptile	1. Residential & Commercial Development; 3. Energy Production & Mining; 5. Biological Resource Use; 6. Human Intrusion & Disturbance																										
desert night lizard	*Xantusia vigilis*	reptile	Reptile	1. Residential & Commercial Development; 3. Energy Production & Mining; 11. Climate Change & Severe Weather; 6. Human Intrusions & Disturbance																										
Desert Rosy Boa	*Lichanura orcutti*	reptile	Reptile	8. Invasive & Problematic Species & Genes (isolated populations); 5. Biological Resource Use; 11. Climate Change & Severe Weather																										
Gila Monster	*Heloderma suspectum*	reptile	Reptile	1. Residential & Commercial Development; 6. Human Intrusions & Disturbance; 8. Invasive & Problematic Species & Genes; 5. Biological Resource Use																										
Gilbert's skink	*Plestiodon gilberti rubricaudatus*	reptile	Reptile	11. Climate Change & Severe Weather; 8. Invasive & Problematic Species & Genes; 7. Natural System Modifications																										
Glossy Snake	*Arizona elegans*	reptile	Reptile	1. Residential & Commercial Development; 3. Energy Production & Mining; 6. Human Intrusions & Disturbance; 11. Climate Change & Severe Weather																										
Great Basin Collared Lizard	*Crotaphytus bicinctores*	reptile	Reptile	7. Natural System Modifications; 8. Invasive & Problematic Species & Genes; 3. Energy Production & Mining; 5. Biological Resource Use																										
greater short-horned lizard	*Phrynosoma hernandesi*	reptile	Reptile	8. Invasive & Problematic Species & Genes; 7. Natural System Modifications; 5. Biological Resource Use; 3. Energy Production & Mining																										
long-tailed brush lizard	*Urosaurus graciosus*	reptile	Reptile	3. Energy Production & Mining; 6. Human Intrusions & Disturbance; 1. Residential & Commercial Development; 7. Natural System Modifications																										
Mojave Desert Tortoise	*Gopherus agassizii*	reptile	Reptile	3. Energy Production & Mining; 6. Human Intrusions & Disturbance; 1. Residential & Commercial Development; 8. Invasive & Problematic Species & Genes; 7. Natural System Modifications; 11. Climate Change & Severe Weather																										
Mojave fringe-toed lizard	*Uma scoparia*	reptile	Reptile	6. Human Intrusion & Disturbance; 8. Invasive & Other Problematic Species & Genes (isolated populations); 11. Climate Change & Severe Weather; 3. Energy Production & Mining; 1. Residential & Commercial Development																										
Mojave shovel-nosed snake	*Chionactis occipitalis*	reptile	Reptile	1. Residential & Commercial Development; 3. Energy Production & Mining; 6. Human Intrusions & Disturbance; 11. Climate Change & Severe Weather; 5. Biological Resource Use																										
Northern Alligator Lizard	*Elgaria coerulea*	reptile	Reptile	11. Climate Change & Severe Weather; 8. Invasive & Problematic Species & Genes (isolated populations); 7. Natural System Modifications																										
Northern Rubber Boa	*Charina bottae*	reptile	Reptile	11. Climate Change & Severe Weather; 7. Natural System Modifications; Improper Agriculture & Aquaculture																										
Panamint Alligator Lizard	*Elgaria panamintina*	reptile	Reptile	11. Climate Change & Severe Weather; 7. Natural System Modifications; 2. Improper Agriculture & Aquaculture																										
Panamint rattlesnake	*Crotalus stephensi*	reptile	Reptile	1. Residential & Commercial Development; 5. Biological Resource Use; 6. Human Intrusion & Disturbance; 7. Natural System Modifications																										
pygmy short-horned lizard	*Phrynosoma douglasii*	reptile	Reptile	7. Natural System Modifications; 11. Climate Change & Severe Weather; 6. Human Intrusions & Disturbance; 5. Biological Resource Use																										
ring-necked snake	*Diadophis punctatus*	reptile	Reptile	11. Climate Change & Severe Weather; 7. Natural System Modifications																										
Sidewinder	*Crotalus cerastes*	reptile	Reptile	8. Invasive & Problematic Species & Genes; 7. Natural System Modifications; 5. Biological Resource Use; 3. Energy Production & Mining																										
Sonoran Mountain Kingsnake	*Lampropeltis pyromelana*	reptile	Reptile	11. Climate Change & Severe Weather; 7. Natural System Modifications; 5. Biological Resource Use																										
western pond turtle	*Actinemys marmorata*	reptile	Reptile	2. Improper Agriculture & Aquaculture; 1. Residential & Commercial Development; 7. Natural System Modifications; 8. Invasive & Problematic Species & Genes; 11. Climate Change & Severe Weather																										
Western Skink	*Eumeces skiltonianus*	reptile	Reptile	11. Climate Change & Severe Weather; 8. Invasive & Problematic Species & Genes; 7. Natural System Modifications; 5. Biological Resource Use; 3. Energy Production & Mining																										


Source: NDOW


Source: NDOW

A Note on Climate Change

Climate change is a significant threat to wildlife and their associated habitat. Many SGCN are particularly vulnerable due to life history characteristics that limit their ability to adapt and adjust, such as low dispersal capabilities, occurrence in disjunct populations separated by unsuitable habitats, or reliance on narrow and highly specific biological niches (e.g., narrow temperature tolerance). The 2022 SWAP largely addresses climate change concerns through actions directed at habitats rather than species, although certain species accounts identify species-specific actions. The 2012 SWAP included a climate change vulnerability assessment (CCVI score) of all SGCN. This assessment used a tool developed by NatureServe that is no longer functional. However, while the CCVI scores were not updated for this revision, the 2012 results are reported in each species account and are still viewed as relevant assessments for conservation. New to the 2022 SWAP are select habitat climate change vulnerability assessments in Chapter 4 and Appendix D.

Climate change is a concern from a broad, regional perspective, and several partners have developed or are developing tools that can be used in conjunction with the 2022 SWAP. For example, The Intermountain West Joint Venture recently released a Resilient Landscapes Resource List (IJWV, 2022). Additionally, The Nature Conservancy is developing a climate change corridor assessment using key species to identify areas that should be conserved as opportunities for species to migrate due to climate change. Finally, updated guidance from the Association of Fish and Wildlife Agencies (AFWA, 2022 draft) for incorporating climate change into management plans will help guide future conservation actions in addition to already prioritized actions.

Terrestrial Invertebrates

Global insect extinctions are occurring due to habitat loss, degradation, and fragmentation; use of polluting and harmful substances; the spread of invasive species; global climate change; pesticide exposure; direct overexploitation; and co-extinction of species dependent on other species (Cardoso et al., 2020).

Invertebrates are a key component of Nevada's landscapes, serving as native plant and crop pollinators; as prey for countless fish, amphibian, reptile, bird, and mammal species; and as herbivore communities in natural ecosystems. Protecting invertebrate communities is crucial to the support of other SGCN and key habitats across the state. In addition, communities of terrestrial invertebrates endemic to sand dunes, cold and warm water springs, and alkaline grasslands are crucial components of these isolated habitats along with endemic plant, aquatic invertebrate, and vertebrate species. These insect communities are similarly vulnerable to localized habitat destruction or disturbances including intense recreational use, pesticide application, energy development projects, hydrologic changes, drought, and overgrazing.

There is a lack of knowledge about many critical questions on distribution, species composition, habitat requirements, and demographics for most terrestrial invertebrate species. Ways to begin addressing these knowledge gaps may include greater use of community science programs to catalog species; increased funding for taxonomy, inventories, and related studies; and the creation of standardized protocols for inventorying and monitoring (Cardoso et al., 2011). Although we know insect declines and extinctions are occurring worldwide, we cannot fully understand what is happening in Nevada without baseline data on what species occur here (taxonomy), where they occur (inventories), and how they are doing (conservation status ranking).

In describing the need for statewide conservation of imperiled invertebrates, we recognize that many groups of invertebrates are known to be declining, including beetles, dragonflies, and other insect groups (Ball-Damerow et al., 2014; Harris et al., 2019; Wagner et al., 2021). This chapter, and the invertebrate taxa included as SGCN, focus on bees (*Hymenoptera: Apoidea*) and butterflies (*Lepidoptera: Rhopalocera*). This is partly in recognition of their diversity in Nevada, with roughly 210 species and many endemic subspecies of butterflies, and with over 800 species of bees. In addition, these taxa often have the most recent information on population trends, habitat requirements, and documented threats compared to other insect groups. Future work may include additional insect groups or specific taxa that warrant conservation attention.

Regulatory Setting

State regulatory authority over native, terrestrial invertebrates is limited in Nevada. NDOW does not have management authority over terrestrial invertebrates. The Nevada Department of Agriculture has statutory authority over some insects, but this is limited to pest species and the importation of insects into the state. NDNH maintains data and status information on many invertebrates but does not have formal statutory authority to manage and regulate insects.

Species of Greatest Conservation Need: Ecology and Conservation

Bee Ecology

Nevada has high bee species diversity, with over 800 species recorded in the state, including members of all six bee families found within the U.S. Within the Nevada bee fauna, there are solitary, eusocial, and social parasitic bees, and threats and conservation needs differ for these groups. Eusocial bees and social parasites (*Bombus spp.*) are at higher risk of pathogen spillover from commercially managed bees. Many solitary bees, especially those in arid regions, exhibit a variety of voltinism adaptations (number of broods or generations per year often in response to environmental variables), and can also delay their emergence for years to hedge their bets against catastrophic losses in very dry years. This makes it challenging to assess bee population stability within any one year.

Habitat diversity and basin and range topography have contributed to high levels of endemism within Nevada bees. Many of these endemics show high levels of dietary specialization. Some species of bees collect pollen from only one or a few closely related plant species. Narrow plant phenological windows and unpredictable rainfall results in short flight periods for adult bees or delayed emergence. Nest substrate specialization can further limit the suitable habitat for bees. Although many ground-nesting bees are less vulnerable to wildfire than their cavity-nesting counterparts, ground disturbance from activities such as off-road vehicle use and agricultural practices can destroy underground nests.

Several habitat types appear to be especially important for bees in Nevada. Some of the most vulnerable habitats include sand dunes for taxa *Anthophora mortuaria, Anthidium rodecki, Perdita crotonis caerulea,* and *Perdita vespertina;* creosote- (*Larrea tridentata*) dominated basins and associated Mojave Desert habitat for taxa including *Megandrena mentzeliae, Perdita meconis*, and *Perdita cephalotes*; and higher elevation grasslands and meadows for taxa including *Bombus fervidus, Bombus appositus*, and *Bombus occidentalis*.

Butterfly Ecology

Nevada has a high diversity of butterflies, with over 210 resident species in the state. In addition, the habitat diversity, basin and range topography, and past climatological changes in the state have resulted in high levels of subspecific endemism for butterflies, especially for butterflies in the Lycaenidae and Hesperiidae families in the White Mountains, Wassuck Range, Toiyabe Range, Independence Mountains, Ruby Mountains, Spring Mountains, and Snake Range, as well as in Reese River Valley and Big Smoky Valley (Austin & Murphy, 1987). Most of these subspecies are moderate to extreme larval specialists, feeding on only one or a few closely related plant species for each population. Finally, plant phenology and precipitation patterns often result in narrow flight windows for adult butterflies that are dependent on the emergence and growth of their caterpillar food plants and local floral resources.

Several habitat types appear to be especially important for butterfly populations in Nevada. Some of the most vulnerable habitats include sand dunes for butterflies including *Euphilotes pallescens arenamontana* and *E. p. calneva*; springs and seeps for taxa including *Argynnis nokomis carsonensis, A. n. apacheana*, and *Cercyonis oetus pallescens*; alkaline saltgrass for *Pseudocopaeodes eunus flavus* and *P. e. obscurus*; valley riparian areas for taxa including *Hesperia uncas grandiosa, H. u. reeseorum, P.*

sabuleti basinensis, and *Limenitis archippus lahontoni*; and slopes of lower elevation canyons for taxa including *Euphilotes ellisii basinensis*, *E. enoptes aridorum*, and *Philotiella speciosa septentionalis*.

Distribution, Abundance, and Trends

Several lepidopterists have surveyed Nevada and documented the distributions of butterfly species across the state. Several groups of butterflies appear to have high levels of subspecific diversity, including *Cercyonis oetus, Cercyonis pegala, Polites sabuleti*, and several species in the *Lycaenidae* family, while other species are notably absent (Emmel & Emmel, 1971; Shields, 1975; Austin & Austin, 1980; Austin & Murphy, 1987; Austin, 1987; Austin, 1992). However, knowledge of pollinator population trends in Nevada is scarce compared to those for most vertebrate species. The Nevada Butterfly Monitoring Network, a partner with the North American Butterfly Monitoring Network, has been collecting data on butterfly populations in the northwest Nevada region since 2015, and the North American Butterfly Association has had an annual 4th of July Count in the Toiyabe Range since 2021. In addition to these locations, U.S. Fish & Wildlife Service biologists monitor populations of the federally endangered Carson wandering skipper (*Pseudocopaeodes eunus obscurus*) and Mount Charleston blue butterfly (*Icaricia shasta charlestonensis*). Finally, NDNH maintains data and tracks the status of imperiled species, including butterflies, and recent reports on selected taxa on the NDNH Watch and Track lists are available from the organization.

While the locations of many endemic butterfly subspecies are known, much less is known about the distribution of native bees in Nevada, and many parts of the state remain relatively unexplored. Few, if any, regional inventories exist on the bee diversity of particular mountain ranges or valleys. Knowledge of species distributions is largely focused on vulnerable habitats such as sand dunes. However, bee diversity is likely high, even in urban areas and urban edges; a 2021 pollinator survey of the Steamboat buckwheat, *Eriogonum ovalifolium var. williamsae,* found 12 distinct morphospecies of bees (Kevin Burls, pers. comm.).

Key Habitat Location and Condition

As discussed in the ecology sections above, the high levels of habitat specificity and resulting endemism for bees and butterflies result in several “hotspot” regions of bee and butterfly diversity. In particular, many species of plants and animals are endemic to inland sand dune regions due to their unique soil, temperature, and disturbance characteristics, along with large distances between dunes (Bowers, 1982). Alkaline saltgrass habitats are a second habitat type that shares edaphic and abiotic traits distinct from nearby areas, and these regions are also home to a number of endemic flying insect populations. Low elevation riparian areas, including the Humboldt and Reese Rivers, appear to harbor significant numbers of endemic butterfly species and also create corridors that extend ranges of some species, such as the viceroy butterfly (*Limenitis archippus*) along the Humboldt River or Lorquin’s admiral butterfly (*Limenitis loquini*) along the Walker River. Finally, many species of pollinators, including solitary bees and members of the *Lycaenidae* butterfly family, appear to thrive in low-elevation canyons that are dominated by shrubs in both the Great Basin and Mojave Desert, including in the edges of the Carson Range, Wassuck Range, Pilot Mountains, Toiyabe Mountains, and Spring Mountains.

Threats and Research Needs

Insect populations are subjected to numerous threats (Wagner et al., 2021), including:

- Habitat loss, alteration, fragmentation, and degradation from development, agriculture, and recreational use
- Climate change, especially warmer temperatures in the autumn, prolonged drought, and extreme weather events
- Pesticide use
- Introduced/invasive species, including both plants and insect species
- Lack of current population information
- Infectious disease
- Overgrazing

Threats have been documented for many endemic butterfly subspecies by NDNH. Threats are less well researched for many of the widespread species that are now known to be in decline across large portions of their range (Forister et al., 2021; Forister et al., 2022).

Because of the limited information available for both butterfly and bee population trends across Nevada, research needs for imperiled species are largely similar. For most taxa included in the SGCN, the highest priority actions include:

- Surveys & status assessments
- Habitat quality assessments in vulnerable habitats
- Protection of vulnerable habitats and host plant populations

Conservation Actions, Expected Outcomes, Adaptive Management

Actions to address SGCN invertebrates fall into four broad categories:

- Increase knowledge of distribution and status of rare terrestrial invertebrates.
- Conserve, protect and restore sensitive habitats that contain multiple at-risk invertebrate species.
- Establish a rare invertebrate program in Nevada to enhance the conservation of rare insects and other terrestrial invertebrates in the state.
- Increase outreach, educational information, and other communication about rare terrestrial invertebrates in Nevada.

Increase Nevada data on rare terrestrial invertebrates

Increasing our knowledge and data on species is a top priority because there is such variety in Nevada's invertebrate assemblage, and because there is a significant gap in knowledge of the distribution and population status of most species. There are a variety of ways to address this need, including, but not limited to:

- Gather data on priority species from a variety of sources including but not limited to museum specimens, consultant survey data, university researchers, and land management agencies.
- Develop a checklist of terrestrial invertebrates that are known to occur in Nevada that includes current taxonomy. Crosswalk the checklist with the NDNH's Biotics database to ensure all known terrestrial invertebrates are listed in the database. This will provide a starting point for Conservation Status Rank assessments.
- Conduct baseline surveys in high-priority areas for occurrences of priority species and enter data into appropriate database(s).
- Conduct updated surveys for "historical" species' locations and species with little known data.

- Establish and implement a monitoring program to assess population status and threats to inform conservation status rank (i.e., S-rank) assessments.
- Conduct Conservation Status Rank assessments using NatureServe methodology within the NDNH Biotics database.

Conserve, protect and restore sensitive habitats that contain multiple at-risk invertebrate species

Invertebrates are often tightly tied to very restricted habitat types. Conservation of habitats, including host plants and other ecological requirements of invertebrates, is a priority and can positively impact many invertebrate populations.

- Identify habitats with multiple imperiled species, both vertebrate and invertebrate (e.g., Ash Meadows, Spring Mountains, Wassuck Range), and document them in a centralized location or database.
- Identify habitats vulnerable to disturbance or to local species or host plant extirpation (e.g., north valleys of Reno, Reese River Valley, Big Smoky Valley, etc.) and document them in a centralized location or database.
- Identify habitats that are the only known location for at-risk invertebrate taxa (e.g., Reese River for *Cercyonis oetus alkalorum* or the Sweetwater Mountains for *Thorybes nevada blanca*) and document them in a centralized location or database.
- Collaborate with state and federal agencies, non-governmental organizations, Tribes, and other landowners to manage sensitive habitats for imperiled invertebrate species through habitat restoration and conservation actions.

Establish a rare invertebrate program in Nevada to enhance the conservation of rare insects and other terrestrial invertebrates in the state.

Management authority for invertebrates is limited in Nevada. Furthermore, several entities have some authority, maintain information, or are otherwise engaged in invertebrate conservation. Working collaboratively and implementing strategic actions across the spectrum of state and federal agencies, non-governmental organizations, and private groups will enhance conservation efforts.

- Determine the most appropriate place to house a rare invertebrate program in Nevada (e.g., NDNH, UNR, UNLV, NDOW).
- Staff the rare invertebrate program with qualified entomologists who can carry out the objectives and actions of this plan, and establish a representative governance structure to include state and federal agencies and others with an interest and ability to conduct conservation actions for invertebrates.
- Work collaboratively across entities to establish priorities for the rare invertebrate program, annual actions and goals, and reporting metrics for conservation outcomes.

Increase communication and education about rare terrestrial invertebrates in Nevada

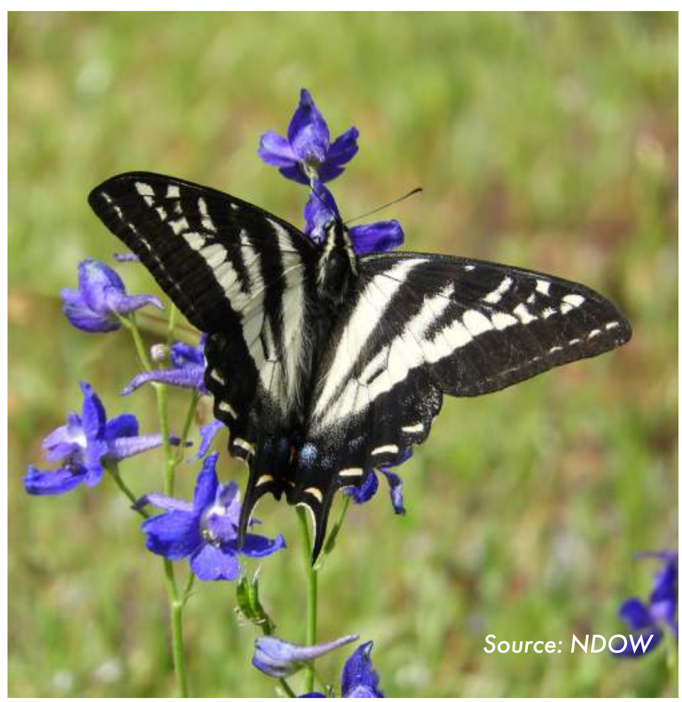
As with all SGCN conservation, increasing knowledge and shared stewardship of rare invertebrates by the public will enhance conservation outcomes. Many citizen science programs already exist for species such as national monarch butterfly efforts and local bio-blitz opportunities. In addition, many conservation programs, including establishing backyard habitats and urban gardens, can have significant benefits for bees and butterflies. Using tools such as iNaturalist to engage with the public, providing education on how to create pollinator-friendly habitats, and using pollinators as a mechanism to connect the public to nature are examples of communication and education programs that can improve conservation outcomes.

- Collaborate with other state agencies, federal agencies, Tribes, universities, non-profit groups, ranchers and growers, and other organizations and individuals.
- Through the Invertebrate Program, establish a communications working group to develop and distribute frequent communication and awareness about conservation efforts.
- Give presentations about Nevada's rare terrestrial invertebrates (public, professional meetings, schools, ranching and farming conferences, etc.) to increase education opportunities and awareness of the importance of these species.
- Create rare insect-related curricula for schools, outdoor education camps, etc.
- Develop community science opportunities to spread awareness and gather data (bio blitzes, etc.).

Central to these actions is the need to partner and collaborate with state and federal agencies, non-governmental organizations, tribes, and other private interest groups and individuals. In addition, several management plans and guidelines from partners are available and should be incorporated into strategic actions, such as the Western Monarch Conservation Strategy. Finally, utilizing a variety of tools such as Candidate Conservation Agreements with Assurances (CCAAs) can greatly benefit invertebrate conservation. For example, The Nevada Department of Transportation (NDOT) is participating in the Nationwide CCAA for the Monarch Butterfly. This CCAA brings together more than 40 organizations from across the energy and transportation sectors to implement conservation actions collectively and voluntarily in rights of ways that improve conservation outcomes for monarch butterflies.

Select Resources and Strategies for Terrestrial Pollinators

- Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators, link
- Managing for Pollinators on Public Lands, Department of the Interior Pollinator Protection Plan
- Department of the Interior, National Seed Strategy
- Western Association of Fish and Wildlife Agencies Western Monarch Conservation Plan 2019-2069
- Nevada Department of Agriculture, Nevada Managed Pollinator Protection Plan
- Xerces Pollinator Conservation Resources: Mountain Region, link



Source: NDOW

Chapter 4

Key Habitats of Nevada

Source: NDOW

Defining Nevada's Landscape for Wildlife

Habitat as defined within the Nevada State Wildlife Action Plan (SWAP) falls within two concepts: wildlife-species-specific habitat and broad habitat classifications based on terrestrial vegetation or aquatic characteristics. Key habitats fall within the second category, and the Nevada Department of Wildlife (NDOW) most often applies conservation practices at this conceptual scale. While Nevada contains many different habitats across the State, including urban areas, agricultural areas, and others, this plan focuses on 20 key habitats to address in detail. These 20 key habitats were classified for the SWAP, and several of the habitats are described together due to their spatial extents across the landscape. A description of how these key habitats were delineated can be found in Appendix C.

This chapter consists of an overview of the terrestrial and aquatic key habitats found in Nevada with discussions on how these habitats were defined including location, extent, and relative condition(s) of each habitat, threats influencing key habitats across the state, research priorities, and conservation actions. Unique discussions on specific threats, current conditions, potential climate influences, and biophysical settings can be found within each habitat description.

Defining the Location and Relative Condition of Nevada's Key Habitats

Terrestrial Habitats

Terrestrial Key Habitats discussed in this SWAP include:

- Aspen Woodland
- Desert Grasslands

- High Elevation Sagebrush Dominated Shrublands
- Low Elevation Sagebrush Dominated Shrubland
- Lower Montane Woodlands and Chaparral
- Montane Shrublands
- Mojave Mid-Elevation Mixed Desert Scrub
- Mojave Warm Desert
- Pinyon-Juniper Woodland
- Riparian and Wetland
- Salt Desert Shrub
- Upper Montane Coniferous Forest and Woodland
- Other Critical Habitats including:
    - Alpine and Tundra
    - Playas and Ephemeral Pools
    - Sand Dunes and Badlands
    - Cliffs and Canyons
    - Caves and Mines

These habitats represent the major habitat types supporting terrestrial Species of Greatest Conservation Need (SGCN) in Nevada and differ from the 2012 SWAP (Appendix C). These key habitats are based on the Biophysical Settings (BpS) concept from Landfire to provide a baseline reference for evaluating current and potential future vegetation assemblages (Landfire, 2020). BpS concepts were based on the NatureServe terrestrial ecological systems classification, which defined types as recurring plant communities found together on landscapes that share common landscape settings and natural disturbance regimes (Comer et al., 2003). Terrestrial habitat types and the associated vegetation descriptions as derived from biophysical settings, while imperfect and idealized, allow for a cohesive discussion of terrestrial habitats. The underlying biophysical settings that have been aggregated here into each key habitat are briefly discussed in the individual sections.

Biophysical settings are based on quantitative state-and-transition models that have been developed with the input and review of multiple specialists across fields. Biophysical settings models represent vegetation that may have been dominant on the landscape pre-Euro-American settlement and provide associated reference condition baselines that can be compared against current conditions to evaluate estimated habitat status within the State (Blankenship et al., 2021; Swaty et al., 2022).

Reference condition data are unique to each biophysical setting and are defined for "succession classes" associated with states as defined by the models. These states correspond with development stages based on vegetation cover, structure, and age (Blankenship et al., 2021). Succession class data from Landfire provide current biophysical-level estimates for succession class distribution and may also be used to estimate the amount of each key habitat that has been converted to uncharacteristic vegetation conditions, urbanized areas, agricultural areas, and barren or sparse conditions. Biophysical setting reference condition distributions within each key habitat are compared here to Landfire succession class data to estimate departure from the baseline condition as well as to estimate overall vegetation departure from the reference condition for each key habitat (Swaty et al., 2022).

Represented within Nevada are 97 unique biophysical settings, including perennial ice/snow, barren-rock/sand/clay, and open water, (Appendix A). Approximately 3,281,597 of Nevada's approximately 70,759,181 acres (as calculated from Landfire raster sets) fall within the perennial ice/snow, barren-rock/sand/clay, and open water biophysical settings.

NEVADA KEY HABITATS

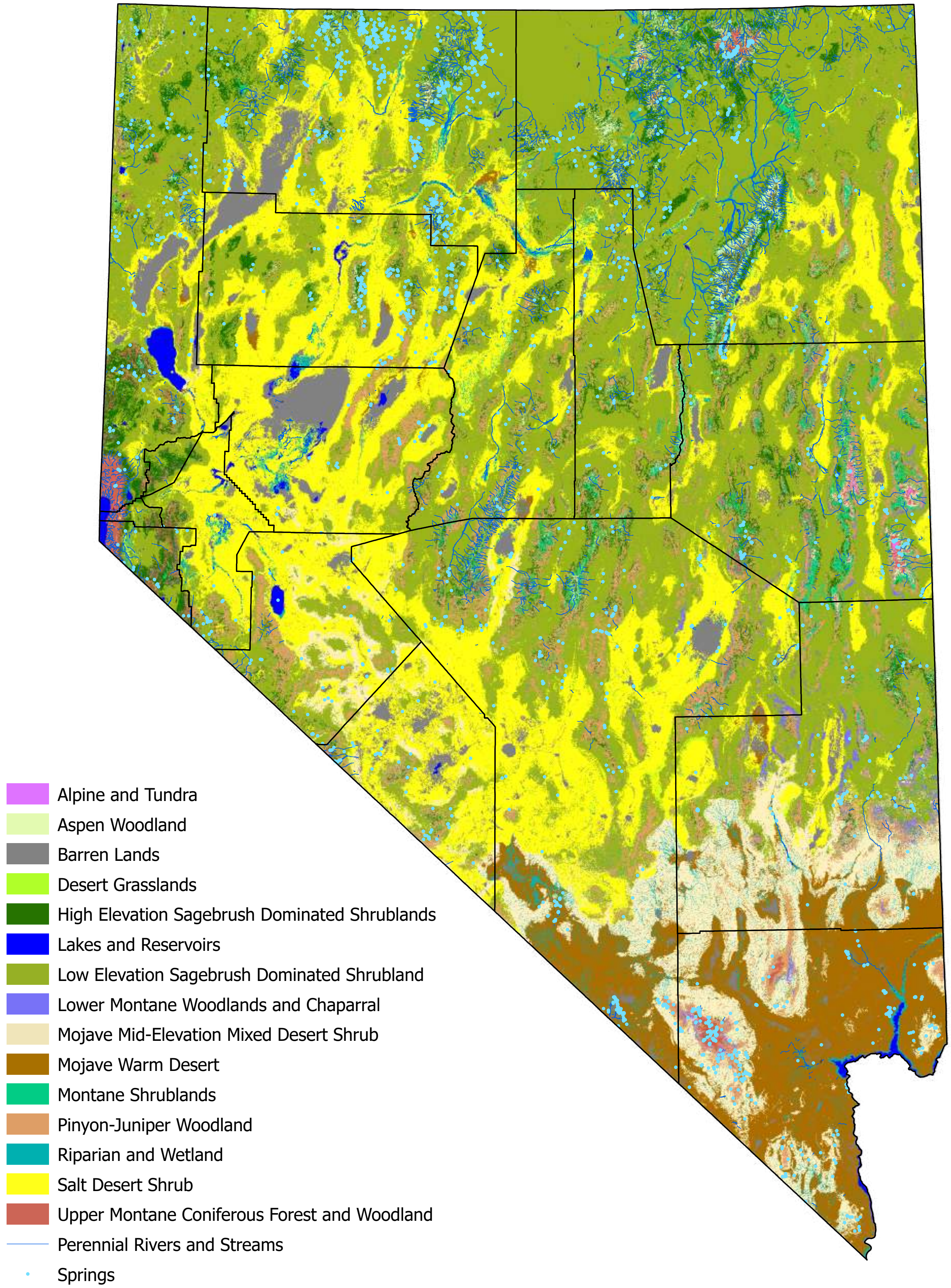


Figure 6. Nevada's Key Habitats. Please note, cave and mines are not displayed.

The remaining approximately 67,477,584 acres are represented by vegetated biophysical settings and associated state-and-transition models, current succession class data, and reference conditions which have been used to assess the relative condition of key habitats containing these settings (Appendix C).

Aquatic Habitats

Across Nevada, aquatic systems play a critical part in maintaining species biodiversity and ecologic function. Three key aquatic habitats are discussed in the SWAP including:

- Lakes and Reservoirs
- Perennial Rivers and Streams
- Springs

Perennial Rivers and Streams occurring across Nevada are based on the National Hydrography Dataset Flowlines product (NHD), while springs have broadly been mapped based on data from the Springs Stewardship Institute (USGS, 2022; Springs Stewardship Institute, 2021). Lakes and Reservoirs have been mapped using Landfire data to avoid masking issues/conflicts with terrestrial habitat mapping.

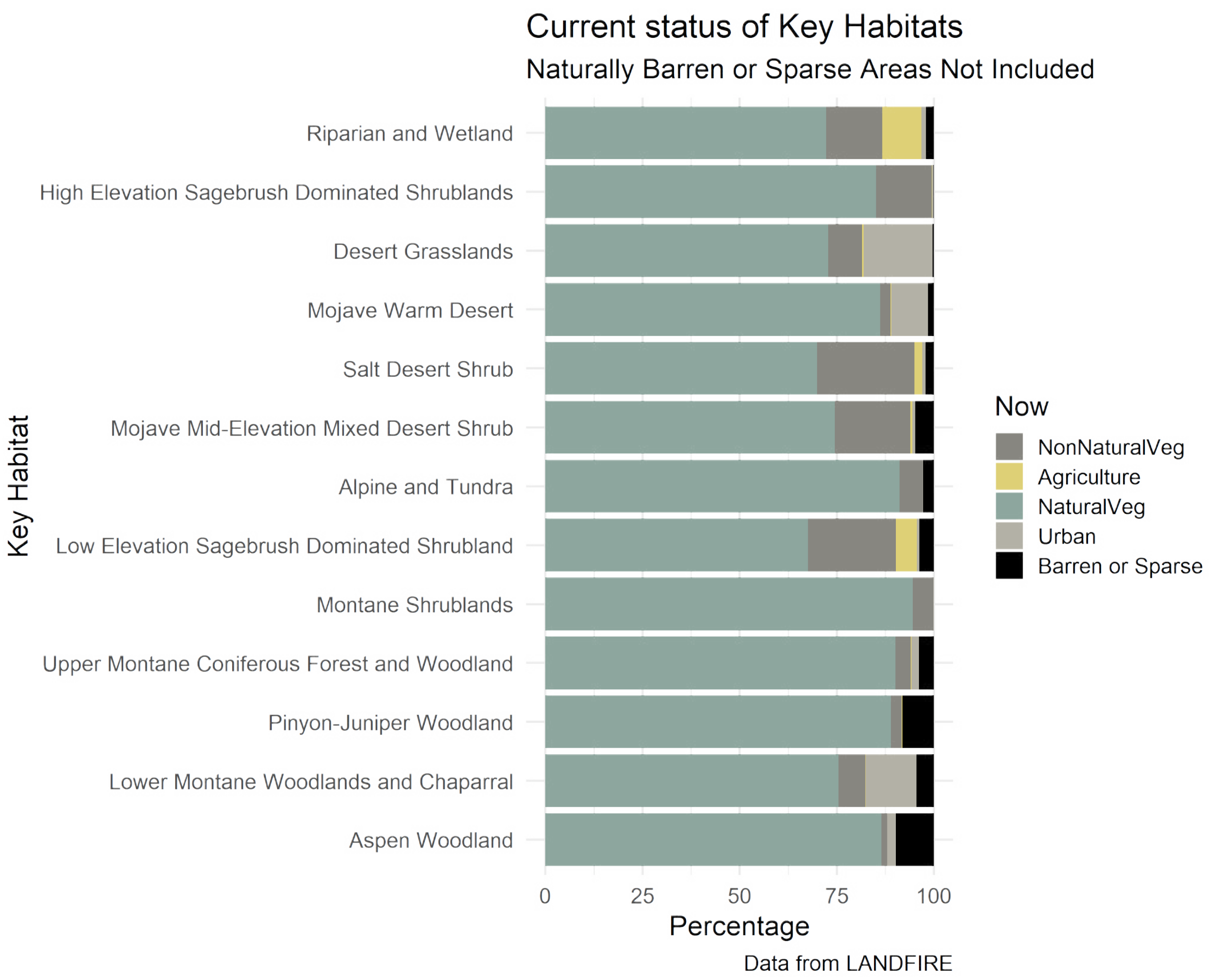


Figure 7. Percent of Nevada key habitats converted from historic BpS state-and-transition simulation reference condition to non-natural vegetation, agricultural, barren or sparse, or urban land covers.


Source: NDOW


Source: NDOW

The aquatic framework for the SWAP was defined by ecological drainage units which are aggregations of NHD twelfth level Hydrologic Unit Codes (HUC 12). This refines the aquatic habitats to a more focused, smaller scale and is more representative of the management of the species found within these environments.

Overview of Current Conditions/ Status

Nevada is the most arid state in the nation, and many aquatic habitats have been significantly influenced by anthropogenic needs for agriculture and livestock production, municipal uses, mining, and other development. Few of these habitats have remained in their natural conditions. Significant resources are devoted to the protection, enhancement, and restoration of these habitats to improve ecologic function and use by wildlife species for their life cycle needs.

Terrestrial habitats are often influenced by similar uses across the landscape but are also significantly affected by other factors such as wildfire and conversion.

Additional datasets relevant to specific habitats that can inform the condition and trend of vegetation communities will be addressed in relevant key habitat sections. Specific methodologies for delineating key habitat locations and relative conditions are outlined in Appendix C.

Overall Threats to Nevada's Key Habitats and Management Strategies

Each key habitat in Nevada faces unique threats, is prioritized differently for landscape management, and is managed by one or more federal or state agencies with differing jurisdictions and authorities. As such, threats and management strategies are closely coordinated among agencies to address the different habitat needs across Nevada. With differing resource and land management agency missions and priorities, it is important to identify the threats that most impact each habitat and develop effective mechanisms for addressing those threats.

The following is a list of the habitat threats previously identified in the NDOW Habitat Division Strategic Habitat Framework document but is not fully comprehensive (NDOW, 2019). Descriptions of threats specific to individual key habitats can be found in the key habitat descriptions in this chapter and include, but are not limited to:

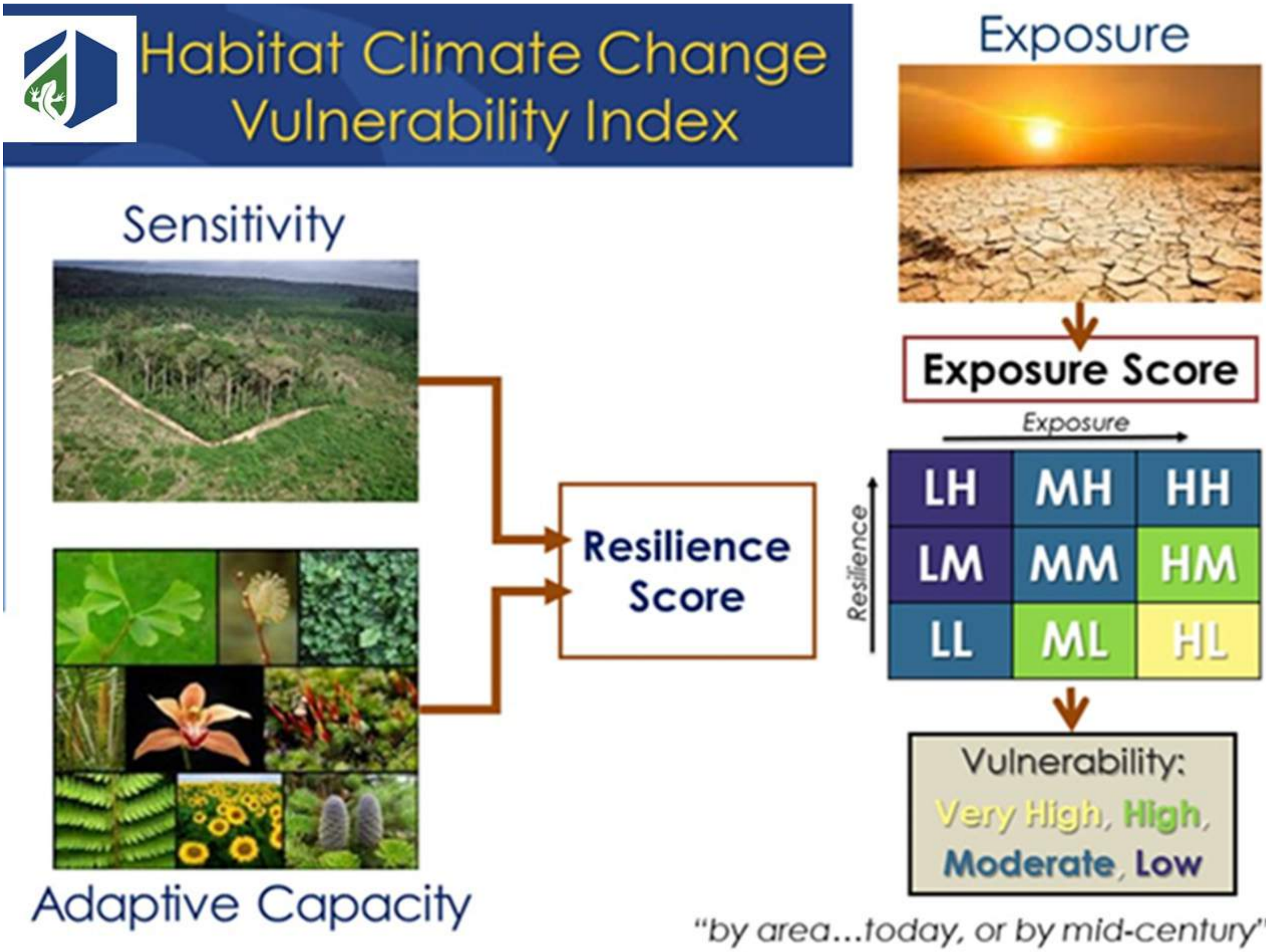
- Over-utilization by livestock
- Free-roaming equids populations over recommended Appropriate Management Levels (AML)
- Drought and disease
- Wildfire or lack of fire
- Anthropogenic development (mining, energy development, recreation, etc.)
- Native and non-native invasive species, including aquatic species
- Climate change and desertification
- Lack of protection or appropriate management of critical habitat
- Groundwater withdrawals, surface water diversion, and other developments impacting water sources

The International Union for Conservation of Nature (IUCN) Red List and Conservation Measures Partnership Major Threats (IUCN, 2022) have also been identified for key habitats identified within this plan.

IUCN Level 1 threats were discussed in Chapter 3; IUCN Level 2 and 3 threats can be found in Table 7, with a more detailed discussion of Level 3 threats contained in the individual habitat narratives of this chapter. All of these threats contribute to the loss of ecosystem functionality and result in additional stress on Nevada's wildlife and habitats. NDOW contributes significant resources and staff to address the protection, enhancement, and restoration of terrestrial habitats and toward collaborative efforts with federal, state, local, tribal, and non-governmental organization partners to work across these landscapes.

Habitat Climate Change Vulnerability Analysis

Increasing climate stress interacts with other environmental stressors to alter species composition and site productivity while degrading ecosystem services. Nevada's wildlife managers require knowledge of these stressors and their effects, ideally in mapped form, to guide adaptative management. We used outputs from the NatureServe Habitat Climate Change Vulnerability Index (HCCVI) to document patterns of vulnerability for a subset of our key habitats that cover the majority of the state. The HCCVI summarizes multiple factors that result in measures of exposure and resilience. Detailed methods, including explanations of exposure and resilience measures and methods used in analysis are available in Comer et al. 2019. The HCCVI incorporates measures of climate exposure and ecosystem resilience (based on measures of sensitivity and adaptive capacity) to derive normalized 0.01-1 index scores to estimate vulnerability. Quartiles are used to split index results to determine the proportion of habitats falling in Severe, High, Moderate, and Low climate change vulnerability categories. Index scores closer to 0.01 indicate more severe relative vulnerability or contribution to overall vulnerability.



Severe: Severe vulnerability results from high climate change exposure and low system resilience and is expected to result in system transformation.

High: High vulnerability results from High or moderate climate change exposure combined with either low or medium resilience. System transformation(s) and/or considerable climate induced stress are expected outcomes.

Moderate: Moderate vulnerability scores result from either moderate exposure and resilience or high-moderate exposure and high resilience. Future vulnerability remains and may increase under further anthropogenic disturbances that lower the adaptive capacity of landscapes.

Low: Low vulnerability scores reflect low exposure scenarios in systems with expected moderate-high resilience. Climate stress is expected to be lowest in these systems, however it may still be present to some degree.

Figure 8. From Comer et al, 2019; Analytical framework for the habitat climate change vulnerability index.

A climate baseline (mid-20th century) was compared with projections for the mid-21st century to measure climate change exposure. HCCVI output includes maps indicating overall climate vulnerability, as well as patterns in factors causing vulnerability, over the upcoming decades. With prior support from the Bureau of Land Management, NatureServe completed HCCVI assessments for the biophysical settings that make up a subset of our key habitats which cover most of the state. The NatureServe HCCVI was run for Aspen, Low & High Elevation Sagebrush Dominated Shrublands, Mojave Warm Desert, Mojave Mid-Elevation Mixed Desert Shrub, Pinyon-Juniper Woodlands, and Salt Desert Shrub key habitats.

The results of each assessment were combined in mapped form, allowing us to summarize climate change vulnerability across the state for each selected key habitat. Results are further summarized by habitat statewide and within each Major Land Resources Area (MLRA) where they occur (Appendix C). This provides overall patterns of vulnerability, the character of climate exposure, and factors affecting habitat resilience. The information from these habitat assessments will help identify type- and place-specific recommendations for adaptive habitat management.

Indexed scores represent a trade-off in terms of synthesizing and flattening a large volume of data coupled with a need for relatively simple representation. Areas scored as ‘Moderate’ or ‘High’ vulnerability are considered to be at considerable risk for climate stress and/or ecosystem transformations resulting from climate exposure, decreased ecosystem resilience and the interaction of the two. As an example, 80% of low elevation sagebrush habitats fall within Moderate Climate Change Vulnerability, however, there is substantial sensitivity of native plant species to climate stress interacting with wildfire (40% of these areas have moderately departed fire regimes while 50% have highly departed regimes). Vast areas of Wyoming sagebrush, a key component of low elevation sagebrush dominated key habitats, have been lost from intense fires as a result of increasing invasive grass cover and warming-drying trends that reduce fire return intervals. Also, 95% of these areas have inherently limited adaptive capacity due in part to low topographic variability (i.e., they occur on flat to gently rolling landscapes, where on average, climate change can force native species to migrate longer distances).

Careful interpretation of the components of indexed HCCVI scores based on ecosystem knowledge is required for interpretation of potential future impacts, and to identify appropriate adaptive management responses.


Source: NDOW

Table 9: IUCN-CMP Level 2 threats impacting Nevada's Key Habitats.

LEVEL 2 THREAT	LEVEL 3 THREAT (GENERAL)
1.1 Housing & Urban Areas	
1.2 Commercial & Industrial Areas	
2.3 Livestock Farming & Ranching	2.3.1 Nomadic Grazing 2.3.2 Small-holder Grazing, Ranching, or Farming 2.3.3 Agro-industry Grazing, Ranching, or Farming 2.3.4 Scale Unknown/Unrecorded
3.1 Oil & Gas Drilling	
3.2 Mining & Quarrying	
3.3 Renewable Energy	
4.1 Roads & Railroads	
4.2 Utility & Service Lines	
4.3 Shipping Lanes	
4.4 Flight Paths	
6.1 Recreational Activities	
6.2 War, Civil Unrest & Military Exercises	
7.1 Fire & Fire Suppression	7.1.1 Increase in Fire Frequency/Intensity 7.1.2 Suppression in Fire Frequency/Intensity
7.2 Dams & Water Management/Use	7.2.1 Abstraction of Surface Water (domestic use) 7.2.2 Abstraction of Surface Water (commercial use) 7.2.3 Abstraction of Surface Water (agricultural use) 7.2.6 Abstraction of Ground Water (commercial use) 7.2.7 Abstraction of Ground Water (agricultural use)
7.3 Other Ecosystem Modifications	
8.1 Invasive Non-Native/Alien Species/ Diseases	8.1.1 Unspecified Species 8.1.2 Named Species
8.2 Problematic Native Species/Diseases	8.2.2 Named Species
8.4 Problematic Species/Diseases of Unknown Origin	
8.6 Diseases of Unknown Cause	
9.2 Industrial & Military Effluents	9.2.1 Oil Spills 9.2.2 See page from Mining
9.3 Agricultural & Forestry Effluents	9.3.2 Soil Erosion, Sedimentation
11.1 Habitat Shifting & Alteration (Climate)	
11.2 Droughts	
11.3 Temperature Extremes	
11.4 Storms & Flooding	

Conservation Strategies, Objectives, and Actions

Healthy habitats generally have greater resistance and resilience to disturbances and provide excellent resources for wildlife. NDOW's main habitat objective is to protect habitats from threats and maintain or improve their current state, and we meet this objective with proactive management strategies and on-the-ground, actionable efforts. Maintenance and protection of these areas are often the most effective and efficient strategies to address certain threats, preventing the need for extensive on-the-ground restoration and rehabilitation efforts. Proactive strategies can take two forms: those with implied actions or efforts and administrative/cooperative planning.

One example of a proactive strategy is strategically placed fuel breaks, which can be an effective way to prevent or reduce the size of wildfires. Land management agencies can help identify locations that warrant fuel breaks by assessing wildfire history, ignition sources, fuel types, and expected fire behavior. Fuel breaks such as greenstrips, brownstrips, or mowing may reduce the likelihood of a catastrophic and large-scale wildfire impacting intact and high-quality habitat areas.

NDOW is currently developing a statewide Habitat Conservation Framework (HCF), as identified under State of Nevada Executive Order 2021-18, that will provide a strategy for conservation, restoration, rehabilitation, and protection of Nevada's habitats, through collaborative planning and assessment of ecological threats, opportunities, and collective prioritization. A foundational element of the HCF is the development of two supporting plans for sagebrush habitats (Sagebrush Habitat Plan) and wildlife connectivity (Wildlife Connectivity Plan). These plans will help NDOW meet its objective of protecting and maintaining habitats.

As climate change alters habitats and disrupts ecosystems, scientists and resource managers will need to continue working to better understand and manage, where appropriate, components of critical habitats such as migration and movement patterns, and how those will be influenced by changing climatic and habitat conditions. Efforts like Migrations in Motion are currently underway by partners such as The Nature Conservancy to map the average direction mammals, birds, and amphibians need to move to track hospitable climates as they move across the landscape, connecting current habitats with projected suitable habitats under climate change (Lawler et al., 2013; McGuire et al., 2016). NDOW and partners will need to continue close collaboration in these efforts to manage changing habitat conditions and species needs. NDOW actively engages with researches through multiple agency, NGO, and universities to study ecology and management of the states ecosystems and wildlife. The Agency is an integral parter in the newly established Nevada Cooperative Fish and Wildlife Research Unit hosted at the University of Nevada, Reno. The NV CRU is a cooperative effort between NDOW, UNR, the USGS, the Wildlife Management Institute (WMI) and FWS to enhance the effectiveness of conservation science in the state.

Administrative/cooperative planning efforts, such as providing input during land-use planning efforts, can help shape the scale and impact (beneficial, neutral, or negative) of projects on federally administered public lands. For example, participating as a cooperating agency during National Environmental Policy Act analyses allows NDOW to weigh in on proposed development projects by offering land managers alternative strategies to avoid or minimize impacts avoiding and reducing the threats to healthy lands.

Cooperative partnerships with federal, local, or tribal agencies also offer opportunities to increase protections for high-value habitats. NDOW is committed to partnering and leveraging resources through existing mechanisms such as Shared Stewardship, Joint Chiefs, Readiness in Environmental Protection Integration, Cooperative Agreements, Assistance Agreements, and others. In addition to continued participation in existing partnerships, NDOW actively explores new partnerships to expand resource pools and agency capacity.

As an example, NDOW staff work with fire suppression officials to pre-position firefighters during severe weather conditions to increase the effectiveness of initial efforts to limit wildfire spread. Timely communication with fire suppression agencies on the location and boundaries of high-value habitats can help prioritize suppression efforts and encourage suppression strategies that minimize the loss of high-quality or intact habitats.

When a private land nexus exists, cooperative relationships with private landowners and non-governmental organizations can help to conserve wildlife habitats. Conservation easements and private-public partnerships encourage the protection of high-quality or intact habitats on private lands, often with significant benefit to adjacent habitats on public land. For example, establishing relationships with private landowners can facilitate common-ground conservation through easement agreements and improve management practices (e.g., grazing, early detection/response for invasive weeds), both help conserve high-quality, high-value habitats (NDOW, 2019).

The objectives and actions described in this chapter are intended to be attainable with the resources available to NDOW and various partners and can be found in the individual habitat accounts. Often, habitat-specific objectives and actions vary by region, individual sites, and microsites and actions will be dependent upon factors such as the annual wildfire season, national or state initiatives, available resources, and site-specific needs. By supporting, investing in, and continuing to develop our projects and vegetation monitoring programs the Department develops site-specific data to document resource condition and trend and habitat improvement project effectiveness.

High-level strategies, adaptation approaches, and adaptation tactic conservation strategies can be found in Table 10 and are fully developed for individual project needs, informed by desired conditions, existing conditions, available resources, and other factors on a per case basis. This table is organized based on the Resist, Accept, Direct (RAD) framework that was developed to address climate-related mitigation; however, it serves as a useful framework for addressing other threats as it considers conservation actions that manage for future anticipated conditions rather than the historic baseline conditions alone. The framework thus allows and encourages managers and planners to consider a broad suite of alternative approaches by planning for and incorporating desired and likely future ecosystem states that may result from ecological transformations that run the gamut from slow to abrupt (Schuurman et al., 2020; Schuurman et al., 2022).

Table 10: High-Level Strategies, Adaptation Approaches, and Adaptation Tactics to Resist, Accept, and/or Direct Ecosystem Change in Nevada's Key Habitats based on review and incorporation of the Northern Institute of Applied Climate Science, RAD, and IUCN-CMP frameworks. Specific tactics are developed at the project level and are informed by desired conditions, existing conditions, available resources, and other factors on a per case basis.

Resist, Accept, & Direct Desired or Anticipated Future Conditions: Maximized ecosystem services over near (5-15 years), intermediate (16-45 years), and longer near (45-100 years) terms scales		
STRATEGIES	**ADAPTATION APPROACHES**	**ADAPTATION TACTICS**
Plan for near-term, intermediate, and long-term scenarios	Plan for and promote habitat connectivity and increase ecosystem redundancy at the landscape scale	Work with partners to define and achieve connectivity goals at the landscape level.
		Locate and map habitat types, corridors, and patches at a landscape scale, and identify priorities for protection and/or restoration.
		Identify climate refugia and corridors that are likely to be important for species movement and persistence.
	External capacity building	Explicitly address the range of costs associated with desired outcomes (incorporate cost surfaces in mapping and modeling processes).
		Support and develop cross-jurisdictional alliances and partnerships; establish and fund resources such as shared positions, agreements, and planning processes.
	Adapt approaches and actions based on change-point detection in species/ ecosystem ranges, distributions, relative abundances, etc. via robust monitoring	Establish robust long-term trends and condition monitoring for wildlife species and vegetation communities (key habitats) using ground level and remote technologies; explicitly define and monitor for change-point detection to identify ecosystem level shifts that necessitate changed strategies, approaches, and tactics.
	Adapt approaches and actions based on systems knowledge gained through continued collaborative interdisciplinary research	Invest in ongoing research and development to inform adaptation tactics that are scalable, effective, and deployable.
		Update and develop regional forecast models to determine likely outcomes under future climate scenarios using dynamic vegetation models and similar tools trained to ongoing data sets.

Resist Desired or Anticipated Future Conditions: Maintain and increase key habitat resilience over near and intermediate-term scales; persistence of key functional groups		
STRATEGIES	**ADAPTATION APPROACHES**	**ADAPTATION TACTICS**
Protect remaining high-quality habitat	Increase connectivity and resilience of native ecosystems	Restore native species, including rare and/or federally/state protected plant species and vegetation structure in areas of low connectivity and/or areas of intermediate habitat quality that have not crossed thresholds into unnatural states
	Increase the resilience of native ecosystems	Manage anthropogenic impacts to mitigate habitat disturbance and loss.
		Proactively restore degraded sites to maintain ecosystem function (for instance, preventing soil erosion to maintain aridisols) for increased short-term resilience and long-term adaptive capacity.
	Protect fire-sensitive ecosystems from fire	Enhance ecosystem/functional group/species age class and structural diversity to enhance post-fire recovery; install fire breaks when and where benefits outweigh costs; maintain water availability for wet systems and groundwater-dependent ecosystems where possible.
	Reduce the impact of biological stressors	Prevent the introduction and establishment of invasive species and remove or control existing invasive species when and where feasible, including the use of bioengineering options, where appropriate.
	Conserve water resources on the landscape	Collaborate with land management agencies and water managers to maintain water availability and quality.
Promote post-disturbance recovery	Facilitate post-disturbance (post-fire) ecosystem recovery to reduce the long-term effects of unacceptable wildfire	Plant restoration species with an emphasis on those most likely to adapt to future conditions by selecting and increasing the best local/regional native seed sources and non-native species.
		Invest in new technologies to increase restoration success.
		Increase monitoring of treatment effects and implement appropriate adaptive management actions.

Accept		
Desired or Anticipated Future Conditions: Possible conversion to novel states, depletion of C3 grasses ("cool season grasses") and other functional groups due to climate change, complex range shifts in N-S & E-W based on individualistic responses to multiple abiotic gradients, loss of habitat due to conversion or degradation from other anthropogenic disturbances		
STRATEGIES	**ADAPTATION APPROACHES**	**ADAPTATION TACTICS**
	Explicitly determine where change is acceptable or unavoidable	Work with proponents, municipalities, user groups, and other public to properly site, minimize, and mitigate habitat disturbing uses.
		Identify areas where (and why) unguided adaptation has led to adapted ecosystems/ species/ecotypes that are functioning at an acceptable level.

Direct		
Desired or Anticipated Future Conditions: Multiple novel stable state systems, complex range shifts in N-S & E-W based on individualistic responses to multiple abiotic gradients, maximized habitat functionality based on range shifts and changing conditions, adaptation to changing disturbance regimes		
STRATEGIES	**ADAPTATION APPROACHES**	**ADAPTATION TACTICS**
Manage transitions		Manage vegetation community (key habitat) transitions by planting the best available species to meet targeted species needs; for instance, plant native or beneficial non-native species from outside historic 20th century climactic envelopes to provide thermal cover and forage for big game species when sites have crossed thresholds that are otherwise considered irreversible.
		Prioritize and maintain unique landforms for refugia.
Facilitate ecosystem adaptation to expected future climate regimes	Facilitate ecosystem adjustments through species transitions	Facilitate the movement of species that are expected to be adapted to future conditions and fire regimes.
		Facilitate and maintain ecosystem services as new species assemblages arise.
Maintain and Enhance Genetic Diversity	Use seeds, germplasm, and other genetic material from across a greater geographic range	Plant the right seed at the right place at the right time; base seed transfer on USDA seed transfer zones when possible.
		Focus habitat goals on providing diverse, high-functioning communities that meet the needs of multiple wildlife species.

Examples of specific on-the-ground restoration and rehabilitation actions NDOW undertakes to address threats and/or habitat degradation are listed below. This list is not meant to be proscriptive or exhaustive as actions for specific needs are developed individually based on site history and details.

- Mechanical removal – physical activities and techniques to inhibit or remove unwanted plant establishment/growth.
- Prescribed fire – a planned, intentionally ignited, and managed fire that is used to meet management objectives, usually to reduce fuels and/or create a mosaic of habitats for plants and animals.
- Fencing – building physical barriers to prevent an animal's access to an area.
- Grazing management – activities that change the way livestock use the land. Actions can include changing stocking rates and densities, livestock rotations, seasons of use, utilization rates, active management (e.g., herding, mineral/supplement placement), etc.
- Fuel management – removing or modifying vegetation to reduce the risk of severe wildfire behavior.
- Passive diversion – non-mechanical changes to water flow. Techniques include flow-through systems, floats, perforated pipes, spring boxes, off-source boxes, and others.
- Hardened road crossings – changing the surface of a road where it crosses a waterway to reduce soil erosion and improve water quality and habitat health.
- Chemical treatment – using herbicides to inhibit or remove unwanted plant growth, typically to enhance desired plants.
- Biological control - the use of animals, fungi, or diseases to control invasive populations.
- Planting/seeding – adding and encouraging the growth of a desired plant.
- Seeding (e.g., drilling, broadcasting)
- Bioengineering – the use of vegetation in civil engineering construction, specifically for projects including environmental modifications such as surface soil protection, slope stabilization, watercourse and shoreline protection, windbreaks, vegetation barriers, or the ecological enhancement or restoration of an area.
- Channel restoration - physically altering some component of the water channel to achieve a desired result.
- Wetland creation and restoration
- Dredging - removal of sediment and debris from a channel or impoundment.
- Water right acquisition
- Rare plant protection and habitat enhancement

Aspen Woodland

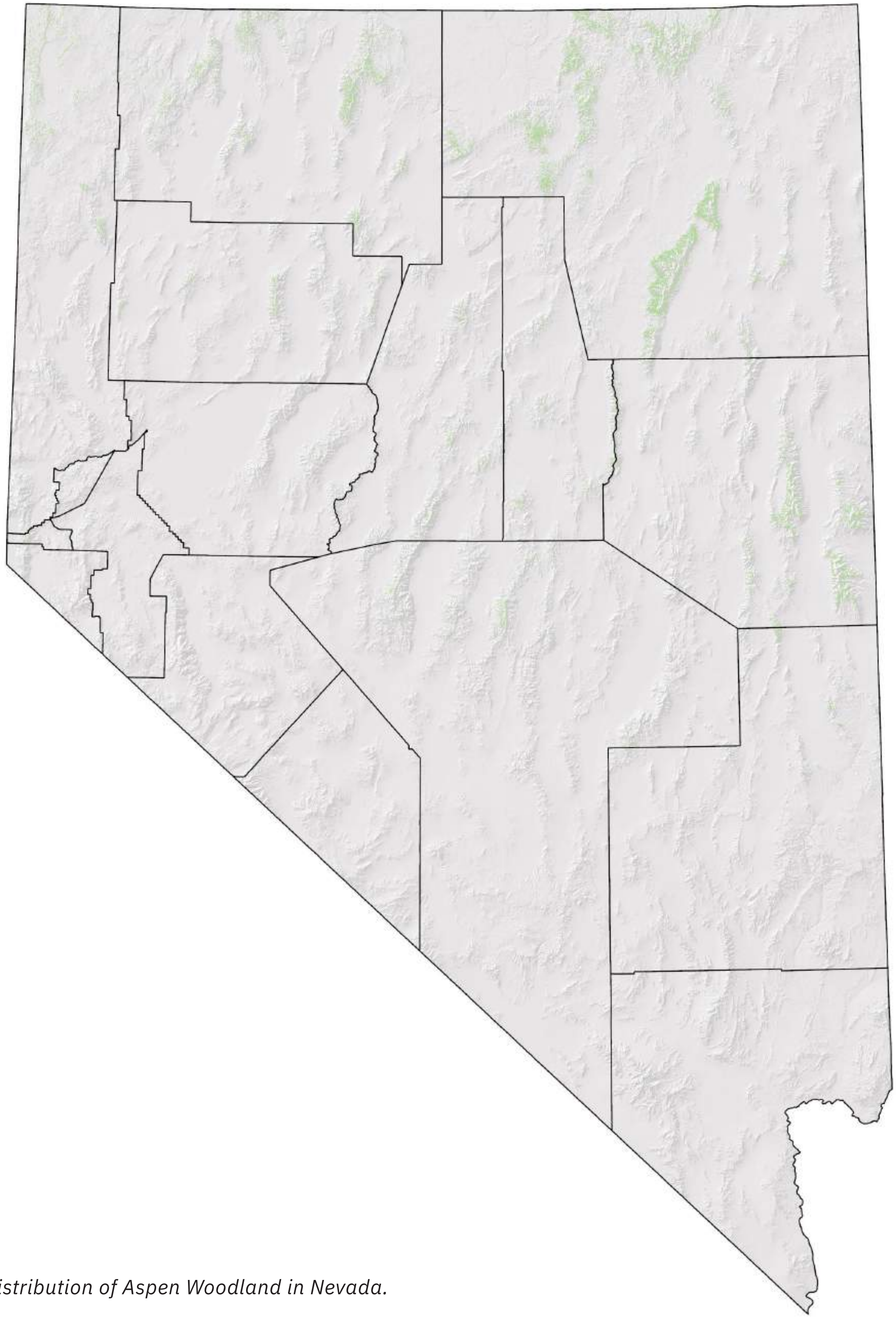


Figure 9. Distribution of Aspen Woodland in Nevada.

Key Habitat Description and Elements of Aspen Woodland

Vegetation and Abiotic Environment

Aspen is one of the most widely distributed native tree species in North America, and due to its high productivity and structural diversity, aspen supports the largest variety of animal and plant species of all western united states forest types. Aspen woodlands are high in biodiversity, second only to riparian areas (Kay, 1997b). In the western United States, quaking aspen (*Populus tremuloides*) communities are established at suitable sites on mountains and high plateaus (Jones, 1985). Aspen can form extensive stands or be more limited and expressed as riparian stringers or disjunct patches. In the higher reaches of riparian drainages, aspen may occur in dense stands of smaller-stature trees on side slopes and snow pocket areas (Dobkin et al., 1995). In Nevada, extensive aspen communities are found in the Snake, Schell Creek, White Pine, Jarbidge, Independence, and Monitor Ranges, as well as the Santa Rosa and Ruby Mountains (Neel, 1999). Scattered stands of aspen occur as far south as the Spring Mountains near Las Vegas and in the adjacent Sheep Range (Lanner, 1984). Aspen rarely grows from seed due to seed bed requirements and high vulnerability to herbivory. Clones likely maintained their presence on those sites for thousands of years through vegetative regeneration. The presence of aspen indicates a long history of disturbance, primarily resulting from frequent fires. Given these characteristics, aspen condition is an excellent indicator of ecological integrity (Kay, 1997a).

Within Nevada, aspen generally occupies elevations between 6,000 and 8,000 feet (Lanner, 1984). Aspen communities are found on all aspects and grow where soil moisture is not a limiting factor. Climatic conditions vary greatly over the range which aspen occupies in the western United States, but most aspen areas receive at least 15 inches of precipitation per year (Jones & Debyle, 1985). Climax aspen communities, which persist at a site for several centuries without appreciable change, occur throughout the West. When found in association with coniferous species, aspen communities may progress toward conifer dominance or replacement in the absence of disturbance (Mueggler, 1985; Bates et al., 2006). Grasslands and shrublands may also replace aspen communities on sites not suited for the establishment and growth of conifers (Mueggler, 1985). "Firebreak" is a common term used to describe aspen because of its difficulty to burn and tendency to diminish crown fires spreading from adjacent conifer stands. Aspen only readily burns in early spring or late fall, when the trees are leafless and understory plants are dry (Kay, 1997a).

Aspen communities can be multi-layered. The aspen woodland tree canopy is composed of a mix of deciduous and coniferous species, co-dominated by conifer often including white fir (*Abies concolor*), subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*), limber pine (*Pinus flexilis*), and ponderosa pine (*Pinus ponderosa*). In later successional stages, conifer species become more dominant. Stands include numerous shrub species and diverse understory, and aspen canopy cover can exceed 85%. Conifers typically comprise less than 25% of relative tree cover, except in later successional stages (Landfire, 2020). When present, tall shrubs form an open and intermittent layer from six to 12 feet. Shorter shrubs and tall forbs frequently form a more continuous layer at about three feet. Shrubs common in aspen stands in Nevada include snowberry (*Symphoricarpos albus*) and currant (*Ribes sp.*). Common forbs in aspen understory include meadow-rue

(*Thalictrum spp.*), yarrow (*Achillea millefolium*), columbine (*Aquilegia spp.*), lupine (*Lupinus perennis*), and larkspur (*Delphinium spp.*) (Neel, 1999).

Occurrences of habitat are found on cooler sites, north-facing slopes, and drainages. Soils generally occur on sedimentary rocks, derived from alluvium, colluvium, and residuum from differing parent materials. (Landfire, 2020). Sites are found at water bodies, streams, and meadow edges, and can be found in Nevada at rock reservoirs, springs, and seeps. At lower elevations, aspen stands often occur in ravines, north slopes, and wet depressions as these sites trend toward cooler, wetter conditions. At higher elevations, there is more variability in topographic conditions where aspen occurs due to the overall increase in precipitation and wetter conditions as well as cooler temperatures. At these higher elevations, aspen woodland types are also found in slight depressions and on sites subject to snowdrift accumulation (Landfire, 2020).

General Wildlife Values

Aspen communities generate exceedingly high biodiversity, especially in multi-layered stands complemented by intermittent shrubs and herbaceous species. Birds and small mammals utilize mid-story structures and the shrub-herbaceous understory for foraging, nesting, and protective cover. Mature trees are particularly important to cavity-nesting species because stems grow to more than 10 inches in diameter and the wood is soft and easy to excavate. Downed trees in aspen habitats can create slow-moving water conditions favorable to amphibians, including Columbia spotted frogs.

Existing Environment

Dominant Biophysical Settings

The dominant biophysical settings comprising aspen woodland are Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland and Rocky Mountain Aspen Forest and Woodland (Table 11).

Table 11: Dominant biophysical settings comprising aspen key habitats in Nevada. Roughly 775,319 acres of Nevada may have historically supported aspen communities based on biophysical setting analysis.

ASPEN WOODLAND	775,319 ACRES
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	140,254 acres
Rocky Mountain Aspen Forest and Woodland	635,065 acres

Habitat Conditions

Native Americans managed the landscape for at least 12,000 years before European settlement and are thought to have utilized prescribed fire extensively. The resultant higher frequency low-intensity fires may have contributed to the presence and condition of aspen today (Kay, 1997b). Aspen has declined 60 to 90% throughout the West and in Nevada. Many aspen stands containing old-age or single-age trees have not successfully regenerated for 80 years or longer (Kay, 1997b; Kay & Bartos, 2000). The decline of aspen communities has been largely attributed to declines in natural disturbances (e.g., fire suppression in the surrounding landscape) and increases in grazing pressure. Aspen communities that have been burned by wildfire or prescribed fire often fail to regenerate because regeneration is impeded by excessive browsing, resultantly, many aspen stands in Nevada are dominated by old-age or single-age trees (Hessel & Graumlich 2002; Kay, 1997b;

Rhodes et al., 2017). The Humboldt-Toiyabe National Forest has management responsibility for most aspen occurring in Nevada, and the condition of the aspen communities on forest lands ranges from very poor to good. Some aspen clones have been reduced to a single tree or are no longer present on the landscape, particularly at lower elevations. Aspen is considered by some to be among the most imperiled terrestrial habitats in Nevada (NDOW, 2019).

PERCENT OF VEGETATED NEVADA ASPEN WOODLAND CONVERTED TO OTHER CLASSES

Table 12: Percent of aspen key habitat converted to agriculture, barren or sparsely vegetated cover, non-natural vegetation, and/or urbanized lands based on Landfire successional class analysis. Non-natural vegetation types include both nonnative exotic-dominated areas as well as areas dominated by natural vegetation that is outside the range of variation (cover, height, dominant type) that would be expected under typical conditions. Natural vegetation includes all areas remaining in young-old age successional classes as outlined below although the distribution of age classes within natural vegetation states may be outside of the range of variation expected under historic conditions.

ASPEN WOODLAND	
CURRENT STATE	**PERCENT HABITAT**
Agriculture	0.04%
Barren or Sparse	9.8%
Natural Vegetation	86.5%
Non-Natural Vegetation (invasive or native)	1.5%
Urban	2.3%

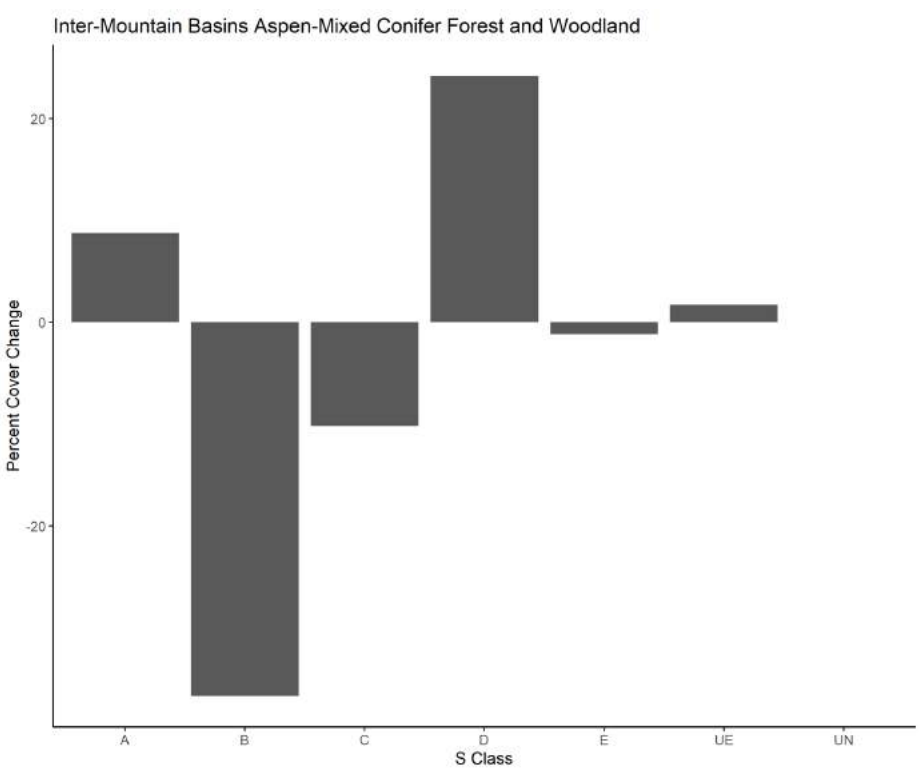


Figure 10. Succession class data for biophysical setting Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

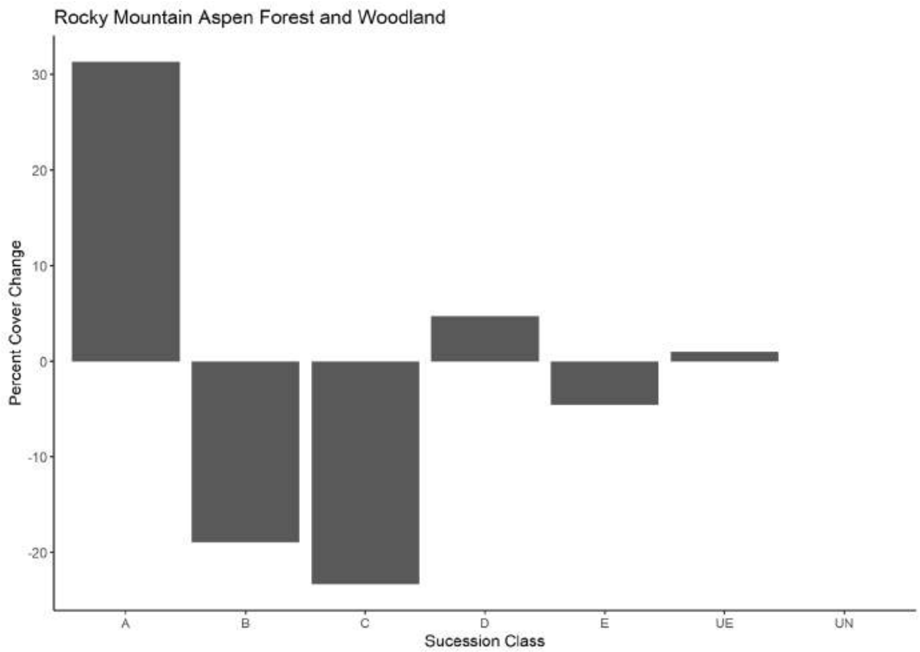


Figure 11. Succession class data for biophysical setting Rocky Mountain Aspen Forest and Woodland. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

Habitat Threats

This is a strongly fire-adapted community with fire return intervals (FRIs) varying for mixed-severity fire with the encroachment of conifers. Generally, aspen is considered a "fire-proof" vegetation type that does not burn during the normal lightning season, though there is evidence of fire scarring and the potential that burning by Native peoples may have occurred in some areas (Hessel & Graumlich, 2002). Fire frequencies vary between 25-300 years depending on the aspen community types and site conditions (Landfire, 2020). Pre-European settlement, disease, and insect-caused mortality do not appear to be major impacts on this habitat type; however, older aspen stands are more susceptible to disease outbreaks. Some aspen woodland sites can be prone to snowslides, mudslides, and rotational slumping, as well as flooding.

Threats to aspen communities in Nevada include fire suppression, improper livestock grazing, mining development and exploration, conifer encroachment, recreational pressure, spring developments, and browsing by big game species. Conifer encroachment is a problem for aspen communities in Nevada, particularly in the Sierra Nevada, Schell Creek, and Snake ranges, and could eventually result in the elimination of aspen clones in these areas if disturbance is not allowed to occur or is not introduced into these communities. Livestock and wild ungulates consume different types of forage that are available in aspen communities which alters vegetation structure and contributes to the declining condition of aspen communities. Utilization by wild ungulates tends to reduce shrubs and tall palatable forbs while favoring the growth of native grasses in aspen communities; livestock grazing tends to reduce native grasses and promote introduced species and edaphic conditions (Kay & Bartos, 2000). Although aspen can withstand moderate levels of grazing by livestock and wild ungulates, caution should be taken in efforts to restore aspen through prescribed burning because burning plus repeated browsing accelerates the elimination of aspen clones that have weakened root reserves (Kay, 1997b).

Aspen communities in riparian areas provide many recreational and commercial uses in Nevada (Neel, 1999). People are drawn to aspen stands for camping which contributes to soil compaction and potential disturbance to wildlife. In northeastern Nevada, gold exploration in aspen communities is widespread. Directional drilling and scheduling exploration activities outside of critical wildlife seasons and life history stages (e.g., nesting) can reduce some of the potential effects of mineral exploration, but complete habitat loss may occur if an aspen community is removed during mining operations, as has been observed for mining projects occurring in Nevada. Spring development within and upslope of aspen woodlands is also a concern for aspen communities because of their need for water. If the aspen clone is lost due to factors that lead to dewatering on the site, there are no known means of aspen clone reestablishment (Kay et al., 1994). Issues of concern for wildlife in aspen communities include resource competition and climate change.

Changes in land use patterns and management can also significantly impact aspen habitat conditions and distribution across the landscape, as well as contribute to changes in successional patterns of stands. In Nevada, both biophysical settings making up aspen woodlands are primarily comprised of early and late successional stages, indicating a deficit of mid-successional ranges B and C.

Climate Change Vulnerability

Within the Nevada portion of the aspen distribution, overall HCCVI is 91% in moderate and 9% in high relative vulnerability. Exposure is 10% severe, 87% high, and 3% moderate (Table 13). This overall exposure results from contrasting component measures, with climate departure scoring at 44% severe and 56% high, while change in suitability, factoring in actual climate variability across the range of the type, scored as 10% low, 15% moderate, 52% high, and 24% severe. By mid-century and assuming a higher emission scenario (8.5), several climate variables are projected to have departed by greater than two standard deviations from the 20th-century baseline mean. These include Annual Mean Temperature (increasing 3 degrees Celsius) and Mean Temperature of the Warmest Quarter (increased by 3.3-3.4 degrees Celsius).

Overall vulnerability contributed by resilience is measured at 79% moderate and 21% low within the state. Among resilience measures, sensitivity measures contribute toward vulnerability, with 5% of areas scoring moderate for landscape condition. Fire regime departure scores 44% moderate and 53% high vulnerability. The impacts of invasive plants appear to have little to no impact on resilience. Since this montane forest occurs throughout the slopes of this basin and range landscape, topographic roughness contributes to moderate vulnerability in 80% of the state’s area and 18% contributes toward high vulnerability (i.e., in high elevation plateaus).

When viewed across the MLRAs in Nevada (Figure *12*), patterns of climate change vulnerability vary, with the lowest estimated vulnerability found among aspen habitats in the Great Salt Lake and eastern Central Nevada Basin and Range MLRAs. Those supporting aspen habitats with more severe vulnerability are scattered throughout the Malheur High Plateau, Owyhee High Plateau, and other northern MLRAs within Nevada.

Predicted Climate Change Effects

Aspen is generally a water-limited, drought-intolerant species, though less impacted by these stresses at higher elevations where temperatures remain cooler and soil conditions

Table 13: Percentage of potential Aspen Key Habitats within Nevada with Low, Moderate, High, and Severe Overall Vulnerability, Exposure, and Resilience.

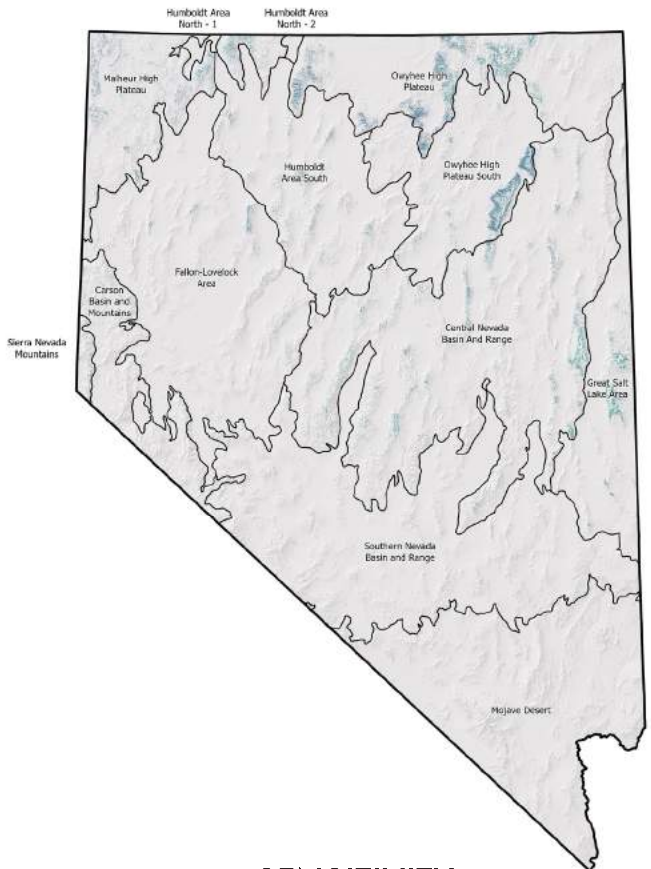
		PERCENT AREA WITHIN EACH RELATIVE VULNERABILITY RANKING			
		LOW	MODERATE	HIGH	SEVERE
Climate Change Vulnerability Index		0%	91%	9%	0%
Vulnerability from Measures of Exposure	Climate Departure	0%	0%	56%	44%
	Climate Suitability	10%	15%	52%	23%
	Overall Exposure	<1%	3%	87%	10%
Vulnerability from Measures of Sensitivity	Landscape Condition	95%	5%	<1%	0%
	Fire Regime Departure	2%	44%	53%	1%
	Invasive Annual Grasses	99%	1%	<1%	0%
	Overall Sensitivity				
Vulnerability from Measures of Adaptive Capacity	Topoclimatic Variability	3%	80%	18%	<1%
	Overall Adaptive Capacity	.227	.772	0	0
Vulnerability from Measures of Overall Resilience		.212	.787	.001	0

more mesic; however, drought can cause death or decline of aspen if local site conditions degrade. Ecological consequences resulting from a changing climate have the potential to greatly impact forests through the alteration of fire regimes (Shinneman & McIlroy, 2019; Yang et al., 2015), increased frequency and intensity of droughts, invasion by non-native species, fire impacts on recruitment (Hansen et al., 2016), other extreme weather events, and susceptibility to outbreaks of pathogens and/or insect infestations (Kay, 1997b; Kulakowski et al., 2013; Kretcham et al., 2020).

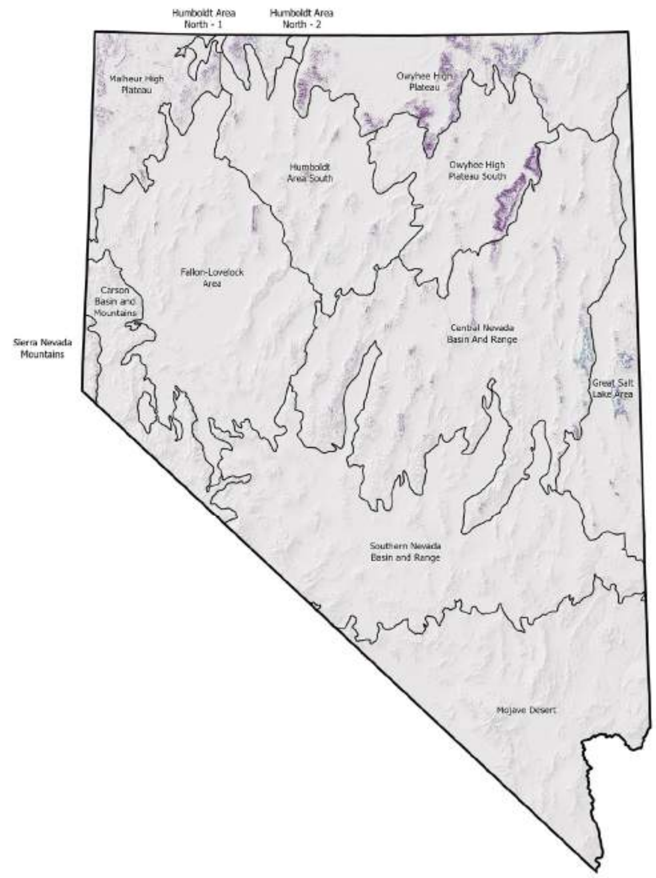
Interactions between different ecological factors and variable extreme weather make the net effect of a warming climate difficult to predict. For example, other stressors such as heavy ungulate browsing on sprouts (Rhodes et al., 2017; Rogers & Mittanck, 2014), may prevent aspen from establishing new trees (Romme et al., 2001; Morelli & Carr, 2011) or changes in the abundance of insects and diseases on aspen (Bell et al., 2015).

However, this system represents stable mixed aspen-conifer woodlands maintained by periodic disturbance that prevents conifers from dominating and shading out the aspen, so increased fire frequency may result in conversion to Rocky Mountain Aspen Forest and Woodland.

OVERALL VULNERABILITY (HCCVI)



EXPOSURE



SENSITIVITY

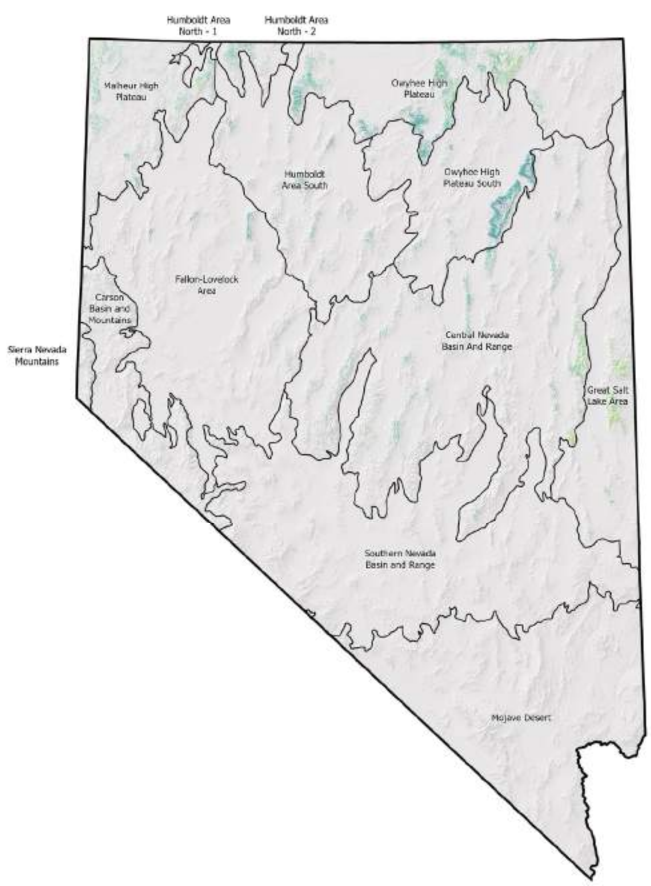


Figure 12. Aspen woodland patterns of climate change vulnerability across MLRAs in Nevada. Overall HCCVI vulnerability measures incorporate patterns of potential climate exposure and habitat resilience, which incorporates ecosystem sensitivity and adaptive capacity (overall sensitivity shown here). Vulnerability, ranked from low to severe, is spatially variable based on multiple components of exposure and sensitivity.

It is also possible that this disturbance-dependent, stable mixed aspen-conifer woodland, and forest system could become more common over time if more frequent droughts limit conifer canopy closure (Berrill et al., 2017; Kulakowski et al., 2013). Taking into account the moisture influence across the landscape where this biophysical setting is found and the benefits to wildlife habitat and forage, aspen is both valuable and vulnerable, particularly in light of a changing climate (Morelli & Carr, 2011), making research paramount to better interpret the potential implications across to aspen communities across Nevada.

Conservation Strategy

Objective 1: Identify and assess aspen woodlands across Nevada by 2027.

- Action: Assess the condition of aspen woodlands in Nevada using the Resource Implementation Protocol for Rapid Assessment Matrices (Humboldt-Toiyabe National Forest) or other approved protocol(s).
- Action: Identify and prioritize aspen woodlands for restoration through management treatment(s).

Objective 2: Monitor reference sites once established or identified, as prioritized aspen woodlands before any restoration or management activities.

- Action: Implement monitoring plans and develop a repository for data or incorporate data into existing databases developed by federal agencies or partners such as the Western Aspen Alliance.

Objective 3: Manage aspen woodlands to not exceed 10% loss to type conversion through 2032.

- Action: In small patch aspen communities, protect recently (within the previous three years) treated (burned or tree removal) regenerating aspen saplings with stand exclosure fencing.
- Action: Avoid spring development in and directly above and/or connected to aspen woodlands that withdraw water beyond sustainable levels.

Objective 4: Develop and implement an aspen restoration decision process.

- Action: Assess conditions, identify challenging or problematic conditions, identify or develop appropriate management actions/response opportunities, and monitor post-implementation to assess aspen response to actions/response options utilized.

Objective 5: Develop and/or identify management actions and response options.

- Action: Incorporate actions such as tree hinging, root separation, cutting/girdling subdominant conifers, clear-felling or burning aspen and conifers, selectively treating overstory conifers, modifying grazing management regimes, implementing exclosure fencing (temporarily or permanently), utilizing wildlife-friendly fencing to allow access, modifying recreation use/dispersed camping/off-road use/woodcutting, etc., and/or restoring natural fire regimes.


Source: NDOW

Priority Research Needs

- A statewide health assessment of aspen stands, including high-resolution remote sensing of aspen distribution and condition.
- Assessment of suitable rest intervals for aspen woodlands after natural disturbance or treatment.
- Individual levels and effects of livestock and big game resource use in aspen communities to aid in the management of grazing allotments containing aspen communities.
- Analysis of anticipated shifts in distribution with differing climate regimes.
- Improved understanding of aspen dynamics across geographic and biophysical gradients; broad-scale and long-term.

Key SGCN Species

- Great Basin spadefoot (*Spea intermontana*)
- Western toad (*Anaxyrus boreas*)
- American Kestrel (*Falco sparverius*)
- Dusky Grouse (*Dendragapus obscurus*)
- Flammulated Owl (*Psiloscops flammeolus*)
- Lewis's Woodpecker (*Melanerpes lewis*)
- Long-eared Owl (*Asio otus*)
- Northern Goshawk (*Accipiter gentilis*)
- Northern Pygmy-Owl (*Glaucidium gnoma*)
- Sierra Nevada Mountain Willow Flycatcher (*Empidonax traillii brewsteri*)
- Hoary Bat (*Lasiurus cinereus*)
- Little Brown Myotis (*Myotis lucifugus*)
- Montane Shrew (*Sorex monticolus*)
- Mule Deer (*Odocoileus hemionus*)
- Sierra Nevada Snowshoe Hare (*Lepus americanus tahoensis*)
- Silver-haired Bat (*Lasionycteris noctivagans*)
- Spotted Bat (*Euderma maculatum*)
- Western Jumping Mouse (*Zapus princeps*)
- Western Small-footed Myotis (*Myotis ciliolabrum*)
- Northern Rubber Boa (*Charina bottae*)

Desert Grasslands

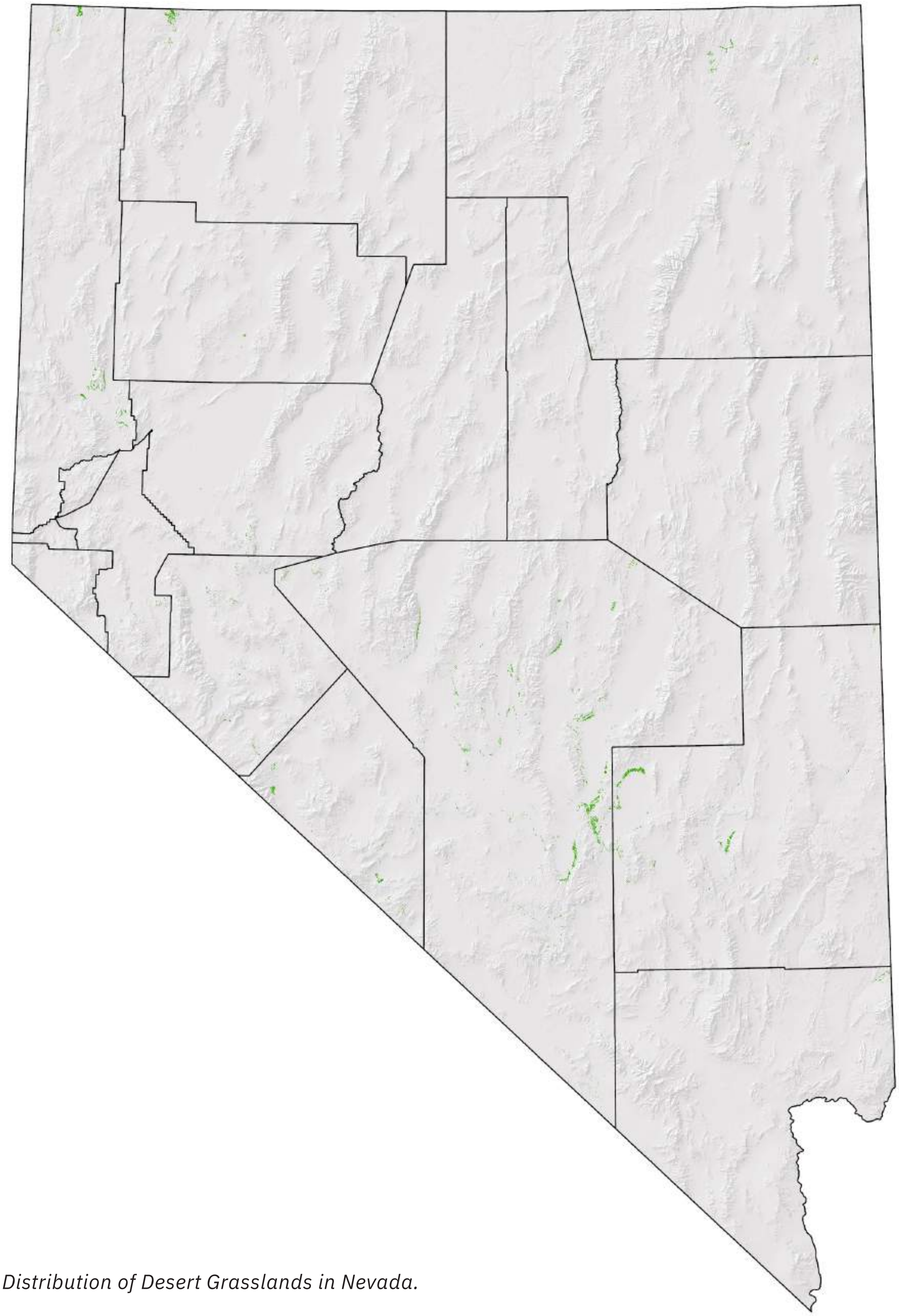


Figure 13. Distribution of Desert Grasslands in Nevada.

Key Habitat Description and Elements of Desert Grasslands

Vegetation and Abiotic Environment

Desert grasslands are widespread semi-arid to arid grassland groups occurring throughout the Intermountain West composed of dominant, drought-resistant perennial bunchgrasses. These ecological systems are found at approximately 4,200 to 9800 feet of elevation across the Intermountain West region and are differentiated from invasive annual grass dominated states resulting from disturbance. Within the Great Basin Complex of Nevada, desert grasslands occur at 4,200 to 7600 feet. Semi-desert grassland ecosystems are found on xeric sandsheets, stabilized dunes, swales, playas, mesatops, plateau parks, alluvial flats, and plains in well-drained, sandy, or sandy-loam soils (West, 1983e; West & Young, 2000). Sites occur on a variety of aspects and slopes ranging from flat to moderately steep (NatureServe, 2022). Annual precipitation is usually 6-10 inches in the Great Basin. Grasslands within this system are typically characterized by a sparse to moderately dense herbaceous layer dominated by drought-resistant perennial bunchgrasses. These grasslands are typically dominated or codominated by Indian ricegrass (*Acnatherum hymenoides*), bottlebrush squirreltail (*Elymus elymoides*) and/or needle-and-thread grass (*Hesperostipa comata*), James' galleta (*Pleuraphis jamesii*), and are associated with big sagebrush (*Artemisia tridentata sp.*), shadscale (*Atriplex confertifolia*), Ephedra (*Ephedra spp.*), snakeweed (*Gutierrezia sarothrae*), or winterfat (*Kraschenínnikovia lanata*).

At higher elevations, the desert grasslands systems are represented on flat to rolling plains, in basalt or rhyolite substrates, and dry benches in northern Nevada's Columbia Plateau. Soils vary but are typified by relatively deep, medium- to fine-textured, imperfectly drained, and non-saline soils, often with a microphytic crust. Key bunchgrasses include Idaho fescue (*Festuca idahoensis*), Great Basin wildrye (*Leymus cinereus*), bluebunch wheatgrass (*Pseudoroegneria spicata*), and Sandberg's bluegrass (*Poa secunda*) (West & Young, 2000). Bunchgrass patches are mixed with mountain shrub and mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*).

General Wildlife Values

Wildlife values of grassland habitats vary significantly among the different ecological systems bundled in this group, and they vary significantly among plant communities within a single ecological system. Stands of grasses occurring within this habitat are important to different species as a primary food source and contribute to overall ecosystem health and biodiversity.

Existing Environment

Dominant Biophysical Settings

The dominant Biophysical Settings comprising Desert Grasslands are semi-arid ecological systems that consist of lower-elevation dry grasslands found on plains, mesas, and foothills throughout the Intermountain western U.S. Grasslands occurring within these ecotypes are dominated and a mix of cool- and warm-season grasses where precipitation occurs during both winter and summer.

Table 14: Dominant biophysical settings comprising desert grasslands key habitats in Nevada.

DESERT GRASSLANDS	114,279 ACRES
Columbia Plateau Steppe and Grassland	9,930 acres
Inter-Mountain Basins Semi-Desert Grassland	104,350 acres

Habitat Conditions

Before European settlement, fire played an important role in the desert grassland ecosystems of the Great Basin. In Nevada, plant communities developed under thousands of years of colder, wetter climatic conditions associated with low-severity fires. This relationship increased the dominance of herbaceous cover while decreasing woody plant abundance (Young & Miller, 1985; Miller & Eddleman, 2001). Historically, fire cycle rotations in lower xeric grassland communities are estimated at 50-100 years, and in higher mesic grassland communities as frequently as 15 to 25 years (Baker, 2006; Miller & Heyerdahl, 2008; Chambers et al., 2014). With the present trend of drier and warmer climatic conditions across this physiographic region coinciding with rapid proliferation of cheatgrass (*Bromus tectorum*) in the past 50 years (Miller & Eddleman, 2001), fire frequency intervals have decreased significantly. In many mid- to low elevation desert grassland ecosystems, fire return intervals have tightened to less than 12 years, altering ecosystem processes native bunchgrasses require and lowering these species' resistance to fire and resilience to reestablish after a fire.

Habitat Threats

Within the Great Basin ecoregion, the main threats to desert bunchgrass habitats are structural development and cultivation of cropland, removal of native sagebrush and herbaceous cover, introduction and propagation of invasive species, improper management of livestock grazing, fire suppression practices, and conifer encroachment. Within Nevada, threats to desert grasslands are habitat loss from the spread of invasive annual grasses (e.g., cheatgrass), wildfire frequency and severity, and conifer encroachment and infill. All these threats are interwoven, making holistic approaches for effecting management mechanisms and techniques paramount.

Cheatgrass has become the most problematic stressor to native perennial bunchgrass (and sagebrush-dominated) communities. This annual grass was introduced to western rangelands from Eurasia in the 1890s (Mack, 1981) and

Table 15: Percent of Desert Grasslands key habitat converted to agriculture, barren or sparsely vegetated cover, non-natural vegetation, and/or urbanized lands based on Landfire successional class analysis. Non-natural vegetation types include both nonnative exotic-dominated areas as well as areas dominated by natural vegetation that is outside the range of variation (cover, height, dominant type) that would be expected under typical conditions. Natural vegetation includes all areas remaining in young-old age successional classes as outlined below although the distribution of age classes within natural vegetation states may be outside of the range of variation expected under historic conditions.

PERCENT OF VEGETATED NEVADA KEY HABITATS CONVERTED TO OTHER CLASSES	
CURRENT STATE	**PERCENT HABITAT**
Agriculture	0.4%
Barren or Sparse	0.3%
Natural Vegetation	72.8%
Non-Natural Vegetation (invasive or native)	8.7%
Urban	17.8%

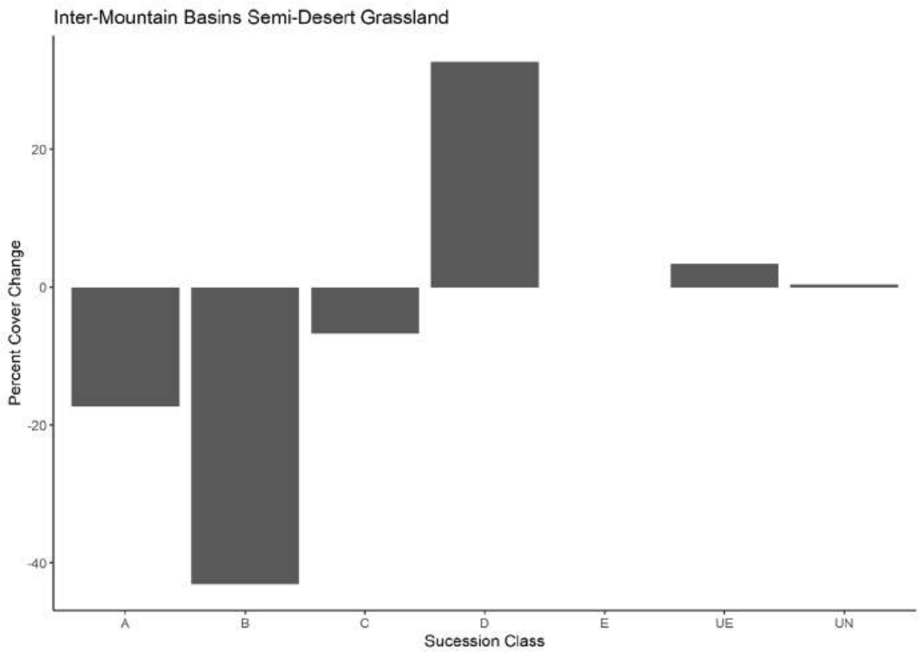


Figure 14. Succession class data for Inter-Mountain Basin Semi-Desert Grasslands. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

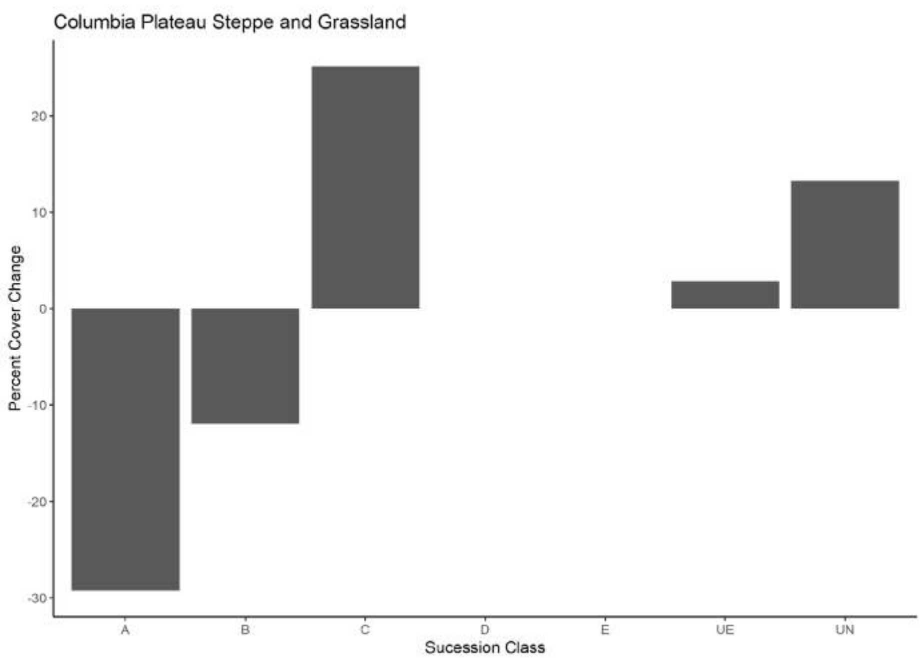


Figure 15. Succession class data for Columbia Plateau Steppe and Grassland. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

is well suited to Intermountain West climates. Cheatgrass exhibits a broader ecological amplitude (exploiting a larger gradient of xeric and mesic ecological sites) than native perennial bunchgrasses and has had profound effects on the physical and effective environments of native plant assemblages and communities (Chambers et al., 2014).

Cheatgrass establishment in the landscape and tendency to form monoculture stands has and is lowering native ecosystems' resilience and resistance qualities. For example, the reduction of an ecosystem's ability to regain and retain its fundamental functionality was described by the effects of cheatgrass on individual species community structure, both spatially and compositionally (Miller et al., 2011). The outcome can be further exacerbated when desert grassland communities are exposed to catalyst stressors like drought, fire, and overgrazing (Miller et al., 2011; Chambers et al., 2014).

Predicted Climate Change Effects

With current drier and warmer climatic conditions being experienced across the Great Basin, expansion of cheatgrass, dampening of native perennial bunchgrass successional stages, and tightening of fire return intervals are anticipated to continue. On lower drier sites, ecological consequences from such a climate shift would be similar to extended drought conditions. Accomplishing the task of returning degraded cold desert shrublands to their status as net carbon sinks will not be easy. The success of large-scale restoration through direct seeding is hampered by low and unpredictable amounts of precipitation, and this problem will only be exacerbated as the climate continues to warm (Finch, 2012). Many desert grassland sites and stands occur in basins surrounded by mountain ranges, which may allow for species in this system to transition into foothill elevational zones as the suitable climate is diminished at lower elevations.

Conservation Strategy

Objective 1: Stabilize semi-desert perennial grasslands by addressing conversion to shrub-dominated systems resulting from management practices that decrease the competitiveness of native perennial grasses.

- Action: Develop specific wildlife objectives and Best Management Practices for grasslands; incorporate them into land management (and grazing) planning processes where appropriate.
- Action: Inventory low elevation grasslands and their soil site potentials; incorporate native grassland maintenance and restoration objectives in fire rehabilitation plans.
- Action: Support maintenance of free-roaming equids populations within Appropriate Management Levels.

Objective 2: Stabilize perennial grasslands by addressing annual exotic grass invasions and rabbitbrush increases resulting from management practices that decrease the competitiveness of native perennial grasses.

- Action: Investigate the feasibility of restoring steppe grassland habitats to characteristic classes including the restoration of a fire return interval that discourages shrub encroachment applied at very small scales under controlled conditions and prescriptive chemical treatments to preclude annual exotic invasive grass establishment and dominance.
- Action: Chemically treat and/or seed semi-desert grassland sites with native grasses appropriate to the site after a fire or chemical treatment.


Source: NDOW

Priority Research Needs

- Inventory and analysis of anticipated shifts in annual grass proliferation and distribution with differing climate regimes.
- Investigate the effectiveness of landscapescale chemical treatments to dampen close loop fire cycles of invasive annuals.
- Increasing resistance and resilience of native grassland sites at scales reasonable to land managers.

Key SGCN Species

- Western toad (*Anaxyrus boreas*)
- Bobolink (*Dolichonyx oryzivorus*)
- Long-billed Curlew (*Numenius americanus*)
- Prairie falcon (*Falco mexicanus*)
- Short-eared owl (*Asio flammeus*)
- Swainson's hawk (*Buteo swainsoni*)
- Western burrowing owl (*Athene cunicularia hypugaea*)
- Desert kangaroo rat (*Dipodomys deserti*)
- Eastgate pocket gopher (*Thomomys bottae lucrificus*)
- Fish Springs pocket gopher (*Thomomys bottae abstrusus*)
- Pale kangaroo mouse (*Microdipodops pallidus*)
- San Antonio pocket gopher (*Thomomys bottae curtatus*)
- Pygmy short-horned lizard (*Phrynosoma douglasii*)
- Checkered white (*Pontia protodice*)
- Common sootywing (*Pholisora catullus*)
- Large marble (*Euchloe ausonides*)
- Marine blue (*Leptotes marina*)
- Melissa blue (*Plebejus melissa*)
- Monarch (*Danaus plexippus plexippus*)
- Mt. Charleston blue (*Icaricia shasta charlestonensis*)
- Nevada skipper (*Hesperia nevada*)
- Ruddy copper (*Tharsalea rubidus*)
- Sandhill skipper (*Polites sabuleti*)
- Sara orangetip (*Anthocharis sara*)
- West Coast lady (*Vanessa annabella*)
- Western tailed-blue (*Cupido amyntula*)

Sagebrush: High and Low Elevation Sagebrush Dominated Shrublands

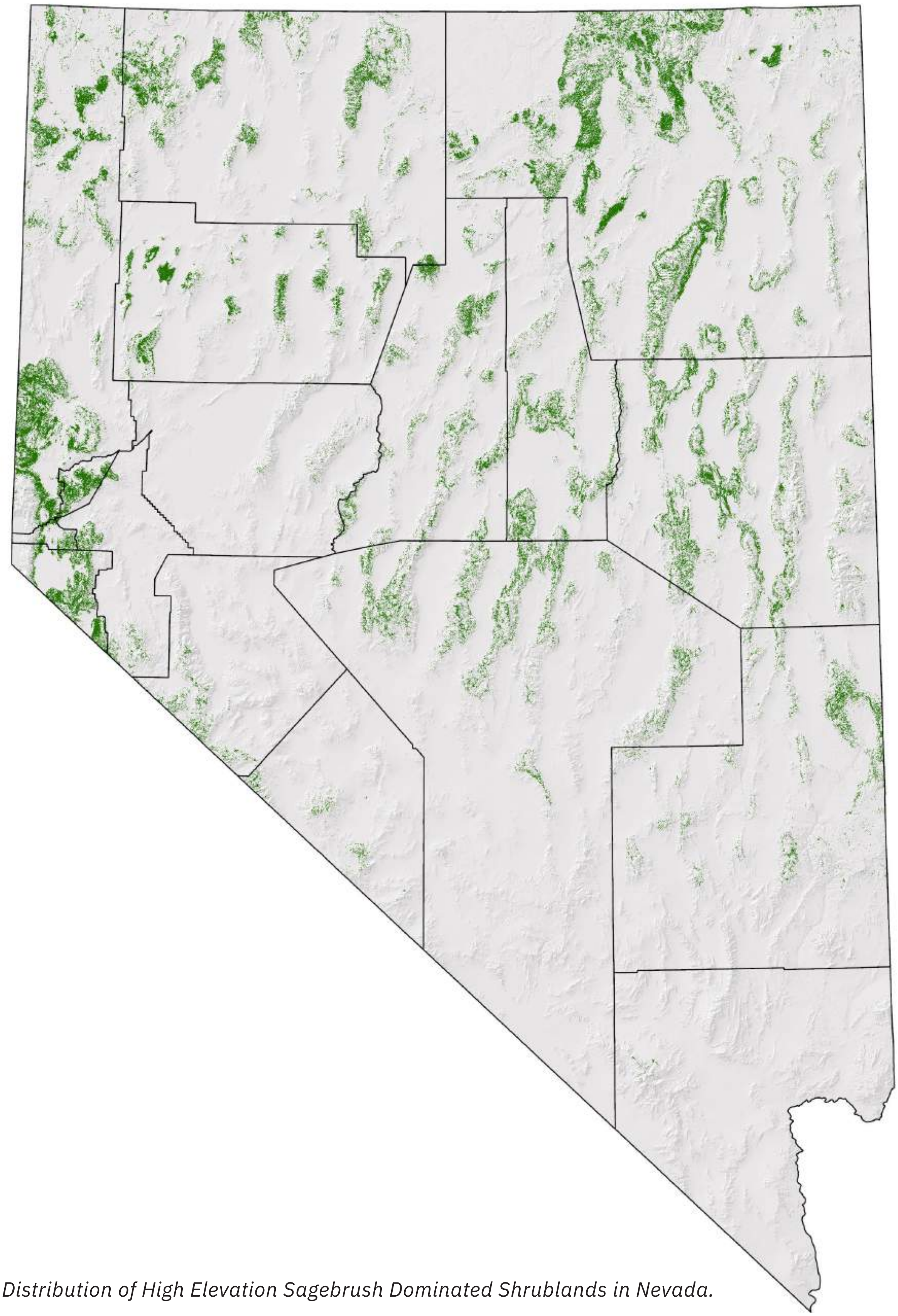


Figure 16. Distribution of High Elevation Sagebrush Dominated Shrublands in Nevada.

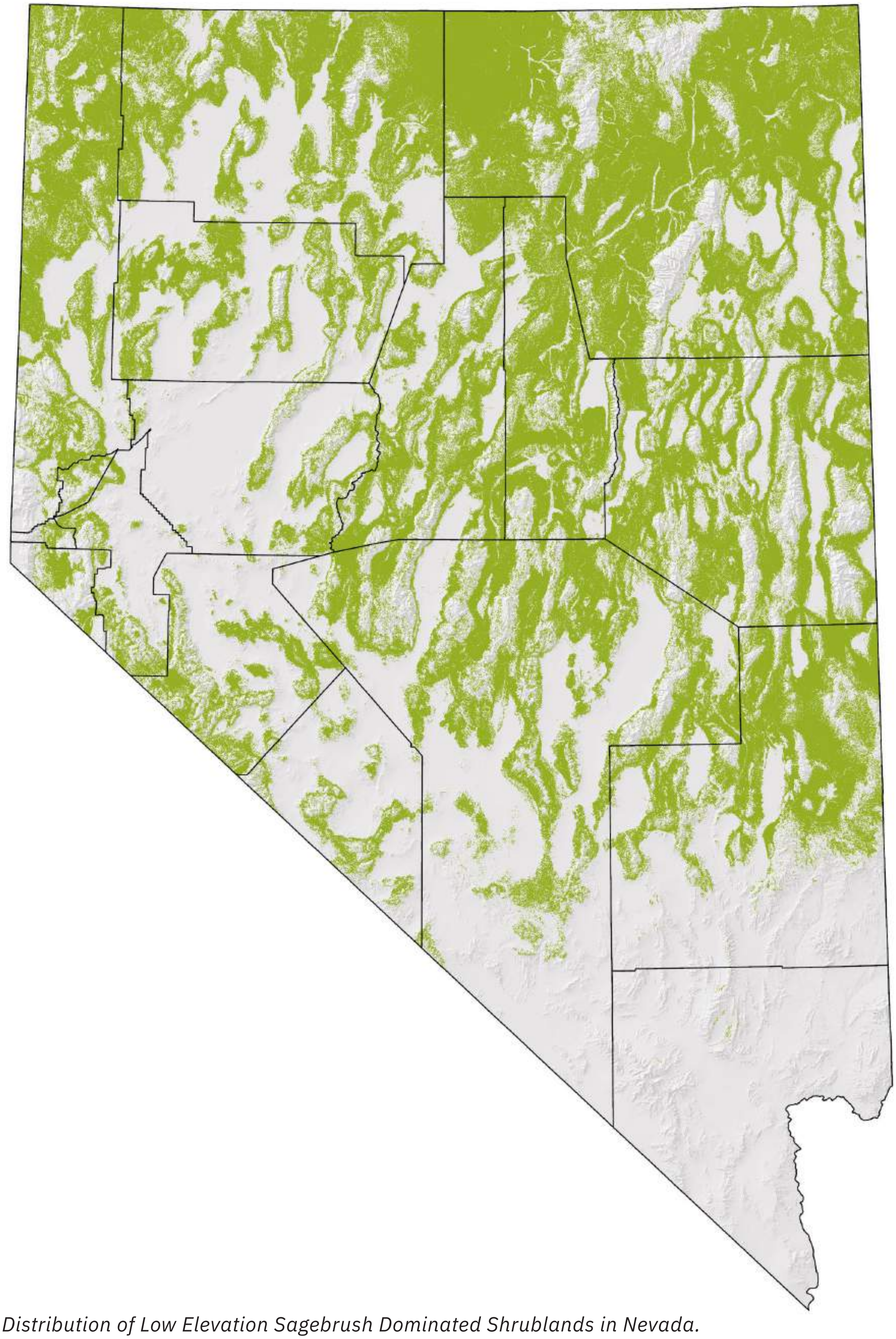


Figure 17. Distribution of Low Elevation Sagebrush Dominated Shrublands in Nevada.

Key Habitat Description and Elements of Sagebrush

Vegetation and Abiotic Environment

The sagebrush biome supports more than 350 plant and animal species throughout the west (Wisdom et al., 2005a). Sagebrush generally occurs throughout the Great Basin and is most common in valleys and mountain ranges north of the Mojave Desert. Sagebrush habitat types are generally found in a mosaic with other habitat types (aspen, riparian, salt desert scrub, pinyon juniper, lower montane woodlands, montane shrublands, coniferous forest, etc.) but can occur as large monotypic expanses. Sagebrush generally occurs as the dominant or co-dominant shrub in many plant communities. Given the mixed patterns of sagebrush across the landscape, the community is often referred to as the sagebrush ecosystem or biome. Sagebrush habitats generally occur between 4,500 and 10,000 feet and are widespread throughout valley, foothill, and mountain environments. Annual precipitation ranges from 6 to 35 inches, mostly in the form of snow, and temperatures range from -30 to 110 degrees Fahrenheit. Overstory structures can range from 10-50% cover and heights less than 6 inches on exposed slopes to 15-20 feet high in drainages where basin big sagebrush has extended its roots into the water table.

There are some 27 recognized species and distinct subspecies of sagebrush in Nevada. Dominant species include basin big sagebrush (*Artemisia tridentata ssp. tridentata*), mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*), Wyoming big sagebrush (*Artemisia tridentata ssp. Wyomingensis*), low sagebrush (*Artemisia arbuscula*), and black sagebrush (*Artemisia nova*) (Cronquist et al., 1994). For this SWAP, sagebrush is separated into two primary habitat communities: High Elevation Sagebrush and Low Elevation Sagebrush.

High Elevation Sagebrush

These communities are typically less than five-feet tall and dominated by Mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*). A variety of other shrubs can be found in some occurrences, but these are seldom dominant. They include black sagebrush (*Artemisia nova*), low sagebrush (*Artemisia arbuscula*), silver sagebrush (*Artemisia cana ssp. viscidula*), fringed sagebrush (*Artemisia rigida*), rubber rabbitbrush (*Ericameria nauseosa*), green rabbitbrush (*Chrysothamnus viscidiflorus*), ephedra (*Ephedra spp.*), mountain snowberry (*Symphoricarpos oreophilus*), antelope bitterbrush (*Purshia tridentata*), wax currant (*Ribes cereum*), and serviceberry (*Amelanchier alnifolia*). The canopy cover is usually between 20-80% (Landfire, 2020).

The herbaceous layer is usually well-represented, but bare ground may be common in particularly arid or disturbed occurrences. Graminoids that can be abundant include Idaho fescue (*Festuca idahoensis*), squirreltail (*Elymus elymoides*), needlegrass (*Stipa spp.*), western wheatgrass (*Pascopyrum smithii*), mountain brome (*Bromus marginatus*), prairie junegrass (*Koeleria macrantha*), bluebunch wheatgrass (*Pseudoroegneria spicata*), Thurber's needlegrass (*Achnatherum therburianum*), or Sandberg's bluegrass (*Poa secunda*). Forbs are often numerous and an important indicator of health and important for wildlife values. Forb species may include paintbrush (*Castilleja spp.*), cinquefoil (*Potentilla spp.*), fleabane (*Erigeron spp.*), Phlox (*Phlox spp.*), milkvetch (*Astragalus spp.*), Lupine (*Lupinus spp.*), buckwheat (*Eriogonum spp.*), balsamroot (*Balsamorhiza spp.*), yarrow (*Achillea millefolium*), pussytoes

(*Antennaria spp.*) among many other genera (Mueggler & Stewart, 1980; Hironaka et al., 1983; Tart, 1996)).

These communities support a myriad of sagebrush obligate and more generalized wildlife species. Several species, including sage-grouse and mule deer, are predominantly dependent on sagebrush habitats for meeting most of their life history needs. High Elevation Sagebrush in good condition and having a healthy understory supports a wider diversity of wildlife. The diversity of forage species makes High Elevation Sagebrush particularly important as summer habitat (NDOW, 2019).

Low Elevation Sagebrush

These less resistant and resilient communities are composed of mostly Wyoming sagebrush and basin big sagebrush occurring in concave slopes and inset alluvial fans, and black sagebrush and low sagebrush, mostly on convex slopes. Other shrubs can be found and are sometimes dominant. They include horsebrush (*Tetradymia spp.*), spiny hopsage (*Grayia spinosa*), rubber rabbitbrush (*Ericameria nauseosa*), green rabbitbrush (*Chrysothamnus viscidiflorus*), ephedra (*Ephedra spp.*), shadscale (*Atriplex confertifolia*), four-wing saltbush (*Atriplex canescens*), and greasewood (*Sarcobatus spp.*) (Landfire, 2020).

The herbaceous layer is typically less well-represented than High Elevation Sagebrush plant communities with more bare ground present. Graminoids that can be abundant include squirreltail (*Elymus elymoides*), needlegrass (*Stipa spp.*), bluebunch wheatgrass (*Pseudoroegneria spicata*), Thurber's needlegrass (*Achnatherum therburianum*), Indian ricegrass (*Achnatherum hymenoides*), or Sandberg's bluegrass (*Poa secunda*). The invasive annual cheatgrass (*Bromus tectorum*) and multiple annual invasive forbs are also abundant in sites and present a serious threat to increased fire cycles related to increased fine fuel loading. Forbs are typically less abundant within the Low Elevation Sagebrush plant communities but can vary and be abundant in some Wyoming and low sagebrush plant communities. Forb species may include paintbrush (*Castilleja spp.*), Fleabane (*Erigeron spp.*), Phlox (*Phlox spp.*), milkvetch (*Astragalus spp.*), Buckwheat (*Eriogonum spp.*), balsamroot (*Balsamorhiza spp.*), yarrow (*Achillea millefolium*), pussytoes (*Antennaria spp.*) among many other genera (Mueggler & Stewart, 1980; Hironaka et al., 1983; Tart, 1996)) (Landfire, 2020).

Low Elevation Sagebrush support numerous sagebrush obligate and more generalized wildlife species. Several species, including sage-grouse, pygmy rabbit, Great Basin pocket mouse, sagebrush vole, sagebrush lizard, sage thrasher, Brewer's sparrow, and sage sparrow, are predominantly dependent on sagebrush habitats for meeting most of their life history needs. Low Elevation Sagebrush in good condition and having a healthy understory supports a wider diversity of wildlife and is often particularly important as winter habitat with low snow accumulations and ready access to forage species. Much of this valuable winter habitat has been converted to less beneficial cheatgrass or conifer-dominated communities (NDOW, 2019).

General Wildlife Values

In Nevada, eight species are predominantly dependent on sagebrush habitat for most of their life history needs: pygmy rabbit (*Brachylagus idahoensis*), Great Basin pocket mouse (*Perognathus parvus*), sagebrush vole (*Lemmiscus curtatus*), sagebrush lizard (*Sceloporus graciosus*), greater sage-grouse (*Centrocercus urophasianus*), sage thrasher (*Oreoscoptes montanus*), Brewer's sparrow (*Spizella breweri*), and sage sparrow (*Artemisiospiza nevadensis*) (the last three also occur as breeding species in cold desert scrub but to a much lesser extent) (WAPT, 2012). While these eight are entirely or nearly entirely dependent on sagebrush habitat, approximately 367 species, including mammals, birds, reptiles, invertebrates, and plants, depend upon this habitat type at some point during the natural life cycle (Wisdom et al., 2005b).

Healthy sagebrush habitat also supports a diverse undergrowth of bunchgrasses and forbs. The presence of this highly productive understory is critical to the needs of other wildlife species. The various shrew species that live in sagebrush are insectivores, but they depend on the productivity of the herbaceous component for the abundant production of their prey items, as well as for cover. Several species nest in sagebrush habitat, and on habitats adjacent to sagebrush habitat, spending time foraging or hunting prey on ground squirrels and jack rabbits (e.g., prairie falcons on cliffs and rimrock, and ferruginous hawks on the pinyon-juniper edge or sometimes on rimrock) (WAPT, 2012).

Existing Environment

Dominant Biophysical Settings

The dominant biophysical settings comprising High and Low Elevation Sagebrush (Tables 16 and 17).

Table 16: Dominant biophysical settings comprising High Elevation Sagebrush Dominated key habitats in Nevada. Roughly 3,417,079 acres of Nevada may have historically supported high elevation sagebrush-dominated shrublands communities based on biophysical setting analysis.

HIGH ELEVATION SAGEBRUSH DOMINATED SHRUBLANDS	3,417,079 ACRES
Inter-Mountain Basins Montane Sagebrush Steppe	3,417,079 acres

Table 17: Dominant biophysical settings comprising low elevation sagebrush dominated shrublands key habitats in Nevada. Roughly 28,287,739 acres of Nevada may have historically supported low elevation sagebrush-dominated shrublands communities based on biophysical setting analysis.

LOW ELEVATION SAGEBRUSH DOMINATED SHRUBLANDS	28,287,739 ACRES
Great Basin Xeric Mixed Sagebrush Shrubland	14,571,107 acres
Inter-Mountain Basins Big Sagebrush Shrubland-Upland	7,156,884 acres
Inter-Mountain Basins Big Sagebrush Shrubland-Semi-Desert	3,839,987 acres
Inter-Mountain Basins Big Sagebrush Steppe	2,641,751 acres
Other	78,010 acres


Source: NDOW


Source: NDOW

Habitat Conditions

Nevada's sagebrush ecosystems, like those across the West, have faced unprecedented and increasing range-wide rates of change in the recent past (Remington et al., 2021). Fire suppression and overgrazing have decreased fire return intervals at high elevations leading to pinyon and juniper encroachment and infilling particularly at higher elevations (Miller & Eddleman, 2001). These same trends can be found in some locations at lower elevations; however, increased fire return intervals are more problematic at lower elevations with invasive annual grasses and forbs creating a persistent and continuous fuel structure.

Much of the basin big sagebrush and Wyoming big sagebrush range in Nevada currently lacks an understory of native bunchgrasses and forbs that were historically present. Shrub cover has increased from what are generally regarded as pre-settlement conditions, and non-native annual grasses, most notably cheatgrass, along with invasive annual forbs including storksbill (*Erodium cicutarium*), burr buttercup (*Ceratocephala testiculata*), and multiple Brassicaceous species have invaded big sagebrush range, bringing with them an accelerated fire interval for which sagebrush regeneration cannot compensate. Historic, and in some cases current, overgrazing has depleted perennial bunchgrasses, which is problematic given that this functional group is most competitive at suppressing annual invasive grasses (Bates & Davies, 2014, Blank & Morgan, 2012; Chambers et al., 2007; Davies & Johnson 2017; Reisner et al., 2013). Low and black sagebrush are being similarly invaded by cheatgrass throughout the state.

PERCENT OF VEGETATED NEVADA DOMINATED SHRUBLANDS CONVERTED TO OTHER CLASSES

Table 18: Percent of high and low elevation sagebrush-dominated shrublands key habitat types converted to agriculture, barren or sparsely vegetated cover, non-natural vegetation, and/or urbanized lands based on Landfire successional class analysis. Non-natural vegetation types include both non-native exotic dominated areas as well as areas dominated by natural vegetation that is outside the range of variation (cover, height, dominant type) that would be expected under typical conditions. Natural vegetation includes all areas remaining in young-old age successional classes as outlined below although the distribution of age classes within natural vegetation states may be outside of the range of variation expected under historic conditions.

HIGH ELEVATION SAGEBRUSH DOMINATED SHRUBLANDS	
CURRENT STATE	**PERCENT HABITAT**
Agriculture	0.10%
Barren or Sparse	0.18%
Natural Vegetation	85.11%
Non-Natural Vegetation (invasive or native)	14.32%
Urban	0.30%
LOW ELEVATION SAGEBRUSH DOMINATED SHRUBLAND	
CURRENT STATE	**PERCENT HABITAT**
Agriculture	5.44%
Barren or Sparse	3.77%
Natural Vegetation	67.61%
Non-Natural Vegetation (invasive or native)	22.57%
Urban	0.60%

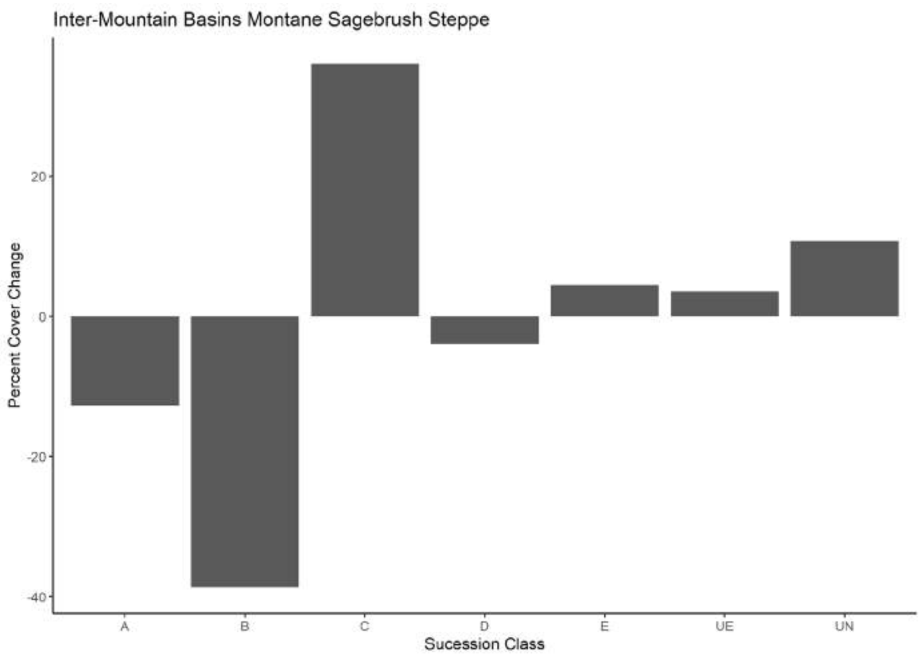


Figure 18. Succession class data for biophysical setting Inter-Mountain Basins Montane Sagebrush Shrublands. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

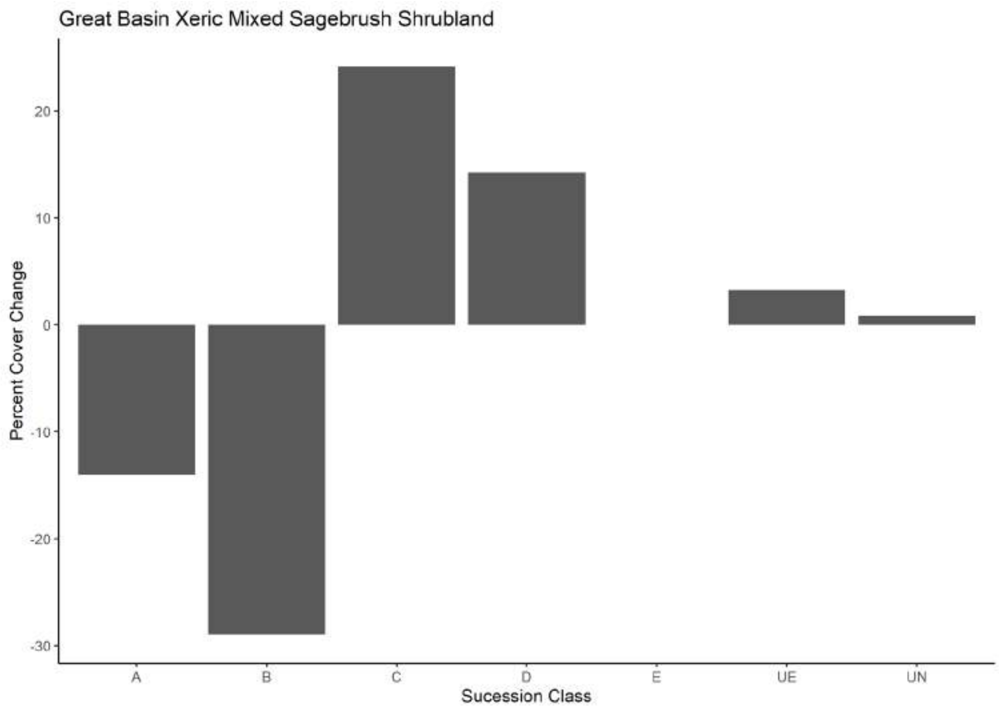


Figure 19. Succession class data for biophysical setting Great Basin Xeric Mixed Sagebrush Shrublands. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

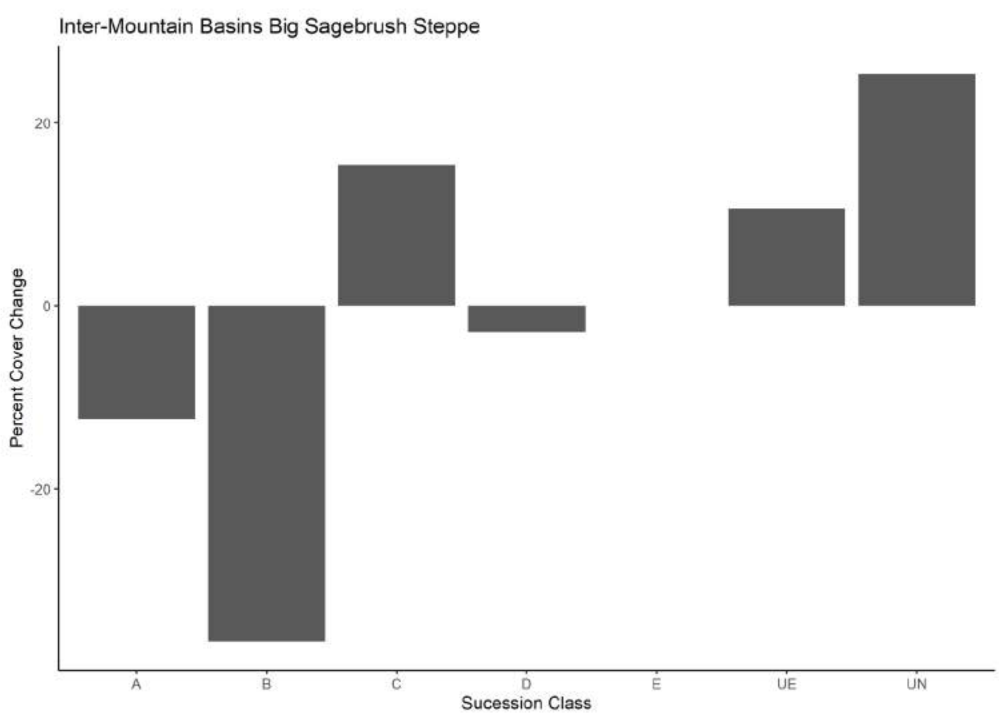


Figure 20. Succession class data for biophysical setting Inter-Mountain Basins Big Sagebrush Steppe. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

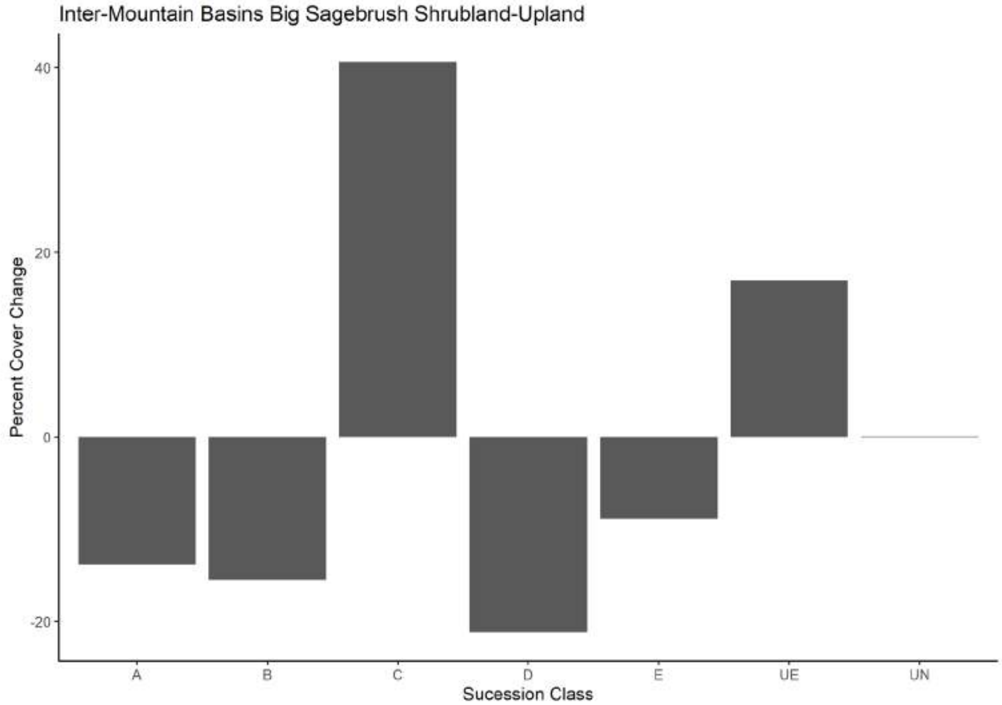


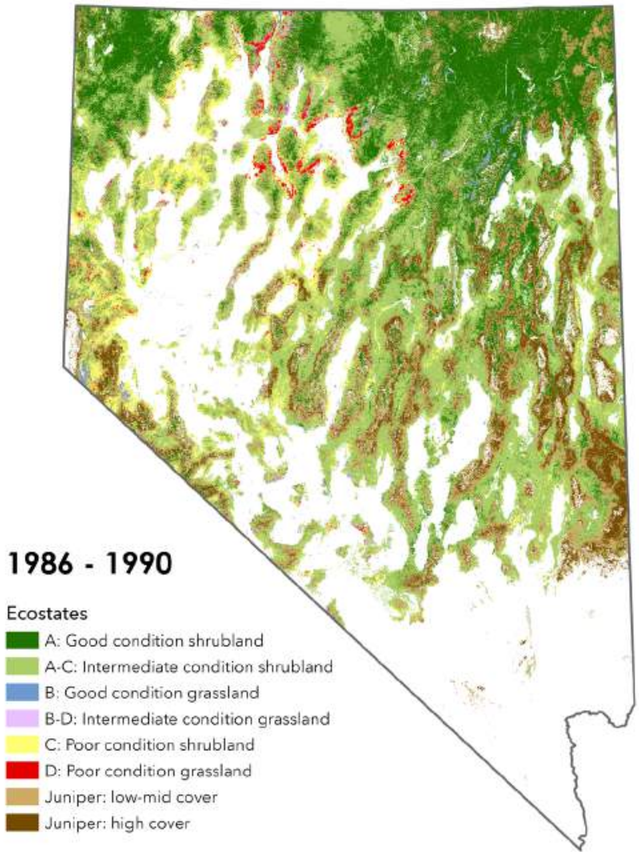
Figure 21. Succession class data for biophysical setting Inter-Mountain Basins Big Sagebrush Shrubland-Upland. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

In northern Nevada, medusahead grass (*Taeniatherum caput-medusae*), which is an aggressive exotic grass that can tolerate the shallow clay soils of these range sites can cause a similar negative impact. Overall, a temporal conversion from shrubland with high species diversity to annual grassland with drastically reduced wildlife value is occurring.

Pinyon pine and juniper expansion into shrubland has thrived with range overgrazing from the 19th Century through the first half of the 20th Century (Young & Sparks, 2002), and fire suppression after the 1920s (Blackburn & Tueller, 1970; Pyne, 2004). Pinyon-juniper expansion into sagebrush drastically alters vegetation community structure and creates conditions difficult to restore to pre-invasion conditions. Pinyon-juniper expansion is also generally facilitated by regional warming (Tausch & Nowak, 1999). Currently, there is considerable discussion in Nevada on the need to manipulate the balance between woodland expansion and healthy sagebrush community maintenance in light of the recent effort to list the greater sage-grouse (*Centrocercus urophasianus*) under the Endangered Species Act (WAPT, 2012).

Habitat Threats

Potential sagebrush systems within Nevada, pre-European settlement, represented an estimated 31,704,818 acres, or roughly 44.81% of the State (NDOW, Landfire 2020). Numerous threats exist in sagebrush habitats and the relatively arid and low resistance and resilience of this ecosystem explain much of the loss, especially within the Great Basin. Wildfire and invasive species, conifer invasion, overutilization of domestic and feral equids, land use and development, climate change, and drought are the primary threats leading to degraded and



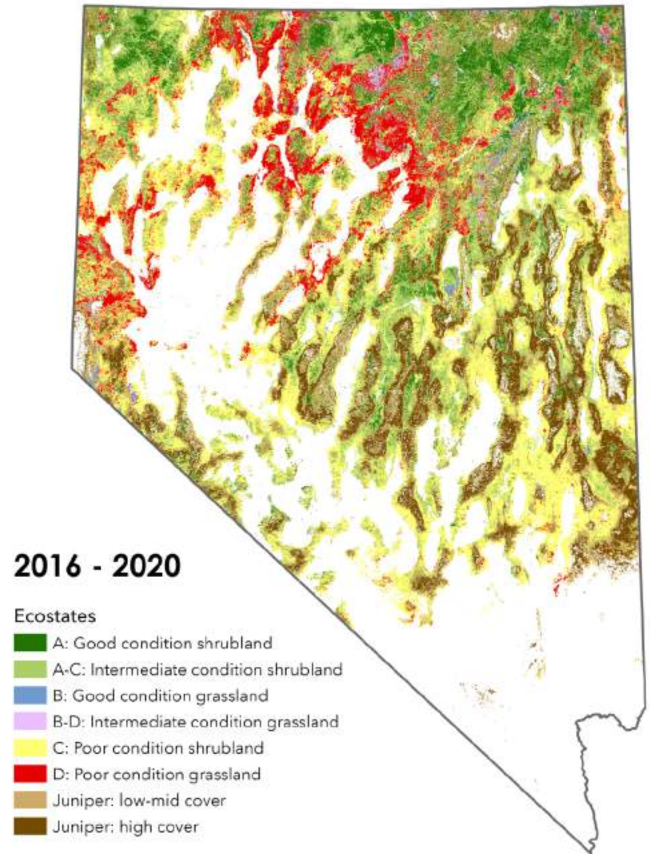


Figure 22. Ecostate time series of potential sagebrush habitat in Nevada. Time series maps are based on the cover and proportion of functional groups including shrub cover, perennial grass and for cover, annual grass and forb cover, and tree cover within Nevada's high and low elevation sagebrush-dominated key habitats. Habitat areas are masked to Landfire biophysical settings representing potential sagebrush vegetation communities.

fragmented habitat conditions. Individually these threats are serious but cumulatively they threaten the High and Low Elevation Sagebrush habitat types.

Loss of sagebrush habitat due to multiple stressors and impacts has been far reaching at the state level over the last several decades (Figure 22; NDOW, analysis following SageCon 2021). During this period, good and intermediate quality sagebrush habitat within Nevada declined from 70.2 % of potential habitat to 35.5% of potential habitat. Loss of habitat has been largest in warmer, drier, and generally lower-elevation sites; continued climate change may exacerbate current trends in degradation and loss of these systems resulting in increasingly fewer restoration opportunities aimed at resisting losses or restoring previously compromised habitat.

Wildfire and Invasive Species

Wildfire and the invasion of annual grasses are considered the greatest threat to Nevada sagebrush habitats. Historical and contemporary management practices have led to reduced resistance and resilience in sagebrush plant communities and altered the natural fire regime. These altered fire regimes are resulting in large-scale ecotype conversion from native shrub-perennial herbaceous community conversions to fire-prone, non-native annual plant communities. Subsequently, accelerated fire cycles, increased fire size and severity, and longer fire seasons, are outpacing postfire recovery and management practices. It is currently estimated that land managers are addressing less than 10% of the average annual rate of spread of invasive plants (Remington et al., 2021).

Conifer Invasion

Pinyon and juniper encroachment has increased considerably in cover and density in Nevada and is well documented (Miller et al., 2019). The detrimental effects of pinyon-juniper encroachment impact sagebrush plant community composition and productivity, water and nutrient cycles, and resilience to fire and resistance to cheatgrass, and has compromised wildlife habitat values (Remington et al., 2021).

Overutilization

Historic and current (location specific) cattle and free-roaming equid populations have resulted in a reduction and loss of perennial bunchgrasses. The loss of perennial bunchgrasses has compromised the integrity of many sagebrush plant communities lowering their resistance and resilience potentials and allowing for cheatgrass and other non-native invasive species to be present and sometimes abundant. Impacts are particularly pronounced at sites near water (springs, meadows, riparian) (Remington et al., 2021).

Historic land conversion and contemporary land use and development (e.g., urban/suburban sprawl, recreation, roads, mining, renewable energy, conversion to agriculture, off-highway vehicle use, etc.) further fragment the sagebrush sea. Additionally, these activities have accommodated and promoted invasive species spread. These greater demands on sagebrush communities have increased fire ignitions and further propagated the wildfire-invasive grass cycle (Remington et al., 2021).

This combination of major habitat type conversions is rapidly depleting and fragmenting the expansive sagebrush sea. New road development, existing road improvement, and urban/suburban and industrial development are also contributing to depletion and fragmentation. Increased human population in several areas of the state has exerted increased pressure on the landscape, and thus sagebrush community integrity will continue to be challenged over time.

Climate Change Vulnerability

High Elevation Sagebrush

Within the Nevada portion of the High Elevation Sagebrush key habitat distribution, overall HCCVI is 46% in moderate and 53% in high relative vulnerability. Exposure is 11% severe, 68% high, 17% moderate, and 5% low. This overall exposure estimate results from contrasting component measures, with climate departure scoring at 80% severe while change in suitability, factoring in actual climate variability across the range of the type, scored as 67% low and 29% moderate. By mid-century and assuming a higher emission scenario (8.5), several climate variables are projected to have departed by greater than two standard deviations from the 20th-century baseline mean. These include Annual Mean Temperature (increasing 2.9 degrees Celsius) and Mean Temperature of the Warmest Quarter (increased by 3.4 degrees Celsius).

Overall resilience is measured at 82% moderate within the state, and with 18% of the area with higher vulnerability from resilience measures. Among resilience measures, fire regime departure contributes most toward vulnerability, with 24% of area scoring moderate and 76% high. This could be partially explained by juniper expansion into this sagebrush steppe. Given the relatively unfragmented distribution and elevation where this shrub steppe occurs, both landscape condition and invasive annual grass contribute relatively little to vulnerability within Nevada.

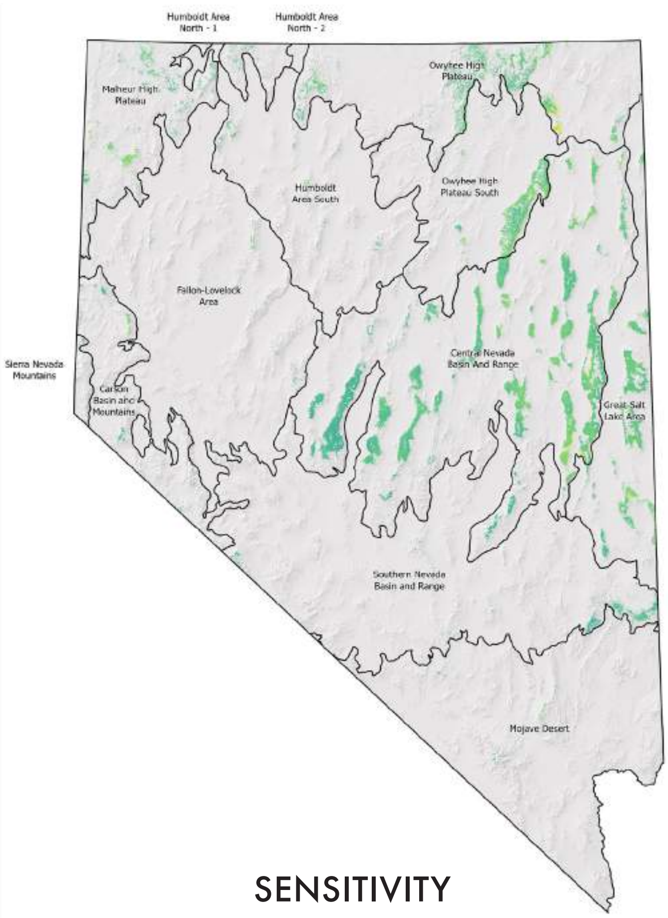
Table 19: Percentage of potential High Elevation Sagebrush Dominated Shrubland Key Habitats within Nevada with Low, Moderate, High, and Severe Overall Vulnerability, Exposure, and Resilience.

		PERCENT AREA WITHIN EACH RELATIVE VULNERABILITY RANKING			
		LOW	MODERATE	HIGH	SEVERE
Climate Change Vulnerability Index		1%	46%	53%	0%
Vulnerability from Measures of Exposure	Climate Departure	5%	6%	9%	80%
	Climate Suitability	67%	29%	5%	0%
	Overall Exposure	5%	17%	68%	11%
Vulnerability from Measures of Sensitivity	Landscape Condition	74%	22%	4%	<1%
	Fire Regime Departure	20%	24%	76%	0%
	Invasive Annual Grasses	68%	15%	12%	5%
	Overall Sensitivity	37%	52%	11%	0%
Vulnerability from Measures of Adaptive Capacity	Topoclimatic Variability	<1%	24%	71%	5%
	Overall Adaptive Capacity	0%	29%	71%	0%
Vulnerability from Measures of Overall Resilience		0%	82%	18%	0%

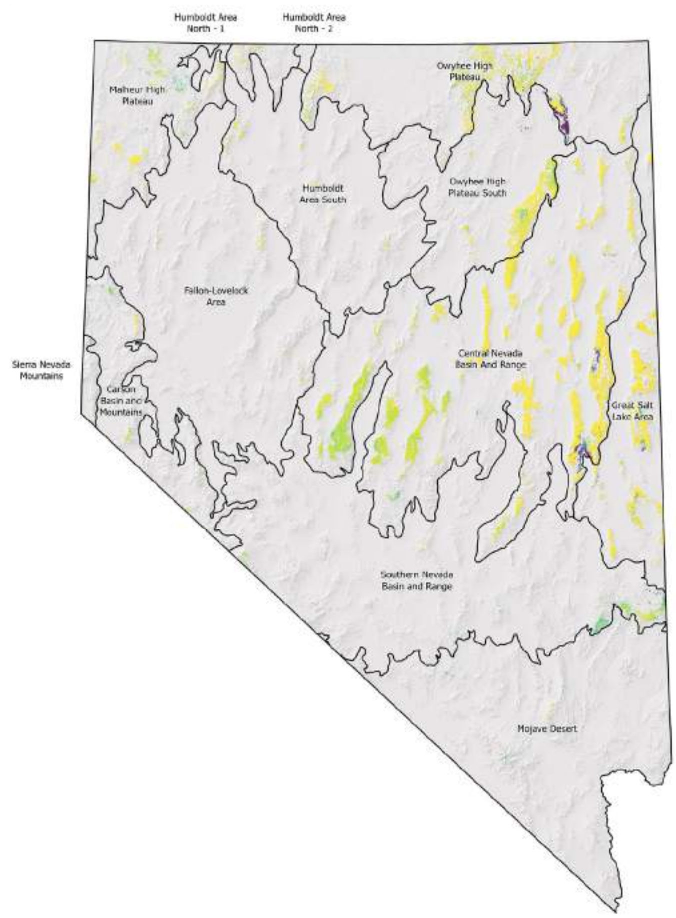
However, even though these sagelands occur along the mountain slopes of basin and range landscapes, relatively limited topographic roughness contributes to moderate vulnerability in 24% of the state's area and 71% contributes toward high vulnerability (e.g., on montane plateaus).

When viewed across the MLRAs in Nevada (Figure 23), patterns of climate change vulnerability vary, with a moderate estimated vulnerability found in substantial proportions of each MLRA statewide. Those areas supporting these sagebrush habitats with the least severe vulnerability are concentrated in the Central Nevada Basin and Range (Toiyabe Range), and in scattered portions of the Malheur High Plateau, Owyhee High Plateaus (North and South), and Southern Nevada Basin and Range MLRAs within Nevada. These patterns are explained as much by patterns of climate exposure (mostly moderate-high statewide) but more so by resilience measures. Sensitivity components of resilience, appear to be least severe in sagebrush habitats throughout the Central Nevada Basin and Range and adjacent Great Salt Lake Area MLRAs.

OVERALL VULNERABILITY (HCCVI)



EXPOSURE



SENSITIVITY

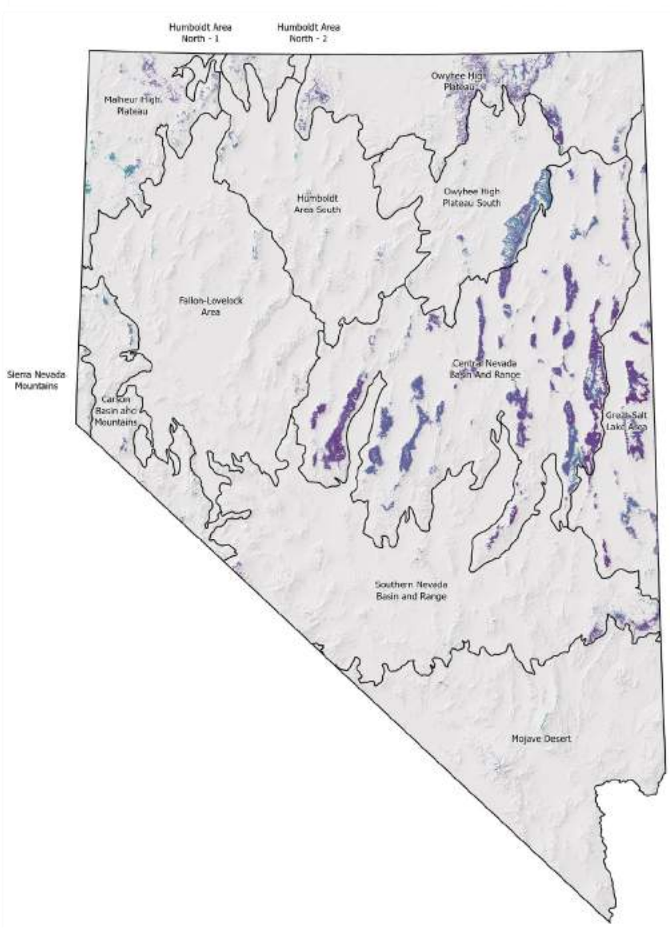
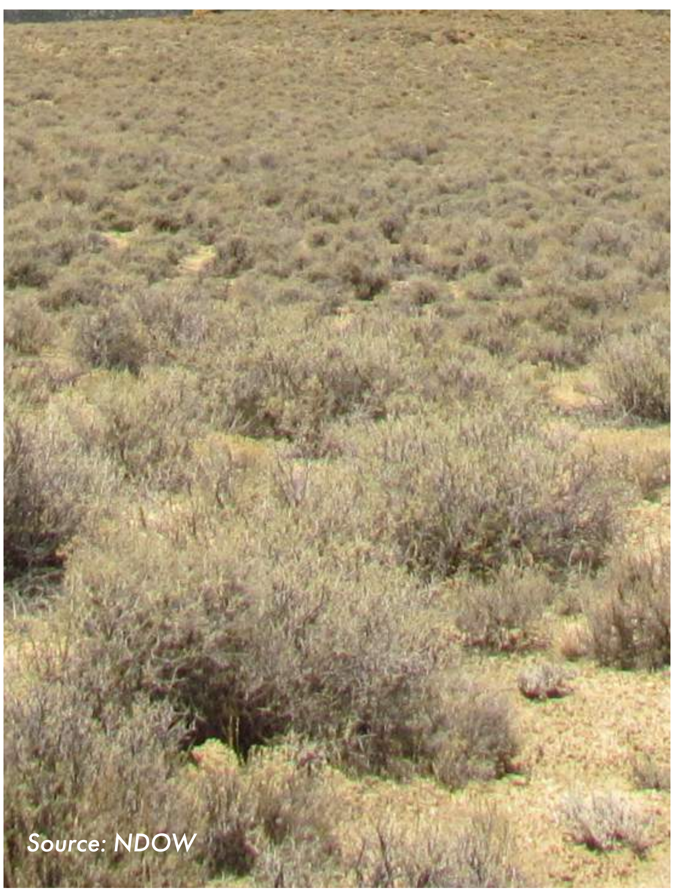


Figure 23. High elevation sagebrush patterns of climate change vulnerability across MLRAs in Nevada. Overall HCCVI vulnerability measures incorporate patterns of potential climate exposure and habitat resilience, which incorporates ecosystem sensitivity and adaptive capacity (overall sensitivity shown here). Vulnerability, ranked from low to severe, is spatially variable based on multiple components of exposure and sensitivity.


Source: NDOW


Source: NDOW

Low Elevation Sagebrush Key Habitat

Within the Nevada portion of the Low Elevation Sagebrush distribution, overall HCCVI is 80% in moderate and 19% in low relative vulnerability. Exposure is 22% moderate and 77% low. This overall exposure estimate results from similar component measures, with climate departure scoring at 68% low, 27% moderate, and 5% high, while change in suitability, factoring in actual climate variability across the range of the type, scored as 74% low, 21% moderate, and 5% high. By mid-century and assuming a higher emission scenario (8.5), several climate variables are projected to have departed by greater than two standard deviations from the 20th-century baseline mean. These include Annual Mean Temperature (increasing 2.9-3.0 degrees Celsius), Mean Temperature of the Warmest Quarter (increased by 3.4-3.5 degrees Celsius), and Maximum Temperature of the Warmest Month (increased by 3.5-3.6 degrees Celsius).

Vulnerability contributed by overall resilience is measured at 65% moderate and 35% high within the state. Among resilience measures, sensitivity measures contribute toward vulnerability, with 28% of areas scoring moderate and 6% high contributed to altered landscape condition. Fire regime departure scores 40% moderate vulnerability and 59% high vulnerability. Impacts of invasive plants vary in their impact on resilience, with 58% of land area scoring low, 16% moderate, 17% high, and 9% severe. Since this low elevation sagebrush occurs throughout flats and rolling plains in this basin and range landscape, very low topographic roughness contributes to high vulnerability in 59% of the state area and 37% contributes to severe vulnerability.

Table 20: Percentage of potential Low-Elevation Sagebrush Dominated Shrubland Key Habitats within Nevada with Low, Moderate, High and Severe Overall Vulnerability, Exposure, and Resilience.

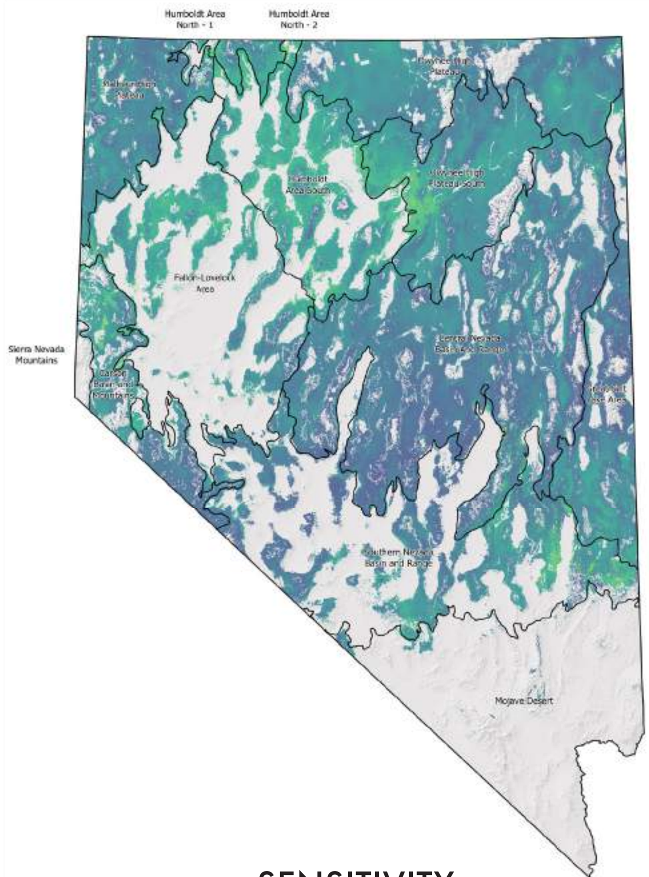
		PERCENT AREA WITHIN EACH RELATIVE VULNERABILITY RANKING			
		LOW	MODERATE	HIGH	SEVERE
Climate Change Vulnerability Index		19%	80%	1%	0%
Vulnerability from Measures of Exposure	Climate Departure	68%	27%	5%	<1%
	Climate Suitability	74%	21%	5%	<1%
	Overall Exposure	77%	22%	1%	0%
Vulnerability from Measures of Sensitivity	Landscape Condition	65%	28%	6%	1%
	Fire Regime Departure	1%	40%	59%	0%
	Invasive Annual Grasses	58%	16%	17%	1%
	Overall Sensitivity	31%	55%	14%	0%
Vulnerability from Measures of Adaptive Capacity	Topoclimatic Variability	0%	4%	59%	37%
	Overall Adaptive Capacity	0%	5%	95%	0%
Vulnerability from Measures of Overall Resilience		<1%	65%	35%	0%

When viewed across the MLRAs in Nevada (Figure 24), patterns of climate change vulnerability vary, with the lowest estimated vulnerability found in substantial proportions of each MLRA statewide; and most concentrated in the Central Nevada Basin and Range and adjacent MLRAs. Those areas supporting these Low Elevation Sagebrush habitats with more severe vulnerability are concentrated in the Humboldt Area South, western portions of the Owyhee High Plateau South, the Fallon-Lovelock Area, and eastern extremes of the Southern Nevada Basin and Range MLRAs within Nevada. These same patterns are generally followed in summary measures of climate exposure and sensitivity.

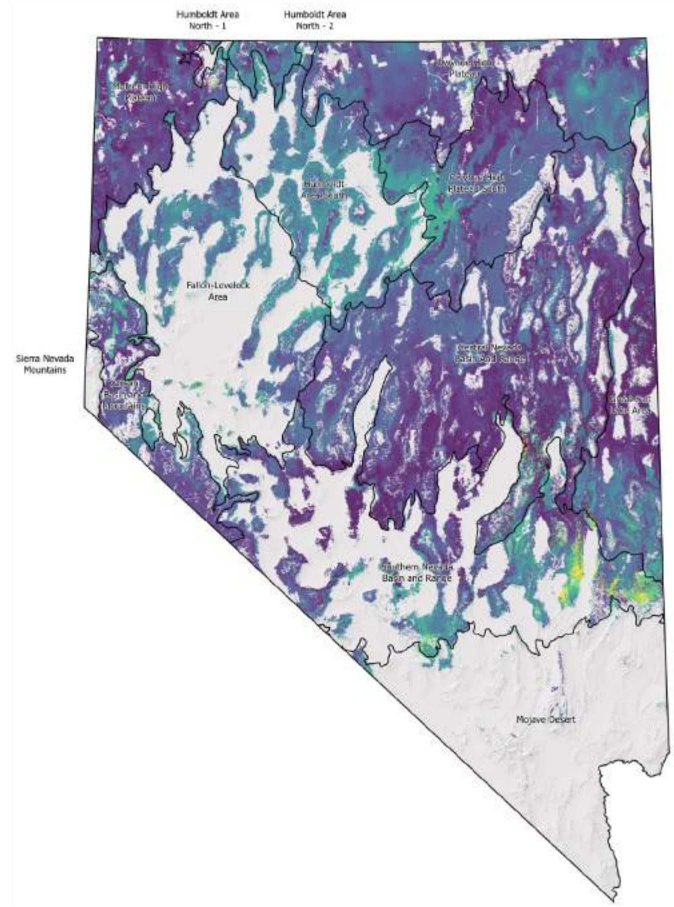
Predicted Climate Change Effects

Recent analysis projects highly variable changes in chronic drought (2070-2100 versus 1980-2010) across the intermountain west, particularly within the basin and range landscapes of Nevada where the projected number of days of dry topsoil conditions tends to increase in the western Great Basin and decrease in the eastern Great Basin; however, extreme drought conditions are projected to increase across the southwest with serious

OVERALL VULNERABILITY (HCCVI)



EXPOSURE



SENSITIVITY

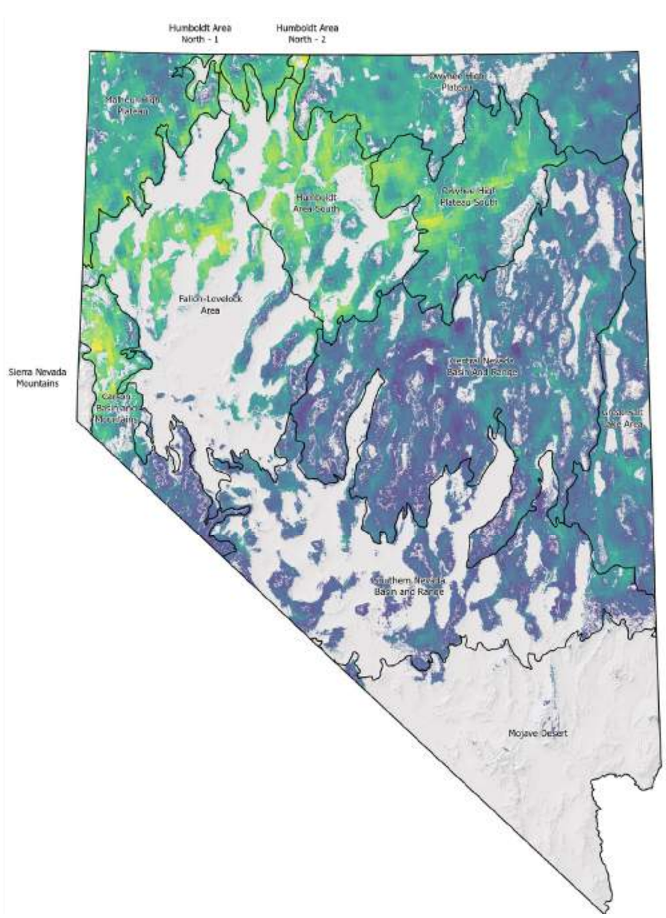


FIgure 24. Low elevation sagebrush patterns of climate change vulnerability across MLRAs in Nevada. Overall HCCVI vulnerability measures incorporate patterns of potential climate exposure and habitat resilience, which incorporates ecosystem sensitivity and adaptive capacity (overall sensitivity shown here). Vulnerability, ranked from low to severe, is spatially variable based on multiple components of exposure and sensitivity.

implications for soil water stress (Bradford et al., 2020). Vulnerability analysis for intermountain basins big sagebrush shrublands (2040-2070) projects generally decreasing suitability for this ecological system (Comer et al., 2019).

Projected vegetation changes within the sagebrush ecosystem include increases in bare ground, decreases in sagebrush, other shrubs, and herbaceous cover, and large declines in perennial C3 grass species accompanied by an increase in perennial C4 grass species, although, much like projections of primary climate indicators, projection of functional group change is spatially diverse (Palmquist et al., 2021, Homer et al., 2015).

Conservation Strategy

Objective 1: Develop a Sagebrush Habitat Plan (per Executive Order 2021-18 titled "Creating the Nevada Habitat Conservation Framework") assessing threats and identifying strategies to direct resources.

- Action: Utilize new online mapping products to assess the current status and condition.
- Action: Based on the assessment, develop strategies and approaches to identify opportunities and address threats in a meaningful framework.
- Action: To address wildfire and invasives, identify suppression priority areas and share with land management agencies.
- Action: To address wildfire and invasives, continue implementing targeted fuel breaks and fuel treatments, and restoration/rehabilitation projects on greater than 30,000 acres per year.
- Action: To address conifer removal, in areas of sagebrush encroached by conifers, implement treatments on greater than 5,000 acres per year, with emphasis on treating Phase I and Phase II conifer densities.
- Action: Develop and launch a project planning and management tool/database to manage restoration and rehabilitation projects, including a public interface to showcase and remain transparent with the public.

Objective 2: Prevent sagebrush conversion by addressing improper livestock grazing and recreation events in higher wildlife value resource areas.

- Action: Continue reviewing projects and participating in planning efforts (e.g., National Environmental Policy Act, county authorizations, land transfers, etc.) to avoid, minimize, and mitigate development and recreation risks and prevent improper grazing.

Objective 5: Support research focused on research priorities (described below).

- Action: Participate with the newly developed Cooperative Research Unit exploring research needs and solutions.


Source: NDOW

Priority Research Needs

- A statewide health assessment of sagebrush plant communities and strategies to address threats.
- Tools and mapping products to better understand the spatial extent and help develop restoration priorities for compromised sagebrush plant communities (e.g., invasive annual grasses invasion).
- Seed and herbicide tools, technologies, and practices to address limited success in Low Elevation Sagebrush that are of low resistance and resilience and where precipitation is a limiting factor.
- Seeding success of Low Elevation Sagebrush.
- Restoration of sagebrush communities that currently have inadequate perennial bunchgrasses.
- Effects of contemporary grazing practices on perennial grasses and forbs in the Great Basin.

Key SGCN Species

- Great Basin spadefoot (*Spea intermontana*)
- Railroad Valley toad (*Anaxyrus nevadensis*)
- Western toad (*Anaxyrus boreas*)
- Brewer's sparrow (*Spizella breweri*)
- Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianu*)
- Common nighthawk (*Chordeiles minor*)
- Ferruginous hawk (*Buteo regalis*)
- Golden eagle (*Aquila chrysaetos*)
- Greater sage grouse (*Centrocercus urophasianus*)
- Loggerhead shrike (*Lanius ludovicianus*)
- Long-eared owl (*Asio otus*)
- Pinyon jay (*Gymnorhinus cyanocephalus*)
- Prairie falcon (*Falco mexicanus*)
- Sage thrasher (*Oreoscoptes montanus*)
- Sagebrush sparrow (*Artemisiospiza nevadensis*)
- Short-eared owl (*Asio flammeus*)
- Swainson's hawk (*Buteo swainsoni*)
- Western burrowing owl (*Athene cunicularia hypugaea*)
- American pika (*Ochotona princeps*)
- Canyon bat (*Parastrellus hesperus*)
- Dark kangaroo mouse (*Microdipodops megacephalus*)
- Desert kangaroo rat (*Dipodomys deserti*)
- Fringed myotis (*Myotis thysanodes*)
- Merriam's shrew (*Sorex merriami*)
- Mexican free-tailed bat (*Tadarida brasiliensis*)

- Mule deer (*Odocoileus hemionus*)
- Pale kangaroo mouse (*Microdipodops pallidus*)
- Pallid bat (*Antrozous pallidus*)
- Panamint kangaroo rat (*Dipodomys panamintinus*)
- Preble's shrew (*Sorex preblei*)
- Pygmy rabbit (*Brachylagus idahoensis*)
- Townsend's big-eared bat (*Corynorhinus townsendii*)
- Western small-footed myotis (*Myotis ciliolabrum*)
- White-tailed jackrabbit (*Lepus townsendii*)
- Yuma myotis (*Myotis yumanensis*)
- Desert horned lizard (*Phrynosoma platyrhinos*)
- Great Basin collared lizard (*Crotaphytus bicinctores*)
- Greater short-horned lizard (*Phrynosoma hernandesi*)
- Northern alligator lizard (*Elgaria coerulea*)
- Pygmy short-horned lizard (*Phrynosoma douglasii*)
- Sonoran Mountain kingsnake (*Lampropeltis pyromelana*)
- Western skink (*Plestiodon skiltonianus*)
- American bumble bee (*Bombus pensylvanicus*)
- Arrowhead blue (*Glaucopsyche piasus*)
- Checkered white (*Pontia protodice*)
- Common sootywing (*Pholisora catullus*)
- Dotted blue (*Euphilotes enoptes aridorum*)
- Honey Lake blue (*Euphilotes pallescens calneva*)
- Indiscriminate cuckoo bumble bee (*Bombus insularis*)
- Large marble (*Euchloe ausonides*)
- Marine blue (*Leptotes marina*)
- Mattoni's blue (*Euphilotes pallescens mattonii*)
- Melissa blue (*Plebejus melissa*)
- Monarch (*Danaus plexippus plexippus*)
- Morrison's bumble bee (*Bombus morrisoni*)
- Rice's blue (*Euphilotes pallescens ricei*)
- Ruddy copper (*Tharsalea rubidus*)
- Sandhill skipper (*Polites sabuleti*)
- Sara orangetip (*Anthocharis sara*)
- Square dotted blue (*Euphilotes battoides fusimaculata*)
- Tailed copper (*Tharsalea arota*)
- West Coast lady (*Vanessa annabella*)
- Western tailed-blue (*Cupido amyntula*)
- White-shouldered bumble-bee (*Bombus appositus*)
- Yellow bumble bee (*Bombus fervidus*)

Lower Montaine Woodlands and Chaparral

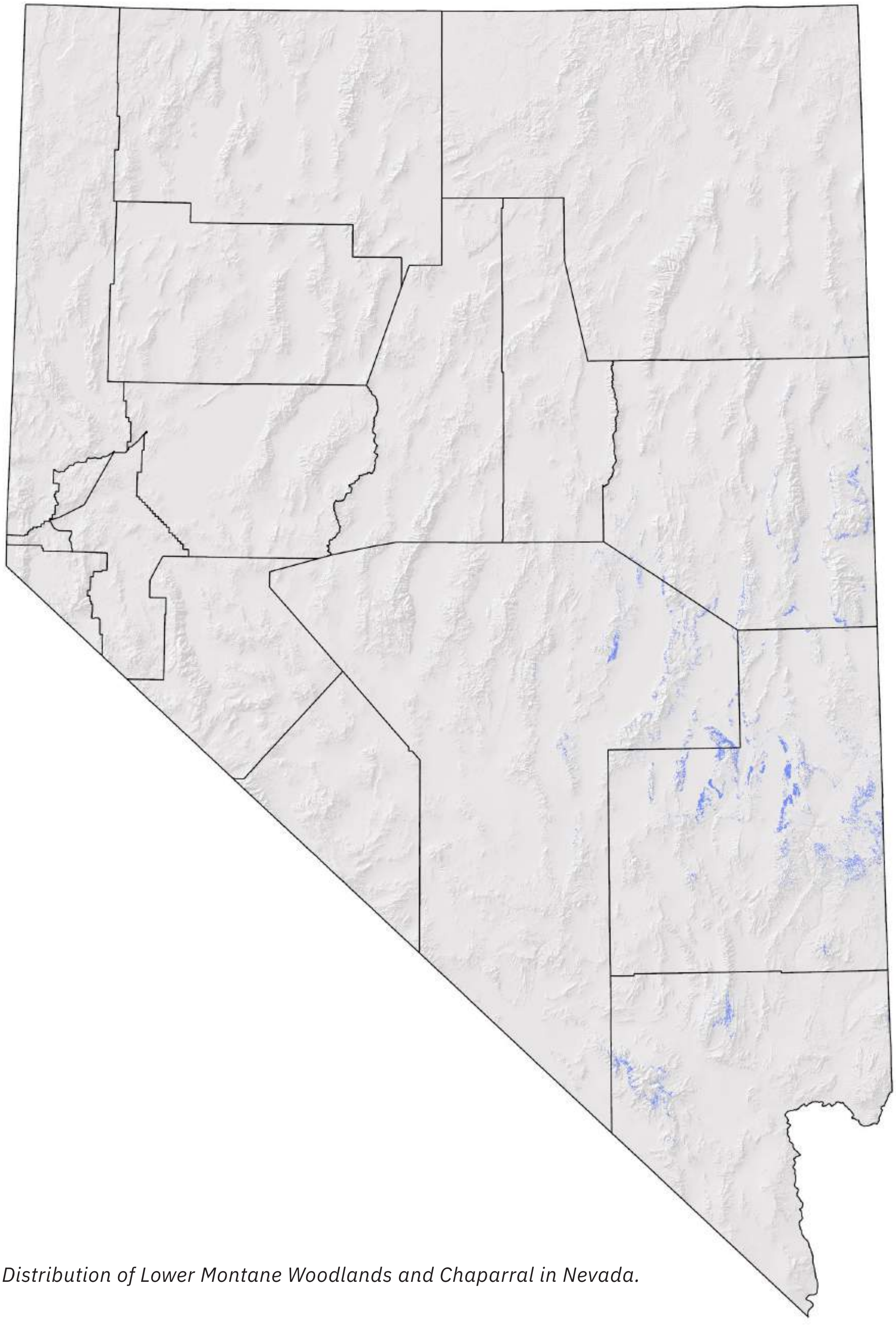


Figure 25. Distribution of Lower Montane Woodlands and Chaparral in Nevada.

Key Habitat Description and Elements of Lower Montane Woodlands and Chaparral

Vegetation and Abiotic Environment

Chaparral habitat is generally characterized by hot, dry summers and cool, moist winters and is mostly dominated by a dense growth of small-leaved evergreen shrubs. Many chaparral species are fire-adapted, either resprouting vigorously after burning or producing fire-resistant seeds. Shrub stands occurring within montane woodlands are often the result of recent stand-replacing fires and, with fire suppression, are likely to be encroached by pinyon and juniper that will persist until the next stand-replacing fire (NatureServe, 2022), usually recurring every 50-75 years.

In Nevada, Great Basin semi-desert chaparral is found where lowelevation desert landscapes transition into pinyon-juniper woodlands, typically on side slopes, with shrub cover alternating between thick patches and fairly open canopies with shrub interspaces either occupied by patchy grasses and forbs or bare ground. Characteristic species may include manzanita (*Arctostaphylos spp*.), ceanothus (*Ceanothus spp.*), mountain mahogany (*Cercocarpus spp.*), California buckwheat (*Eriogonum fasciculatum*), ashy silktassel (*Garrya flavescens*), shrub live oak (*Quercus turbinella*), and oakleaf sumac (*Rhus trilobata*). The typical fire regime in these systems varies with the amount of organic accumulation (NatureServe, 2022), but is typically stand replacing with a mean fire return interval of fewer than 100 years.

Mogollon chaparral habitat occurs relatively scarcely in southern Nevada on foothills, mountain slopes, and canyons in hot, dry climates, primarily along the mid-elevation transition between Mojave Desert scrub and montane habitats. Turbinella oak (*Quercus turbinella*) dominates the shrub canopy with mountain mahogany, canotia (*Canotia holocantha*), desert ceanothus (*Ceanothus greggii*), cliffrose (*Purshia spp.*), sumac (*Rhus spp.*), and manzanita intermixed throughout. Perennial grasses inhabit the shrub understory in various amounts depending on shrub density (NatureServe, 2022).

Rocky Mountain Gambel oak-mixed montane shrublands occur sparsely in the mountains, plateaus, and foothills in southeastern Nevada. These systems are dominated by moderate to tall shrubs with the overstory predominantly consisting of Gambel oak (*Quercus gambelii*) with the understory typically comprising intermixed serviceberry (*Amelanchier sp.*), antelope bitterbrush (*Purshia tridentata*), mountain mahogany (*Cercocarpus ledifolius*), desert peach (*Prunus andersonii*), cliffrose (*Purshia spp.*), sagebrush (*Artemesia spp*.), and snowberry (*Symphoricarpos sp.*). Herbaceous species are sparse to moderately dense with perennial grasses occurring more often than forbs. Fire in these systems typically increases the density and cover of Gambel oak and serviceberry and helps encourage the mosaic distribution of species in the system (NatureServe, 2022).

General Wildlife Value

Lower montane chaparral and shrub habitats provide habitat for a broad range of different wildlife species, providing forage for herbivores including small mammals and big game species. The dense vegetation in these habitats provides cover for a wide variety of wildlife including birds, mammals, and reptiles. Mule deer rely on species such as turbinella oak, serviceberry, snowberry, cliffrose, and bitterbrush for browse, with cliffrose being a mule deer staple, especially in winter months. The fruits and acorns on chaparral and mountain shrub species are important for small mammals, birds, and beaver, and when grasses are sparse in fall and winter some herbivore species forage on chaparral twigs, leaves and bark. Shrubs are important to many mammals as shade during hot weather, and moderate temperature and wind velocity in the winter. Many birds find a variety of habitat needs in the montane chaparral as it provides seeds, fruits, insects, protection from predators and climate, as well as singing, roosting, and nesting sites (Verner & Boss, 1980; Storer & Usinger, 2004).

Existing Environment

Dominant Biophysical Settings

In general, lower montane chaparral is a limited habitat type in Nevada, making up less than one half of one percent of the landscape. Of the chaparral habitats found in Nevada, the Great Basin semi-desert chaparral type occupies the largest acreage and can be found in the western and central Great Basin, and east slopes of the Sierra Nevada. This chaparral typically occurs on piedmont slopes, foothills, plateaus, and mountains in low to mid elevational ranges (2,600-9,800 feet) that are typically characterized by dry summers and precipitation occurring in the form of snow during the winter months. These shrublands are mostly found on south-facing slopes, where soils are rocky and well drained. This biophysical setting is typically established when the canopy is eliminated after stand-replacing fires or clearcut logging in Ponderosa pine, white fir, or Douglas fir forests or pinyon-juniper woodlands, and persists for several decades before trees begin to reestablish. Excessively rocky or droughty, fire-prone montane systems may support relatively persistent chaparral communities (NatureServe, 2022).

Mogollon chaparral is more common in Arizona and New Mexico but also extends into southern Nevada where it can be found in mountainous areas from 3,200-7,200 feet on foothills, mountain slopes, and canyons. Stands are dominant along the mid-elevation transition from the Mojave Desert into the mountains and are often associated with more xeric and coarse-textured substrates such as limestone, basalt, or alluvium, especially in transition areas with more mesic woodlands (NatureServe, 2022).

Table 21: Dominant biophysical settings comprising Lower Montane Woodlands and Chaparral dominated key habitats in Nevada. Roughly 348,3139 acres of Nevada may have historically supported these communities based on biophysical setting analysis

LOWER MONTANE WOODLANDS AND CHAPARRAL	348,313 ACRES
Great Basin Semi-Desert Chaparral	267,109 acres
Rocky Mountain Gambel Oak-Mixed Montane Shrubland	41,655 acres
Mogollon Chaparral	37,885 acres

Habitat Conditions

The lower-elevation portions of these habitat types are susceptible to overutilization by livestock due to the gentle terrain and easy accessibility (Brown, 1982a). Fire suppression, working in concert with overutilization by ungulates, has likely contributed to the progression of mountain shrub stands towards dominance by pinyon and juniper in many areas of its occurrence in Nevada (NatureServe, 2022). However, the fire-adapted nature of lower montane chaparral vegetation allows for these habitat types to persist after a fire when systems are intact at the time of the fire.

Habitat Threats

The lower-elevation portions of these habitat types are susceptible to overutilization by livestock due to the gentle terrain and easy accessibility, especially the Great Basin semi-desert and Mogollon chaparral communities. Grazing prescriptions can be designed to make grazing more compatible with lower-elevation chaparral habitat, particularly in areas that serve as critical habitat for wildlife. High-elevation stands of Great Basin semi-desert chaparral are typically rocky and have less palatable browse species with sparse grass understories that are less accessible to livestock and are less likely to experience impacts from livestock. Rocky Mountain Gambel oak-mixed montane shrubland is also susceptible to livestock disturbance. Soil erosion and subsequent water quality impacts are concerns where livestock disturbance is a threat, as well as the invasion of exotic species like cheatgrass. Greater invasive species abundance increases the amount of fine fuels in the system, changing the fire regime to more frequent fires that chaparral communities may not be able to recover from (NatureServe, 2022).

In areas where trees have encroached into chaparral shrublands and/or shrub density has surpassed historic fire regime levels due to fire suppression, uncharacteristic crown fires with greater fire intensity are possible. Even though most chaparral vegetation species are fire-adapted, an increase in fire intensity can result in damage that surpasses species' ability to survive despite their adaptations, allowing invasive species to take over, further preventing native chaparral vegetation from reestablishing and essentially removing all habitat values.

Human development including residential development, fragmentation from roads, development near urban areas, and mining has impacted lower montane chaparral communities both directly through vegetation removal or indirectly by altering natural fire regimes Construction of roads and power transmission lines fragment vegetation and provide vectors for invasive species (NatureServe, 2022).

In some places in this key habitat, recreational activities have disturbed wildlife resulting in movements, displacement, behavior changes, and impacts on reproductive success. Off-road vehicles are also vectors for invasive species and increase fire risk when conditions are dry.

Predicted Climate Change Effects

Climate change effects specific to Great Basin Semi-desert chaparral are limited; however, warmer temperatures and drought are the key climate drivers anticipated to affect chaparral habitats in Nevada. While chaparral species generally have adaptation to drought, recently Nevada's drought intensity and duration are prolonged and/or more frequent and will likely contribute to plant dieback, shrub mortality, and/or altered community composition, including increased dead fine fuel load that may increase larger fires (McEvoy et al., 2020). While many chaparral species are fire adapted, more frequent fires as a result of warmer climates and drought can inhibit chaparral regeneration and facilitate conversion to non-native grasslands or degraded shrublands with reduced biodiversity Invasive and problematic species perpetuate shifting fire regimes and compete with native vegetation for limited resources.

Climate change is expected to increase tree encroachment into mountain shrub communities, which is further exacerbated by fire suppression. If unmanaged, tree encroachment will result in the loss of shrubs and other understory species in these habitats. This is expected to affect the eastern regions of Nevada and the Mojave region more than other

Table 22: Percent of vegetated Nevada key habitats converted to other classes

LOWER MONTANE WOODLANDS AND CHAPARRAL	
CURRENT STATE	**PERCENT HABITAT**
Agriculture	0.19%
Barren or Sparse	4.48%
Natural Vegetation	75.41%
Non-Natural Vegetation (invasive or native)	6.9%
Urban	13.02%

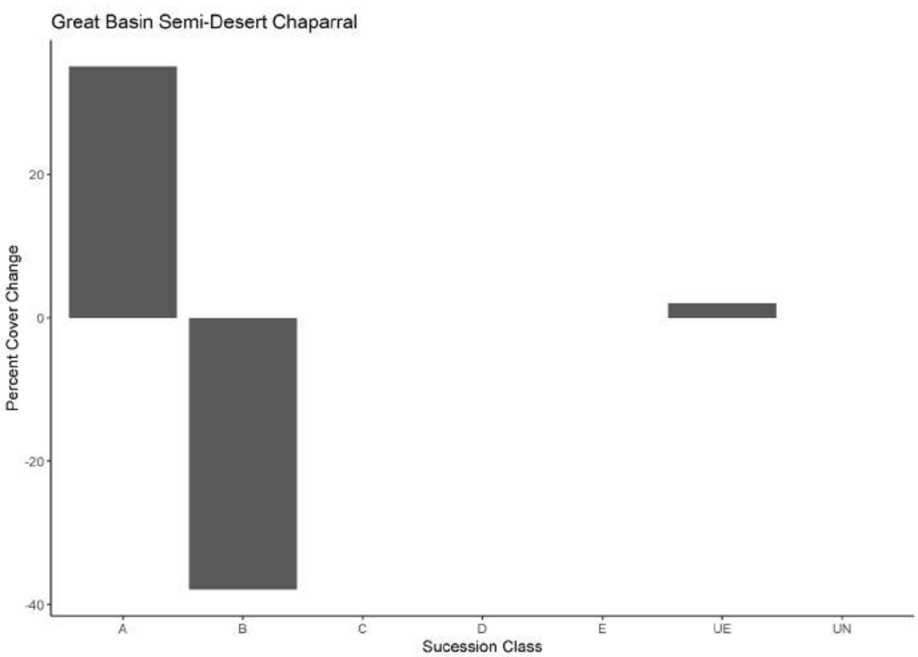


Figure 26. Succession class data for biophysical setting Great Basin Semi-Desert Chaparral. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

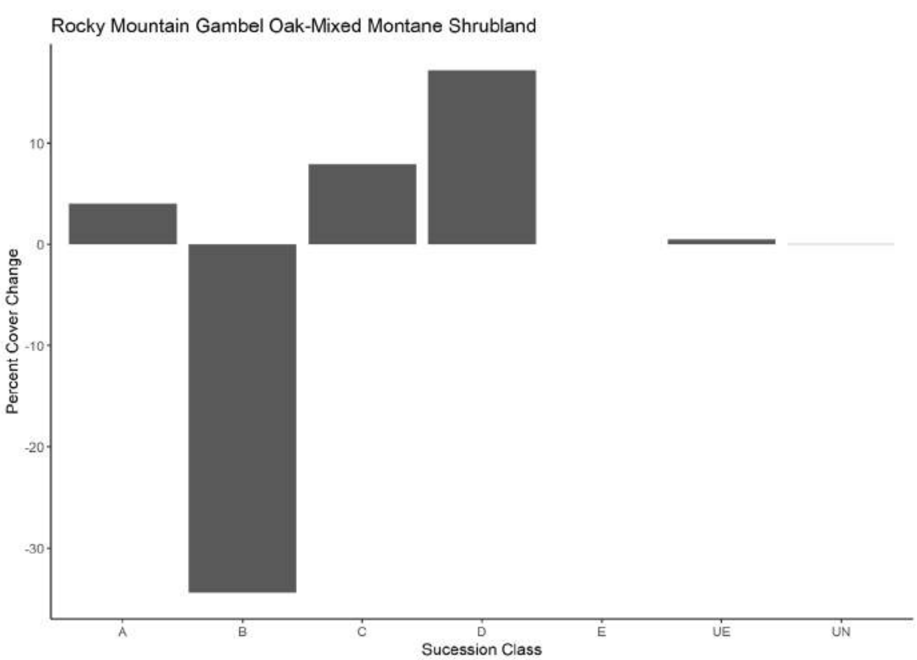


Figure 27. Succession class data for biophysical setting Rocky Mountain Gambel Oak-Mixed Montane Shrublands. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

parts of the state. Losses of mountain shrub communities are expected to negatively impact mule deer production and fawn survival as these habitats are so predominantly populated by summering mule deer does. In addition to this loss, tree encroachment by pinyon and juniper species within mountain shrub communities results in the suppression of browse productivity that comprises a critical part of deer summer range (NDOW, 2011).

Conservation Strategy

Objective 1: Identify and assess lower montane woodland and chaparral habitats across Nevada by 2027.

- Action: Identify and assess the condition of lower montane woodland and chaparral habitats using existing methods or by developing new methods.

Objective 2: Work with state and federal partners to identify prescribed treatments to increase resiliency in lower montane woodland and chaparral habitat communities by 2032.

- Action: Prioritize lower montane woodland and chaparral habitats for restoration through management treatment(s).
- Action: Assess the applicability of prescribed fire or mechanical techniques to encourage and restore plant vigor and resiliency in chaparral and mountain shrub habitats and remove encroaching tree species to maintain historic fire regimes.

Objective 3: Work with state, federal, and private entities to develop grazing plans that reduce impacts on lower montane woodland and chaparral habitats communities, especially in critical wildlife habitat.

- Action: Collaborate with state, federal, and private entities by providing the most up-to-date information on wildlife habitat status in lower montane woodland and chaparral habitats and additional input on grazing plans.

Priority Research Needs

- A statewide inventory and assessment of lower montane woodland and chaparral in Nevada.
- Assessment of appropriate restoration techniques for Great Basin Semi-desert chaparral.
- Specific biophysical setting research related to climate change impacts to lower montane and semi-desert chaparral and successional changes in new climate regimes.
- Develop knowledge and new methods to improve the establishment of lower montane-chaparral species that are particularly difficult to reestablish by seed following a fire, for example, mountain mahogany.

Key SGCN Species

- Great Basin spadefoot (*Spea intermontana*)
- Western toad (*Anaxyrus boreas*)
- American kestrel (*Falco sparverius*)
- Black-chinned sparrow (*Spizella atrogularis*)
- Brewer's sparrow (*Spizella breweri*)
- Clark's nutcracker (*Nucifraga columbiana*)
- Dusky flycatcher (*Empidonax oberholseri*)
- Dusky grouse (*Dendragapus obscurus*)
- Long-eared owl (*Asio otus*)
- Mountain quail (*Oreortyx pictus*)
- Pinyon jay (*Gymnorhinus cyanocephalus*)
- Scott's oriole (*Icterus parisorum*)
- Virginia's warbler (*Leiothlypis virginiae*)
- Allen's chipmunk (*Neotamias senex*)
- Bighorn sheep (*Ovis canadensis*)
- Greater bonneted bat (*Eumops perotis*)
- Hoary bat (*Lasiurus cinereus*)

- Humboldt yellow-pine chipmunk (*Neotamias amoenus celeris*)
- Inyo shrew (*Sorex tenellus*)
- Little brown myotis (*Myotis lucifugus*)
- Long-eared myotis (*Myotis volans*)
- Merriam's shrew (*Sorex merriami*)
- Mexican free-tailed bat (*Tadarida brasiliensis*)
- Mule deer (*Odocoileus hemionus*)
- Silver-haired bat (*Lasionycteris noctivagans*)
- Spotted bat (*Euderma maculatum*)
- Townsend's big-eared bat (*Corynorhinus townsendii*)
- Trowbridge's shrew (*Sorex trowbridgii*)
- Western small-footed myotis (*Myotis ciliolabrum*)
- White-tailed jackrabbit (*Lepus townsendii*)
- Gilbert's skink (*Plestiodon gilberti rubricaudatus*)
- Greater short-horned lizard (*Phrynosoma hernandesi*)
- Northern alligator lizard (*Elgaria coerulea*)
- Northern rubber boa (*Charina bottae*)
- Pygmy short-horned lizard (*Phrynosoma douglasii*)
- Sonoran mountain kingsnake (*Lampropeltis pyromelana*)
- Western skink (*Plestiodon skiltonianus*)
- American bumble bee (*Bombus pensylvanicus*)
- Arrowhead blue (*Glaucopsyche piasus*)
- Carson Valley wood nymph (*Cercyonis pegala carsonensis*)
- Checkered white (*Pontia protodice*)
- Common sootywing (*Pholisora catullus*)
- Golden hairstreak (*Habrodais grunus*)
- Indiscriminate cuckoo bumble bee (*Bombus insularis*)
- Indra swallowtail (*Papilio indra*)
- Large marble (*Euchloe ausonides*)
- Lupine blue (*Icaricia lupini*)
- Marine blue (*Leptotes marina*)
- Mattoni's blue (*Euphilotes pallescens mattonii*)
- Melissa blue (*Plebejus melissa*)
- Monarch (*Danaus plexippus plexippus*)
- Morrison's bumble bee (*Bombus morrisoni*)
- Mt. Charleston blue (*Icaricia shasta charlestonensis*)
- Red-tailed blazing star bee (*Megandrena mentzeliae*)
- Ruddy copper (*Tharsalea rubidus*)
- Sachem (*Atalopedes campestris*)
- Sandhill skipper (*Polites sabuleti*)
- Sara orangetip (*Anthocharis sara*)
- Tailed copper (*Tharsalea arota*)
- West Coast lady (*Vanessa annabella*)
- Western tailed-blue (*Cupido amyntula*)
- White-shouldered bumble-bee (*Bombus appositus*)
- Yellow bumble bee (*Bombus fervidus*)

Mojave Mid-Elevation Mixed Desert Shrub and Mojave Warm Desert

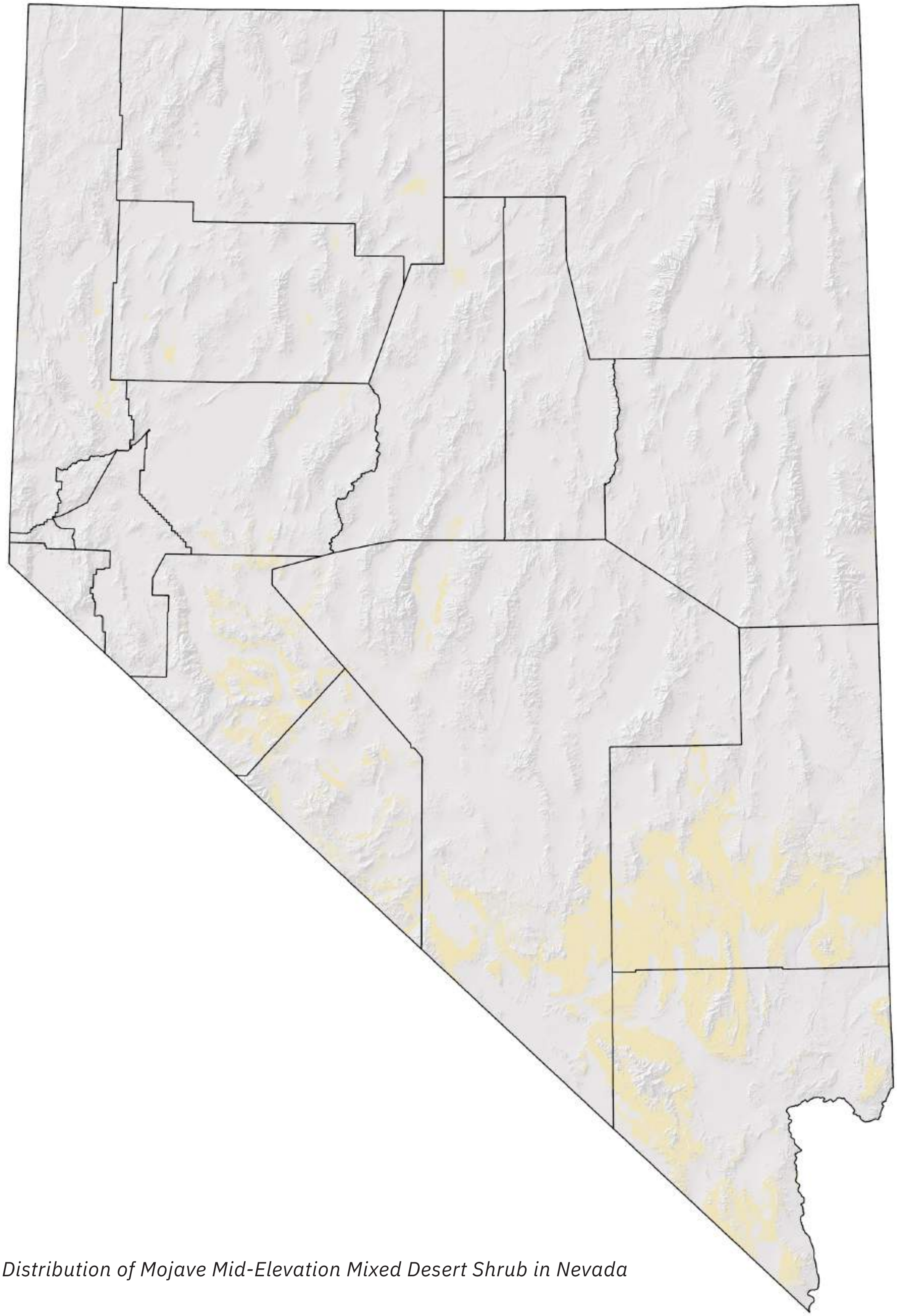


Figure 28. Distribution of Mojave Mid-Elevation Mixed Desert Shrub in Nevada

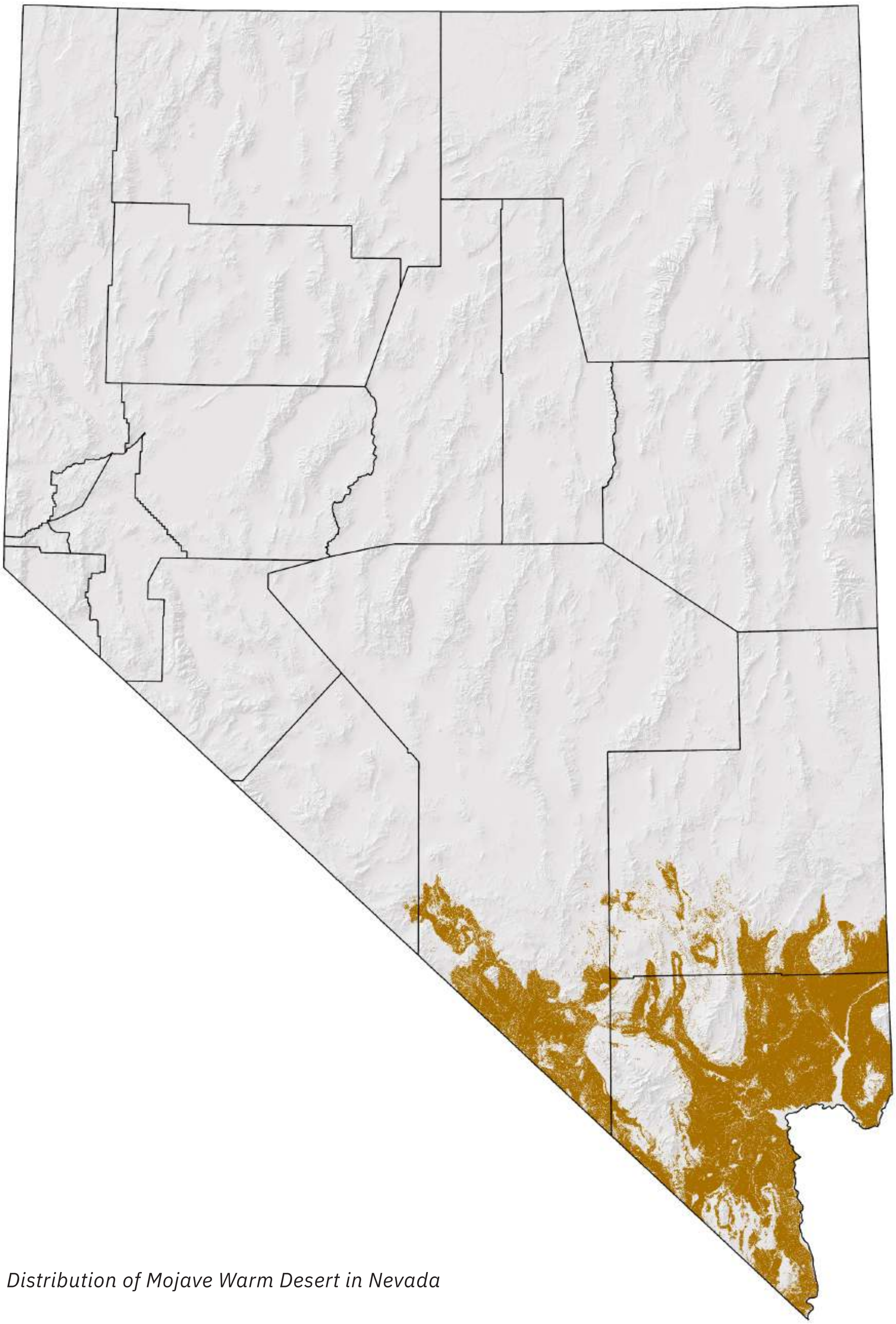


Figure 29. Distribution of Mojave Warm Desert in Nevada

Key Habitat Description and Elements of Mojave Mid-Elevation Mixed Desert Shrub

Vegetation and Abiotic Environment

The complex of vegetation types that comprise the Mojave Warm Desert and Mixed Desert Scrub habitat are uniquely adapted to the harsh conditions present in desert ecosystems. Plants are typically tolerant of low humidity, prolonged droughts, desiccating winds, rocky or very sandy soils, and the periodic influx of high quantities of water in the form of surface flooding.

Mojave Mid-Elevation Mixed Desert Shrub

Mojave Mid-Elevation Mixed Desert Scrub assemblages occur in the transition zones between the lower elevation Mojave Warm Desert and higher elevation lower montane woodlands as well as along the ecotone with the southern Great Basin. Vegetation assemblages within this key habitat can be highly variable; however, most are dominated by blackbrush and Joshua tree associations with lesser amounts of halophytic species on lower elevation saline soils and chaparral species at higher elevation transition zones (Landfire, 2020; NatureServe, 2018). This aggregation represents vegetation assemblages that occur from roughly 2,200-7,000 feet on a variety of soils that share a semi-arid climate typified by low and highly variable precipitation, hot summers, and relatively cool winters (NatureServe, 2018). Annual precipitation typically varies from approximately 1.5-10 or more inches at higher elevations. Precipitation gradients are typically the strongest filters or controls on vegetation distribution within both Mojave and Sonoran systems with relatively few communities (typically *Atriplex spp*.) primarily controlled by salinity gradients (Beatley, 1975).

Dominant or co-dominant shrubs include Joshua tree (*Yucca brevifolia*, also treated as *Yucca jaegeriana*; see Lenz, 2007; for simplicity and consistency discussion here references *Y. brevifolia* following the Flora of North America), blackbrush (*Coleogyne ramosissima*), Nevada ephedra (*Ephedra nevadensis*), spiny hopsage (*Grayia spinosa*), staghorn cholla (*Cylindropuntia versicolor*), Gambel's oak (*Quercus gambelii*), greenleaf manzanita (*Arctostaphylos patula*), and cup-leaf ceanothus (*Ceanothus greggii*). In more mesic settings blackbrush may attain a much larger growth form, often to heights over six feet tall, creating a very different wildlife habitat than the short, shrubby thermic version. Juniper (*Juniperus spp.*), and more rarely single-leaf pinyon (*Pinus monophylla*), can be common to dominant, especially at higher elevations. Grass understory species associated with these brush communities include Indian ricegrass (*Acnatherum hymenoides*), needle-and-thread (*Hesperostipa comata*), and James' galleta (*Pleuraphis jamesii*).

Mojave Warm Desert

Mojave Warm Desert habitats are dominated by creosote bush (Sonora-Mojave-Baja Creosote-White Bursage Desert Scrub) occurring on well-drained sandy flats and bajadas throughout most of the Mojave Desert from roughly 500-5,000 feet elevation in Nevada. Its range extends from the Colorado River on the south to Pahranagat Valley on the north. Vegetation communities are typically dominated by broad-leafed shrubs with low cover of herbaceous and graminoid species. Species diversity and composition typically vary along elevational gradients associated with soil moisture availability, with higher diversity and cover occurring on wetter sites at higher elevations (NatureServe, 2018).

Dominant shrub species are creosote bush (*Larrea tridentata*), white bursage (*Ambrosia* *dumosa*), Mormon tea (*Ephedra spp.*), *Atriplex spp.*, spiny hopsage, and beavertail cactus (*Opuntia basilaris*). Joshua trees can vary in abundance. In general, these sites are poorly adapted to fire and other disturbances as the dominant shrub species are typically long-lived with low recruitment and retention rates.

General Wildlife Value

Mojave Mid-Elevation Mixed Desert Shrub

Mixed desert shrub habitat provides more vegetative structure and wildlife cover than the Mojave warm desert shrub, particularly for birds like the black-chinned sparrow (*Spizella atrogularis*), cactus wren (*Campylorhynchus brunneicapillus*), and Scott's oriole (*Icterus parisorum*). Similar to warm desert shrub habitat, the presence of Joshua trees is important to species of greatest conservation need like Bendire's thrasher (*Toxostoma bendirei*), Scott's oriole, and the desert night lizard (*Xantusia vigilis*).

Mojave Warm Desert

Mojave warm desert is essential habitat for a diverse complement of wildlife: birds like greater roadrunner (*Geococcyx californianus*), rock wren (*Salpinctes obsoletus*), lesser nighthawk (*Chordeiles acutipennis*), and western burrowing owl (*Athene cunicularia*); mammals varying in size from the diminutive desert pocket mouse (*Chaetodipus penicillatus*) to desert bighorn sheep (*Ovis canadensis nelsoni*), and an assemblage of reptiles including the desert iguana (*Dipsosaurus dorsalis*), Gila monster (*Heloderma suspectum*), spotted leaf-nosed snake (*Phyllorhynchus decurtatus*), and the Mojave Desert tortoise (*Gopherus agassizii*), the latter of which is listed under the Endangered Species Act.

Existing Environment

Dominant Biophysical Settings:

Mojave Mid-Elevation Mixed Desert Shrub

The dominant biophysical settings comprising Mojave mid-elevation mixed desert shrub key habitats are Mojave Mid-Elevation Mixed Desert Shrub and Sonora-Mojave Semi-Desert Chaparral (Table 23).

Table 23: Dominant biophysical settings comprising Mojave mid-elevation mixed desert shrub key habitats in Nevada. Roughly 4,488,386 acres of Nevada may have historically supported Mojave mid-elevation mixed desert shrub communities based on biophysical setting analysis.

MOJAVE MID-ELEVATION MIXED DESERT SHRUB	4,488,386 ACRES
Mojave Mid-Elevation Mixed Desert Scrub	4,446,311 acres
Sonora-Mojave Semi-Desert Chaparral	41,130 acres
Colorado Plateau Blackbrush-Mormon-tea Shrubland	945 acres

Mojave Warm Desert

The dominant biophysical settings comprising Mojave Warm Desert systems are Sonora-Mojave Creosote bush-White bursage Desert Scrub, Inter-Mountain Basins Sparsely Vegetated Systems, and North American Warm Desert Sparsely Vegetated Systems (Table 24).

*Table 24: Dominant biophysical settings comprising Mojave warm desert shrub key habitats in Nevada. Roughly 5,035,731 acres of Nevada may have historically supported Mojave warm desert shrub communities based on biophysical setting analysis. * Note: The BpS classifications containing Inter-Mountain Basins designations are likely misclassifications that are better represented by other terrestrial ecological classifications such as North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation (NatureServe Explorer, Comer et al 2003).*

MOJAVE WARM DESERT	5,035,731 ACRES
Sonora-Mojave Creosotebush-White Bursage Desert Scrub	3,553,185 acres
*Inter-Mountain Basins Sparsely Vegetated Systems	1,111,589 acres
North American Warm Desert Sparsely Vegetated Systems	223,525 acres
Sonora-Mojave Mixed Salt Desert Scrub	84,511 acres
Inter-Mountain Basins Mixed Salt Desert Scrub	49,639 acr
Inter-Mountain Basins Semi-Desert Shrub-Steppe	7,931 acres
Inter-Mountain Basins Greasewood Flat	1,819 acres

Habitat Conditions

Desert tortoise conservation initiatives on BLM-managed lands and the inclusion of much of the montane shrub types within the USFS's Spring Mountains National Recreation Area have provided a measure of protection for many areas of blackbrush and associated vegetation complexes within Mojave Mid-Elevation Mixed Desert Shrub and Mojave Warm Desert associations; however, urbanization, increased anthropogenic disturbance, non-native plants, and highly departed fire regimes represent major threats to the area.

Mojave Mid-Elevation Mixed Desert Shrub

Increased cover of non-native invasive annuals including but not limited to red brome (*Bromus rubens*), cheatgrass (*Bromus tectorum*), and mustards (various Brassicaceae members) in the understory of shrublands throughout the Sonoran and Mojave Deserts have increased dramatically over the past several decades, the consequence was punctuated by the 2005 Southern Nevada Complex and Hackberry Complex fires involving several separate and merging fires in southern Nevada, Arizona, Utah, and California. The dominance of invasives post-fire persists to this day with cover variation governed entirely by cumulative precipitation and increased fire frequency in previously burned areas. The heavy fuel-loading burned in 2005, as part of the 739,037 acre Southern Nevada Complex fire, caused a shift to non-native annual grasslands and forblands. Blackbrush was largely eliminated from burned areas and there is no expectation of blackbrush returning except under fortuitous weather scenarios as the species requires centuries for site recolonization of surfaces in the absence of invasive plant competition (Abella et al., 2021; Brooks, 2007; SWAP, 2012).

PERCENT OF VEGETATED NEVADA MOJAVE MID-ELEVATION MIXED DESERT SHRUB CONVERTED TO OTHER CLASSES

Table 25: Percent of Mojave Mid-Elevation Mixed Desert Shrub key habitat converted to agriculture, barren or sparsely vegetated cover, non-natural vegetation, and/or urbanized lands based on Landfire successional class analysis. Non-natural vegetation types include both non-native exotics dominated areas as well as areas dominated by natural vegetation that is outside the range of variation (cover, height, dominant type) that would be expected under typical conditions. Natural vegetation includes all areas remaining in young-old age successional classes as outlined below although the distribution of age classes within natural vegetation states may be outside of the range of variation expected under historic conditions.

MOJAVE MID-ELEVATION MIXED DESERT SHRUB	
CURRENT STATE	**PERCENT HABITAT**
Agriculture	0.4%
Barren or Sparse	5.1%
Natural Vegetation	75.1%
Non-Natural Vegetation (invasive or native)	18.5%
Urban	0.8%

Mojave Warm Desert

Before the mid-20th Century, stressors to Mojave Warm Desert included the varied effects of 19th-Century westward expansion and associated land uses. Among these were widespread livestock operations, irrigated agriculture, and mining in the latter half of the 19th Century. Surface disturbances and accelerated erosion occurred during this period and coincide with the introduction of invasive species like red brome, cheatgrass, Russian thistle (*Salsola tragus*), Halogeton (*Halogeton glomeratus*), filaree (*Erodium cicutarium*), and Mediterranean grass (*Schismus barbatus*). Interstate energy and commerce, multi-modal transportation, and World War 2-era military training exercises and test centers followed. Conversion of habitat by economic and urban development became more significant in the latter half of the 20th Century as regional water supplies, energy, and the advent of technologies like air conditioning allowed for more hospitable living environments of a growing Southwest populace. The popularity of outdoor activities like dispersed recreation and motorized cross-country travel from regional metropolitan centers, casual and organized off-highway vehicle pursuits, and fossil-fuel energy generation and transmission infrastructure increased. The cumulative consequences contributing to habitat degradation, fragmentation, and loss are significant and prompted, for example, widespread protection of the Mojave population of the desert tortoise under the federal Endangered Species Act in 1989. For perspective, at that time population growth in Clark County, Nevada had increased by nearly sixfold since 1959 (119,143 to 708,750) and would reach over 2.2 million by 2021.

PERCENT OF VEGETATED MOJAVE WARM DESERT CONVERTED TO OTHER CLASSES

Table 26: Percent of Mojave Warm Desert key habitat converted to agriculture, barren or sparsely vegetated cover, non-natural vegetation, and/or urbanized lands based on Landfire successional class analysis. Non-natural vegetation types include both non-native exotics dominated areas as well as areas dominated by natural vegetation that is outside the range of variation (cover, height, dominant type) that would be expected under typical conditions. Natural vegetation includes all areas remaining in young-old age successional classes as outlined below although the distribution of age classes within natural vegetation states may be outside of the range of variation expected under historic conditions.

MOJAVE WARM DESERT	
CURRENT STATE	**PERCENT HABITAT**
Agriculture	0.5%
Barren or Sparse	2.1%
Natural Vegetation	72.9%
Non-Natural Vegetation (invasive or native)	19.1%
Urban	5.5%

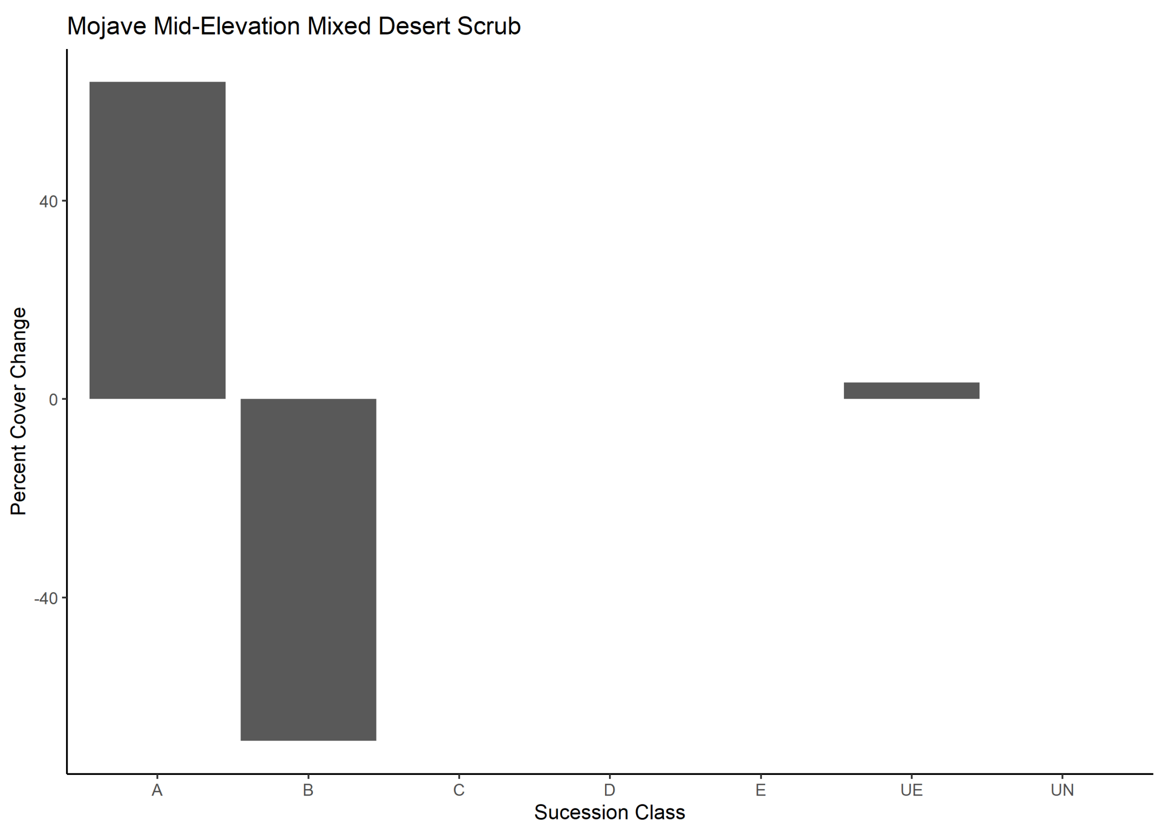


Figure 30. Succession class data for biophysical Mojave Mid-Elevation Mixed Desert Shrub. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

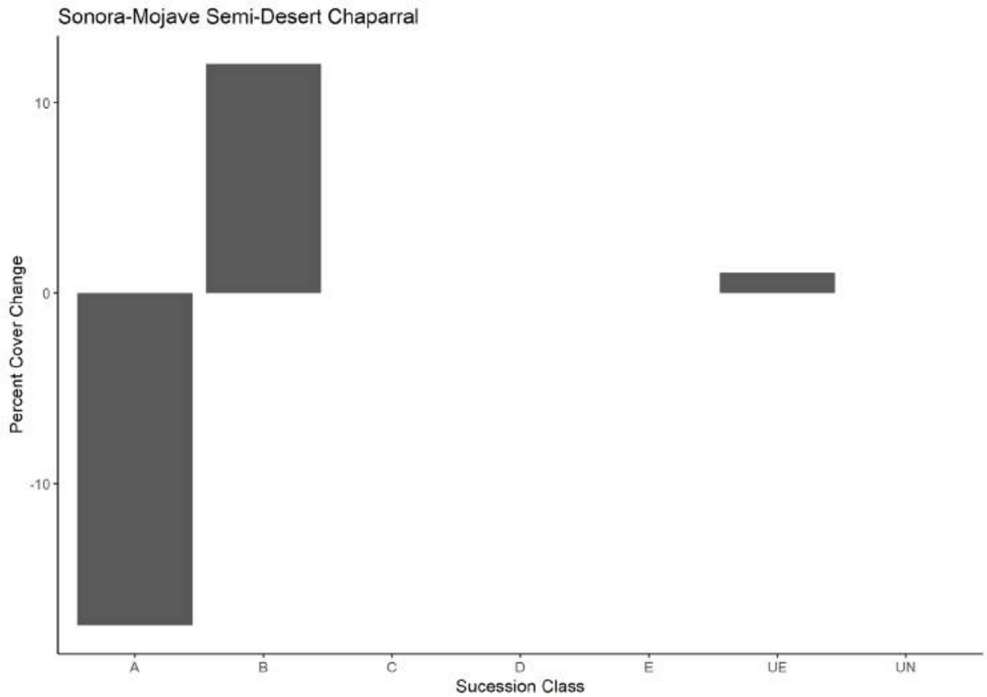


Figure 31. Succession class data for biophysical Sonora-Mojave Semi-Desert Chaparral. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

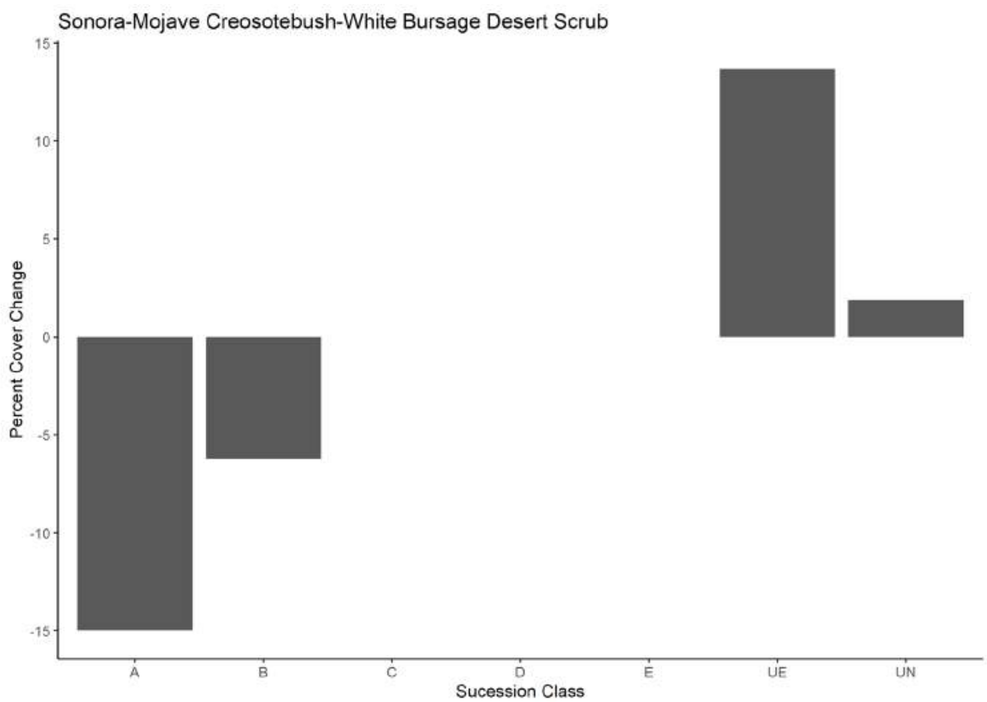


Figure 32. Succession class data for biophysical setting Sonora-Mojave Creosotebush-White Bursage Desert Scrub. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS Description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

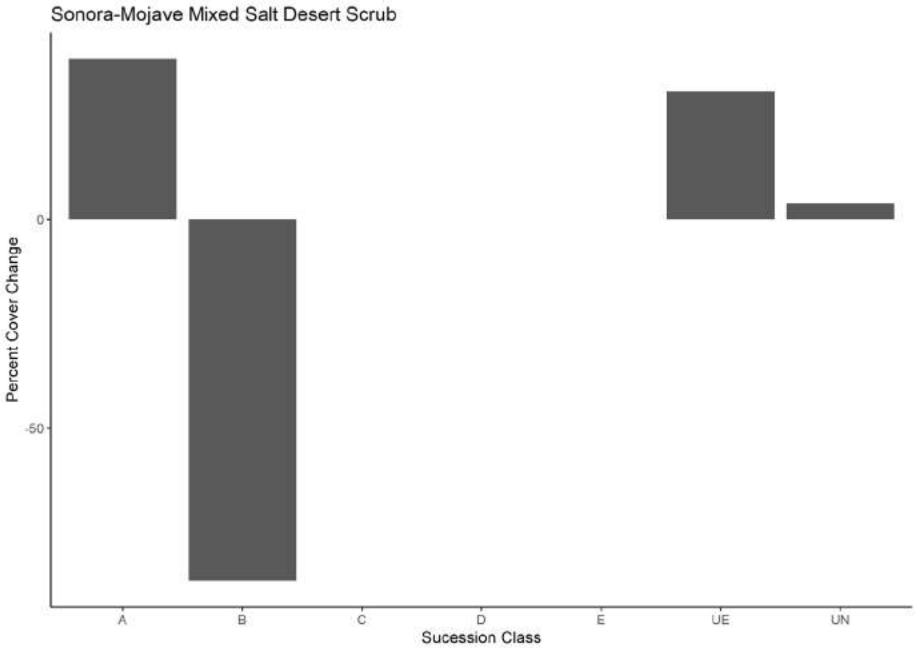


Figure 33. Succession class data for biophysical Sonora-Mojave Mixed Salt Desert Scrub. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

Habitat Threats

Increasing anthropogenic disturbance and increased cover of non-native invasive species are a major threat to Mojave Mid-Elevation Mixed Desert Shrub and Mojave Warm Desert habitats. Invasive annual species (such as red brome) and altered fire history interact in a similar manner to the more well-known cheatgrass-fire cycle to increase post-fire invasion during periods of favorable precipitation (Abella et al., 2010). In southern Nevada, motorized and non-motorized off-highway vehicle recreation related to suburban growth and tourism is heavily impacting the urban-wildland interface and outlying areas, leaving structural damage to shrubs and soils leading to accelerated disturbance and erosion. As economic development continues to increase, the demands on desert land and water and energy resources also increase. The ability to gauge ecosystem processes and health for responding with timely management has been further challenged by phenomena attributed to climate change (e.g., extended drought conditions, increased fire frequency and intensity, and increased volumes of suspended particulates).

Free-roaming equids populations in many areas are Appropriate Management Level (AML), often venturing beyond herd management areas, leading to additional pressures in habitats that in many cases have been altered by past and present livestock grazing. Free-roaming equids preferentially graze graminoid and herbaceous forb species which diminishes the sustainability of a diverse understory of seed-bearing grasses and forbs (Abella, 2008). Free-roaming equids within the Great Basin have been shown to lead to decreases in diversity and plant cover across a range of habitats and elevation gradients (Beever & Brussard, 2000).

The added utilization contributes structural damage to shrubs, causes biocrust disturbance which adversely affects soil stability, and accelerates soil erosion. In addition to ever-increasing demands for intra- and interstate multi-modal energy, utility, and transportation infrastructure, new construction is adding to existing linear disturbances across the mid-elevation mixed scrub. The consequences of these disturbances directly or indirectly contribute to the conversion and degradation of the ecosystem and habitat integrity. Efforts to rely less on fossil-fueled energy generation and meet state and national renewable energy portfolio standards have spurred a boom in utility-scale solar energy development and transmission in the Mojave Warm Desert. Constructed, scheduled, and planned installation of solar energy (primarily photovoltaic panels) facilities on public lands is a significant use of land area that approaches tens of thousands of acres and converts and degrades ecosystem and habitat integrity. In 2018, USFWS prepared a species status assessment for Joshua tree (*Yucca brevifolia*) as a result of these impacts.

Climate Change Vulnerability

Mojave Warm Desert

Within the Nevada portion of the Mojave Warm Desert distribution, overall HCCVI is 19% in moderate and 81% in high relative vulnerability. Exposure is 28% severe, 53% high, 20% moderate. This overall exposure estimate results from contrasting component measures, with climate departure scoring at 100% severe while change in suitability - factoring in actual climate variability across the range of the type - scored as 50% low, 24% moderate, 13% high, and 13% severe. By mid-century and assuming a higher emission scenario (8.5), several climate variables are projected to have departed by greater than 2 standard deviations from the 20th-century baseline mean. These include Annual Mean Temperature (increasing 2.7 degrees Celsius) and Mean Temperature of the Warmest Quarter (increased by 3.2 degrees Celsius).

Overall resilience is measured at 33% moderate within the state, and with 67% of the area with higher vulnerability from resilience measures. Among resilience measures, sensitivity measures least toward vulnerability, with 32% of areas scoring moderate for Landscape condition. Impacts of invasive plants appear limited with available data. Since this desert scrub occurs throughout flats and rolling landscapes in this Basin and Range landscape, very low topographic roughness contributes to high vulnerability in 16% of the state's area and 84% contributes to severe vulnerability.


Source: NDOW

Table 27: Percentage of potential Mojave Warm Desert Key Habitats within Nevada with Low, Moderate, High and Severe Overall Vulnerability, Exposure, and Resilience.

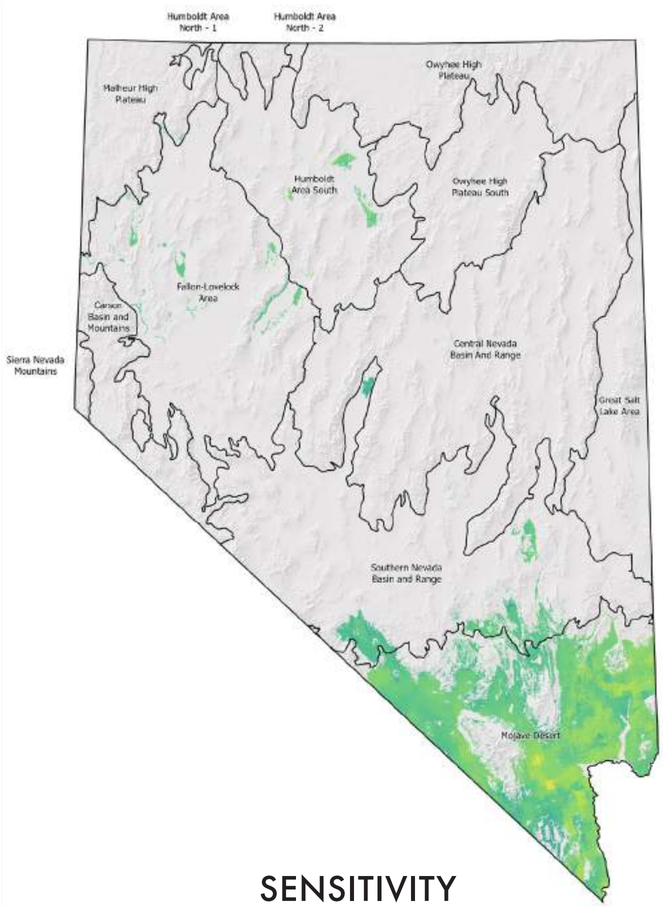
		PERCENT AREA WITHIN EACH RELATIVE VULNERABILITY RANKING			
		LOW	MODERATE	HIGH	SEVERE
Climate Change Vulnerability Index		0%	19%	81%	0%
Vulnerability from Measures of Exposure	Climate Departure	0%	0%	0%	100%
	Climate Suitability	50%	24%	13%	13%
	Overall Exposure	0%	20%	53%	27%
Vulnerability from Measures of Sensitivity	Landscape Condition	55%	32%	7%	6%
	Invasive Annual Grasses	99%	1%	<1%	0%
	Overall Sensitivity	65%	35%	<1%	0%
Vulnerability from Measures of Adaptive Capacity	Topoclimatic Variability	0%	<1%	16%	84%
	Overall Adaptive Capacity	0%	<1%	10%	90%
Vulnerability from Measures of Overall Resilience		0%	33%	67%	0%

When viewed across its primary distribution within the Mojave Desert and Southern Nevada Basin and Range MLRAs (Figure 34), patterns of climate change vulnerability vary, with the least severe vulnerability found among slopes and flats south of the Sloan Canyon National Conservation Area and in the area north and east of Tonopah. Elsewhere throughout its distribution, mid-elevation desert habitats scored with moderate-high vulnerability. Severe vulnerability for this habitat throughout the Las Vegas area is indicted by both severe climate exposure and sensitivity measures.

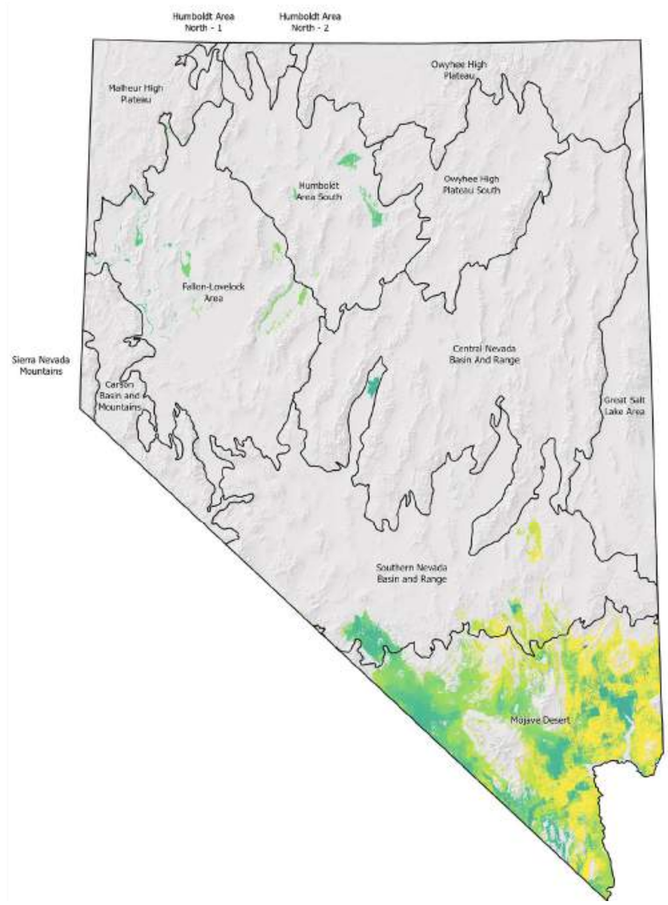
Mojave Mid-Elevation Desert

Within the Nevada portion of the Mojave Mid-Elevation Desert Key Habitat distribution, overall HCCVI is 45% in moderate and 55% in high relative vulnerability. Exposure is 15% severe, 76% high, and 9% moderate. This overall exposure estimate results from contrasting component measures, with climate departure scoring at 100% severe while change in suitability, factoring in actual climate variability across the range of the type, scored as 19% low, 49% moderate, 26% high, and 5% severe. Overall resilience is measured at 99% moderate within the state.

OVERALL VULNERABILITY (HCCVI)



EXPOSURE



SENSITIVITY

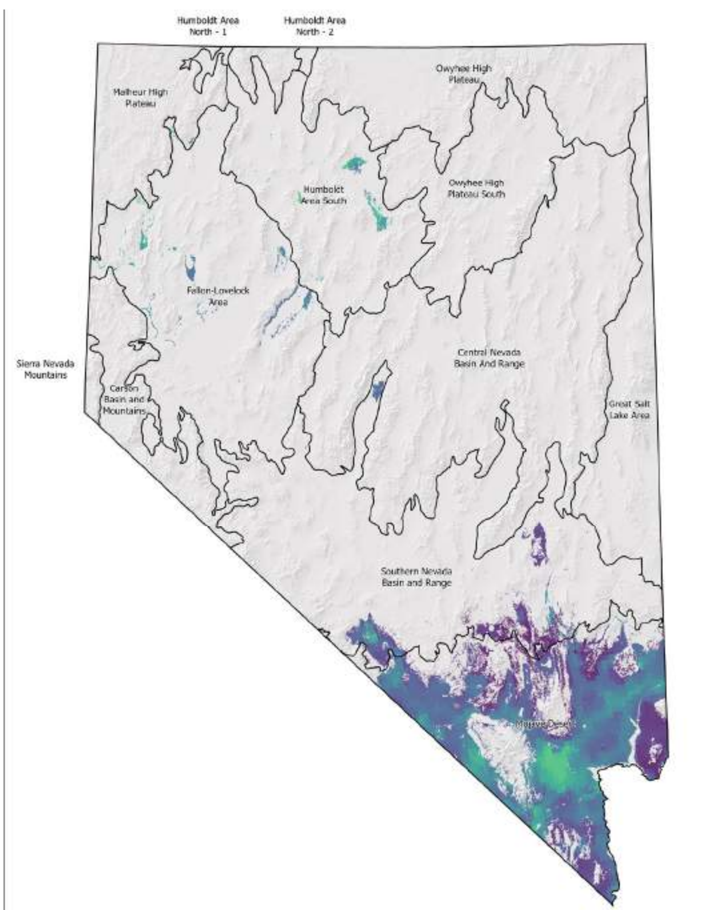


Figure 34. Mojave warm desert patterns of climate change vulnerability across MLRAs in Nevada. Overall HCCVI vulnerability measures incorporate patterns of potential climate exposure and habitat resilience, which incorporates ecosystem sensitivity and adaptive capacity (overall sensitivity shown here). Vulnerability, ranked from low to severe, is spatially variable based on multiple components of exposure and sensitivity.

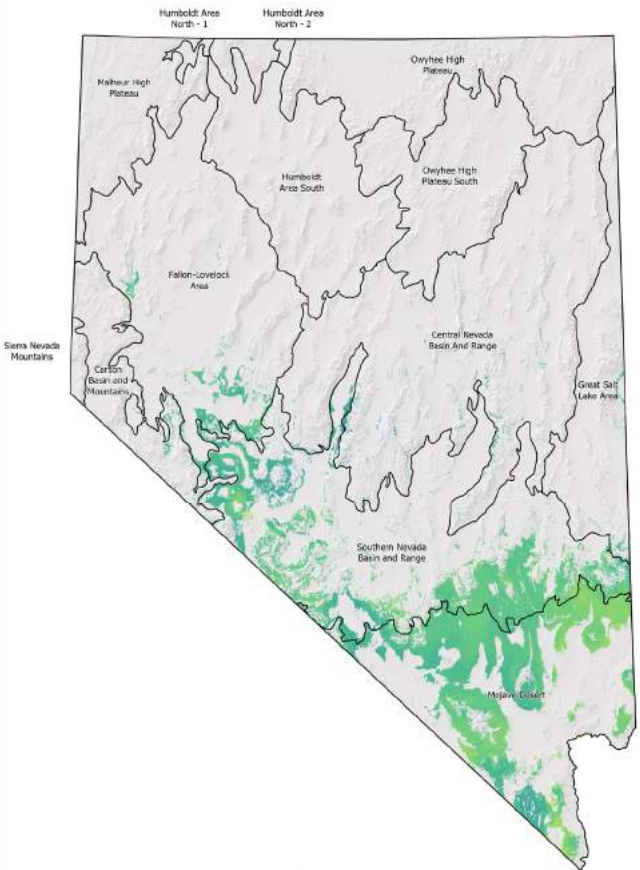
Among resilience measures, sensitivity measures contribute relatively little toward vulnerability, with landscape condition scoring low for 89% and moderate for 10%. Fire regime departure is scored at 73% low and 25% moderate. The impacts of invasive plants appear to be very limited. Since this desert scrub occurs throughout rolling plains and foothill slopes of the Mojave Basin and Range landscape, very low topographic roughness contributes to high vulnerability in 70% of the state's area and 29% contributes to severe vulnerability.

When viewed across its primary distribution within the Mojave Desert and Southern Nevada Basin and Range MLRAs (Figure 35), patterns of climate change vulnerability vary, with the least severe vulnerability found among slopes and flats south of the Sloan Canyon National Conservation Area and in the area north and east of Tonopah. Elsewhere throughout its distribution, mid-elevation desert habitats scored with moderate-high vulnerability.

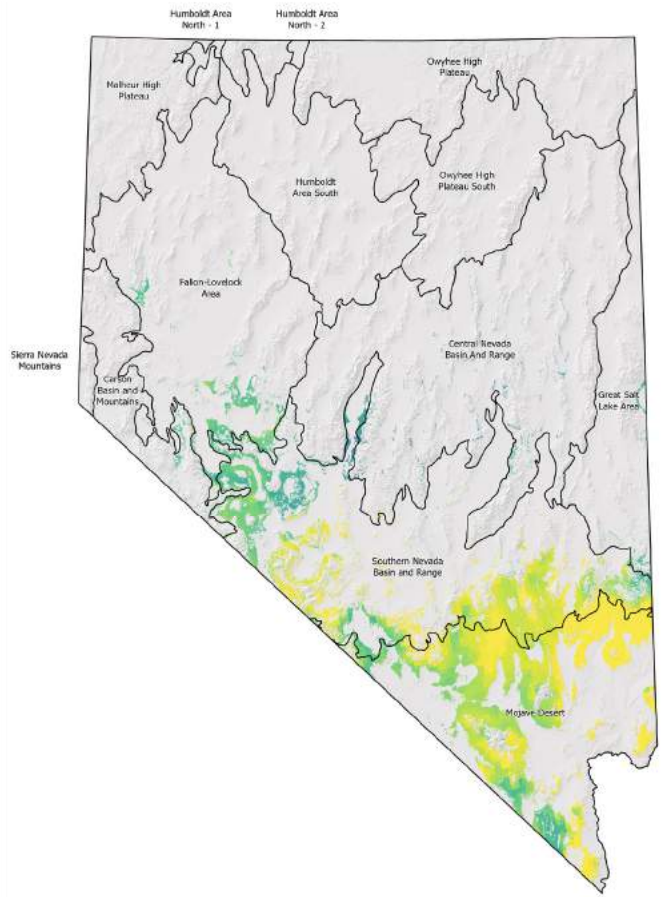
Table 28: Percentage of potential Mojave Mid-Elevation Desert Key Habitats within Nevada with Low, Moderate, High and Severe Overall Vulnerability, Exposure, and Resilience.

		PERCENT AREA WITHIN EACH RELATIVE VULNERABILITY RANKING			
		LOW	MODERATE	HIGH	SEVERE
Climate Change Vulnerability Index		0%	45%	55%	0%
Vulnerability from Measures of Exposure	Climate Departure	0%	0%	0%	100%
	Climate Suitability	19%	49%	26%	5%
	Overall Exposure	0%	9%	76%	15%
Vulnerability from Measures of Sensitivity	Landscape Condition	89%	10%	<1%	<1%
	Fire Regime Departure	73%	26%	1%	<1%
	Invasive Annual Grasses	100%	0%	0%	0%
	Overall Sensitivity	95%	5%	0%	0%
Vulnerability from Measures of Adaptive Capacity	Topoclimatic Variability	0%	<1%	70%	30%
	Overall Adaptive Capacity	0%	<1%	99%	0%
Vulnerability from Measures of Overall Resilience		0%	99%	<1%	0%

OVERALL VULNERABILITY (HCCVI)



EXPOSURE



SENSITIVITY

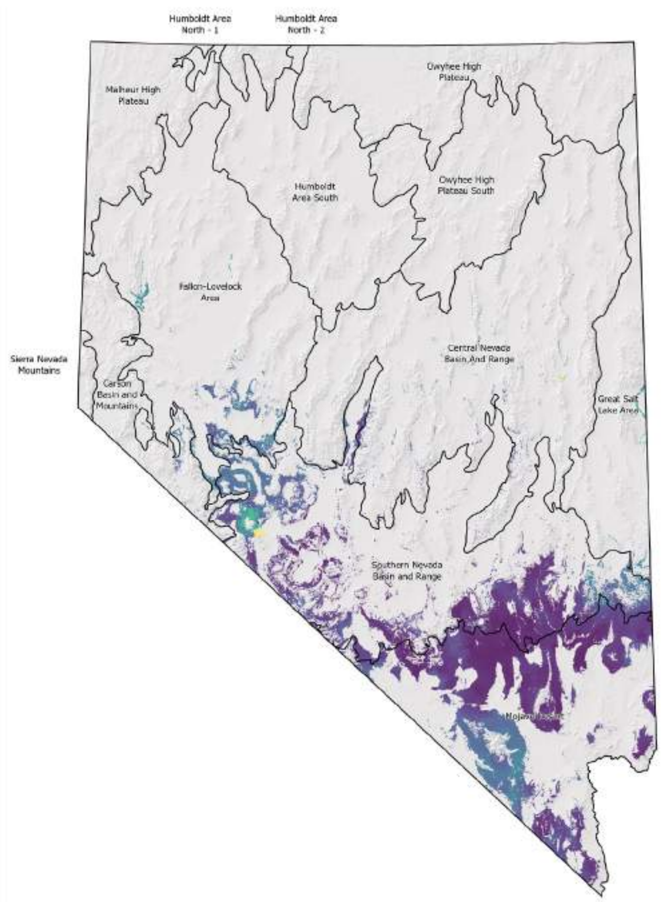


Figure 35. Mojave mid-elevation mixed desert shrub patterns of climate change vulnerability across MLRAs in Nevada. Overall HCCVI vulnerability measures incorporate patterns of potential climate exposure and habitat resilience, which incorporates ecosystem sensitivity and adaptive capacity (overall sensitivity shown here). Vulnerability, ranked from low to severe, is spatially variable based on multiple components of exposure and sensitivity.

Source: NDOW

Source: NDOW

Predicted Climate Change Effects

Arid systems comprising the Mojave Warm Desert and Mid-Elevation Mixed Desert Shrub systems will likely continue to be challenged by factors attributed to climate change (e.g., extended drought conditions, novel and increasing fire frequency and intensity, increased volumes of suspended particulates, and flux of seasonal weather patterns involving temperature increases). Past droughts have been associated with high rates of mortality in the dominant perennial shrub species within the region, signifying the potential for substantial plant community shifts under future scenarios (Archer & Predick, 2008). Invasive annual species present within these systems are likely to increase in cover in the future, and fire season lengths are likely to increase as well (Abatzoglou & Kolden, 2011; Underwood et al., 2019).

Given the relatively slow recovery time of these communities following disturbance events and the historically long fire return intervals within the region (Abella, 2010; Landfire, 2020), wholesale shifts in vegetative communities within the medium term are a likely scenario for the region.

Conservation Strategy

Objective 1: Identify and assess existing programs, partnerships, and data relative to Mojave Mid-Elevation and Mixed Desert Shrub habitats across southern Nevada by 2027.

- Action: Utilize new online mapping products to assess status and condition.
- Action: Develop strategies and approaches for identifying and addressing threats in a meaningful framework.
- Action: To address wildfire and invasives, identify suppression priority areas and coordinate with land management agencies to identify tools and mechanisms to address.
- Action: Develop a project planning and management tool/database to manage restoration and rehabilitation projects, including a public interface to showcase and remain transparent with the public.

Objective 2: Manage Mojave Mid-Elevation and Mixed Desert Shrub habitats to minimize loss or conversion of these habitats to 10% through 2027.

- Action: To address wildfire and invasives, continue implementing targeted fuel breaks and fuel treatments, and restoration/rehabilitation projects on greater than 5,000 acres per year.
- Action: Ensure there is no net unmitigated loss or fragmentation of habitat in areas designated by the Clark County Multiple Species Habitat Conservation Plan as Intensive Management Areas or Less Intensive Management Areas, or in areas designated as Multiple Use.
- Action: Maintain functional connectivity among presently intact Mojave Warm Desert and Mojave Mid-elevation Mixed Scrub habitats and account for northward extensions of these key habitats into other regions. Focus on the cumulative impacts of habitat conversion and degradation associated with the development of utility-scale renewable energy generation facilities, and infrastructure.

Objective 3: Prevent the transition of undeveloped Mojave Warm Desert and Mojave Mid-Elevation Mixed Scrub habitats to uncharacteristic classes exceeding 30% in mesic blackbrush and creosote bush-white bursage and 10% in thermic blackbrush through 2032.

- Action: Actively engage in partnerships promoting native plant seeds and materials programs for developing warehouse and repository centers in the Mojave Eco-Region, optimizing collaborative efforts involving seed collection, cleaning, banking, commercial vendor involvement, and grow-out capacity for large-scale restoration projects.
- Action: Support habitat restoration programs involving the development of biological control agents targeting brome grasses, effective herbicide prescriptions and use, and other management tools.
- Action: Develop cultivars of native plants that perform better from the seed or seedling stage to improve seeding success.

Key SGCN Species

- Amargosa toad (*Anaxyrus nelsoni*)
- Great Plains toad (*Anaxyrus cognatus*)
- Red-spotted toad (*Anaxyrus punctatus*)
- American kestrel (*Falco sparverius*)
- Arizona Bell's vireo (*Vireo bellii arizonae*)
- Bendire's thrasher (*Toxostoma bendirei*)
- Costa's hummingbird (*Calypte costae*)
- Crissal thrasher (*Toxostoma crissale*)
- Gambel's quail (*Callipepla gambelii*)
- Gilded flicker (*Colaptes chrysoides*)
- Golden eagle (*Aquila chrysaetos*)
- LeConte's thrasher (*Toxostoma lecontei*)
- Loggerhead shrike (*Lanius ludovicianus*)
- Lucy's warbler (*Leiothlypis luciae*)
- Peregrine falcon (*Falco peregrinus*)
- Prairie falcon (*Falco mexicanus*)
- Scott's oriole (*Icterus parisorum*)
- Southwestern willow flycatcher (*Empidonax traillii extimus*)
- Western burrowing owl (*Athene cunicularia hypugaea*)
- White-throated swift (*Aeronautes saxatilis*)
- Allen's big-eared bat (*Idionycteris phyllotis*)
- Big-free-tailed bat (*Nyctinomops macrotis*)
- Bighorn sheep (*Ovis canadensis*)
- California leaf-nosed bat (*Macrotus californicus*)
- Canyon bat (*Parastrellus hesperus*)
- Cave myotis (*Myotis velifer*)
- Desert kangaroo rat (*Dipodomys deserti*)
- Desert pocket mouse (*Chaetodipus penicillatus*)

Priority Research Needs

- Species-habitat relationships/predictive models demonstrating vertebrate and invertebrate species responses to the loss of shrubs in Mojave types.
- Habitat integrity/connectivity analysis for Mojave shovel-nosed snake, spotted leaf-nosed snake, and sidewinder.
- Wildlife responses to the conversion of Mojave shrubscapes to solar energy fields
- Action: Implement conifer removal treatments in appropriate locations where soil conditions might allow conversion back to montane shrublands.

- Fringed myotis (*Myotis thysanodes*)
- Greater bonneted bat (*Eumops perotis*)
- Mexican free-tailed bat (*Tadarida brasiliensis*)
- Mule deer (*Odocoileus hemionus*)
- Pallid bat (*Antrozous pallidus*)
- Panamint kangaroo rat (*Dipodomys panamintinus*)
- Western small-footed myotis (*Myotis ciliolabrum*)
- Yuma myotis (*Myotis yumanensis*)
- Common chuckwalla (*Sauromalus ater*)
- Desert horned lizard (*Phrynosoma platyrhinos*)
- Desert iguana (*Dipsosaurus dorsalis*)
- Desert night lizard (*Xantusia vigilis*)
- Desert rosy boa (*Lichanura orcutti*)
- Gila monster (*Heloderma suspectum*)
- Gilbert's skink (*Plestiodon gilberti rubricaudatus*)
- Glossy snake (*Arizona elegans*)
- Great Basin collared lizard (*Crotaphytus bicinctores*)
- Long-tailed brush lizard (*Urosaurus graciosus*)
- Mojave Desert tortoise (*Gopherus agassizii*)
- Mojave fringe-toed lizard (*Uma scoparia*)
- Mojave shovel-nosed snake (Chionactis occipitalis)
- Panamint alligator lizard (*Elgaria panamintina*)
- Panamint rattlesnake (*Crotalus stephensi*)
- Ring-necked snake (*Diadophis punctatus*)
- Sidewinder (*Crotalus cerastes*)
- Western skink (*Plestiodon skiltonianus*)
- A digger bee (*Anthophora mortuaria*)
- A digger bee (*Anthophora forbesi*)
- A digger bee (*Anthophora signata*)
- A digger bee (*Anthophora cockerelli*)
- A leaf cutter bee (*Megachile browni*)
- A leaf cutter bee (*Megachile bruneri*)
- A miner bee (*Perdita stephanomeriae*)
- American bumble bee (*Bombus pensylvanicus*)
- Arizona powdered-skipper (*Systasea zampa*)
- Big-headed perdita (*Perdita cephalotes*)
- Checkered white (*Pontia protodice*)
- Crotch's bumble bee (*Bombus crotchii*)
- Marine blue (*Leptotes marina*)
- Moapa perdita (*Perdita fulvescens*)
- Mojave blue (*Euphilotes mojave virginensis*)
- Mojave gypsum bee (*Andrena balsamorhizae*)
- Mojave poppy bee (*Perdita meconis*)
- Monarch (*Danaus plexippus plexippus*)
- Morrison's bumble bee (*Bombus morrisoni*)
- Red-tailed blazing star bee (*Megandrena mentzeliae*)
- Sachem (*Atalopedes campestris*)
- Sandhill skipper (*Polites sabuleti*)
- Spurge-loving perdita (*Perdita euphorbiae*)
- Virgin River perdita (*Perdita crotonis caerulea*)
- Virgin River twilight bee (*Perdita vespertina*)
- West Coast lady (*Vanessa annabella*)
- Western tailed-blue (*Cupido amyntula*)

Montane Shrublands

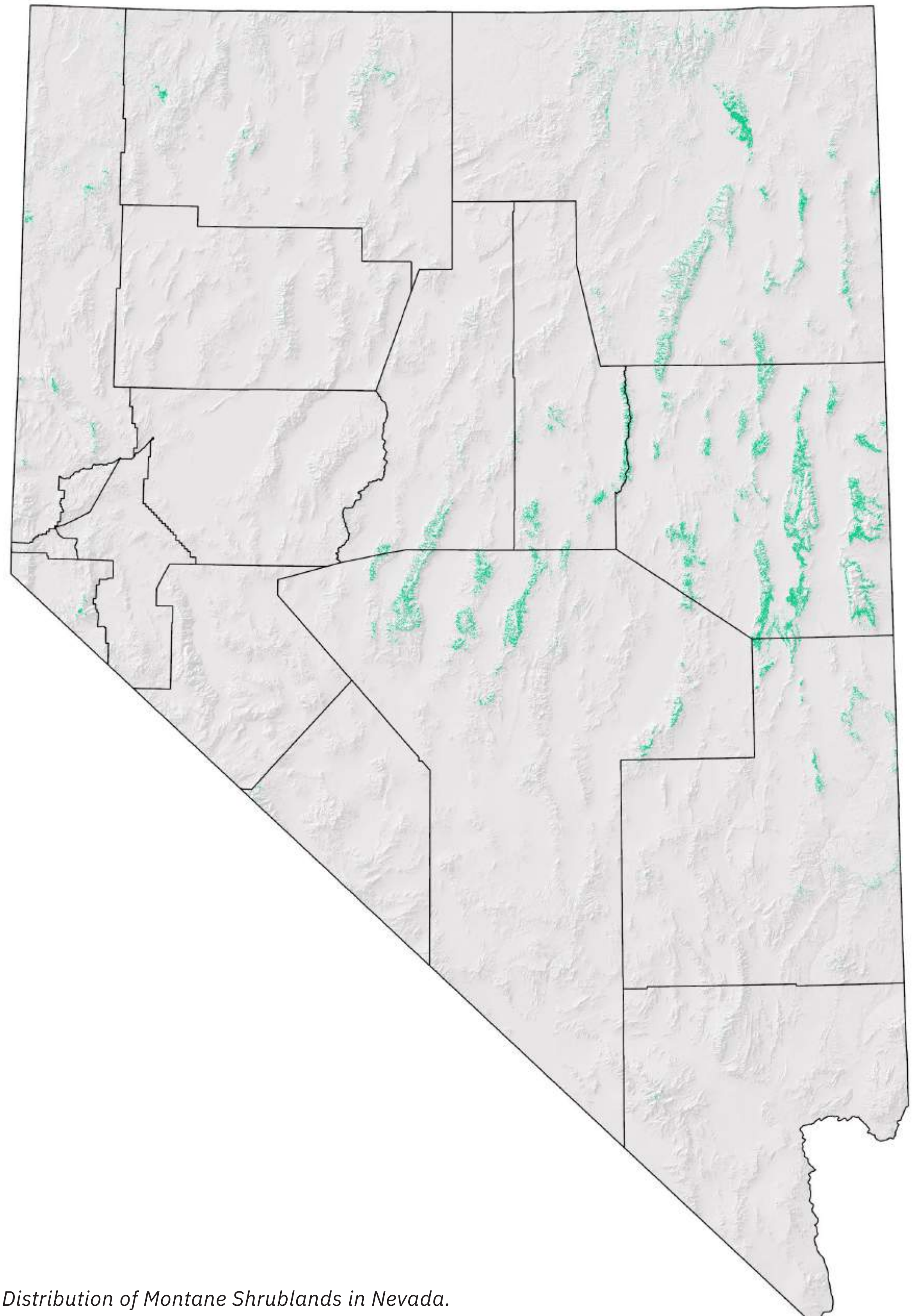


Figure 36. Distribution of Montane Shrublands in Nevada.

Key Habitat Description and Elements of Montane Shrublands

Vegetation and Abiotic Environment

Three biophysical settings comprise montane shrublands in Nevada: Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland, Rocky Mountain Lower Montane-Foothill Shrubland, and Northern Rocky Mountain Montane-Foothill Deciduous Shrubland. Montane shrublands are part of dominant plant associations and alliances that result from spatial heterogeneity in soil types across the physiographic provinces of the Basin and Range complex (Miller et al., 2008). These ecological systems are found in hills and mountain ranges of the Intermountain West basins from the eastern foothills of the Sierra Nevada to the eastern edge of the Rocky Mountains foothills. Montane shrublands can span elevation gradients from 1950-9500 feet. The climate is emblematic of the modified continental macroclimate found throughout the Great Basin with cold wet winters and hot dry summers (Zamora & Tueller, 1973 & Miller et al., 2019). Fire, flooding, and erosion all impact these shrublands, but they typically will persist on sites for long periods, so long as disturbance regimes maintain historic return intervals. This system includes both woodland and shrubland species that share codominance. The distribution of these shrublands is determined by soil moisture availability and by a fire frequency and intensity that is balanced between the elimination of shrubs and the limitation of tree invasion. Montane shrublands are often associated with exposed sites, rocky substrates, and dry conditions which limit tree growth, the principal indicator species that characterize these shrublands form habitat associations that range from xeric to mesic. Many of the associations achieve their best growth within more mesic conditions, e.g., north-facing slopes, narrow canyons, and relatively moist ravines and depressions (Decker, 2007).

General Wildlife Value

Mountain shrubs such as snowberry (*Symphoricarpos sp.*), serviceberry (*Amelanchier sp.*), Stansbury cliffrose (*Purshia stansburyana*), and bitterbrush (*Purshia tridentata*), provide critical browse for mule deer; their fruits are important for small mammals, birds, and beaver, and marmot eat their bark. Cliffrose is a mule deer staple, especially in the winter months. This densely vegetated type also provides important cover for wildlife species from birds to mammals to reptiles.

Curl-leaf mountain mahogany (*Cercocarpus ledifolius*) provides similar values (cover, nest sites, and foraging opportunities) but in a subtly different fashion. The overstory created by mountain mahogany tends to be sparser than the thick canopy that can form in pinyon juniper, and as such more diffuse light reaches the ground. In young-to- middle-aged thickets or savannas of old trees of mountain mahogany the understory often supports a large variety of forbs, grasses, and shrubs, all of which offer foraging opportunities for birds, small mammals, and reptiles. Various mountain shrubs under the canopy of curl-leaf mountain mahogany provide valuable forage to wildlife (Stubbendieck et al., 1992).

Existing Environment

Dominant Biophysical Settings

The dominant biophysical settings comprising montane shrublands are Inter-Mountain Basins Curl-leaf Mahogany Woodland and Shrubland, Rock Mountain Lower Montane-Foothill

Shrubland, and Northern Rocky Mountain Montane-Foothill Deciduous Shrubland (Table 29).

Table 29: Dominant biophysical settings comprising montane shrubland key habitats in Nevada. Roughly 736,747 acres of Nevada may have historically supported aspen communities based on Biophysical Setting analysis.

MONTANE SHRUBLANDS	736,747 ACRES
Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland	697,326 acres
Rocky Mountain Lower Montane-Foothill Shrubland	39,422 acres
Northern Rocky Mountain Montane-Foothill Deciduous Shrubland	18,819 acres

Habitat Conditions

In Nevada, curl-leaf mountain mahogany (*Cercocarpus ledifolius*) stands are stable in distribution, but many stands are not successfully recruiting and are in advanced stages of succession, often with live crowns out of reach of browsing ungulates. Mature, non-regenerating stands are at increased risk of loss by fire. Once burned, these stands may be hard to recover because mountain mahogany does not generally sprout after burning and regeneration of burned stands from seed appears to be quite low (Decker, 2007; Landfire, 2020). Although curl-leaf mountain mahogany produces abundant seeds, seedlings suffer from very high herbivory from mule deer (Odocoileus hemionus) and small mammals (seedlings are very high in palatable nitrogen). Seedlings also require mineral soil as they do not tolerate competition from other plant species, including cheatgrass.

Before the late 1800s, low severity fires played a key role in limiting conifer expansion (establishment of trees into areas that were previously void of trees) and infill (increasing consolidation of previously sparse tree canopies) from mid- to upper-elevation sites into lower montane-foothill shrubland (Chambers et al., 2014; Coates et al., 2017). After European settlement in the 1860s, pinyon-juniper expansion occurred alongside livestock grazing and fire suppression regimes, which increased fire return intervals from 12-24 years to greater than 50 years (Crawford et al., 2004). This increase lengthened successional stages and caused more conifer expansion and infill from distinct pre-settlement habitats (Miller & Heyerdahl, 2008). This mid- to upper-elevation conifer expansion and infill has paralleled cheatgrass's establishment on the lower elevation sites that is causing an elevational squeeze on these shrubland associations across Nevada (Miller et al., 2011).


Source: NDOW

Table 30: Percent of Montana Shrubland habitat converted to agriculture, barren or sparsely vegetated cover, non-natural vegetation, and/or urbanized lands based on Landfire successional class analysis. Non-natural vegetation types include both non-native exotic dominated areas as well as areas dominated by natural vegetation that is outside the range of variation (cover, height, dominant type) that would be expected under typical conditions. Natural vegetation includes all areas remaining in young-old age successional classes as outlined below although the distribution of age classes within natural vegetation states may be outside of the range of variation expected under historic conditions.

MONTANE SHRUBLAND	
CURRENT STATE	**PERCENT HABITAT**
Agriculture	0.04%
Barren or Sparse	0.06%
Natural Vegetation	94.58%
Non-Natural Vegetation (invasive or native)	5.32%
Urban	0.04%

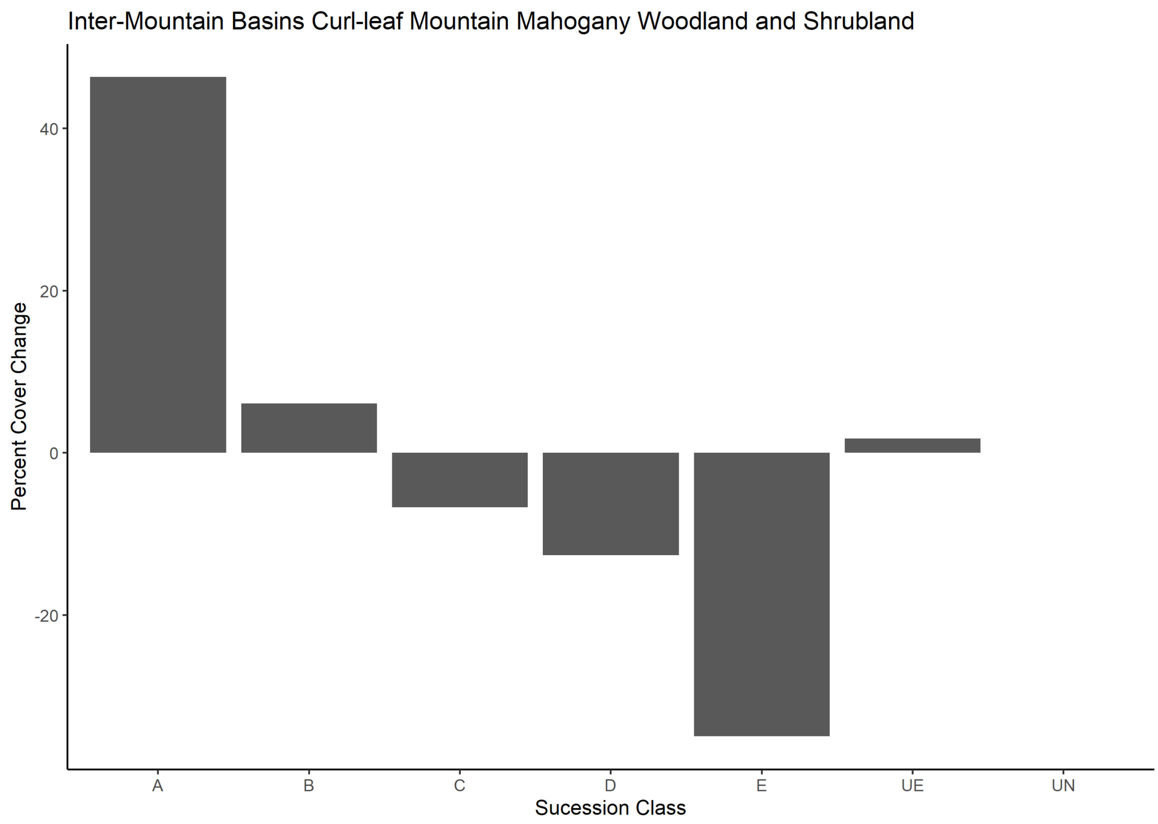


Figure 37. Succession class data for biophysical setting Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

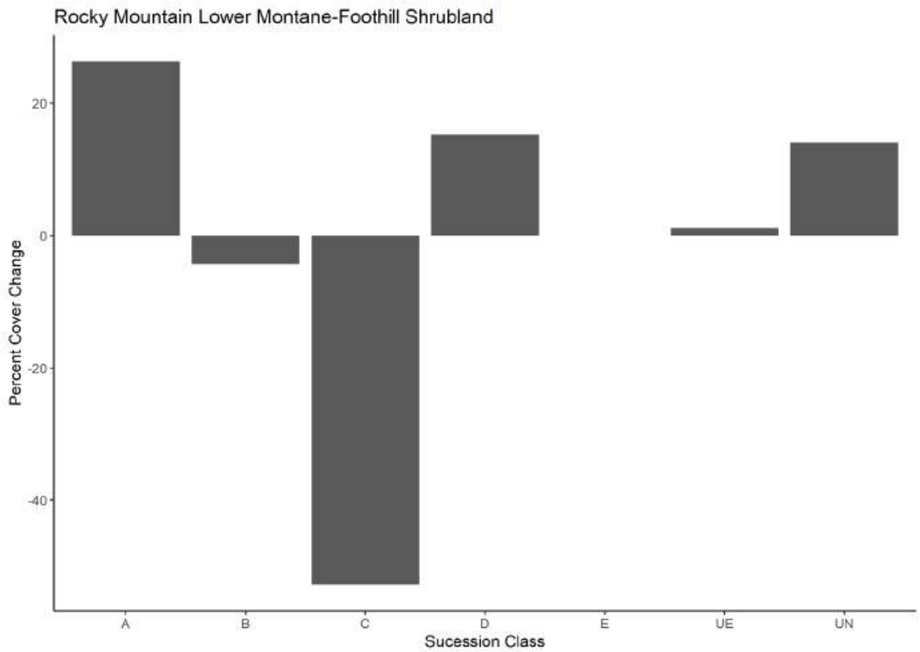


Figure 38. Succession class data for biophysical setting Rocky Mountain Lower Montane-Foothill Shrubland. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

Habitat Threats

Threats to this key habitat type include invasion by cheatgrass (*Bromus tectorum*), uncharacteristic crown fires in woodlands originating from tree-encroached shrublands, tree encroachment of mountain shrub communities, conversion to non-native annual grasslands, and stand densification. The rarity of successful recruitment in curl-leaf mountain mahogany patches that have burned has been identified as a threat to the maintenance of the BpS. In some places of this key habitat, recreational activities have disturbed wildlife resulting in movements, displacement, behavior changes, and impacts on reproductive success. Illegal activities such as poaching and collection or killing of wildlife may constitute a problem for populations in this habitat.

In the lower montane foothill shrubland ecoregion, low-density urban and industrial developments have impacted productive shrubland sites. These land use practices can fragment the landscape and reduce connectivity between patches and the surrounding habitats. Dispersed recreation can cause new roads and trails to dissect the landscape and can cause the spread of invasive annual such as cheatgrass and medusahead (*Taeniatherum caput-medusae*) from other locations. Fire has historically played a part in the composition and distribution of these shrublands; however, alteration of fire intensity and frequency can result in tree encroachment in some areas or the development of dense stands outside the range of natural historic variation.

Predicted Climate Change Effects

Where montane shrubland associations are commonly found throughout its biophysical region, increases in average annual temperature are projected to continue, causing more frequent drought cycles. A reduction in annual snowpack and runoff are predicted to decline as well (Garfin et al., 2014 & Landfire, 2020). Although alderleaf mountain mahogany is well suited to relatively drier site conditions, successful reproduction, and seedling establishment is often correlated and emblematic of adequate soil moisture (Gucker, 2006). With cycles of above-average precipitation occurring less frequently across these shrublands, seedling recruitment and establishment may become more intermittent in the future, especially on more xeric lower elevation sites.

Under hotter drier temperature regimes, montane shrublands at lower elevations are likely to be more exposed to invasion by cheatgrass. With Cheatgrass exhibiting a broader ecological amplitude (i.e., ability to exist over a larger gradient of xeric and mesic sites) than native perennial bunchgrasses, profound effects may occur on the physical and effective environments of shrubland plant assemblages and communities (Chambers et al., 2014). Cheatgrass establishment could further lower montane shrubland native species' resilience and resistance capabilities, therefore reducing individual plant species' (e.g., native shrubs and bunchgrasses) ability to regain and retain their fundamental structure and functionality (Miller et al., 2011).

Conservation Strategy

Objective 1: Identify and assess existing programs, partnerships, and data relative to montane shrubland habitats across southern Nevada by 2027.

- Action: Map montane shrub stands throughout the state at a fine scale to interpret elevational shifts in plant composition and structure.
- Action: Identify and augment natural montane brush regeneration with planted stocks and/or reseeding.
- Action: Implement conifer removal treatments in appropriate locations where soil conditions might allow conversion back to montane shrublands.

Priority Research Needs

- Statewide health assessment of Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland and Rocky Mountain Lower Montane-Foothill Shrubland stands.
- Monitoring of temperature shifts across elevation gradients from lower xeric to higher mesic sites.
- Monitoring fire return intervals and compare to historic trends.
- Improve understanding of the impact of dispersed recreation, human-caused fire events, and the transfer of exotic species.
- Analysis of plant species structure shift (both spatial and compositionally) and distribution caused by increasing temperature regimes.

Key SGCN Species

- Great Basin spadefoot (*Spea intermontana*)
- Western toad (*Anaxyrus boreas*)
- American kestrel (*Falco sparverius*)
- Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianu*)
- Crissal thrasher (*Toxostoma crissale*)
- Dusky flycatcher (*Empidonax oberholseri*)
- Golden eagle (*Aquila chrysaetos*)
- Lincoln's sparrow (*Melospiza lincolnii*)
- Olive-sided flycatcher (*Contopus cooperi*)
- Virginia's warbler (*Leiothlypis virginiae*)
- Canyon bat (*Parastrellus hesperus*)
- Fringed myotis (*Myotis thysanodes*)
- Mexican free-tailed bat (*Tadarida brasiliensis*)

- Mule deer (*Odocoileus hemionus*)
- Townsend's big-eared bat (*Corynorhinus townsendii*)
- White-tailed jackrabbit (*Lepus townsendii*)
- Glossy snake (*Arizona elegans*)
- American bumble bee (*Bombus pensylvanicus*)
- Arrowhead blue (*Glaucopsyche piasus*)
- Checkered white (*Pontia protodice*)
- Indiscriminate cuckoo bumble bee (*Bombus insularis*)
- Indra swallowtail (*Papilio indra*)
- Large marble (*Euchloe ausonides*)
- Lupine blue (*Icaricia lupini*)
- Marine blue (*Leptotes marina*)
- Melissa blue (*Plebejus melissa*)
- Monarch (*Danaus plexippus plexippus*)
- Morrison's bumble bee (*Bombus morrisoni*)
- Sandhill skipper (*Polites sabuleti*)
- Sara orangetip (*Anthocharis sara*)
- West Coast lady (*Vanessa annabella*)
- Western Bumble Bee (*Bombus occidentalis*)
- Western tailed-blue (*Cupido amyntula*)
- White-shouldered bumble-bee (*Bombus appositus*)
- Yellow bumble bee (*Bombus fervidus*)

Pinyon-Juniper Woodland

Figure 39. Distribution of Pinyon-Juniper Woodland in Nevada.

Key Habitat Description and Elements of Pinyon-Juniper Woodland

Vegetation and Abiotic Environment

Pinyon-Juniper Woodland key habitat represents non-encroachment woodlands that historically occurred on shallow rocky soils or rock-dominated sites that were protected from frequent fire, such as rocky ridges, steep slopes, broken topography, and mesa tops. Pinyon-juniper woodland distribution is restricted to narrow elevational bands due to frost and drought occurring during the growing season. Soils supporting this system vary in texture ranging from stony, cobbly, gravelly sandy loams to clay loam or clay. The soil temperature regime is typically mesic and frigid, and the soil moisture regime is typically aridic bordering on xeric and xeric.

Pinyon-juniper woodlands typically range from about 5,000-9,200 feet in elevation, bounded at upper elevations by montane shrub and forest settings, and sagebrush and salt desert shrub settings at lower elevations. Average annual precipitation ranges from 12-16 inches but can reach as high as 22 inches. Monsoonal moisture in summer allows the presence of pinyon and the extent of this BpS is determined by where the climatic precipitation regime is predominantly winter and summer, with spring and fall relatively dry. Utah juniper (*Juniperus osteosperma*), the primary juniper species present, is more tolerant of drought than single-leaf pinyon pine (*Pinus monophylla*); as such, the lower elevations of this setting may lack pinyon (NatureServe, 2018).

Woodlands are dominated by a mix of single-leaf pinyon pine and any of four species of junipers (*Juniperus spp.*) – Utah (*J. osteosperma*), Western (*J. occidentalis*), Rocky Mountain (*J. scopulorum*), or California (*J. californica*); pure or nearly pure occurrences of pinyon; or woodlands dominated solely by juniper. Most sites with this habitat type consist of pinyon and juniper in combination. Single-leaf pinyon-Utah juniper is the most common combination. Rocky Mountain juniper-two-needle pinyon (*Pinus edulis*) appears on the Colorado Plateau in the eastern portion due to higher summer precipitation. Cover by juniper in these habitat types is relatively stable, but the amount of pinyon fluctuates, declining during episodes of severe drought. Overstory cover ranges from 25-50%, although the cover was more typically on the lower end of the range, while the combination of bare ground, exposed rock, gravel, and litter ranges from 25-75%.

Curl-leaf mountain mahogany (*Cercocarpus ledifolius*) is a common associate. Understory vegetation varies due to latitude, elevation, and precipitation. Cool-season bunchgrasses prevail in the northern and western parts of the range where summer precipitation is lower and more variable. In the southern and eastern parts of the range, where summer precipitation is higher and less variable, more warm-season grasses are found. Associated species include shrubs such as greenleaf manzanita (*Arctostaphylos patula*), low sage (*Artemisia arbuscula*), black sage (*Artemisia nova*), sagebrush (*Artemisia tridentata*), mountain mahogany (*Cercocarpus ledifolius*), littleleaf mahogany (*Cercocarpus intricatus*), blackbrush (*Coleogyne ramosissima*), Stansbury cliffrose (*Purshia stansburyana*), mountain buckbrush (*Ceanothus greggii*), mountain snowberry (*Symphoricarpus oreophilus*), ashy silktassel (*Garrya falvescens*), banana yucca (*Yucca baccata*), and bunchgrasses needle-and-thread grass (*Hesperostipa comata*), Idaho fescue (*Festuca idahoensis*), bluebunch wheatgrass (*Pseudoroegneria spicata*), basin wildrye (*Leymus cinereus*), Indian Ricegrass (*Achnatherum hymenoides*), and muttongrass (*Poa fendleriana*).

Due to the lack of fuels in historical old-growth settings, fire was rare. Since the overstory conifers are very long-lived (800 years to greater than 1,000 years), old-growth patches were primarily composed of later seral stages that did not occur as extensive woodlands. Old pinyon-juniper stands may take as much as 400 years to develop. The age structure may vary from uneven to even-aged.

General Wildlife Value

Pinyon-juniper woodlands provide shelter for wildlife, varying from escape and loafing cover in and beneath the canopy to nesting cavities in the boles for birds, bats, and other small mammals. Microclimates of these woodlands likely provide thermal maintenance benefits during the winter and summer months for a variety of wildlife including large mammals. Pinyon-juniper woodlands provide nesting, roosting, and foraging locations for birds and bats, that would otherwise be missing from many mid-elevation sites dominated by shrubs. Species such as the Pinyon jay (*Gymnorhinus cyanocephalus*), juniper titmouse (*Baeolophus ridgwayi*), green-tailed towhee (*Pipilo chlorurus*), and some small mammals (i.e., Pinyon mouse) are strongly tied to this resource. Though not so closely tied to a single species, the juniper berry crop is also an important food resource for birds and small mammals.

Existing Environment

Dominant Biophysical Settings

The dominant Great Basin Pinyon-Juniper Woodland Biophysical Settings dominates this key habitat, other settings are relatively minor inclusions within the type.

Table 31: Dominant biophysical settings comprising Pinyon-Juniper Woodlands key habitats in Nevada. Roughly 4,337,194 acres of Nevada may have historically supported Pinyon-Juniper Woodland communities based on biophysical setting analysis.

PINYON-JUNIPER WOODLAND	4,337,194 ACRES
Great Basin Pinyon-Juniper Woodland	4,323,413 acres
Columbia Plateau Western Juniper Woodland and Savanna	11,003 acres

Habitat Conditions

Pinyon-juniper woodlands, generally found on steep and unproductive soils, are usually in good condition due to difficult access and limited water for livestock. Many woodlands within roughly five miles of historic mines

were likely thinned or cut over during the historic mining era, and younger trees are currently in-filling these sites. The greatest threats to pinyon-juniper woodlands are invasion by non-native cheatgrass and conversion to non-native annual grassland after a fire, uncharacteristic fire fueled either by cheatgrass ignition or originating from tree-encroached shrublands surrounding woodlands, and infilling of young trees between older trees (stand densification; Weisberg et al., 2007). Pinyon-juniper soils can have high soil erosion potential and are reliant on herbaceous cover and cryptogamic soil crusts to minimize precipitation runoff and soil loss (Baker et al., 1995; Belnap et al., 2001).

Table 32: Percent of pinyon-juniper woodland key habitat converted to agriculture, barren or sparsely vegetated cover, non-natural vegetation, and/or urbanized lands based on Landfire successional class analysis. Non-natural vegetation types include both non-native exotic dominated areas as well as areas dominated by natural vegetation that is outside the range of variation (cover, height, dominant type) that would be expected under typical conditions. Natural vegetation includes all areas remaining in young-old age successional classes as outlined below although the distribution of age classes within natural vegetation states may be outside of the range of variation expected under historic conditions.

MONTANE SHRUBLAND	
CURRENT STATE	**PERCENT HABITAT**
Agriculture	0.2%
Barren or Sparse	8.2%
Natural Vegetation	88.9%
Non-Natural Vegetation (invasive or native)	2.7%
Urban	0.03%

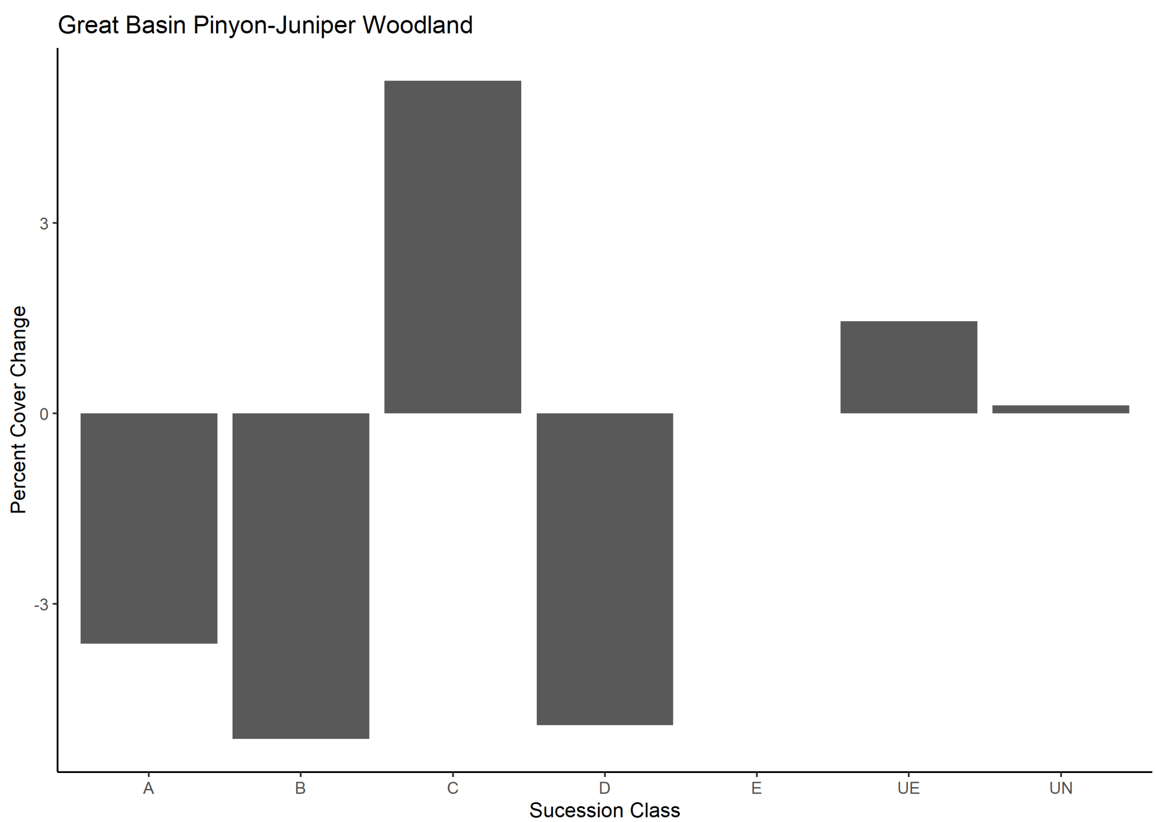


Figure 40. Succession class data for biophysical setting Great Basin Pinyon-Juniper Woodland. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

Habitat Threats

The ecosystem function of pinyon-juniper woodlands is currently threatened by fire suppression, livestock grazing, anthropogenic development, and invasion by non-native annual grasses. Before ecological alterations due to anthropogenic impacts from European settlers, pinyon-juniper woodlands were primarily restricted to small portions of the landscape that were protected from fire. These sites were characterized by rocky ridges or broken topography with little cover by fine fuels.

Starting around 1900, the composition of this habitat type has been largely altered by fire suppression and intensive livestock grazing, which reduces the cover of fine fuels, further reducing the fire return interval at these sites (Swetnam and Baisan 1996). Due to the decrease in fires in this habitat type, much of these systems have transferred to closed-canopy states with a build-up of woody fuels. Subsequently, these modern characteristics increase the likelihood of high-intensity, stand-replacing fires.

The distribution of this habitat type has been altered over the past 120 years, as well. Livestock grazing has suppressed perennial grass growth, which allows for the in-filling of trees and shrubs and altered fire regimes. Pinyon and juniper trees have also expanded onto adjacent shrub and grasslands in many areas (Blackburn & Tueller, 1970; Tausch et al., 1981; Chambers, 2001; Wangler & Minnich, 2006; Landfire, 2007; Weisberg et al., 2007).

The increased density of tree canopy at these sites leads to an increased risk of severe fire. Increased tree canopy shading leads to reduced ground cover in turn increasing soil erosion. (Tausch & West, 1988) In recent years, invasion by non-native annual grass (specifically cheatgrass, *Bromus tectorum*) has combined with the above-described factors to create significant losses of pinyon-juniper woodlands. Cheatgrass and other introduced annuals create increased fine fuel loads which carry fire more easily through this habitat type (Thorne et al., 2007).

During periods of drought, pinyon trees are weakened and more vulnerable to attacks by the native pinyon ips beetle (*Ips confusus*). In recent years of drought, there have been epidemics of pinyon ips beetle infestations, where many mature pinyon trees are killed off. In addition to the loss of trees, this poses an additional threat to the habitat type through increased woody fuel loads, increasing the risk of stand-replacing fires (Furniss & Carolin, 2002; Thorne et al., 2007). Resource management actions such as chaining of live stands of trees quickly lead to epidemic outbreaks of ips beetles through the creation of a ready food source. These epidemics spread beyond the treatment boundary and kill healthy neighboring single-leaf pinyon pines (Furniss & Carolin, 2002).

Additional anthropogenic impacts have severely impacted the ecological function of this habitat type. These include range practices common in the past, such as chaining, tilling, and reseeding with non-native forage-producing grasses. Research has shown that dominant trees can regenerate after this kind of disturbance; however, the effects on native understory vegetation are unknown (Thorne et al., 2007).

The final threat to this habitat type is anthropogenic development, which has impacted pinyon-juniper woodlands throughout the Great Basin. This includes mining infrastructure impacts, industrial development, and residential development. Mining operations have extremely negative impacts on habitat both at the mining site itself and through the construction of new roads and transmission lines required by the mine. Habitat at the mining site is utterly destroyed, while roads and transmission lines create swaths through the ecosystem which act as vectors for invasive species. Industrial and residential development creates many similar impacts on habitat through direct vegetation removal and the introduction of invasive plants. Residential development primarily impacts pinyon-juniper woodlands that are within commuting distance of an urban area. Finally, each of these human developments leads to further fire regime alterations as fire is suppressed at sites adjacent to developments.

Climate Change Vulnerability

Within the Nevada portion of the Pinyon-Juniper Key Habitat distribution, overall HCCVI is 64% in moderate and 33% in high relative vulnerability. Exposure is 60% high, 25% moderate, and 14% low. This overall exposure estimate results from contrasting component measures, with climate departure scoring at 100% severe while change in suitability - factoring in actual climate variability across the range of the type - scored as 84% low and 14% moderate. Overall resilience is measured at 83% moderate within the state, and with 17% of the area with higher vulnerability from resilience measures. By mid-century and assuming a higher emission scenario (8.5), several climate variables are projected to have departed by greater than two standard deviations from the 20th-century baseline mean. These include Annual Mean Temperature (increasing 2.7-2.9 degrees Celsius), Mean Temperature of the Warmest Quarter (increased by 3.3-3.4 degrees Celsius), and Maximum Temperature of the Warmest Month (increased by 3.2-3.6 degrees Celsius).

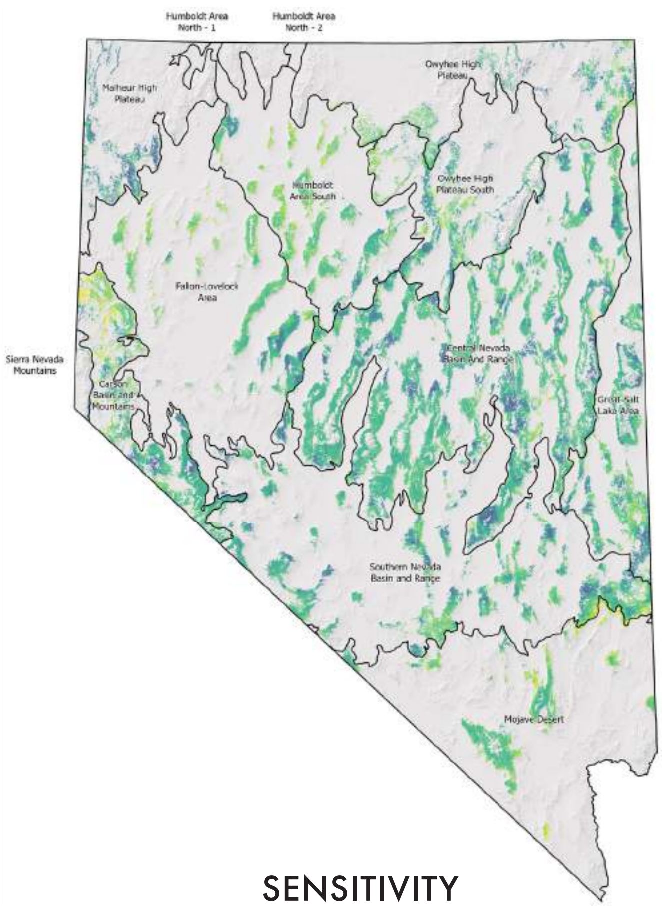
Among resilience measures, fire regime departure contributes most toward vulnerability, with 68% of are scoring moderate and 32% high. Given the relatively unfragmented distribution and elevation where these woodlands occur, both landscape condition and invasive annual grass scores contribute little to vulnerability within Nevada. However, even though these woodlands occur along the low mountain slopes of Basin and Range landscapes, relatively limited topographic roughness contributes to moderate vulnerability in 39% of the state's area and 69% contributes toward high vulnerability.

When viewed across the MLRAs in Nevada (40), patterns of climate change vulnerability vary, with moderate overall vulnerability expressed across much of the state. The lowest estimated vulnerability is found in concentrated areas, most commonly in the Central Nevada Basin and Range MLRA, but also in limited areas of other MLRA throughout the NV portion of this habitat's range. Those areas supporting these Pinyon-Juniper Woodland habitats with more severe vulnerability are concentrated along the transition into the Mojave Desert, within the Carson Basin and Mountains, in the Humboldt Area South, the Fallon-Lovelock Area, and the western portions of the Owyhee High Plateau South MLRA. These same patterns are reflected in the map of climate exposure. Distinct patterns are found in resilience components, such as the summary of sensitivity measures. The most severe vulnerability contributed by sensitivity measures is most concentrated throughout the northwestern distribution of this habitat in the Owyhee High Plateau South, Humboldt Areas South, Fallon-Lovelock Area, and Carson Basin and Mountains MLRAs.

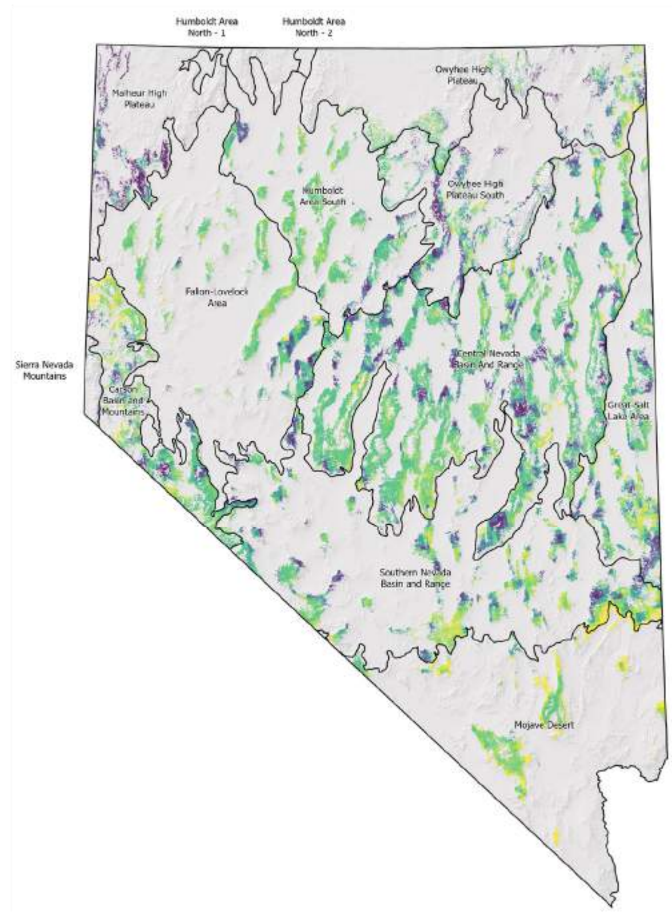
Table 33: Percentage of potential Pinyon-Juniper Key Habitats within Nevada with Low, Moderate, High and Severe Overall Vulnerability, Exposure, and Resilience.

		PERCENT AREA WITHIN EACH RELATIVE VULNERABILITY RANKING			
		LOW	MODERATE	HIGH	SEVERE
Climate Change Vulnerability Index		3%	64%	33%	0%
Vulnerability from Measures of Exposure	Climate Departure	0%	<1%	0%	99%
	Climate Suitability	84%	14%	2%	<1%
	Overall Exposure	14%	25%	60%	2%
Vulnerability from Measures of Sensitivity	Landscape Condition	87%	12%	1%	<1%
	Fire Regime Departure	0%	68%	32%	0%
	Invasive Annual Grasses	87%	6%	5%	2%
	Overall Sensitivity	75%	22%	3%	0%
Vulnerability from Measures of Adaptive Capacity	Topoclimatic Variability	<1%	40%	60%	<1%
	Overall Adaptive Capacity	0%	0%	92%	8%
Vulnerability from Measures of Overall Resilience		0%	83%	17%	0%

OVERALL VULNERABILITY (HCCVI)



EXPOSURE



SENSITIVITY

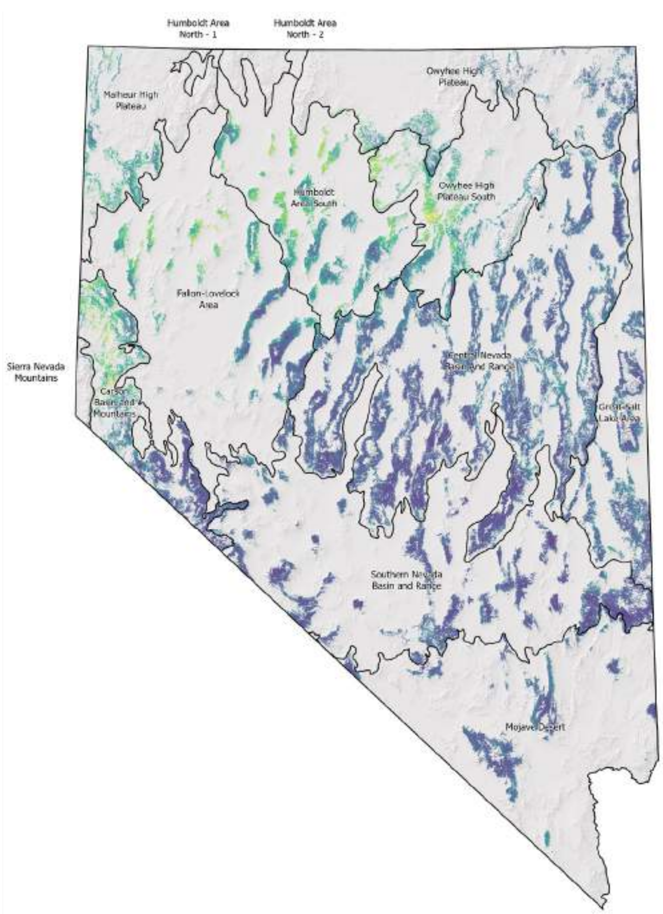


Figure 41. Pinyon-juniper woodland mixed desert shrub patterns of climate change vulnerability across MLRAs in Nevada. Overall HCCVI vulnerability measures incorporate patterns of potential climate exposure and habitat resilience, which incorporates ecosystem sensitivity and adaptive capacity (overall sensitivity shown here). Vulnerability, ranked from low to severe, is spatially variable based on multiple components of exposure and sensitivity.

Predicted Climate Change Effects

The vegetative composition of pinyon-juniper woodlands will likely shift with impacts similar to those previously seen under extended drought (Comer et al., 2018). Seedling survival and establishment will be reduced or nonexistent, which will reduce or eliminate tree recruitment. If tree recruitment is severely reduced or nonexistent, pinyon-juniper woodlands will cease to exist once the remaining trees die.

As described above, drought weakens pinyon trees, allowing for the proliferation of insects that kill off mature trees such as the ips beetle (*Ips calligraphus*). Additionally, more mild cold seasons increase insect survival, allowing for larger populations of insects, including the ips beetle. Along with the predicted increase in recurring drought and increase in atmospheric temperatures, which exacerbate the impacts of drought, ips beetle epidemics are more likely. For example, during a 2002-2003 drought, ips beetle populations reached epidemic levels which killed millions of pinyon trees in the southwestern U.S. (Thorne et al., 2007).

In addition to climatic range shifts and insect epidemics, increased atmospheric temperature and low moisture availability create drier fuels, which will result in more extreme and frequent fire. Increased intensity of fire will increase the rate of stand-replacing fore and subsequent conversion to invasive annual grass and/or vegetation better adapted to the new climatic conditions (Thorne et al., 2007)

Pinyon-juniper woodlands commonly occur along the foothills of large mountain ranges. This creates the capacity of these woodlands to shift upward into higher elevations in response to changing climate. Additionally, the long-lived nature of pinyon and juniper trees may allow mature individuals to survive changing climatic conditions as relicts for several centuries, if not lost to extended drought and larger fires (Sawyer et al., 2009).

Conservation Strategy

Objective 1: Maintain a full range of multi-age stands of true pinyon-juniper woodlands as functional systems for wildlife, including mature stands of pinyon with snags.

- Action: Work with federal partners and grazing permittees to manage grazing regimes (e.g., timing, intensity) in pinyon-juniper woodlands to encourage natural reseeding of native grasses and forbs.

Objective 2: Maintain pinyon-juniper woodlands on soil sites historically characterized by pinyon-juniper communities through 2032.

- Action: Utilize existing and newly developed statewide pinyon-juniper habitat condition and extent maps to plan treatments to manage for habitat complexity.
- Action: Restore degraded understories in encroached ecosystems, if necessary, to replace habitat values relied upon by wildlife.


Source: NDOW

Priority Research Needs

- Continued analysis of anticipated shifts in the distribution of pinyon-juniper woodlands with different climate regimes and the effects any distribution changes may have on wildlife
- Identify how the conversion of pinyon-juniper woodlands over time into invasive annual grasslands with increased fire frequency and/or continuous canopied pure stands in the absence of wild affects wildlife distribution and use
- Assess how climate change may affect the response of ecosystems to various types of pinyon-juniper management (i.e., mechanical vs. hand treatments) as woodlands progress toward pure stands and/or expand into other ecosystem types
- Identify novel management approaches to increase the success and longevity of restoration of wildlife habitat and ecosystem function in pinyon-juniper woodlands, including post-fire rehabilitation on historic pinyon-juniper woodlands and the removal of pinyon and juniper in shrub ecosystems
- Identify and quantify the processes influencing pinyon nut production, including the predicted or measured effects of climate change

Key SGCN Species

- Great Basin spadefoot (*Spea intermontana)*
- Hot Creek toad (*Anaxyrus monfontanus*)
- American kestrel (*Falco sparverius*)
- Black-chinned sparrow (*Spizella atrogularis*)
- Black-throated gray warbler (*Setophaga nigrescens*)
- Brewer's sparrow (*Spizella breweri*)

- Cassin’s finch (*Haemorhous cassinii*)
- Clark’s nutcracker (*Nucifraga columbiana*)
- Common nighthawk (*Chordeiles minor*)
- Dusky flycatcher (*Empidonax oberholseri*)
- Ferruginous hawk (*Buteo regalis*)
- Gray vireo (*Vireo vicinior*)
- Long-eared owl (*Asio otus*)
- Mountain quail (*Oreortyx pictus*)
- Northern goshawk (*Accipiter gentilis*)
- Peregrine falcon (*Falco peregrinus*)
- Pinyon jay (*Gymnorhinus cyanocephalus*)
- Virginia’s warbler (*Leiothlypis virginiae*)
- Allen’s big-eared bat (*Idionycteris phyllotis*)
- Canyon bat (*Parastrellus hesperus*)
- Fringed myotis (*Myotis thysanodes*)
- Hoary bat (*Lasiurus cinereus*)
- Long-eared myotis (*Myotis volans*)
- Mexican free-tailed Bat (*Tadarida brasiliensis*)
- Mule deer (*Odocoileus hemionus*)
- Pallid bat (*Antrozous pallidus*)
- Panamint kangaroo rat (*Dipodomys panamintinus*)
- Townsend’s big-eared bat (*Corynorhinus townsendii*)
- Western small-footed myotis (*Myotis ciliolabrum*)
- Yuma myotis (*Myotis yumanensis*)
- greater short-horned lizard (*Phrynosoma hernandesi*)
- Panamint rattlesnake (*Crotalus stephensi*)
- Sonoran mountain kingsnake (*Lampropeltis pyromelana*)
- Western skink (*Plestiodon skiltonianus*)
- Arrowhead blue (*Glaucopsyche piasus*)
- Checkered white (*Pontia protodice*)
- Common sootywing (*Pholisora catullus*)
- Indiscriminate cuckoo bumble bee (*Bombus insularis*)
- Lupine blue (*Icaricia lupini*)
- Marine blue (*Leptotes marina*)
- Melissa blue (*Plebejus melissa*)
- Monarch (*Danaus plexippus plexippus*)
- Square dotted blue (*Euphilotes battoides fusimaculata*)
- West Coast lady (*Vanessa annabella*)
- Western tailed-blue (*Cupido amyntula*)
- White-shouldered bumble-bee (*Bombus appositus*)
- Yellow bumble bee (*Bombus fervidus*)

Lakes and Reservoirs

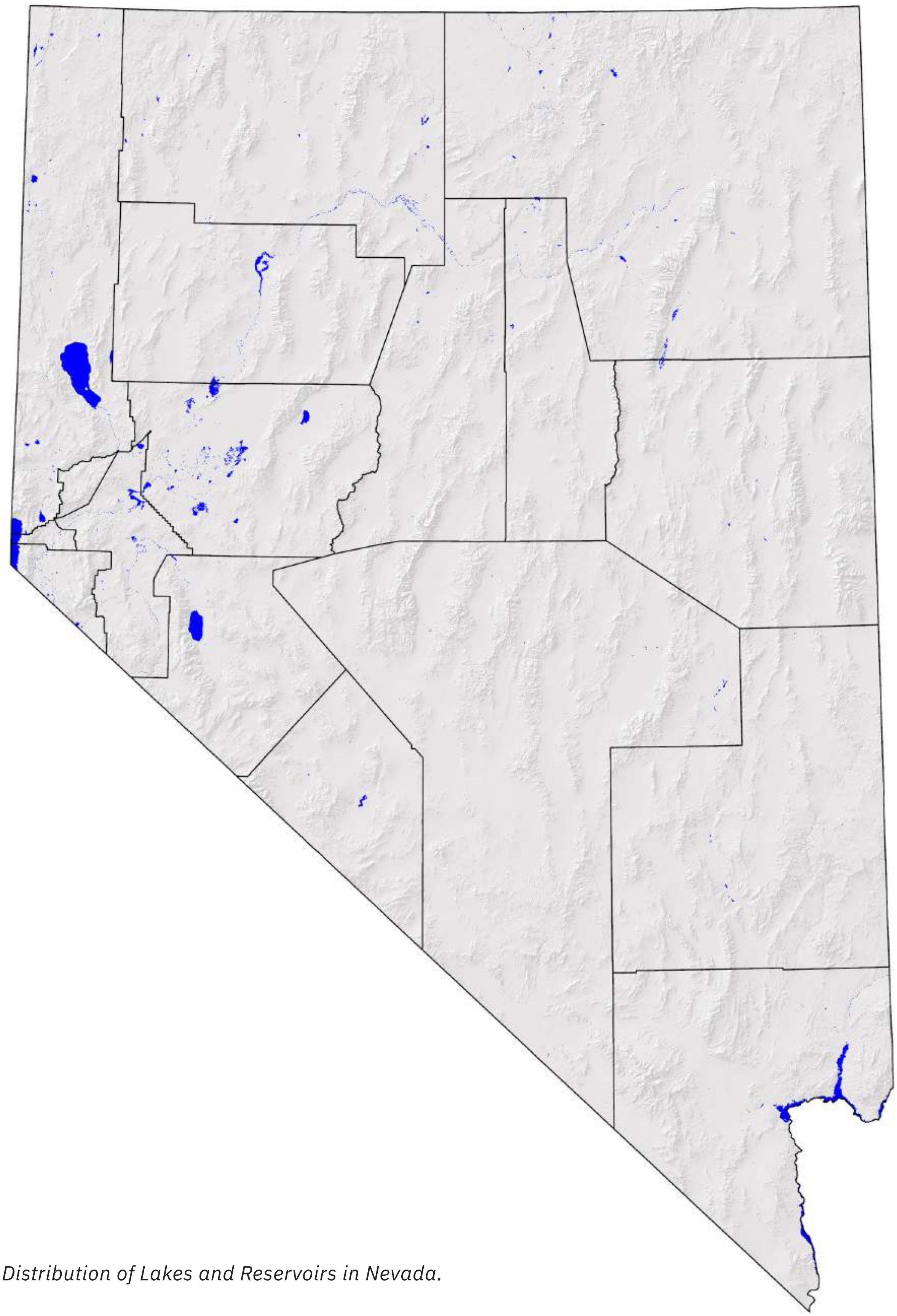


Figure 42. Distribution of Lakes and Reservoirs in Nevada.

Key Habitat Description and Elements of Lakes and Reservoirs

Vegetation and Abiotic Environment

The lakes and reservoirs key habitat includes areas of open water, generally with less than 25% cover of vegetation or soil, including natural lakes, impoundments, and montane pools. Few of Nevada's water bodies are large, other than Lake Tahoe (a part of which lies in Nevada), Pyramid Lake, Walker Lake, Lake Mead, and Lake Mohave. Numerous smaller water bodies, many of them created as reservoirs, dot the landscape. Whether constructed or natural in origin, open water bodies in the state often have some adjacent feature that, while not technically open water, acts synergistically to provide a combination of features that enhance the value of the site for wildlife. These adjacent features may include cliffs, emergent marshes, mud flats, beaches, or islands.

Natural lakes of all sizes will change in surface elevation and storage depending on seasonal precipitation and other factors. Except in periods of drought and significant climatic variation, these changes are relatively minor but play an important role in maintaining shoreline and emergent habitats. Terminal lakes are unique in Nevada and other arid landscapes characterized by basin and range topography creating closed hydrographic drainage basins. These systems have unique attributes and characteristics, particularly for water quality dependent on inflow from their associated isolated hydrographic basins and groundwater. These conditions may result in unique vegetation and species assemblages which makes them particularly vulnerable to changes in surface or groundwater inflow due to water development or drought conditions. In contrast, constructed impoundments and reservoirs may vary widely, either seasonally or annually, in size, storage, and surface elevation, with these fluctuations driven by storage requirements, irrigation demand, power generation, drought, and other factors. These periodic elevation changes, which can reach as much as 50 feet annually on large reservoirs such as Lake Mead, can have significant effects on the availability and maintenance of near-shore aquatic and shoreline transition habitats for both aquatic and terrestrial species.

Montane pools exist occasionally throughout mid- to high-elevation montane habitats in Nevada, frequently in association with wet meadows and other mesic montane habitat types. These shallow aquatic habitats may be permanent or seasonally ephemeral depending on soils, seasonal precipitation levels, groundwater levels, and short- or long-term climatic conditions, but provide an important lentic attribute to the landscape in areas generally dominated by terrestrial mesic and lotic flowing water habitat types.

General Wildlife Value

Open water systems play a critical role in the maintenance of wildlife populations in the state. Numerous species of waterfowl require open water for resting, including during their annual migrations, and as the only type of habitat in which they can feed. Many species of aquatic wildlife, including a variety of fishes, can live nowhere else. Because of the importance of water for insects, a variety of birds and bats focus their foraging efforts on open water. Natural lakes, including terminal lakes, have also played an important role in the evolution and maintenance of native aquatic species and in supporting unique endemic vertebrate and invertebrate species assemblages. For some endemic fishes, including the SGCN, the availability of persistent open water habitats has resulted in the evolution of lacustrine or lake-form variations with unique systematic characteristics differing physically from lotic or flowing-water types of the same species or subspecies. Open water habitats play a critical role in maintaining these unique adaptations.

Constructed reservoirs have been part of the landscape of the American West for over a century. The creation of these reservoirs has impacted habitats by inundating riparian habitats, affecting wetlands by altering water management downstream, and creating habitats that support non-native aquatic and invasive plant species. However, many of these reservoirs are quite prolific fish producers and have created significant summering, wintering, and migratory staging sites for fish-eating birds such as the common loon (*Gavia immer*) and American white pelican (*Pelecanus erythrorhynchos*). Some endemic fishes have adapted to constructed lentic habitats and these landscape features support large adult populations of those species, particularly where they are connected to flowing water systems that support critical life stages. Probably the most significant reservoir in the state relative to bird use is Lake Mead, behind Hoover Dam on the Colorado River. Lake Mead may provide staging and wintering habitat for a large percentage of the western and Clark's grebes (*Aechmophorus occidentalis* and *A. clarkii*, respectively) in the western United States. Other constructed reservoirs supporting significant bird resources include Lahontan Reservoir on the Carson River, Rye Patch and South Fork Reservoirs on the Humboldt River, and Wildhorse Reservoir on the Owyhee River. Lakes Mead and Mohave are critically important for the conservation of endangered Colorado River basin fishes. Lake Mead has one of the few remaining wild razorback sucker (*Xyrauchen texanus*) populations which has demonstrated natural recruitment, while Lake Mohave supports the largest extant wild adult population of razorback sucker which is a critical genetic resource for species conservation and recovery.

Montane pools, as a unique landscape feature generally associated with mid- and high-elevation mesic habitat types, also play an important role for wildlife by providing permanent or seasonal open water and shoreline emergent habitat types in areas otherwise devoid of aquatic habitats or dominated by flowing water systems. Although often fishless because of ephemeral, seasonal occurrence, or discontinuity with lotic systems, these pool features are critically important in supporting all life stages of amphibian species and unique species assemblages of invertebrates (WAPT, 2012).

Existing Environment

Dominant Physical Settings

The dominant physical setting comprising Lakes and Reservoirs is Open Water, making up approximately 418,669 acres of surface area across Nevada; however, the value of aquatic habitat lies under the water's surface.

Habitat Conditions

Nevada's permanent lakes are primarily either terminal basins or artificial impoundments. Because of the natural occurrence of minerals and salts in the watersheds that feed these lakes, they serve as sumps for the transport and collection of a variety of salts, heavy metals, and other dissolved solids. As such, even without inflows of pollutants, water quality in many lakes would not meet most people's expectations of pristine waters. Nonetheless, in the absence of anthropogenic pollutants or alterations in flow, all open water bodies in Nevada would meet the needs of wildlife.

Some rivers in Nevada were heavily contaminated with mercury during the mining heyday of the late 1800s, and these contaminants have affected downstream lake and reservoir habitats. On the other extreme, Lake Tahoe is undoubtedly the most intensively managed and healthiest lake in the state, though water some quality issues still need to be addressed there as well. Walker Lake is the most threatened water body in the state, with significant water quality issues due to upstream water diversions which have resulted in lowering lake elevations and worsening water quality and chemistry in the lake. Water quality in Pyramid Lake has also suffered due to water diversion from the Truckee River, although significant efforts are underway to assure more reliable water delivery to the lake. The presently dry Winnemucca Lake, located in the valley just east of Pyramid Lake, was once a National Wildlife Refuge comprised of an actual lake and an important fishery. The same water diversion that threatens the condition of Pyramid Lake destroyed Winnemucca Lake and now the site is a barren playa that only briefly holds water after rare heavy rains.

Water quality in Lakes Mead and Mohave is relatively good. Water quantity in Lake Mohave is stable through dam regulation. Water quantity in Lake Mead is regulated by the dam to some degree, but more so by upper basin snowpack and runoff conditions, and thus water quantity is more dynamic. Extended drought conditions, spanning more than a decade, in the upper Colorado River Basin and low flows in the Colorado River have caused a drastic decline in the lake level and shoreline retreat to an extent not seen since the initial filling of Lake Mead in the 1930s. Lake Mead levels in 2022 are more than 150 ft below full pool, and current 24-month projections forecast continued lake level declines. Water quality in Lake Mead is influenced by tributary inputs which are principally agricultural runoff and treated wastewater and stormwater runoff from Las Vegas Valley and various upstream urban areas. Industrial contaminants have entered the system, such as perchlorate, but any effects on wildlife have not been identified and remain unknown. Water quality monitoring efforts have indicated that the occurrence of contaminants and other discharge components is generally well within standards and guidelines for water quality and effects on wildlife, and effective remediation programs to reduce inputs of contaminants are in place. Lake Mead serves as the initial storage reservoir for the Colorado River discharge from the river's upper basin and provides long-term storage of agricultural and municipal water supplies and capacity for major flood runoff, which results in frequently changing interannual storage levels. Conversely, Lake Mohave acts as a regulator for discharge from the Hoover Dam to release constant flows for Colorado River downstream water users. Because of this, Lake Mohave surface elevations change frequently but to a much smaller magnitude. Lake Mohave near-shore habitats thus tend to show a much greater degree of stability over time. Lake Mohave also lacks perennial tributary and large-scale municipal input sources and hence has less direct exposure to industrial pollutants and flood flows.

Habitat Threats

The growing demand for water in urbanizing regions of the state is threatening a permanent or temporary loss or modification of open water habitat. Similarly, diversions could continue to modify hydrologic regimes, interrupting natural flow dynamics that result in modified channel and floodplain processes. Reductions in inflows from water diversion or recurrent and cyclical natural drought conditions particularly affect terminal lake systems because of constrained inflow with impacts on water quality and water chemistry from the concentration of naturally occurring and introduced compounds and toxins. Similarly, reservoir habitats are impacted by drought, or reduced inflows, by reducing storage which alters near-shore and shoreline habitats and affects water quality and storage/exchange time including retention of sediments and contaminants.

Montane pool habitats are subject to the same stressors and threats affecting associated riparian and meadow/mesic habitats, including inappropriate land use practices, recreation and road development, and water development and diversion that would affect groundwater maintenance and recharge. Threats to these aquatic habitats are of particular concern because of their relative scarcity on the landscape, and the unique challenges associated with effective protection and restoration at high elevations and in mesic soils.

Predicted Climate Change Effects

The extent of lake and reservoir open water habitats in Nevada is largely dependent on input from the associated stream and river systems, and in most cases, those input flowing water systems are dependent on snowpack-based runoff from local or regional watersheds for the majority of their cumulative annual discharge. The maintenance of these habitats over the next 50 years will be to a great extent influenced by predicted changes in winter-period precipitation. Climate models vary substantially in predicted future precipitation scenarios for the Great Basin and Mojave, although general trends indicate possible increases in the northeastern portions of the state and general drying in the remaining portions (see Chapter 2 for a discussion on specific models used here).

Shifts in precipitation amounts, seasonality, and snow-rain ratios are likely to have substantial implications for aquatic habitats in the State (Fyfe et al., 2017; Saito et al., 2022). The potential for earlier spring onset and an increase in rain-on-snow events could increase the flashiness of runoff inputs and encourage shorter-duration, higher intensity runoff periods in many systems. Earlier onset of storage coupled with higher summer and fall air temperatures and decreased late spring (southern Nevada) and summer (central and northern Nevada) precipitation could influence effective evaporation rates (McEvoy et al., 2020). Imagery analysis from the mid-1980s through the mid-2010s indicates that greening (an increase in NDVI) is occurring on the margins of many lakes, playas, and other wetland systems as a result of decreased surface water and increased marginal vegetation invading formerly inundated areas (Albano ,2020). A predicted earlier onset and increased frequency of summer monsoonal rain events in southern and south-central Nevada are expected to primarily influence other key habitat types (playas and warm desert rivers and streams) and little effect is expected on permanent open water habitats.

Conservation Strategy

Objective 1: Maintain current water quality standards in the open waters of Nevada to provide high-quality aquatic wildlife habitat through 2032.

- Action: Support and encourage the development and implementation of and requirement for Best Management Practices for all construction and maintenance activities in and associated with aquatic and riparian systems, through Nevada Division of Environmental Protection (NDEP) and U.S. Army Corps of Engineers permit requirements and other regulatory mechanisms.
- Action: Encourage the application of land management practices to exceed minimal proper functioning condition standards on all managed forests and rangelands to maximize aquatic system health.
- Action: Support the application of appropriate standards for point- and non-point discharge and efforts to reduce and control input of toxins and contaminants to groundwater and aquatic systems by the Environmental Protection Agency, NDEP, and other agencies, and enforcement of existing discharge permit standards and guidelines.

Objective 2: Increase available habitat through the targeted elimination or suppression of exotic and invasive species that compete with native fauna or managed sport fisheries through 2032.

- Action: Inventory and prioritize aquatic exotic invasive species (including vegetative) locations for treatment.
- Action: Implement existing tools for removal of undesired or invasive nonnative species by physical or chemical control as identified in species management plans, species recovery plans, and recovery implementation plans.
- Action: Temporarily drain small impoundments, as appropriate, to reduce or eliminate invasive species.

Objective 3: Maintain or increase current water levels in lakes and reservoirs through 2032.

- Action: Use the full array of conservation tools to achieve effective conservation status for Nevada's lakes and reservoirs, including the encouragement of active water conservation in municipal and agricultural uses, interagency agreements, and purchase of water rights from willing sellers.
- Action: Develop and disseminate public outreach materials regarding the critical importance of water conservation in Nevada for the proper hydrologic function of Nevada ecosystems and the associated wildlife conservation benefits.

Objective 4: Contribute to the restoration of Walker Lake.

- Action: Encourage the purchase and/or lease of water rights from willing sellers in the Walker Lake watershed for transfer to Walker Lake.
- Action: Work with the Walker River Irrigation District and agricultural producers in the Walker River watershed to improve efficiency in water delivery systems.
- Action: Work with conservation partners and others to explore opportunities to implement restoration strategies that would improve the condition of the Walker River channel and attendant riparian corridor.

Priority Research Needs

- Hydrological investigations of sub-basin aquifer and groundwater connections to surface waters and in-stream flows.
- Habitat restoration needs and approaches for Species of Greatest Conservation Need.
- Effective methods for control and eradication of invasive aquatic species.

Key SGCN Species

- Columbia spotted frog (*Rana luteiventris*)
- Great Plains toad (*Anaxyrus cognatus*)
- Northern leopard frog (*Lithobates pipiens*)
- Red-spotted toad (*Anaxyrus punctatus*)
- Western toad (*Anaxyrus boreas*)
- American avocet (*Recurvirostra americana*)
- American white pelican (*Pelecanus erythrorhynchos*)
- Black tern (*Chlidonias niger*)
- Black-necked stilt (*Himantopus mexicanus*)
- Canvasback (*Aythya valisineria*)
- Cinnamon teal (*Spatula cyanoptera*)
- Least bittern (*Ixobrychus exilis*)
- Long-billed dowitcher (*Limnodromus scolopaceus*)
- Northern pintail (*Anas acuta*)
- Peregrine falcon (*Falco peregrinus*)
- Trumpeter swan (*Cygnus buccinator*)
- Western snowy plover (*Charadrius nivosus*)
- White-faced ibis (*Plegadis chihi*)
- Wilson's phalarope (*Phalaropus tricolor*)
- Yuma ridgway's rail (*Rallus obsoletus yumanensis*)
- Alvord chub (*Siphateles alvordensis*)
- Bonneville cutthroat trout (*Oncorhynchus clarkii utah*)
- Bonytail (*Gila elegans*)
- Cui-ui (*Chasmistes cujus*)
- Inland Columbia Basin redband trout (*Oncorhynchus mykiss gairdneri*)
- Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*)
- Paiute sculpin (*Cottus beldingii*)
- Razorback sucker (*Xyrauchen texanus*)
- Western ridged mussel (*Gonidea angulata*)
- Yuma myotis (*Myotis yumanensis*)
- Western pond turtle (*Actinemys marmorata*)

Rivers and Streams

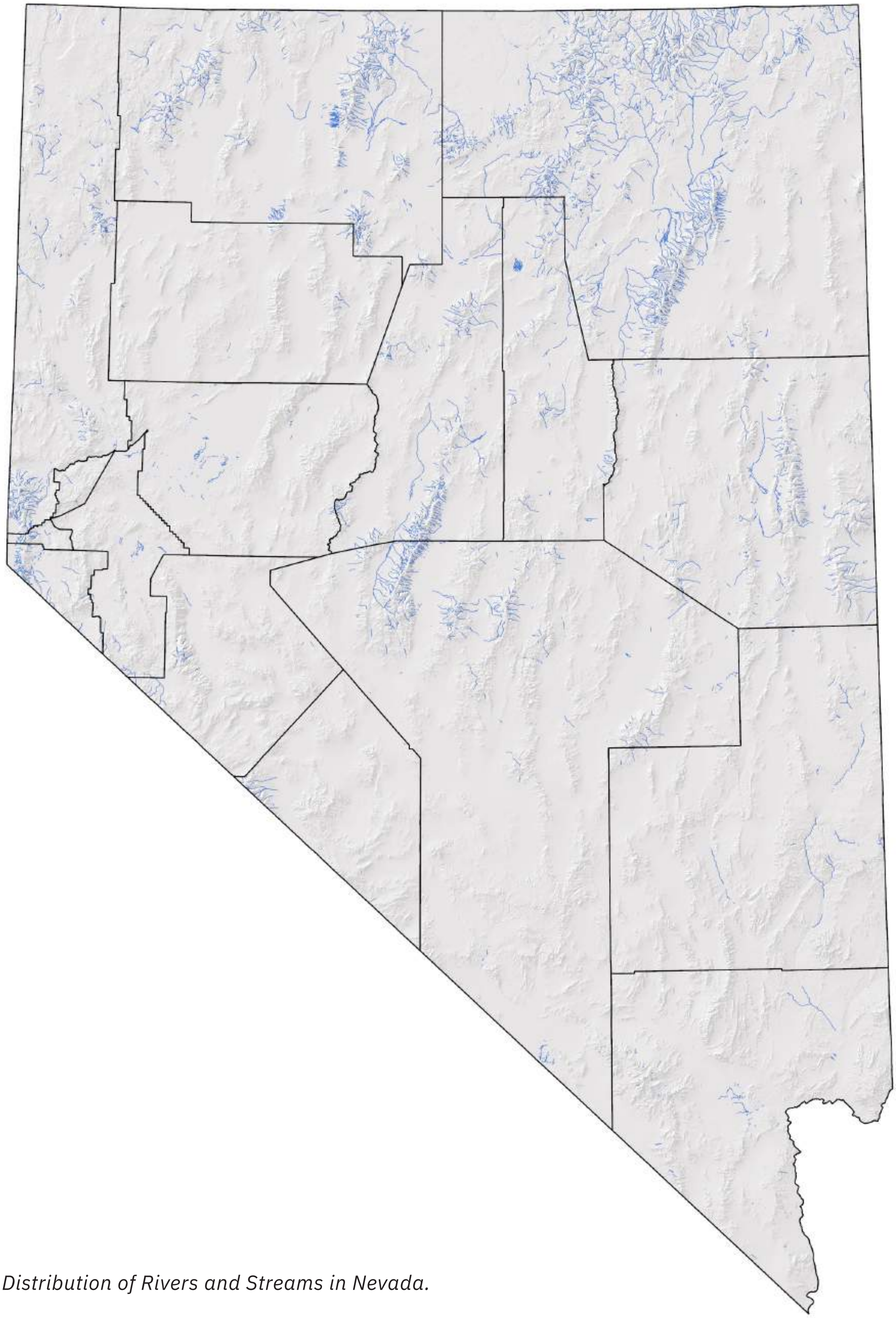


Figure 43. Distribution of Rivers and Streams in Nevada.

Key Habitat Description and Elements of Rivers and Streams

Vegetation and Abiotic Environment

Stream aquatic habitats within the Intermountain key habitat type vary considerably and can be subdivided into two core habitats assemblages: montane and sub-montane aquatic habitats which support a species assemblage dominated by native and introduced salmonids; and sub-montane and lowland aquatic habitats which support a variety of native and introduced fishes including, but generally not dominated by salmonid species.

Montane lotic systems are comprised of first-, second-, and third-order streams containing core habitat that is critical to the State's native salmonid populations. These streams are moderate to high gradient, between 1.6 feet and 16 feet wide with varying degrees of small cobble and rubble intermixed with boulders and occasional bedrock. In areas of poor land management practices, it is not uncommon for moderate to extreme bank incisions and high sediment loading to occur. Dense canopy cover in higher elevation streams provides thermal refuge, while woody debris that is recruited into the stream channel increases habitat complexity. The creation of pools by large rocks, woody debris, and riparian vegetation provide additional thermal refuge as well as places for species to overwinter and slack water to rest in.

Sub-montane lotic systems are composed of third-order streams or larger and range from 16 feet to approximately 170 feet, such as in the Truckee River. Well-assorted cobbles, rubbles, and boulders are present; however, sand/silt is more common in these systems and provides an integral role for Nevada's mollusks such as the California Floater (*Anodonta californiensis*) and Western Pearlshell (*Margaritifera falcata*). These systems are generally associated with moderate to low gradient, cottonwood-dominated valley bottoms. Much like the montane lotic systems wood debris is an important habitat feature for the sub-montane lotic systems providing pool structure and bank stability.

For montane and sub-montane lotic systems which are dominated by salmonid species assemblages, streams and rivers must be narrow and deep with a pool to riffle ratio of 50:50. Pools will vary from less than the average stream width to wider than the average stream width and depth. When streams and rivers exhibit these qualities, along with a healthy riparian to provide cover and stabilize banks, fish densities reach their highest possible levels, if water flows remain adequate.

Sub-montane and lowland stream aquatic systems within the Rivers and Streams habitat type that support SGCN vary tremendously. Some of these stream systems represent primary order stream reaches within terminal drainage systems or disjunct segments of larger drainage systems isolated by naturally or artificially de-watered reaches, such as upper Meadow Valley Wash. Others are lower-order segments of primarily spring-fed discharge systems as in upper White River Valley. Again, the isolation and variable aquatic habitat characteristics of many of these stream systems have resulted in their support of unique aquatic species assemblages across the landscape.

General Wildlife Value

In a desert state such as Nevada, rivers and streams provide critical, life-sustaining water to an extensive array of microbial, plant, and animal species, including many native, endemic, and threatened and endangered species. Nevada, which has the lowest annual rainfall in the United States, has limited surface water resources. Protracted drought and ongoing climate change exacerbate the challenges associated with low water availability. Because of the relative scarcity of aquatic systems in Nevada's landscape, and the naturally disconnected and fragmented nature of these systems in an arid climate, individual lotic systems in this habitat type are critically important for aquatic species because of the unique species and species assemblages that they support. Nevada ranks sixth nationally in species endemism and third in species at risk (NatureServe, 2002); aquatic and aquatic-dependent species represent a significant proportion of these biodiversity and risk indicators.

Existing Environment

Habitat Conditions

Aquatic habitats have also been affected by concentrated grazing, residential development, river channelization, diversion, industrialization, log drives, wildfire suppression, trapping (principally beaver), exotic species (both plants and animals), unregulated recreation (both motorized and non-motorized), road building, mining, pollution, farming, channel dredging, bank armoring, and construction of dams and levees.

Invasive plants may be one of the greatest agents of change in these systems. Tamarisk is an exotic riparian tree that has invaded all of Nevada's river systems to varying degrees. Another aggressive exotic invader present on Nevada's rivers is Russian olive. These exotics have replaced the native midstory on many stretches of Nevada's rivers. Tamarisk has made considerable inroads in the Humboldt system and dominates the extensive delta of the Walker River. Russian olive is particularly prevalent on the Carson River below Dayton. Tall whitetop is another noxious weed invading riparian areas in northern Nevada. The highly invasive nature of both tamarisk and tall whitetop gives them the ability to convert entire landscapes into undesirable monotypes.

All aquatic habitat systems in Intermountain rivers and streams have been altered or modified to some degree from historic conditions, through actions such as channelization, construction of dams and diversions, regulation of flows or diversion of flows for agriculture, recreational and urban development, and the introduction of non-native aquatic species. The level of this alteration ranges from severe on the lower Truckee River where river flows are highly regulated and substantially diverted for agriculture (at times leaving the Truckee River completely dry), to relatively minor in some montane stream drainage systems. Although many montane or sub-montane stream systems are relatively free flowing within terminal or connected basin systems, a substantial number of these systems are impacted by existing land use practices such as inappropriate livestock grazing. Excessive animal grazing and trampling in riparian areas can decrease sediment capture, limit infiltration, and increase the energy of water flow. These hydrogeomorphic impacts can magnify erosion and down-cutting which can lead to the separation of the streambed from the flood plain and decrease riparian area size (Kaweck et al., 2018). Improper riparian grazing can also alter riparian vegetation composition and reduce streambank stability, negatively impacting aquatic habitat, ecosystem function, and biota (Dauwalter et al., 2018). The construction of impoundments and reservoirs has affected some stream systems including Wall Canyon and upper Meadow Valley Wash, where impoundment for recreation has altered seasonal flows and the natural geomorphic process by complete capture of surface flows in most years, leaving downstream stream reaches dependent on spring and groundwater flow for maintenance of aquatic habitats. Extensive alteration of natural channels and diversion of flows for irrigation has resulted in fragmentation and isolation of stream habitats in the Upper White River Valley.

Habitat Threats

Many of the sources of stress identified above continue to exert pressure on aquatic habitats in Nevada. As a result, aquatic habitats continue to face permanent or temporary loss or modification of habitat integrity. Dams and diversions continue to modify hydrologic regimes, interrupting natural flow dynamics that result in modified channel and floodplain processes, and creating barriers to fish movement and migration which fragment aquatic habitats. The pumping of surface waters and connected aquifers alter groundwater flow and recharge patterns. Recreation, development, and grazing create disturbance to wildlife (including movements/displacement, behavior, and reproductive success) and encourage habitat fragmentation. Erosion is also hastened by grazing, poorly functioning hydrological regimes, invasive plants, development, and recreational activities. Inappropriate land use practices which degrade riparian zones also result in an increased ability of invasive plants to outcompete native plant communities resulting in a deteriorated riparian zone that offers far fewer habitat values for wildlife than native communities (Chambers, 2008). Improper placement of roads has also led to erosion, siltation, disturbance to aquatic species, and habitat fragmentation.

Predicted Climate Change Effects

Water resource variability is of particular importance in the arid west where water resources are already limited, and human populations and development are rapidly increasing. Potential climate change effects on intermountain river and stream aquatic habitats are driven by predicted changes in two key interlinked components of climate: precipitation and air temperature (Seager et al., 2007; Field et al., 2007). Interannual increases in average air temperature are well documented and this trend is expected to continue or accelerate through 2050 across Nevada, particularly in summer through late winter in northern and central areas. In mountainous regions that receive precipitation in the form of snow, air temperature increases have changed the timing and frequency of precipitation events, resulting in an increase in precipitation in the form of rain rather than snow, and differences in when precipitation falls in the season and when snow melts (Maurer et al., 2007; Haig et al., 2019).

Observed trends under current conditions across the Great Basin already support substantially earlier timing of spring runoff conditions in many lotic systems and this trend is likely to accelerate. This likely trend towards reduced snowpack duration and increased precipitation as rain particularly in lower elevation and more southerly watershed basins can be expected to impact recharge of local and non-carbonate aquifer systems supporting the quality and quantity of aquatic system base flows particularly, and negatively particularly in lower elevation and hydrographically isolated stream and river reaches. Available models also suggest that the most substantial decreases in average precipitation can be expected in the March through August periods and for air temperature the most significant increases in

June through September. When coupled with the early onset of annual runoff events, these changes are likely to significantly impact many flowing aquatic systems with reduced average summer and fall base flows and increases in in-channel water temperatures. These changes will directly influence seasonal stream flows and aquatic habitat quality in many intermountain river and stream systems, where even small changes in water availability can significantly impact instream habitat conditions, and thus influence the lifecycles of aquatic species such as Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*), a species listed as threatened under the federal Endangered Species Act (Al-Chokhachy et al., 2022).

Conservation Strategy

Objective 1: Limit the increase in weed-invaded and/or entrenched aquatic systems to less than 10% by 2032.

- Action: Encourage the application of land management practices to exceed minimal proper functioning condition standards on all managed forests and rangelands to maximize aquatic system health.
- Action: Support actions by land management partners and local governments to control invasive and noxious plants and weeds, especially tamarisk and emergent plant species which directly impact the functioning of lotic aquatic habitats.
- Action: Implement the NDOW Statewide Aquatic Invasive Species Management Plan.

Objective 2: Increase total linear kilometers of fully functioning riparian aquatic habitat on intermountain and Mohave rivers and streams.

- Action: In collaboration with agency partners and researchers, identify and define the specific habitat characteristics required to provide long-term persistence of native trout populations in montane and sub-montane aquatic habitats.
- Action: Develop streamlined monitoring programs designed to evaluate a stream's potential to support trout populations and identify where changes in land management are needed.
- Action: Construct and maintain management barriers (i.e., fish passage barriers), where needed, to protect SGCN habitat and populations from the invasion of non-native species.
- Action: Implement existing strategies to address and eliminate potential movement barriers to reconnect fragmented stream habitat complexes.
- Action: Maximize connectivity in Mojave tributary river lotic habitats through maintenance of flows and by prioritizing the location of fish movement barriers to isolate invasive species to the downstream extent practicable.
- Action: Identify stream and river reaches where there is a need to apply for in-stream flow water rights for SGCN and pursue the acquisition of those rights where feasible.
- Action: Identify and implement strategies to maintain minimum low-flow period base flows on the Virgin River to limit exposure of priority aquatic species to extended periods above thermal maxima and/or provide thermal refuge habitat.


Source: NDOW

Priority Research Needs

- Effective methods for control and eradication of invasive aquatic species.
- Identify cost-effective low technology actions to slow conversion of montane riparian streams into desert washes.

Key SGCN Species

- Amargosa toad (*Anaxyrus nelsoni*)
- Arizona toad (*Anaxyrus microscaphus*)
- Columbia spotted frog (*Rana luteiventris*)
- Northern leopard frog (*Lithobates pipiens*)
- Red-spotted toad (*Anaxyrus punctatus*)
- Western toad (*Anaxyrus boreas*)
- Bank swallow (*Riparia riparia*)
- Canvasback (*Aythya valisineria*)
- Alvord chub (*Siphateles alvordensis*)
- Big Smokey Valley speckled dace (*Rhinichthys osculus lariversi*)
- Big Spring spinedace (*Lepidomeda mollispinis pratensis*)
- Bonneville cutthroat trout (*Oncorhynchus clarkii utah*)
- Bonytail (*Gila elegans*)
- Bull trout (*Salvelinus confluentus pop. 4*)
- Cui-ui (*Chasmistes cujus*)
- Flannelmouth sucker (*Catostomus latipinnis*)
- Independence Valley speckled dace (*Rhinichthys osculus lethoporus*)
- Inland Columbia Basin redband trout (*Oncorhynchus mykiss gairdneri*)
- Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*)
- Meadow Valley wash desert sucker (*Catostomus clarkii ssp. 2*)

- Meadow Valley wash speckled dace (*Rhinichthys osculus ssp. 11*)
- Moapa dace (*Moapa coriacea*)
- Moapa speckled dace (*Rhinichthys osculus moapae*)
- Moapa White River springfish (*Crenichthys baileyi moapae*)
- Mountain whitefish (*Prosopium williamsoni*)
- Northern leatherside chub (*Lepdomeda copei*)
- Oasis Valley speckled dace (*Rhinichthys osculus ssp. 6*)
- Pahranagat roundtail chub (*Gila robusta jordani*)
- Pahranagat speckled dace (*Rhinichthys osculus velifer*)
- Paiute sculpin (*Cottus beldingii*)
- Razorback sucker (*Xyrauchen texanus*)
- Relict dace (*Relictus solitarius*)
- Sheldon tui chub (*Siphateles bicolor eurysoma*)
- Virgin River chub (*Gila seminuda*)
- Virgin spinedace (*Lepidomeda mollispinis mollispinis*)
- Wall Canyon sucker (*Catostomus sp. 1*)
- Warner sucker (*Catostomus warnerensis*)
- Warner Valley redband trout (*Oncorhynchus mykiss pop. 4*)
- White River desert sucker (*Catostomus clarkii intermedius*)
- White River speckled dace (*Rhinichthys osculus ssp. 7*)
- White River spinedace (*Lepidomeda albivallis*)
- Woundfin (*Plagopterus argentissimus*)
- Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*)
- California floater (*Anodonta californiensis*)
- Western pearlshell mussel (*Margaritifera falcata*)
- Western ridged mussel (*Gonidea angulata*)
- Fish Springs pocket gopher (*Thomomys bottae abstrusus*)
- Inyo shrew (*Sorex tenellus*)
- Northern rubber boa (*Charina bottae*)
- Western pond turtle (*Actinemys marmorata*)

Riparian and Wetland

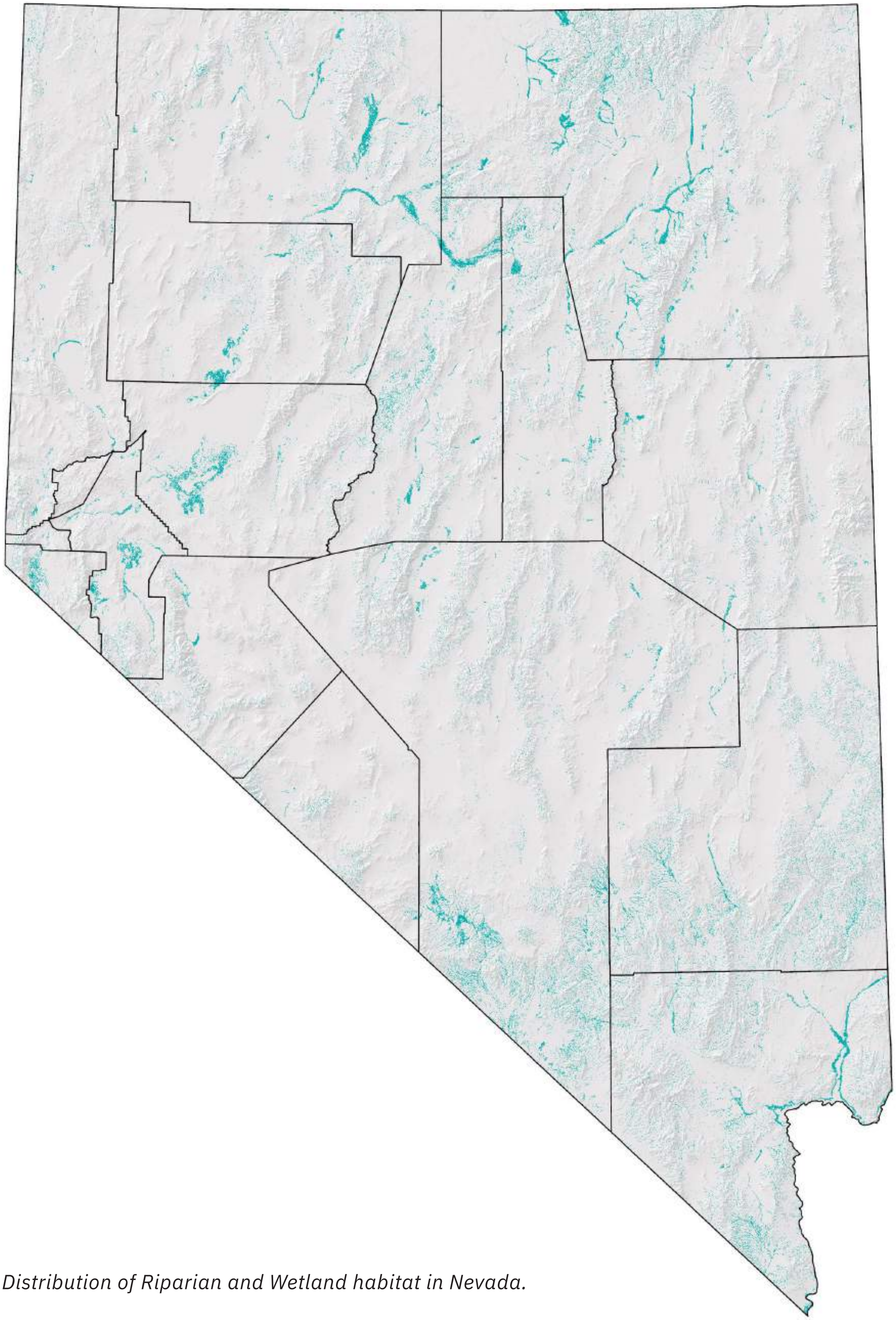


Figure 44. Distribution of Riparian and Wetland habitat in Nevada.

Key Habitat Description and Elements of Riparian and Wetland

Vegetation and Abiotic Environment

Riparian ecosystems provide many ecosystem services and support extensive biodiversity and other values. In arid and semi-arid regions, riparian areas are especially valuable, where available water and associated vegetation is limited across the landscape (Albano et al., 2020).

Riparian and wetland habitat areas are associated with streams, rivers, lakes, springs, ephemeral washes, and, unique to the Great Basin, terminal basins. Riparian and wetland habitats occur throughout Nevada and there is much variability based upon elevation, precipitation amounts and regimes, topography, and geography. Variation in ecological and physical conditions results in a high level of variability in the classification, spatial extent, species composition, and canopy cover of riparian and wetland habitats across Nevada. Additionally, mapping products for riparian and wetland habitats within Nevada are imperfect and convey the variability and difficulty of mapping small habitat types across broad landscapes (Chambers et al., 2021; Chambers et al., 2011).

Most riparian systems in Nevada occur in canyons, floodplains, or valleys and follow the saturation zone of streams, springs outflows, or catchment basins, including seasonally ephemeral waterways. Common soil components include sand, clay, silt, cobble, and gravel. Riparian areas are most often associated with streams, lakes, and wetlands, but may also occur on upland sites if conditions influenced by topography, elevation, and precipitation produce sufficient soil moisture to support the vegetation types. Dominant tree and shrub species in these systems may include Fremont cottonwood (*Populus fremontii*), quaking aspen (*Populus tremuloides*), alder (*Alnus spp.*), and birch (*Betula spp.*).

Lowland riparian habitats are those associated with the floodplains of major river systems primarily occurring below 5,000 feet elevation in the northern two-thirds of the state. Lush habitat conditions supported by these lowland floodplains stand in stark contrast to the arid landscapes through which they course. Except for the Humboldt River, lowland riparian habitats are typically dominated by Fremont cottonwood.

Common shrub components include a wide variety of willow (*Salix spp.*), red-osier dogwood (*Cornus sericea*), Wood's rose (*Rosa woodsii*), arrow weed (*Pluchea sericea*), and others. Herbaceous layers include species such as rushes (*Juncus spp*.), sedges (*Carex spp.*), mesquite (*Prosopis spp.*), perennial grasses, and mesic forbs. Left undisturbed, deciduous riparian habitats attain a complex, multi-layered vertical structure with an intermittent to continuous overstory, a dense midstory, and an understory consisting of grasses and forbs (Landfire, 2020; Chambers & Miller, 2004). Many lowland riparian systems with a history of degradation and disturbance have been invaded by Russian olive (*Elaeagnus angustifolia*), tamarisk (*Tamarix spp.*), perennial pepperweed (tall white top; *Lepidium latifolium*), and many other invasive or noxious weeds. Mature plant heights can range from 6-10 feet. Left undisturbed, deciduous riparian habitats attain a complex, multi-layered vertical structure with an intermittent to continuous overstory, a midstory that is often dense and impenetrable, and an understory rich in grasses and forbs. Riparian floodplain vegetation is typically heterogeneous, but associated meadows of grasses, sedges, and rushes predominate much of the floodplain of the Humboldt River and its tributaries while occurring on shorter, more disjunct stretches of the other northern Nevada river floodplains. Creeping wild rye (*Leymus triticoides*) is one of the most important meadow grasses.

Marshes occur on soils that remain moist or saturated through a significant portion of the year. The length and extent of soil saturation or inundation also influence vegetation type. Water chemistry, pH, temperature, and other factors also influence the community of plants present. Under long-term inundation, cattails (*Typha latifolia*) and pondweed (*Potamogeton spp.*) prefer fresher regimes. Hardstem bulrush (*Schoenoplectus acutus*), alkali bulrush (*Bolboschoenus maritimus*), and sago pondweed (*Stuckenia pectinata*) favor middle ranges. Salt-tolerant plants such as wigeon grass (*Rupia spp.*) inhabit the saltier regimes as well as freshwater. Moist soils refer to substrates inundated for very short intervals often repeated and receding several times throughout a growing season. Plants inhabiting moist soils include Baltic rush (*Juncus balticus*), smartweeds (*Polygonum spp.*), sedges (*Carex spp.*), and spikerushes (*Eleocharis spp.*) (Cowardin, 1979).

General Wildlife Value

Wildlife values afforded by riparian habitats vary significantly among the different ecological systems bundled in this group, and they vary significantly among plant communities within a single ecological system. Meadows and marshes are among Nevada's most diverse and prolific wildlife habitats and are critical to both the breeding and migratory needs of many species of birds. Nevada's marshes have an astonishing capability to produce abundant populations of macroinvertebrates that fuel food chains, either through being consumed first by fishes or directly by shorebirds and small water birds. Springs provide crucial habitat to a significant percentage of Nevada's federally listed and state-protected aquatic species. Riparian areas provide cover, food, and water and act as wildlife movement corridors for a variety of species from butterflies to large mammals. Much of the agricultural production in Nevada occurs in formerly riparian areas associated with the major waterways of the state. Species such as mule deer utilize these areas for migration, forage, and cover in addition to other qualities; however, for other species, agricultural areas represent population sinks where increased mortality offsets the benefits of increased forage and other values. While agricultural areas may serve as habitats for individual species, they largely do not provide the full range of ecosystem services that are associated with functioning riparian areas and may lead to in-stream degradation from water removal and decreased water quality.

Existing Environment

Dominant Biophysical Settings

Inter-mountain Basins Montane Riparian Systems is the dominant biophysical setting for riparian and wetland within Nevada; however, it should be noted that this covers a wide and diverse array of wetland and riparian types (Table 34).

Table 34: Dominant biophysical settings comprising riparian and wetland key habitats in Nevada. Roughly 1,294,240 acres of Nevada may have historically supported riparian and wetland communities based on biophysical setting analysis.

BIOPHYSICAL SETTING NAME	ACRES
Inter-Mountain Basins Montane Riparian Systems	1,294,240
North American Warm Desert Riparian Systems-Stringers	394,592
North American Warm Desert Riparian Systems	196,940
Rocky Mountain Montane Riparian Systems	107,064
Rocky Mountain Subalpine/ Upper Montane Riparian Systems	65,363
Total	2,058,200

Habitat Conditions

Riparian and wetland systems in Nevada are extremely important to both humans and wildlife, and the demands placed on these systems often result in degradation and loss of value for natural systems and wildlife. Most riparian systems in Nevada have been altered or degraded by a variety of anthropogenic activities and demands compared to pre-European settlement conditions. Succession class data indicate significant changes (loss) of early-mid successional classes and increases in unnatural exotic dominated classes, which likely indicates reduced spatial extent of riparian areas and conversion to bare ground or weeds after disturbance events (including abandoned agricultural production) instead of recovery with desirable perennial plant species (Landfire, 2020). Riparian areas in the more arid, Mojave Desert of southern Nevada tend to be rarer and smaller in extent, and likely supported by groundwater rather than precipitation (Albano et al., 2020)

Riparian systems in Nevada are extremely important to both humans and wildlife, and the myriad demands placed on these systems have often meant an increase in value for one user at the expense of another. Although riparian areas comprise only about 2% of western lands, they are some of the most ecologically important habitats providing important resources for many species of aquatic and terrestrial wildlife and domestic animals including instream habitat, abundant forage, cover, and water. Riparian areas are also important for trapping sediment, slowing runoff, and supporting ecologically functioning watersheds (Kaweck et al., 2018). Every riparian system in the state has been altered in some fashion from its condition at the time of Euro-American settlement. Alterations have not always manifested themselves in a manner that has led to declines in wildlife habitat quality or quantity, but it would be impossible to go anywhere in the state and identify a site in its natural condition. The U.S. Fish and Wildlife Service estimates Nevada wetland losses amounted to 52% during the period 1780 to 1980 (Dahl, 1990). Some riparian systems have been lost entirely or altered so dramatically that they no longer offer the range of habitat opportunities that they would offer if they were unmanipulated or perhaps better managed.

Table 35: Percent of riparian and wetland key habitat converted to agriculture, barren or sparsely vegetated cover, non-natural vegetation, and/or urbanized lands based on Landfire successional class analysis. Non-natural vegetation types include both non-native exotic dominated areas as well as areas dominated by natural vegetation that is outside the range of variation (cover, height, dominant type) that would be expected under typical conditions. Natural vegetation includes all areas remaining in young-old age successional classes as outlined below although the distribution of age classes within natural vegetation states may be outside of the range of variation expected under historic conditions.

RIPARIAN AND WETLAND	
CURRENT STATE	**PERCENT HABITAT**
Agriculture	10.0%
Barren or Sparse	2.0%
Natural Vegetation	72.3%
Non-Natural Vegetation (invasive or native)	14.4%
Urban	1.3%

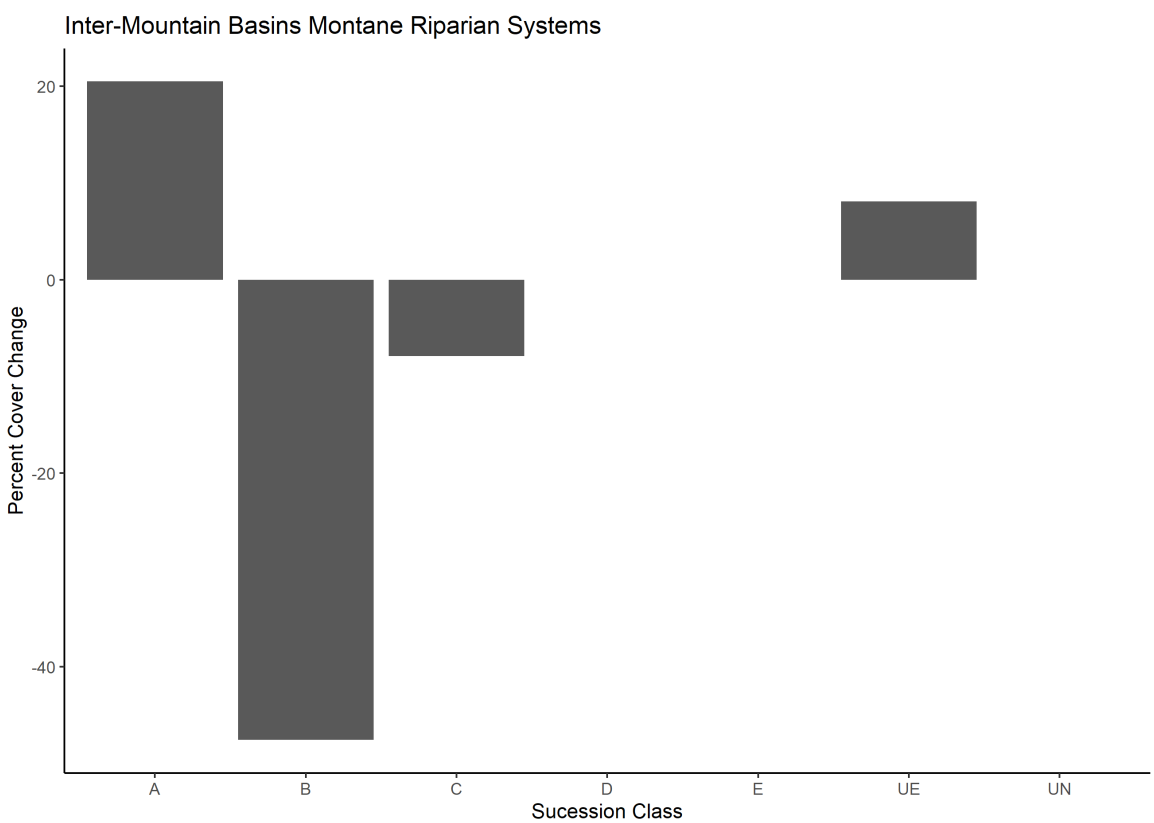


Figure 45. Succession class data for biophysical setting Inter-Mountain Basins Montane Riparian Systems. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

Habitat Threats

As the driest state in the United States, the demand for water in Nevada is high, and this limited resource supports local economies and communities through municipal uses, agricultural production, and mining. Hydrologic changes due to surface and groundwater development and withdrawals, alteration of stream channels and wetlands, including for agricultural and livestock production, land development, as well as the introduction and establishment of non-native invasive species, combined with changing climate, have increased pressure on wetland and riparian systems in arid regions including Nevada, often resulting in declines in their condition and extent (Patten, 1998).

Many of the sources of stress identified above continue to exert pressure on habitats in Nevada. As a result, riparian habitats continue to face permanent or temporary loss or modification of habitat integrity. For wildlife, this means reduced vegetation composition, structure, and cover resulting in loss or degradation of instream habitat, nesting cover, escape cover, and food sources. Riparian areas attract free-roaming horses and domestic livestock because of available water, cooler micro-climates, and abundant forage generally staying green longer into the summer than the surrounding upland vegetation. The negative impacts of regulated and unregulated livestock grazing in riparian zones have been well documented for nearly half a century (Poff et al., 2011). Improper riparian grazing has been shown to reduce riparian vegetation and destabilize streambanks, leading to wide, shallow, and incised stream channels with low physical habitat complexity and poor water quality (Walrath et al., 2016).

These threats result in reduced ecological functionality through loss of plant species diversity and extent, fragmentation into smaller areas of riparian vegetation, and modified hydrologic regimes, natural flow, and floodplain dynamics. Inappropriate land use practices which degrade riparian zones also result in an increased ability of invasive plants to outcompete native plant communities. This results in a deteriorated riparian zone which converts landscapes into monocultures of single plant types that offers far fewer habitat values for wildlife than native communities (Chambers, 2008). Grazing has been identified as the primary threat to western riparian systems; however, more recently, invasive species and climate change are identified as preeminent threats to these habitats. Climate-change impacts on biodiversity may be driven by changes in wetland hydroperiods (Russell et al., 2020). In some cases, climate-change effects on wetland inundation may interact with legacy effects from past land-management practices, including unintentional effects from compaction and intentional manipulation of hydrology or geomorphology from diverting water or creating ditches.

Impacts to riparian and wetland systems are often a result of roads, dams, channelization, flow regulation, and flood control projects for anthropogenic development, groundwater pumping and use, surface water diversions, development for municipal or agricultural use, utilization by non-native ungulates, and introduction of non-native plant species (Chambers et al., 2021; Chambers et al., 2011). Livestock, free-roaming equids, and diversions were the predominant disturbances found in a study of 511 northern Nevada springs (Sada, 2001). The effect of these uses is often expressed as stream channel and waterway incision with subsequent loss of bank and soil stability, reduction in depth to groundwater, changes in soil and vegetation composition, and loss of water quality (Chambers et al., 2021; Chambers et al., 2011).

Predicted Climate Change Effects

Dryland wetlands and riparian habitats are naturally resilient to periods of drought (Sandi et al., 2020); however, current habitat conditions are generally unfavorable for riparian systems statewide as large percentages of Nevada's riparian habitat is classified as uncharacteristic, meaning that they departed from their natural regime (Landfire, 2020). Uncharacteristic and poor habitat conditions in riparian habitats will undoubtedly reduce their resiliency to climate change. Climate change will likely result in less precipitation, increased air temperatures, and a shift in winter precipitation patterns from snow to rain (Haig et al., 2019). Decreases in precipitation, especially winter snowpack, increasing air temperatures, and overall increasing severity and duration of drought conditions are expected to continue and accelerate across Nevada because of climate change. These conditions are likely to reduce recharge to groundwater aquifer systems and shift flow or recharge regimes further from characteristic and historic conditions. In general, climate change will likely have complex and cascading impacts on ground- and surface-water resources, and thus, on riparian and wetland habitats (Chambers et al., 2021; Haig et al., 2019; Russell et al., 2020).

Three major problems affect riparian habitats in Nevada: the invasion of exotic forbs and trees such as tall whitetop, noxious thistles, Russian olive, and tamarisk; the entrenchment of flow channels; and the loss of perennial flow in non-carbonate waterways (i.e., conversion to desert washes). Characteristic classes for intermountain riparian vegetative systems are early (0-50% native cover 0-5 years old), mid-open (31-100% native cover 5-20 years old), and late closed (31-100% cover greater than 20 years old). Reference conditions indicate roughly an equal three-way split between the three characteristic classes in good health. Uncharacteristic classes include exotic forb and tree species (greater than 5% exotic forb and tree cover), desertified (entrenched with 10-50% upland shrubs), pasture (hay meadow tended for agriculture with or without the introduction of palatable grasses), and shrub-forb-encroached (10-50% cover unpalatable shrubs such as Woods' rose and sumac). Loss of perennial flow results in a conversion to desert washes.

Non-carbonate

Current conditions of non-carbonate riparian systems statewide are unfavorable – only three regions in the state (Eastern Sierra, Toiyabe, and Tonopah) currently have over 60% of their extent in characteristic classes. The other 10 regions have over 40% of their riparian systems in entrenchment or exotic species invasion, ranging from a low of 43% in the Elko region to a high of 88% in the Clover region. Considerable variation exists between regions as to whether the systems are predominantly entrenched or weed-invaded. Of the 10 regions, the western/southern ones tend to be primarily weed-invaded while the eastern/northern ones tend to be primarily entrenched. Fifty years of climate change are predicted to increase the percentages in uncharacteristic classes even more, usually at the expense of the early-succession class. The regions that will change the least in 50 years (less than 10% increase) are the ones that are currently the most deviated, as the remaining increment from 80 to 100% is much less than say, from 50%. The remaining regions of the 10 most deviated were predicted to increase 12-15% in uncharacteristic class percentages. The three regions under 40% deviation were predicted to increase a little more, between 17 and 24%. All would then be over 50% deviated from characteristic classes. The most unfavorable result is the permanent conversion of perennial waterways into desert washes in all regions due to increased evapotranspiration. Regional differences exist in conversion to desert washes: the highest losses between 9% and 13% are predicted in the Eastern Sierra, Eureka, Humboldt, Tonopah, Toiyabe, and Walker regions; intermediate losses between 3 and less than 9% are predicted for the Black Rock, Elko, Lahontan, and Mojave regions; and losses less than 3% are found in the Clover and Owyhee regions.

Carbonate

Carbonate-based riparian systems occur in three regions in Nevada – Calcareous, Clover, and Mojave. These systems are already over 50% entrenched in all three regions. The percentages of classes invaded by exotic species vary from four percent in the Mojave, nine percent in the Calcareous Ranges, to 19% in the Clover Valley region. Entrenchment is not predicted to increase more than one or two percent for any of the three regions with 50 years of climate change. Exotic species invasion will increase from three to nine percent and the resulting total percentage of vegetation weed-invaded will range from 15 to 22% among the three regions. No conversion to desert washes occurs on carbonate geology due to the buffering of the aquifer.

Conservation Strategy

Objective 1: Gain a better understanding of the location, extent, and condition of wetland and riparian habitats.

- Action: Inventory wetlands and riparian habitats across the state and identify functional conditions.
- Objective 2: Protect wetland and riparian systems that are functioning within natural variation.
- Action: Assess and prioritize projects for wetland and riparian protection annually by region and continue to implement identified projects.
- Action: Collaborate and coordinate with federal land management agencies and state and local governments to avoid and minimize development actions that could impair wetland and riparian habitats or deplete groundwater which may result in the loss or degradation of wetland and riparian habitats.

Objective 3: Restore and rehabilitate impaired wetland and riparian habitats.

- Action: Develop a wetland and riparian habitat restoration decision process to identify and prioritize project work and outline potential actions based on existing and potential future conditions.
- Objective 4: Develop a centralized database of inventoried, treated areas and potential restoration projects to track progress.

Priority Research Needs

- Statewide health assessment and mapping of wetland and riparian systems to better understand the spatial extent and condition of wetland and riparian systems.
- Identification of wetland and riparian systems where management efforts may be most effective at reducing the effects of climate change and development of cost-effective strategies.
- Effective methods for control and management of invasive and noxious weeds impacting wetland and riparian systems.
- Monitor changes in precipitation, temperature, and runoff dynamics and their effects on the maintenance of productive riparian and wetland habitats.
- Assessment of vegetation/species die-off events such as screwbean mesquite, that influence habitat availability.

Key SGCN Species

- Amargosa toad (*Anaxyrus nelsoni*)
- Arizona toad (*Anaxyrus microscaphus*)
- Columbia spotted frog (*Rana luteiventris*)
- Dixie Valley toad (*Anaxyrus williamsi*)
- Great Basin spadefoot (*Spea intermontana*)
- Great Plains toad (*Anaxyrus cognatus*)
- Hot Creek toad (*Anaxyrus monfontanus*)
- Northern leopard frog (*Lithobates pipiens*)
- Railroad Valley toad (*Anaxyrus nevadensis*)
- Red-spotted toad (*Anaxyrus punctatus*)
- Relict leopard frog (*Lithobates onca*)
- Western toad (*Anaxyrus boreas*)
- American Avocet (*Recurvirostra americana*)
- American kestrel (*Falco sparverius*)
- American white pelican (*Pelecanus erythrorhynchos*)
- Arizona Bell's vireo (*Vireo bellii arizonae*)
- Bald eagle (*Haliaeetus leucocephalus*)
- Bank swallow (*Riparia riparia*)
- Black tern (*Chlidonias niger*)
- Black-necked stilt (*Himantopus mexicanus*)
- Canvasback (*Aythya valisineria*)
- Cinnamon teal (*Spatula cyanoptera*)
- Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianu*)
- Costa's hummingbird (*Calypte costae*)
- Dusky flycatcher (*Empidonax oberholseri*)
- Gambel's quail (*Callipepla gambelii*)
- Great Basin willow flycatcher (*Empidonax traillii adastus*)
- Greater sage grouse (*Centrocercus urophasianus*)
- Least bittern (*Ixobrychus exilis*)
- Lewis's woodpecker (*Melanerpes lewis*)
- Lincoln's sparrow (*Melospiza lincolnii*)
- Long-billed curlew (*Numenius americanus*)
- Long-billed dowitcher (*Limnodromus scolopaceus*)
- Long-eared owl (*Asio otus*)
- Lucy's warbler (*Leiothlypis luciae*)
- Mountain quail (*Oreortyx pictus*)
- Northern pintail (*Anas acuta*)
- Sierra Nevada mountain willow flycatcher (*Empidonax traillii brewsteri*)
- Southwestern willow flycatcher (*Empidonax traillii extimus*)
- Tricolored blackbird (*Agelaius tricolor*)
- Trumpeter swan (*Cygnus buccinator*)
- White-faced ibis (*Plegadis chihi*)

- White-throated swift (*Aeronautes saxatilis*)
- Wilson's phalarope (*Phalaropus tricolor*)
- Yellow-billed cuckoo (*Coccyzus americanus occidentalis*)
- Yuma ridgway's rail (*Rallus obsoletus yumanensis*)
- Allen's big-eared bat (*Idionycteris phyllotis*)
- Big-free-tailed bat (*Nyctinomops macrotis*)
- California leaf-nosed bat (*Macrotus californicus*)
- Canyon bat (*Parastrellus hesperus*)
- Desert pocket mouse (*Chaetodipus penicillatus*)
- Fringed myotis (*Myotis thysanodes*)
- Greater bonneted bat (*Eumops perotis*)
- Little brown myotis (*Myotis lucifugus*)
- Long-eared myotis (*Myotis volans*)
- Mountain pocket gopher (*Thomomys monticola*)
- Mule deer (*Odocoileus hemionus*)
- Pahranagat Valley montane vole (*Microtus montanus fucosus*)
- Preble's shrew (*Sorex preblei*)
- Sierra Nevada mountain beaver (*Aplodontia rufa californica*)
- Sierra Nevada snowshoe hare (*Lepus americanus tahoensis*)
- Silver-haired bat (*Lasionycteris noctivagans*)
- Spotted bat (*Euderma maculatum*)
- Trowbridge's shrew (*Sorex trowbridgii*)
- Western jumping mouse (*Zapus princeps*)
- Western red bat (*Lasiurus blossevillii*)
- Western water shrew (*Sorex palustris*)
- White-tailed jackrabbit (*Lepus townsendii*)
- Yuma myotis (*Myotis yumanensis*)
- Gilbert's skink (*Plestiodon gilberti rubricaudatus*)
- Long-tailed brush lizard (*Urosaurus graciosus*)
- Northern alligator lizard (*Elgaria coerulea*)
- Northern rubber boa (*Charina bottae*)
- Panamint alligator lizard (*Elgaria panamintina*)
- Ring-necked snake (*Diadophis punctatus*)
- Sonoran Mountain kingsnake (*Lampropeltis pyromelana*)
- Western skink (*Plestiodon skiltonianus*)
- Arrowhead blue (*Glaucopsyche piasus*)
- Carson Valley wood nymph (*Cercyonis pegala carsonensis*)
- Checkered white (*Pontia protodice*)
- Common sootywing (*Pholisora catullus*)
- Indra swallowtail (*Papilio indra*)
- Large marble (*Euchloe ausonides*)
- Melissa blue (*Plebejus melissa*)
- Monarch (*Danaus plexippus plexippus*)
- Nokomis fritillary (*Argynnis nokomis carsonensis*)
- Ruddy copper (*Tharsalea rubidus*)
- Sandhill skipper (*Polites sabuleti*)
- Sara orangetip (*Anthocharis sara*)
- Small wood-nymph (*Cercyonis oetus pallescens*)
- Tailed copper (*Tharsalea arota*)
- Uncas skipper (*Hesperia uncas grandiosa*)
- West Coast lady (*Vanessa annabella*)
- Western tailed-blue (*Cupido amyntula*)

Salt Desert Shrub

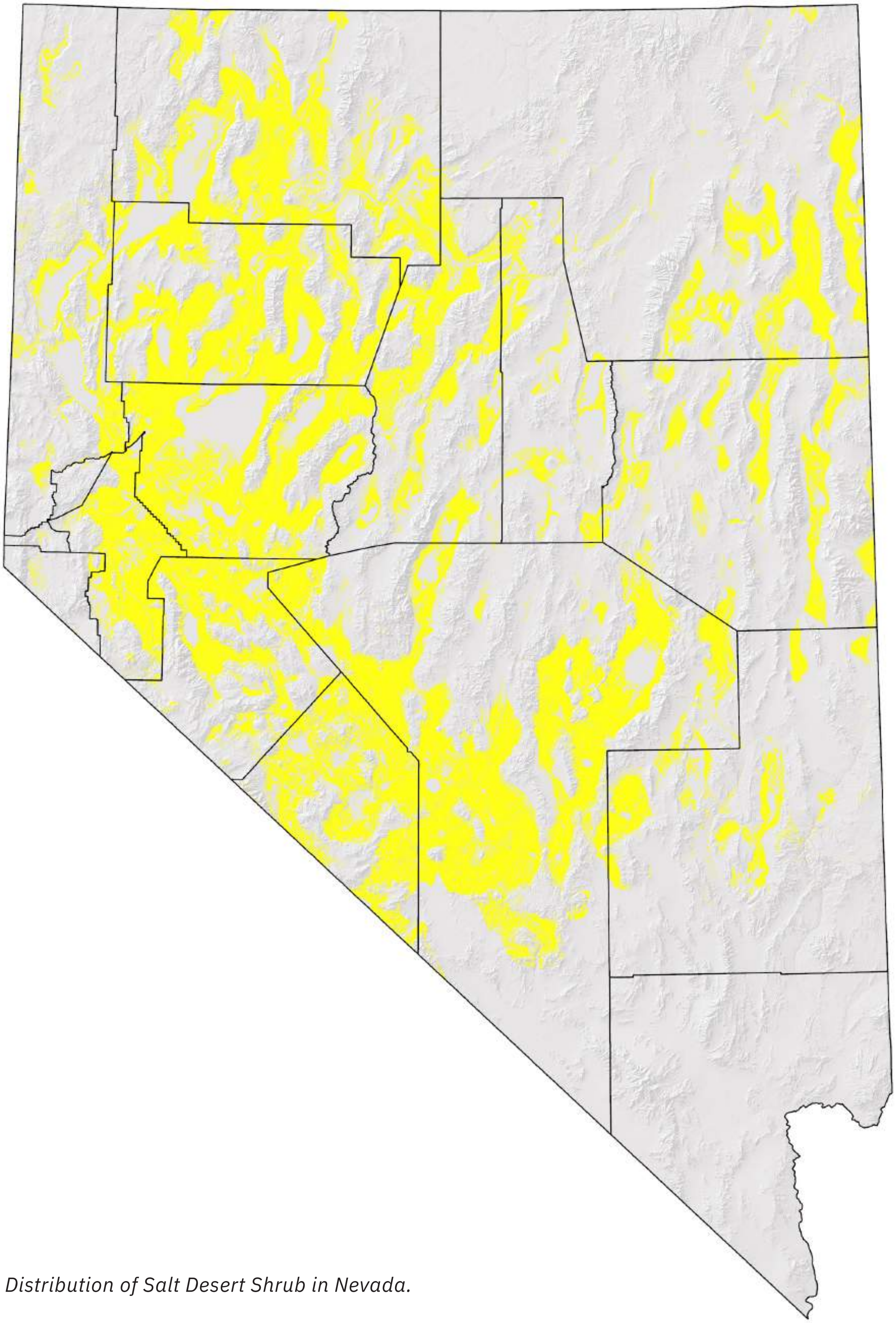


Figure 46. Distribution of Salt Desert Shrub in Nevada.

Key Habitat Description and Elements of Salt Desert Shrub

Vegetation and Abiotic Environment

The Salt Desert Shrub type is one of the most extensive habitat types in the state of Nevada, covering nearly 17 million acres. Distribution of the salt desert shrub type generally occurs at elevations of 3,500-6,500 ft from lower slopes to valley bottoms on alluvial flats or lake plains and adjacent to playas within the Great Basin physiographic region. Annual precipitation in the salt desert shrub zone is typically 5-8 inches but can range from 3-12 inches per year. Temperatures range between extremes of -20 degrees Fahrenheit and 110 degrees Fahrenheit with a mean of 45-65 degrees Fahrenheit. The average growing season ranges from 100 to 250 days. Saline, alkaline, and calcareous soils are typical in the Salt Desert Shrub type. Shallow water tables do occur in some alluvial flats with halophytic plants growing. Plant communities are generally characterized by the presence of a variety of salt-tolerant shrubs of the Goosefoot family (*Chenopodiaceae*) (Landfire, 2020; WAPT, 2012).

Vegetation community composition is largely influenced by soil conditions (e.g., salinity, alkalinity, and drainage). Shrubs are typically dominant and range from sparse to dense. Typical vegetation on valley bottoms and alluvial flats is dominated by greasewood (*Sarcobatus vermiculatus*). Greasewood ecosystems, the largest groundwater-dependent ecosystem by area in Nevada, are usually found at elevations ranging from 3,800–5,800 feet, in areas with average annual precipitation ranging from 5-8 inches (Provencher et al., 2020). Moving up in elevation on alluvial fans gives way to shadscale (*Atriplex confertifolia*), fourwing saltbush (*Atriplex confertifolia*), winterfat (*Krascheninnikovia lanata*), budsage (*Artemisia spinescens*), ephedra (*Ephedra sp.*), horsebrush (*Tetradymia canescens*), grey rabbitbrush (*Ericameria nauseosa*), green rabbitbrush (*Chrysothamnus viscidiflorus*), Bailey's greasewood (*Sarcobatus baileyi*), broom snakeweed (*Gutierrezia sarothrae*), spiny hopsage (*Grayia spinosa*), and sagebrush (*Artemesia spp.*) (Landfire, 2020; WAPT, 2012). The herbaceous layer can be non-existent to abundant depending upon site conditions. Forbs are generally low in abundance, but highly variable (Landfire, 2020).

General Wildlife Values

Salt desert shrub is the most important habitat in Nevada for several SGCN, including pale kangaroo mouse (*Microdipodops pallidus*) and loggerhead shrike (*Lanius ludovicianus*). Soils of this habitat tend to be loose and either sandy or gravelly and are often easy to excavate by burrowing wildlife. Blowing sand tends to accumulate around the shrubby bases of the saltbushes, particularly shadscale. This creates hummocks of soil that lend themselves well to burrowing and denning. The two most dependable herbivorous food staples are ricegrass (*Oryzopsis spp.*) and shadscale seeds, although forb seeds and leaf material will also be used when present. In the Great Basin, salt desert shrub is also important for foraging raptors and bats, and provides habitat to various reptiles, birds, small mammals, and invertebrates. Valley bottoms, where quailbush (*Atriplex spp.*) and four-wing saltbush (*Atriplex canescens*) create huge mature plants, as much as 10 feet in diameter, provide thorny redoubts protecting bird nests. Salt desert shrub also serves as an important support habitat for several sagebrush breeders. Washes within this habitat type have unique attributes for certain terrestrial species, including endemic amphibians because of their function as a conduit for surface runoff and subsoil moisture (NDOW, 2019).

Existing Environment

Dominant Biophysical Settings

The dominant biophysical settings comprising Salt Desert Shrub are Mixed Salt Desert Scrub, Inter-Mountain Basins Greasewood Flat, and Semi-Desert Shrub-Steppe (Table 36).

Table 36: Dominant biophysical settings comprising salt desert shrub key habitats in Nevada.

SALT DESERT SHRUB	16,667,943 ACRES
Inter-Mountain Basins Mixed Salt Desert Scrub	12,690,051 acres
Inter-Mountain Basins Greasewood Flat	3,643,910 acres
Inter-Mountain Basins Semi-Desert Shrub-Steppe	333,982 acres

Habitat Conditions

Natural disturbances such as flooding, drought, and insects occur and are unpredictable. Native vegetation is adapted to such disturbances and able to persist and thrive when adequate resources exist. However, anthropogenic influences of climate change, overgrazing, disturbance, and others have led to an increase in some invasive exotic species including cheatgrass (*Bromus tectorum*), Halogeton (*Halogeton glomeratus*), Russian thistle (*Salsola sp.*), and in certain places, tamarisk (*Tamarix sp.*). Such invasions have compromised native communities and effected a shift toward less desirable conditions. Historically, perennial grasses such as Indian ricegrass (*Oryzopsis hymenoides*) were likely much more prevalent in this habitat type than they are today. Historically, fire was infrequent in the Salt Desert Shrub type, but with cheatgrass invading many areas, especially during wetter years, fire will play a larger role in the future. Some species will resprout (greasewood, horsebrush, rabbitbrush) depending upon burn severity, but many of the native plant species can be extremely difficult and costly to restore (Landfire, 2020; WAPT, 2012).

The Salt Desert Shrub type has significant departures from its reference conditions throughout much of its northerly and easterly range, with percentages in uncharacteristic classes currently ranging from 35% (*Calcareous*) to 72% (Black Rock Plateau), with the exception of the Owyhee Plateau (four percent). Habitat integrity is better in the southern regions (Walker, Toiyabe, Tonopah, Mojave), with uncharacteristic class percentages currently ranging from 1-12% (Landfire, 2020; WAPT, 2012).


Source: NDOW

Table 37: Percent of salt desert shrub key habitat converted to agriculture, barren or sparsely vegetated cover, non-natural vegetation, and/or urbanized lands based on Landfire successional class analysis. Non-natural vegetation types include both non-native exotic dominated areas as well as areas dominated by natural vegetation that is outside the range of variation (cover, height, dominant type) that would be expected under typical conditions. Natural vegetation includes all areas remaining in young-old age successional classes as outlined below although the distribution of age classes within natural vegetation states may be outside of the range of variation expected under historic conditions.

SALT DESERT SHRUB	
CURRENT STATE	**PERCENT HABITAT**
Agriculture	2.1%
Barren or Sparse	2.1%
Natural Vegetation	69.9%
Non-Natural Vegetation (invasive or native)	25.0%
Urban	0.9%

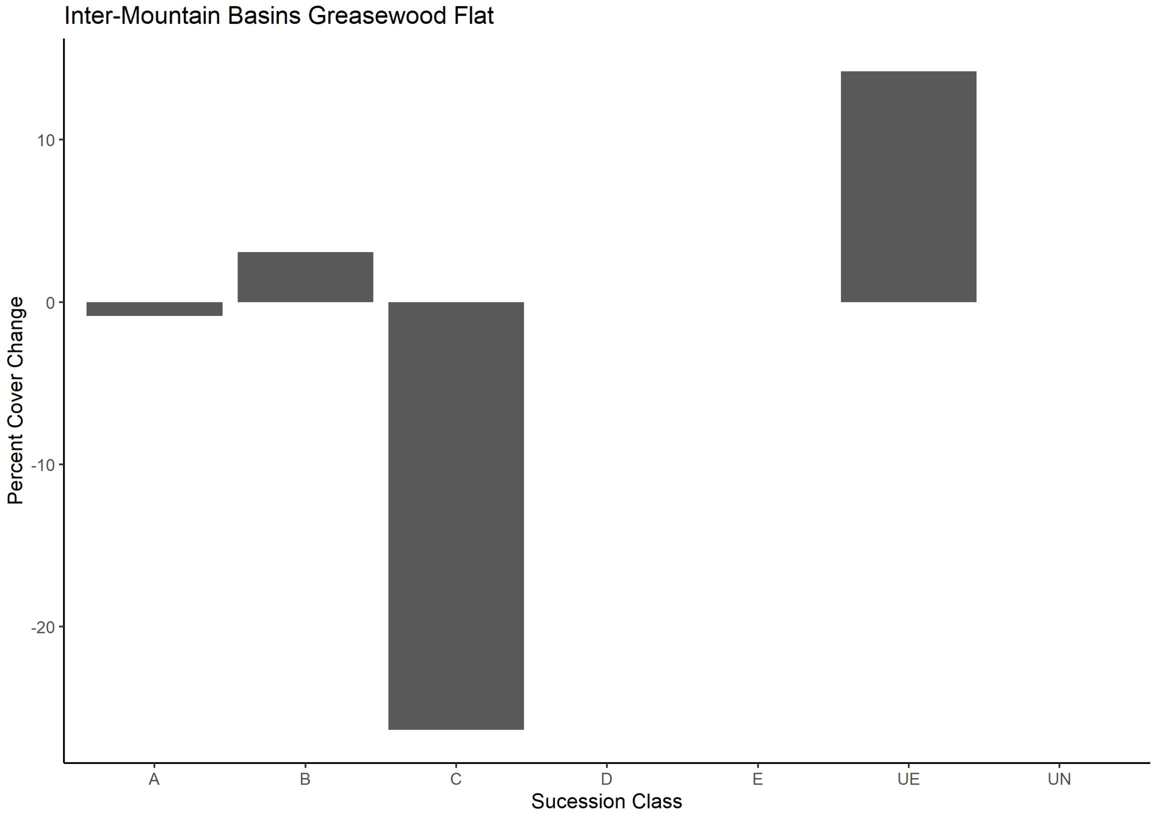


Figure 47. Succession class data for biophysical setting Inter-Mountain Basins Greasewood Flat. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

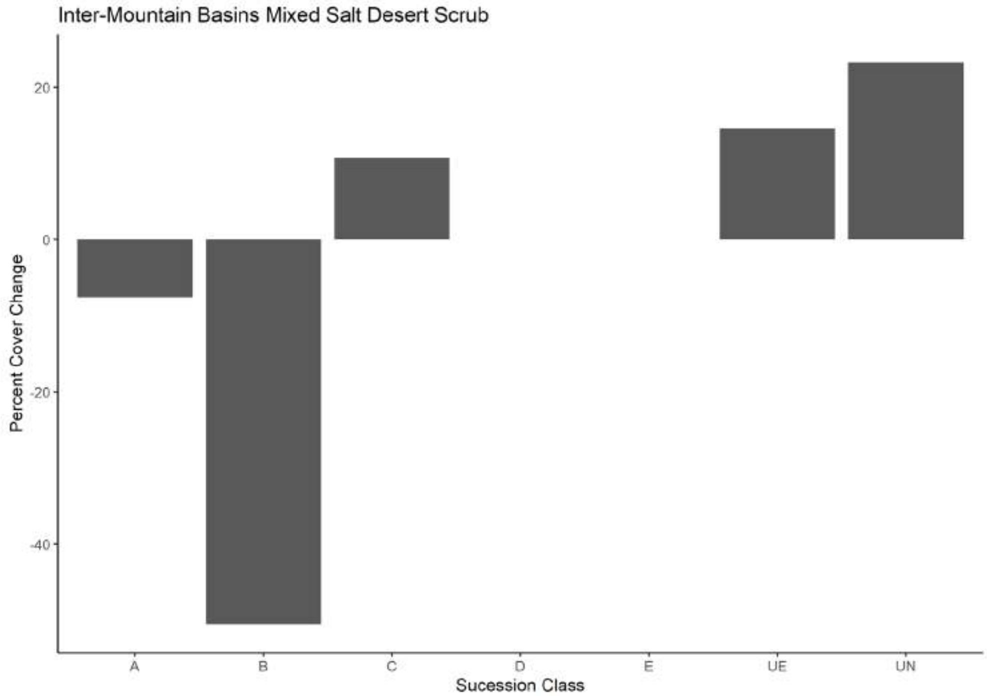


Figure 48. Succession class data for biophysical setting Inter-Mountain Basins Mixed Salt Desert Scrub. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

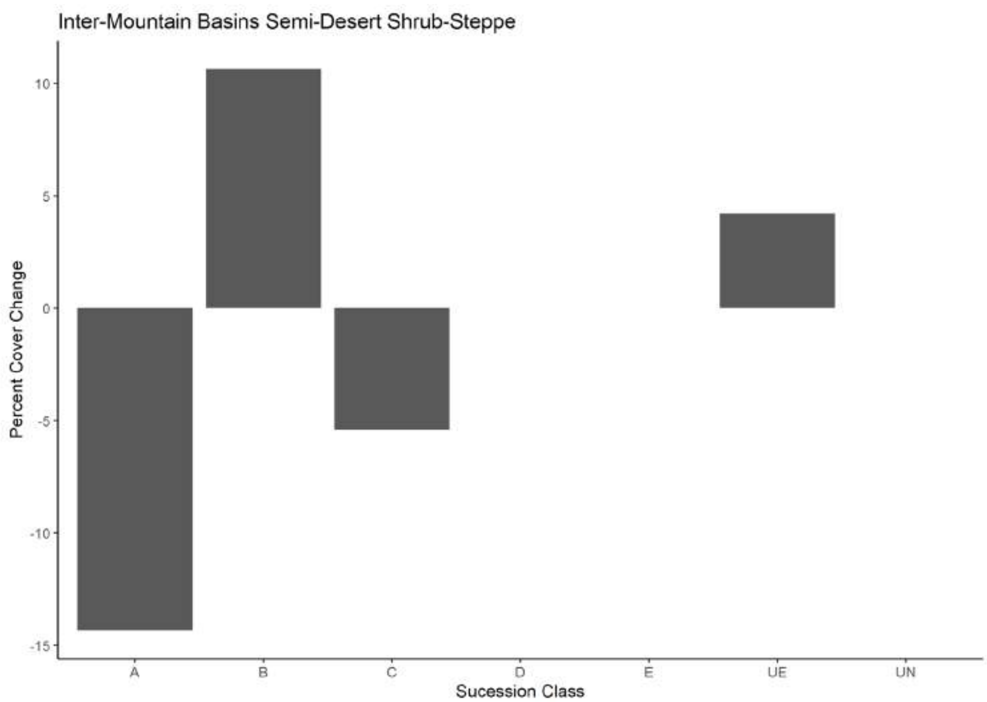


Figure 49. Succession class data for biophysical setting Inter-Mountain Basins Semi-Desert Shrub-Steppe. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS Description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

Habitat Threats

Various land uses from grazing (historic and contemporary), development (e.g., industrial, renewable energy, and right of ways), motorized recreation, and others have resulted in a significant departure from reference conditions. Collectively these land uses have resulted in the reduction or removal of important native seed-bearing grasses and forbs, and in many places, native understory has been replaced by non-native invasive species, including cheatgrass, halogeton, Russian thistle, and tamarisk on wetter soils. Natural disturbances in greasewood ecosystems are primarily attributed to continuous inundation and flash flooding, and these systems can transition from fire-resistant systems to more fire-prone systems in areas where groundwater withdrawals contribute to falling water tables (Provencher et al., 2020). Loss of these systems increased cheatgrass cover, which is especially prevalent during wetter years and can provide a continuous fuelbed creating the potential for larger and more frequent wildfires. Off-road vehicle activity can spread invasive species and cause structural damage to vegetation, stripping them of their value as wildlife cover, and soil disturbance can lead to accelerated erosion, particularly around washes. Ever-increasing development including industrial, renewable energy, and right of way presents an ongoing and future threat to this type. Free-roaming equids over Appropriate Management Levels (AML) are also a threat, and especially problematic near water and riparian resources, which are scarce in this habitat type (Landfire, 2020; WAPT, 2012).

Climate Change Vulnerability

Within the NV portion of the Salt Desert Shrub Key Habitat distribution, overall HCCVI is 46% in moderate and 53% in high relative vulnerability. Exposure is 11% severe, 68% high, 17% moderate, and 5% low. This overall exposure estimate results from contrasting component measures, with climate departure scoring at 80% severe while change in suitability (factoring in actual climate variability across the range of the type) scored as 67% low, 29% moderate, and 5% high. By mid-century and assuming a higher emission scenario (8.5), several climate variables are projected to have departed by greater than two standard deviations from the 20th-century baseline mean. These include Annual Mean Temperature (increasing 2.7-2.9 degrees Celsius), Mean Temperature of the Warmest Quarter (increased by 3.3-3.6 degrees Celsius), and Maximum Temperature of the Warmest Month (increased by 3.3-3.6 degrees Celsius).

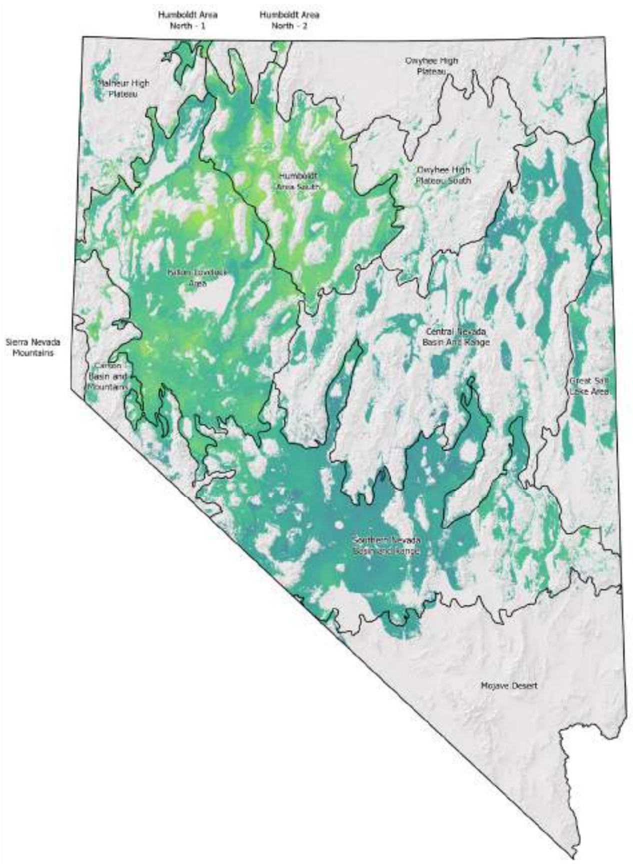
Overall resilience is measured at 82% moderate within the state, and with 18% of the area with higher vulnerability from resilience measures. Among resilience measures, sensitivity measures contribute toward vulnerability, with 22% of areas scoring moderate for Landscape condition. Fire regime departure scores 24% moderate and 76% high vulnerability. Impacts of invasive plants vary in their impact on resilience, with 68% of land area scoring low, 15% moderate, 12% high, and 5% severe. Since this cold desert scrub occurs throughout flats in this Basin and Range landscape, very low topographic roughness contributes to high vulnerability in 24% of the state’s area and 71% contributes to severe vulnerability.

Table 38: Percentage of potential Salt Desert Shrub Key Habitats within Nevada with Low, Moderate, High and Severe Overall Vulnerability, Exposure, and Resilience.

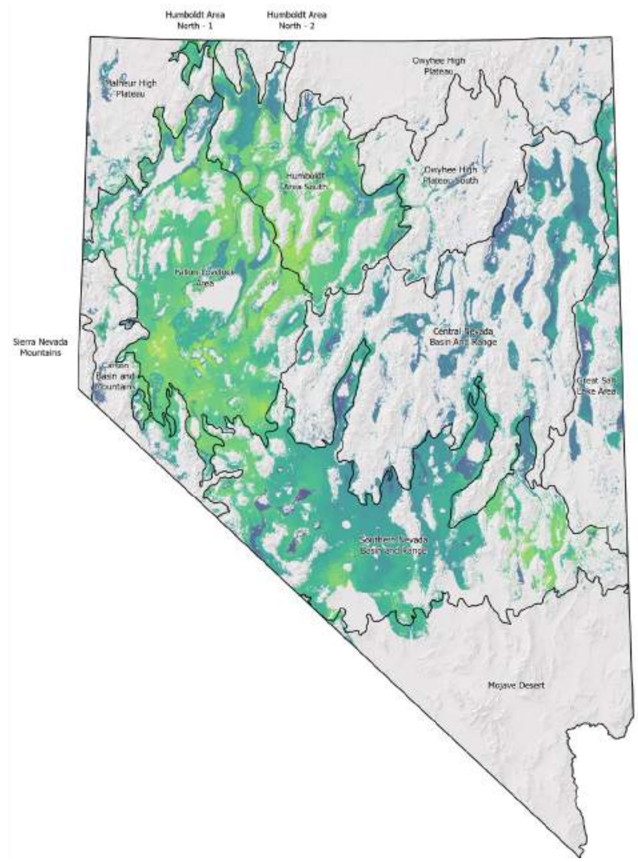
		PERCENT AREA WITHIN EACH RELATIVE VULNERABILITY RANKING			
		LOW	MODERATE	HIGH	SEVERE
Climate Change Vulnerability Index		0%	74%	26%	0%
Vulnerability from Measures of Exposure	Climate Departure	<1%	54%	7%	39%
	Climate Suitability	39%	59%	3%	0%
	Overall Exposure	5%	62%	34%	0%
Vulnerability from Measures of Sensitivity	Landscape Condition	56%	32%	10%	2%
	Fire Regime Departure	37%	41%	19%	3%
	Invasive Annual Grasses	86%	10%	3%	<1%
	Overall Sensitivity	60%	36%	5%	0%
Vulnerability from Measures of Adaptive Capacity	Topoclimatic Variability	0%	<1%	12%	88%
	Overall Adaptive Capacity	0%	<1%	78%	22%
Vulnerability from Measures of Overall Resilience		0%	66%	34%	0%

When viewed across the MLRAs in Nevada (49), patterns of climate change vulnerability vary, with the lowest estimated vulnerability found in substantial proportions of each MLRA statewide; and most concentrated in the Central Nevada Basin and Range MLRA. Those areas supporting these Salt Desert Shrub habitats with more severe vulnerability are concentrated in the Humboldt Area South and Fallon-Lovelock Area MLRAs within Nevada. This same pattern holds for climate exposure measures. Sensitivity components of resilience are highest in most of the Southern Nevada Basin and Range, northern portions of the Central Nevada Basin and Range, and northern extremes of the Fallon-Lovelock and adjacent areas.

OVERALL VULNERABILITY (HCCVI)



EXPOSURE



SENSITIVITY

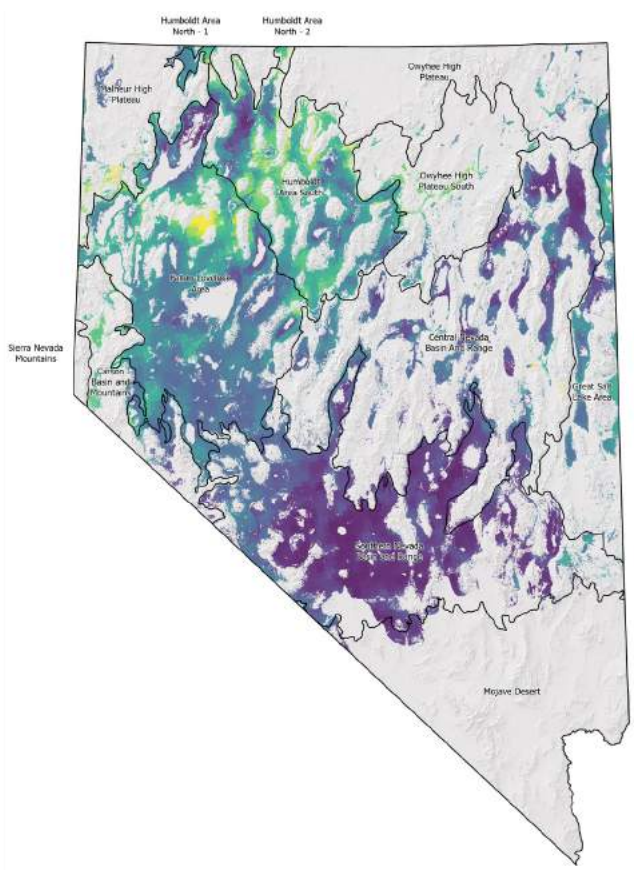


Figure 50. Salt desert shrub patterns of climate change vulnerability across MLRAs in Nevada. Overall HCCVI vulnerability measures incorporate patterns of potential climate exposure and habitat resilience, which incorporates ecosystem sensitivity and adaptive capacity (overall sensitivity shown here). Vulnerability, ranked from low to severe, is spatially variable based on multiple components of exposure and sensitivity.

Predicted Climate Change Effects

Many of the species in the salt desert shrub type have wide ecological distributions and are tolerant of a wide range of climatic conditions. Species often combine morphological and physiological attributes (e.g., small, heavily protected leaves, high root-to-shoot ratios) allowing them to tolerate stress. Climate change impacts on the salt desert shrub type may include both positive and negative shifts for individual species. The Salt Desert Shrub type is likely to be relatively insensitive to the direct effects of climate change. However, given the indirect effects, this habitat type has a moderate to high vulnerability to climate change.

Risks of direct and indirect effects of fire and introduced species create a relatively high risk of vulnerability to the combination of future impacts. Fire and invasive species issues are expected to increase in the future given more extreme precipitation events and the fertilization effects of increased atmospheric carbon dioxide. This combination may result in an increase in annual grasses, which will in turn be more likely to fuel wildfire (Bradley, 2016; Smith, 1987). Most of the dominant woody species in salt desert shrublands are poorly adapted to fire, and they will be vulnerable to increases in fire frequency (Padgett, 2018).

Conservation Strategy

Objective 1: Assess the condition of the existing Salt Desert Shrub type and the risk of invasive species, and develop a strategy to address these risks by 2032.

- Action: Utilizing new online mapping products, assess vulnerability, and identify strategies to address and mitigate risks.

Objective 2: Minimize impacts to Salt Desert Shrub resulting from land, improper livestock grazing, recreation, or other land uses.

- Action: Continue reviewing projects and participating in planning efforts for projects on federally administered lands (e.g., National Environmental Policy Act, County planning, land transfers, etc.) to avoid, minimize, and mitigate impacts on salt desert shrub communities.

Priority Research Needs

- A statewide health assessment of Salt Desert Shrub, including high-resolution remote sensing of condition and departure from reference community, along with risk vulnerability assessment to guide future restoration work.
- Post-fire range rehabilitation techniques (e.g., herbicides, seed coating technology, and plant breeding).

Key SGCN Species

- Brewer’s Sparrow (*Spizella breweri*)
- Common nighthawk (*Chordeiles minor*)
- Ferruginous hawk (*Buteo regalis*)
- Golden eagle (*Aquila chrysaetos*)
- Loggerhead shrike (*Lanius ludovicianus*)
- Peregrine falcon (*Falco peregrinus*)
- Sage thrasher (*Oreoscoptes montanus*)
- Sagebrush sparrow (*Artemisiospiza nevadensis*)
- Swainson’s hawk (*Buteo swainsoni*)

- White-throated swift (*Aeronautes saxatilis*)
- Dark kangaroo mouse (*Microdipodops megacephalus*)
- Desert kangaroo rat (*Dipodomys deserti*)
- Mexican free-tailed bat (*Tadarida brasiliensis*)
- Mule deer (*Odocoileus hemionus*)
- Pale kangaroo mouse (*Microdipodops pallidus*)
- Panamint kangaroo rat (*Dipodomys panamintinus*)
- Preble's shrew (*Sorex preblei*)
- Yuma myotis (*Myotis yumanensis*)
- Desert horned lizard (*Phrynosoma platyrhinos*)
- Great Basin collared lizard (*Crotaphytus bicinctores*)
- Greater short-horned lizard (*Phrynosoma hernandesi*)
- Western skink (*Plestiodon skiltonianus*)
- Carson wandering skipper (*Pseudocopaeodes eunus obscurus*)
- Checkered white (*Pontia protodice*)
- Common sootywing (*Pholisora catullus*)
- Dotted blue (*Euphilotes enoptes primavera*)
- Eunus skipper (*Pseudocopaeodes eunus alinea*)
- Eunus skipper (*Pseudocopaeodes eunus flavus*)
- Large marble (*Euchloe ausonides*)
- Marine blue (*Leptotes marina*)
- Monarch (*Danaus plexippus plexippus*)
- Morrison's bumble bee (*Bombus morrisoni*)
- Rice's blue (*Euphilotes pallescens ricei*)
- Sandhill skipper (*Polites sabuleti*)
- Small blue (*Philotiella speciosa septentrionalis*)


Source: NDOW

Upper Montane Coniferous Forest and Woodland

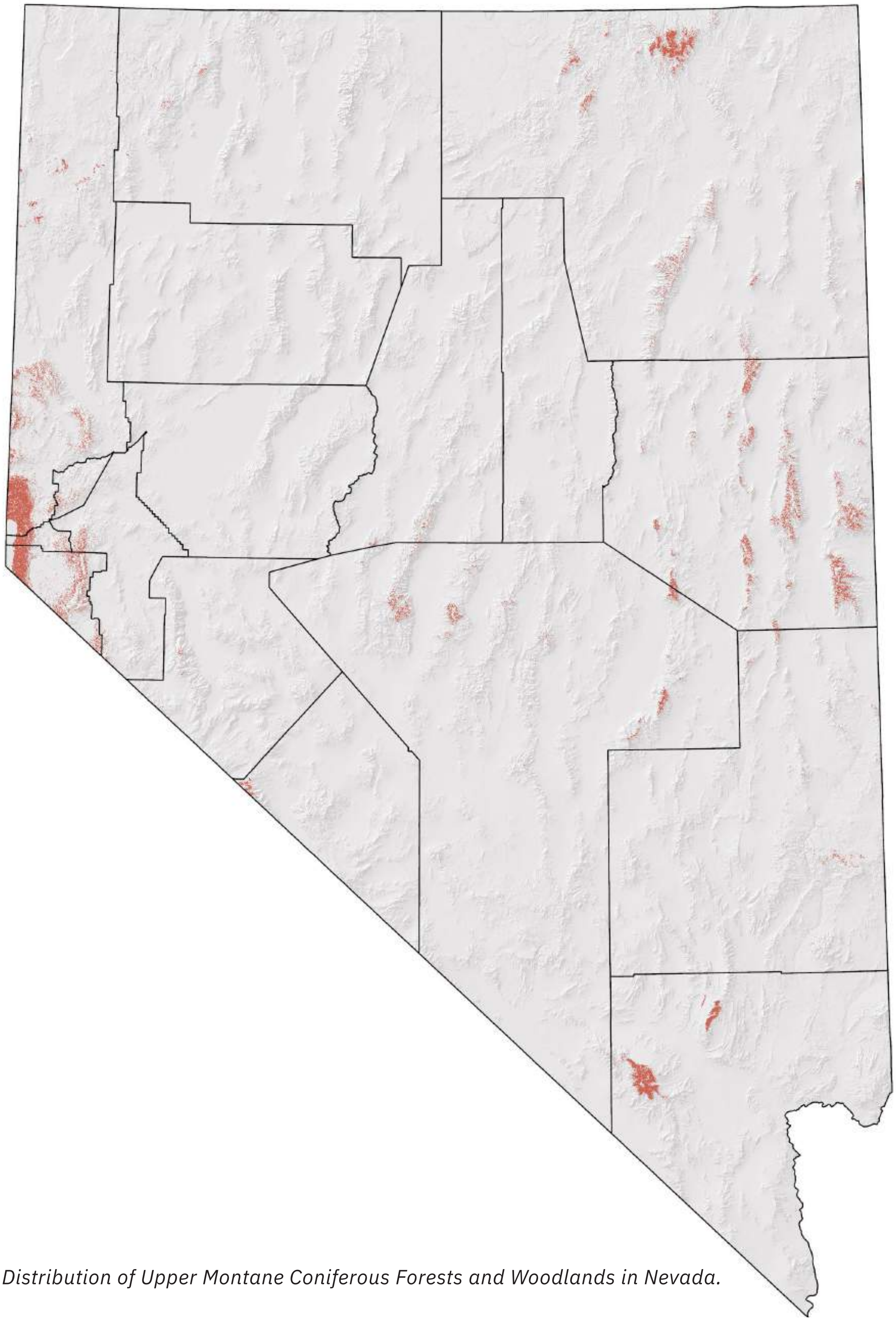


Figure 51. Distribution of Upper Montane Coniferous Forests and Woodlands in Nevada.

Key Habitat Description and Elements of Upper Montane Coniferous Forest and Woodland

Vegetation and Abiotic Environment

The Upper Montane Coniferous Forests and Woodlands in Nevada are comprised of diverse forested communities that occur at elevations between approximately 4,000 and 12,500 feet within the intermountain Great Basin and the Sierra Nevada. Intermountain conifer forests and woodlands within the Great Basin typically occur on cooler, more mesic sites ranging from gentle to very steep mountain slopes, high-elevation ridgetops and upper slopes, plateau-like surfaces, basins, alluvial terraces, well-drained benches, and inactive stream terraces. Higher elevation limber-bristlecone pine woodlands are found well into the subalpine-alpine transition on wind-blasted, mostly west-facing slopes and exposed ridges. Sites are typically harsh, exposed to desiccating winds with rocky substrates and a short growing season that limits plant growth (NatureServe, 2018). Subalpine forest communities occur in dry and cold conditions, often in rain shadows; they occur on stony soils on windswept southerly aspects, deep colluvial soils on northern slopes, and exposed slopes with marginal ground cover (Landfire, 2020). Intermountain conifer forests throughout the Great Basin are dominated by a variety of conifer species including white fir (*Abies concolor*), limber pine (*Pinus flexilis*), subalpine fir (*Abies lasiocarpa*), Douglas fir (*Pseudotsuga menziesii*), and Ponderosa pine (*Pinus ponderosa*). The deciduous quaking aspen (*Populus tremuloides*) is often part of these forest types but only as isolated trees and small clumps. The composition and structure of the overstory are dependent upon the temperature and moisture relationships of the site, and the successional status of the conifer community. White fir dominates at higher, colder locations while Douglas fir co-dominates intermediate zones in a few eastern mountain ranges (NatureServe, 2018). Understory shrub components include greenleaf manzanita (*Arctostaphylos patula*), snowberry (*Symphoricarpos oreophilus*), curl-leaf mountain mahogany (*Cercocarpus ledifolius var. intermontanus*), creeping barberry (*Mahonia repens*), mountain big sagebrush (*Artemesia tridentata spp. vaseyana*), and common juniper (*Juniperus communis*). The herbaceous grass and forb cover includes bluebunch wheatgrass (*Pseudoroegneria spicata*), common yarrow (*Achillea millefolium*), Engelmann aster (*Eucephalus engelmannii*), duncecap larkspur (*Delphinium occidentale*), sticky geranium (*Geranium viscosissimum*), silvery lupine (*Lupinus argenteus*), western sweet cicely (*Osmorhiza occidentalis*), western bracken fern (*Pteridium aquilinum*), western coneflower (*Rudbeckia occidentalis*), Fendler meadowrue (*Thalictrum fendleri*), western valerian (*Valeriana occidentalis*), and northern mule's ear (*Wyethia mollis*). Subalpine forest and woodland habitats within the Great Basin are composed of stands dominated by limber pine, Great Basin bristlecone pine (*Pinus longaeva*), Engelmann spruce (*Picea engelmannii*), subalpine fir, and whitebark pine (*Pinus albicaulis*). Englemann spruce and subalpine fir forests are found at cold sites where precipitation is predominantly in the form of snow. The understory shrub component includes common juniper, mountain gooseberry (*Ribes montigenum*), and mountain mahogany. Dominant herbaceous layer species include Ross sedge (*Carex rossii*) and Fendler meadowrue (Nachlinger et al., 2001).

Sierra coniferous forests and woodlands range from the Sierra Nevada foothills up to ridges and rocky slopes around the timberline. Lower elevations are generally occupied by Jeffrey and ponderosa pine forests on warm, xeric sites on volcanic or granitic substrates that range up to ridges and rocky slopes up to approximately 8,200 feet (NatureServe, 2018). Jeffrey pine is the dominant species on the Nevada side of the Sierra Nevada (often called eastern yellow pine) because it is better adapted to xeric sites at lower elevations, south-facing slopes, or well-drained soils. Sierra coniferous forested systems form closed, multilayered canopies with shrubs present in the understory where openings occur. Common conifer species of the mixed conifer forest and woodland ecological system include white fir, Jeffrey pine (*Pinus jeffreyi*), incense cedar (*Calocedrus decurrens*), ponderosa pine, and sugar pine (*Pinus lambertiana*) (NatureServe, 2018). White fir tends to be the most ubiquitous species since it is shade tolerant and can survive long periods of suppression in brush fields. Red fir conifer forests and woodlands are located at higher elevations, above mixed conifer forest, and the forest stand structure is typified by even-aged red fir trees with very few other plant species present in the other layers. Western white pine (*Pinus monticola*) is often dominant to co-dominant with red fir on the west slopes of the Carson Range. Another conifer system, lodgepole pine (*Pinus contorta*), typically forms stands of similarly sized trees and is widespread in glacial basins at upper montane to subalpine elevations of the central and northern Sierra Nevada (NatureServe, 2018). Dominant shrub layer species include antelope bitterbrush (*Purshia tridentata*), mountain big sagebrush, squaw currant (*Ribes cereum*), snowbush (*Ceanothus cordulatus*), and greenleaf manzanita. Common herbaceous species include bottlebrush squirreltail (*Elymus elymoides*), blue wildrye (*Elymus glaucus*), slender hairgrass (*Deschampsia elongata*), western needle-grass (*Achnatherum occidentale*), woolly mule's ear, and pennyroyal (*Mentha pulegium*).

General Wildlife Values

Many wildlife species depend on the variations in forest tree structure, herbaceous and shrub microsites, and proximity to ecotones necessary for self-maintenance and reproduction. These habitat features provide thermal and security cover, foraging opportunities, and resting and reproductive sites for both resident and migratory species of all sizes. For example, migrant birds benefit from insect-laden trees and can build nests among the branches and foliage or make use of cavities in snags. Mule deer and mountain quail take advantage of herbaceous forage and shrub cover along ecotones. Bats can forage in and around the canopy layer and roost in the crevices and cavities of trees. Chipmunks can forage in downed and decaying logs for fungi and cache foodstuffs on the forest floor, and granivorous birds and mammals find high-elevation structures and seed sources in limber and bristlecone pines (NDOW, 2019).

Existing Environment

Dominant Biophysical Settings

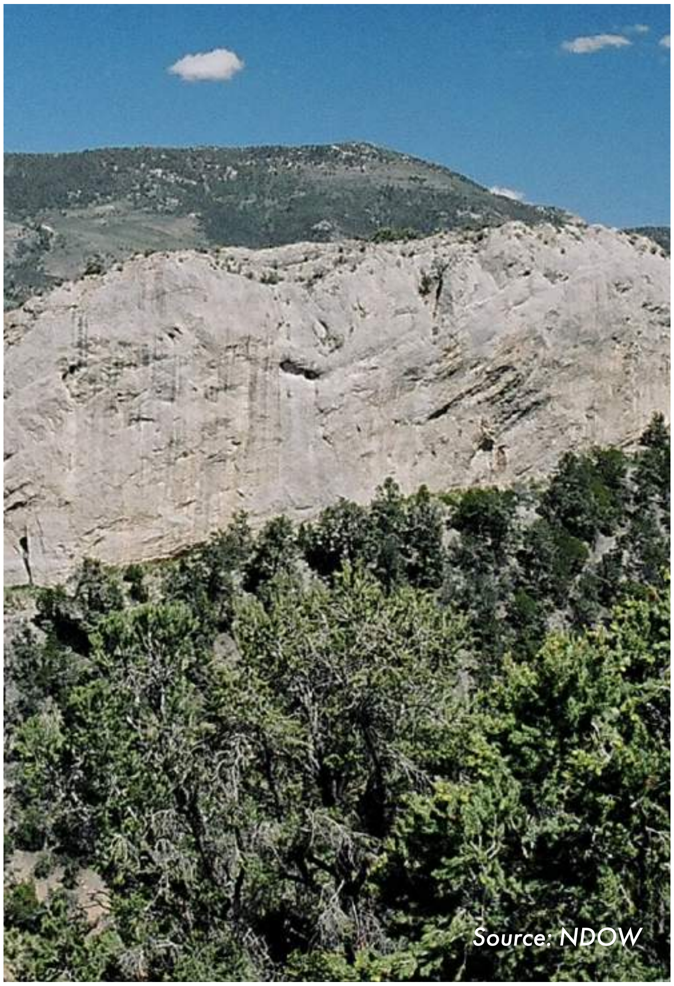
The dominant biophysical settings include California Montane Jeffrey Pine (Ponderosa Pine) Woodland, Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland, Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland, Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland, Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland, Mediterranean California Red Fir Forest-Southern Sierra (Table 39).

Table 39: Dominant biophysical settings comprising upper montane coniferous forest and woodland key habitats in Nevada. Roughly 775,319 acres of Nevada may have historically supported aspen communities based on biophysical setting analysis.

UPPER MONTANE CONIFEROUS FORESTS AND WOODLANDS	686,629 ACRES
California Montane Jeffrey Pine (-Ponderosa Pine) Woodland	199,407 acres
Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland	134,158 acres
Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland	108,383 acres
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	48,787 acres
Mediterranean California Red Fir Forest-Southern Sierra	47,406 acres
Other	148,489 acres

Habitat Conditions

Montane coniferous forests and woodland habitats in Nevada tend to be in fair and poor condition, primarily as a result of fire suppression, and include mixed aspen-conifer, mixed conifer, white fir, ponderosa pine, and subalpine fir communities. Present-day ponderosa pine forests differ greatly from pre-settlement forests because of logging, fuel wood harvest, fire suppression, improper grazing, and urban development. Size-class distributions are now skewed to second growth forests (Figures 51-55), where stands generally exhibit a more closed canopy, higher levels of disease and insect outbreaks, depleted understories, and high susceptibility to crown fires. In general, fire suppression has led to the encroachment of more shade-tolerant, less fire-tolerant species into conifer communities altering fire behavior and fuel loads (for example, white fir colonizing previously occupied ponderosa pine sites). There has also been a corresponding increase in landscape homogeneity and connectivity resulting in the increased potential of large and lethal fires (NatureServe, 2018). Englemann spruce, limber, and bristlecone pine habitats where fire frequency is low are generally in good condition across Nevada, although disease is increasing in the limber pine communities of the Ruby Mountains. In some cases, bristlecone pine has been documented moving down into aspen stands, a phenomenon attributable to fire suppression.



Source: NDOW

Table 40: *Percent of upper montane coniferous forest and woodland key habitat converted to agriculture, barren or sparsely vegetated cover, non-natural vegetation, and/or urbanized lands based on Landfire successional class analysis. Non-natural vegetation types include both non-native exotic dominated areas as well as areas dominated by natural vegetation that is outside the range of variation (cover, height, dominant type) that would be expected under typical conditions. Natural vegetation includes all areas remaining in young-old age successional classes as outlined below although the distribution of age classes within natural vegetation states may be outside of the range of variation expected under historic conditions.*

UPPER MONTANE CONIFEROUS FOREST AND WOODLAND	
CURRENT STATE	**PERCENT HABITAT**
Agriculture	0.15%
Barren or Sparse	3.86%
Natural Vegetation	90.16%
Non-Natural Vegetation (invasive or native)	3.91%
Urban	1.92%

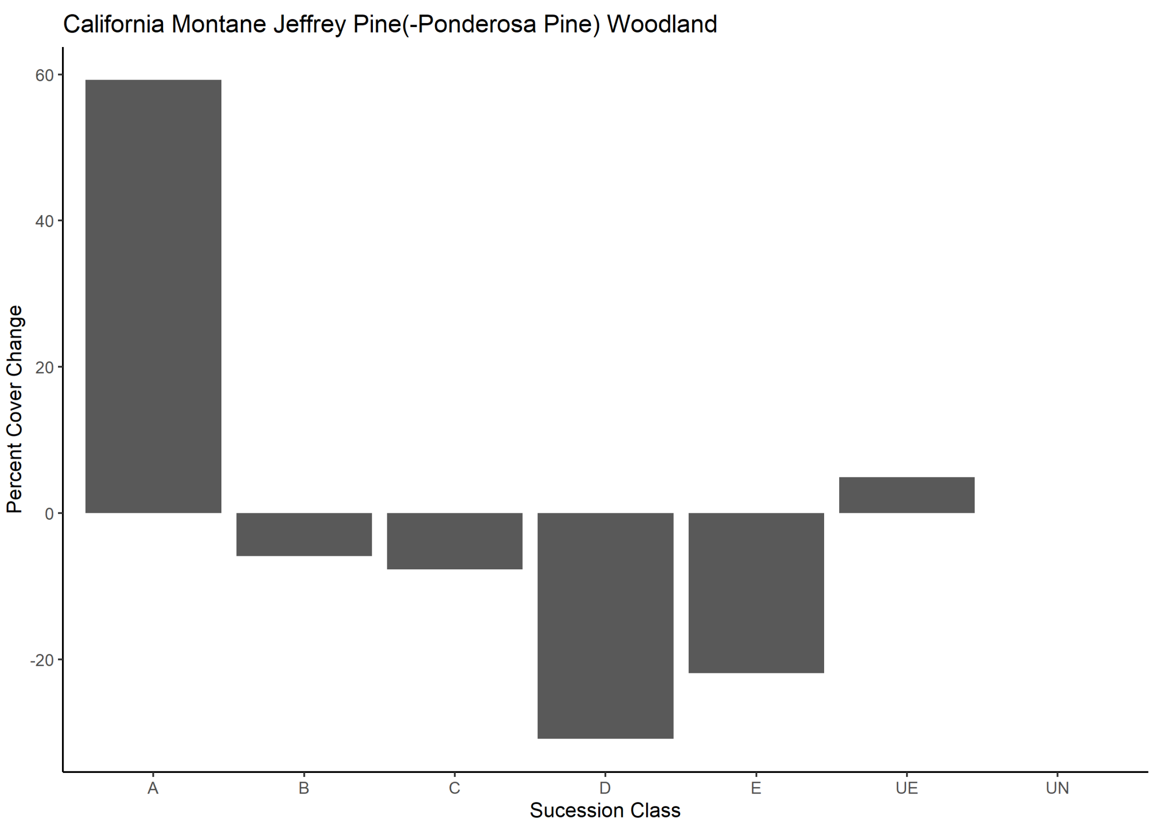


Figure 52. Succession class data for biophysical setting California Montane Jeffrey Pine (-Ponderosa Pine) Woodland. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

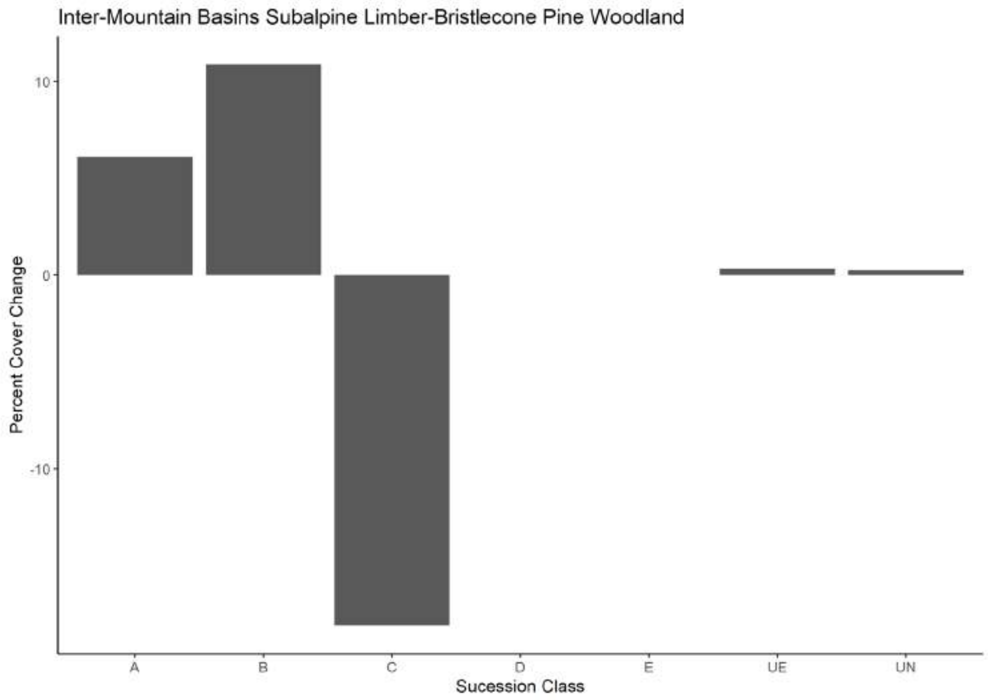


Figure 53. Succession class data for biophysical setting Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

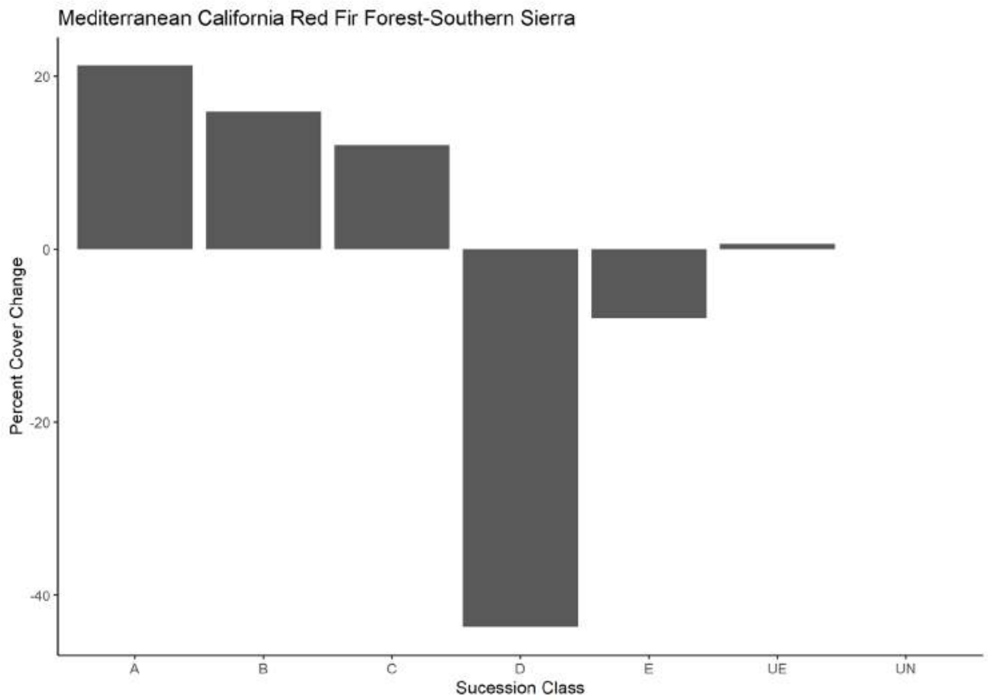


Figure 54. Succession class data for biophysical setting Mediterranean California Red Fir Forest – Southern Sierra. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

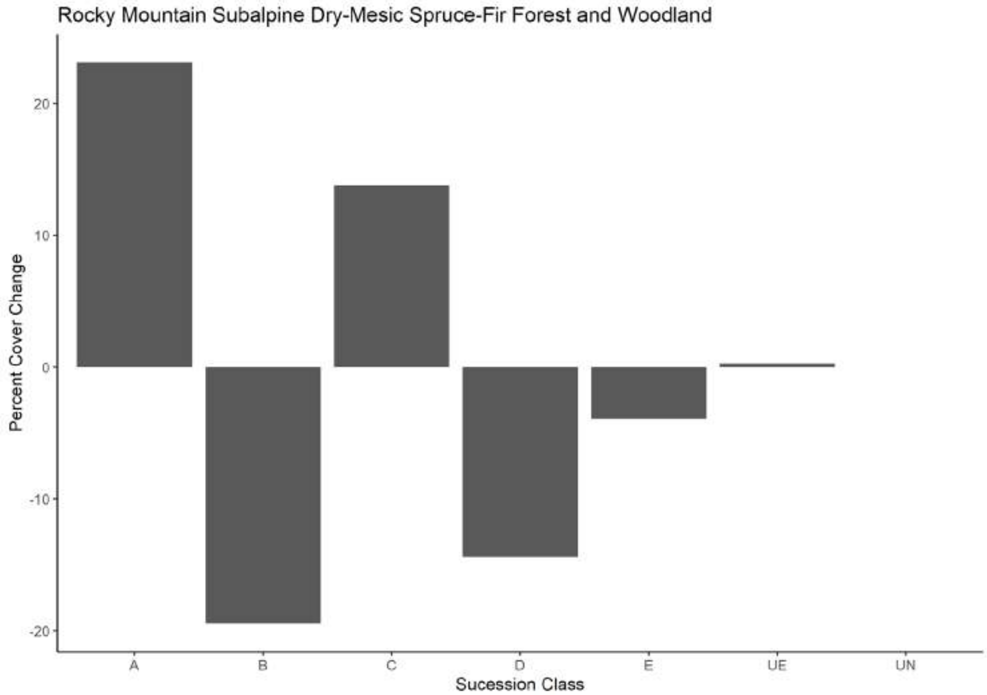


Figure 55. Succession class data for biophysical setting Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

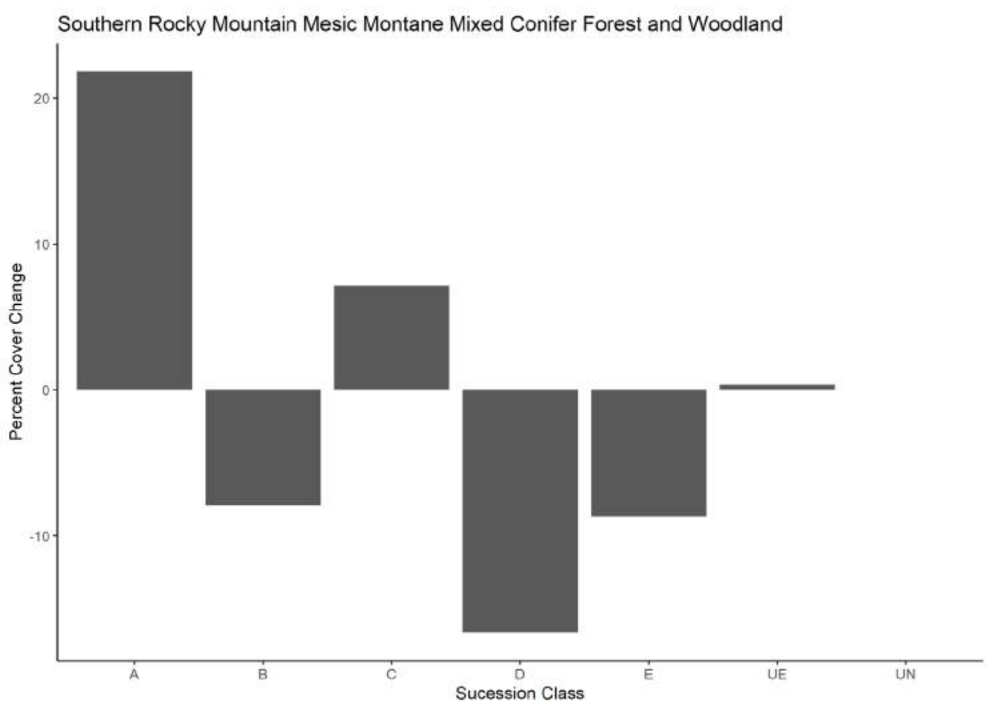


FIgure 56. Succession class data for biophysical setting Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland. Negative numbers represent a loss of land cover within a class, while positive numbers represent increases in land cover. Classes A-E represent young-medium-old successional classes and are specific to a BpS description; UE=unnatural exotic dominated vegetation; UN=unnatural native dominated vegetation outside the range of historic cover, height, or growth form.

Habitat Threats

Natural processes that have shaped the development of upper montane coniferous forests and woodlands in Nevada include fire, insects, and storms, yet many of these have been inhibited by modern forestry practices including fire suppression, salvage logging (cutting of burned trees), suppression logging (cutting of insect-infested trees), and alteration of natural fire intensity. The altered fire regime of coniferous forests and woodlands and continued extreme drought pose some of the most significant threats to this habitat. A long history of fire suppression has resulted in abnormally high fuel levels, increasing cheatgrass and other weed abundance and distribution, and has facilitated disease in many conifer species, including white pine blister rust (*Cronartium ribicola*) in the five-needle white pine species in Nevada (limber, whitebark, bristlecone, and western white pines); fir engraver beetles in white fir; and the mountain pine beetle (*Dendroctonus ponderosae*) in lodgepole and Jeffrey pine. Another challenge to modifying the current practice of high fire suppression is the proximity of this habitat to the urban interface and resultant concerns for human safety and potential economic loss. In the western United States, droughts over the previous 20 years have become more intense and associated with greater precipitation and temperature fluctuations compared to those during the early and mid-twentieth century, contributing to larger wildfires and more severe tree mortality events (Crockett & Westerling, 2018).

Other threats to this habitat include maintenance of a vigorous shrub and herbaceous understory, which may be reduced by improper ungulate or livestock grazing, or recreation. Intermountain coniferous forests and woodlands near urban development can be impacted by activities such as winter recreation, off-highway vehicle use, and dispersed forms of recreation such as hiking and mountain biking, resulting in habitat degradation, fragmentation, and erosion. Urban and suburban development has and will continue to result in permanent habitat loss or conversion and fragment wildlife habitats if conservation of these forest habitats and their associated species is not incorporated into planning processes. An increasing human population is coupled with the need for infrastructure (e.g., roads and utility corridors) that can serve as a conduit for invasive species such as cheatgrass, and result in additional forest fragmentation.

Predicted Climate Change Effects

Climate changes are predicted to have significant consequences on upper montane coniferous forest communities in Nevada and the western United States. Drought coupled with temperature and precipitation extremes has resulted in increased wildfire frequency and intensity, substantial tree die-off events, insect outbreaks, and complete shifts in forest size and age class structure and composition (Crockett & Westerling, 2018; Young et al., 2017). Stand level transitions are occurring particularly with the Sierra Nevada, and successional class data generally show most forests are experiencing reductions within older age classes that are being replaced by younger, even age stands (Figures 51-55). Red fir in Nevada will likely gain area at the expense of subalpine conifers while losing ground to mixed conifers and chaparral. Jeffrey and Ponderosa pine communities are expected to experience significant transitioning from the early class to the mid- successional classes and a slight increase in late classes with transitioning from late-open to late-closed.

Stressed-induced trees during drought results in individuals and stands that become more susceptible to insects and pathogens. Coupled with high tree density, this can lead to substantially large mortality events from insect outbreaks (Weed et al., 2013). Large stands of dead and dying trees from insect outbreaks or drought provide ample fuel and continuity to facilitate large wildfires. Climate change and drought conditions in the Sierra Nevada during 1996-2016 resulted in increased white pine blister rust prevalence at higher elevations and lower prevalence at lower elevations (Dudney et al., 2021), which may have consequences for subalpine communities of whitebark, limber, and bristlecone pines (*Pinus longaeva*) in Nevada.

Anticipating that climate change will continue to alter forest ecosystems, potential strategies might include promoting drought tolerant species, potentially species outside a current range, and in lower density stands (Clark et al., 2016). The severity of drought impacts can be influenced to some degree by forest management practices (i.e., thinning, prescribed burning, etc.) aiming to restore more natural stand structure and composition by reducing tree density, increasing average stand diameter, and competition for resources (Thomas & Waring, 2015). However, managers should prepare for and expect longer periods of drought which will likely continue to increase wildfire frequency and extent and large-scale tree mortality.

Conservation Strategy

Objective: Restore or maintain known coniferous forest stands to achieve ecological function, integrity, and species diversity.

- Action: Encourage and promote federal land management agencies, state agencies, and partners, to proactively manage mid-closed mixed conifer with thinning, prescribed burning, or other forestry practices to improve forest health, open stands, and promote the development of multi-aged conifer and woodland stands with complex structure (e.g., old growth conditions). This will provide a landscape mosaic that includes early to late succession forest, including old growth.
- Action: Encourage and promote federal land management agencies, state agencies, and partners, to conserve Sierra coniferous forests and woodlands that have retained old growth or late- successional characteristics.

Priority Research Needs

- Finer scale delineation of Sierra coniferous forest successional stages and woodlands.
- Impacts of drought and climate change at the forest stand and landscape levels, particularly related to increased wildfire potential.
- Responses of coniferous forests and woodlands to different enhancement or restoration treatment types; establish management actions that are most effective for habitat objectives.
- White pine blister rust and mountain pine beetle dynamics and delineation of susceptible as well as resistant five-needle pine populations.
- Implications of drought, forest succession class, and composition changes on disease outbreak potential from bark beetles, fir engraver beetles, and other insect species.

Key SGCN Species

- Bald eagle (*Haliaeetus leucocephalus*)
- Band-tailed pigeon (*Patagioenas fasciata*)
- Black-backed woodpecker (*Picoides arcticus*)
- Black-throated gray warbler (*Setophaga nigrescens*)
- California spotted owl (*Strix occidentalis occidentalis*)
- Cassin's finch (*Haemorhous cassinii*)
- Clark's nutcracker (*Nucifraga columbiana*)
- Common nighthawk (*Chordeiles minor*)
- Dusky grouse (*Dendragapus obscurus*)
- Flammulated owl (*Psiloscops flammeolus*)
- Grace's warbler (*Setophaga graciae*)
- Hermit warbler (*Setophaga occidentalis*)
- Lewis's woodpecker (*Melanerpes lewis*)
- Mountain quail (*Oreortyx pictus*)
- Northern pygmy-owl (*Glaucidium gnoma*)
- Olive-sided flycatcher (*Contopus cooperi*)
- Peregrine falcon (*Falco peregrinus*)
- Sooty grouse (*Dendragapus fuliginosus*)
- White-headed woodpecker (*Dryobates albolarvatus*)
- Williamson's sapsucker (*Sphyrapicus thyroideus*)
- Allen's big-eared bat (*Idionycteris phyllotis*)
- Allen's chipmunk (*Neotamias senex*)
- Greater bonneted bat (*Eumops perotis*)
- Hoary bat (*Lasiurus cinereus*)
- Humboldt yellow-pine chipmunk (*Neotamias amoenus celeris*)
- Humboldt's flying squirrel (*Glaucomys oregonensis*)
- Inyo shrew (*Sorex tenellus*)
- Little brown myotis (*Myotis lucifugus*)
- Long-eared myotis (*Myotis volans*)
- Montane shrew (*Sorex monticolus*)
- Mountain pocket gopher (*Thomomys monticola*)
- Mule deer (*Odocoileus hemionus*)
- Pacific marten (*Martes caurina*)
- Palmer's chipmunk (*Neotamias palmeri*)
- Preble's shrew (*Sorex preblei*)
- Sierra Nevada mountain beaver (Ap*lodontia rufa californica*)
- Sierra Nevada snowshoe hare (*Lepus americanus tahoensis*)
- Silver-haired bat (*Lasionycteris noctivagans*)
- Spotted bat (*Euderma maculatum*)
- Townsend's big-eared bat (*Corynorhinus townsendii*)
- Trowbridge's shrew (*Sorex trowbridgii*)
- Western small-footed myotis (*Myotis ciliolabrum*)
- Northern alligator Lizard (*Elgaria coerulea*)
- Arrowhead blue (*Glaucopsyche piasus*)
- Checkered white (*Pontia protodice*)
- Crotch's bumble bee (*Bombus crotchii*)
- Indiscriminate cuckoo bumble bee (*Bombus insularis*)
- Indra swallowtail (*Papilio indra*)
- Melissa blue (*Plebejus melissa*)
- Monarch (*Danaus plexippus plexippus*)
- Mt. Charleston blue (*Icaricia shasta charlestonensis*)
- Ruddy copper (*Tharsalea rubidus*)
- Sandhill skipper (*Polites sabuleti*)
- West Coast lady (*Vanessa annabella*)
- Western bumble bee (*Bombus occidentalis*)
- White-shouldered bumble-bee (*Bombus appositus*)
- Yellow bumble bee (*Bombus fervidus*)

Springs

Figure 57. Distribution of Springs in Nevada.

Key Habitat Description and Elements of Springs

Vegetation and Abiotic Environment

Over 25,000 springs and seeps have been identified in Nevada (TNC, 2022), and the state lays claim to the most thermal hot springs, with more than 300 (WAPT, 2012). Springs occur when pressure forces the natural flow of groundwater up through cracks and fissures in the bedrock and out onto the surface of the ground. The groundwater from which springs originate is contained in aquifers that are formed in porous layers of water-bearing permeable rock, rock fractures, or other unconsolidated materials, and may be relatively shallow or deep in the Earth's crust. Aquifers are recharged as precipitation percolates through the ground, and the water resurfaces through springs and human-made wells. Springs occur anywhere from valley floors to the tops of mountains and vary widely in size, temperature, water chemistry, morphology, discharge rate, and persistence, all related to the type of aquifer that supplies it. Generally, three types of aquifers occur in Nevada (mountain block, local, and regional), and these types are distinguished by their residence (or water transit) time and water depth (Sada & Mihevc, 2011). Mountain block aquifer springs have short residence times, are recharged relatively quickly, contain few dissolved chemical components, are often small, ephemeral, cooler, and occur at elevation in the mountains. Local (also referred to as Valley) aquifer springs tend to be warmer than mountain block springs and are often located near the base of mountains on alluvial fans (although they may occur in the mountains or the central parts of some valleys) (Aldous & Gannett, 2021). Regional aquifers often contain what is considered ancient water due to long residence times (sometimes hundreds to thousands of years), are deeper, less affected by precipitation, tend to have higher and more constant discharge rates of warmer water, contain higher amounts of dissolved chemical components, and are usually located on or near the center of valley floors. In addition, springs are generally divided into three categories based on temperature: cold springs (water near or below mean annual air temperature), warm or thermal springs (water 40- 50 degrees Farhenheit above mean annual air temperature), and hot springs (more than 50 degrees Fahrenheit above mean annual air temperature).

Each spring system is different and unique. Many springs important to wildlife represent little more than intermittent seeps that only flow following a major rain event. Some spring systems may consist of a single, isolated independent spring. And others consist of a complex of many springs, some of which may be large and usually thermal or hot water systems associated with regional aquifer flow systems. Big Warm Spring in Railroad Valley, Nye County, for example, has a recorded discharge varying from 780-850 cubic feet per second at 86-91 degrees Fahrenheit, from a source pool 80 feet in diameter. Similar regional spring discharge areas such as Soldier Meadows, Upper White River Valley, Pahranagat Valley, Ash Meadows, and the Warm Springs area of Clark County support important diverse assemblages of spring-dependent endemic species. These larger (and some smaller) spring systems generally support extensive outflow habitats known as springbrooks, which in turn may create downstream wetted areas or wetland and marsh habitats and may also contribute significant flow to associated tributary and first-order stream and river systems, such as the upper White River and Muddy River. Habitat types for terrestrial and aquatic species as a result of spring systems vary tremendously in terms of plant species composition based on elevation, precipitation, and other factors. As a result, spring habitats are usually quite different from the relevant plant assemblages of the surrounding area or uplands and are often easily identified from a distance like an oasis in the desert.

General Wildlife Values

In a desert state such as Nevada, springs provide critical, life-sustaining water to an extensive array of microbial, plant, and animal species, including many native, endemic, and threatened and endangered species. Nevada, which has the lowest annual rainfall in the United States, has limited surface water resources. Protracted drought and ongoing climate change exacerbate the challenges associated with low water availability. Springs contribute a vital water source and islands of habitat between infrequent perennial surface waters, providing water availability and food resources for not only a wide range of unique endemic fishes and other aquatic species, but all of Nevada's wildlife, from bighorn sheep, elk, and deer to birds and bats. Springsnails constitute a large number of tiny, unique aquatic gastropods, tend to be local endemics, in many cases occur at only one or few spring sources, and are highly adapted to the water quality, chemistry, and habitat conditions of their springs. The broad distribution of functional spring and spring outflow systems of all types across Nevada's landscape is an important element in maintaining Nevada's biologically rich ecosystems and wildlife diversity. Springs provide crucial habitat to a significant percentage of Nevada's federally listed and state-protected aquatic species.

Desert springs support relatively small aquatic and riparian systems and are influenced by groundwater, location, precipitation, hydrologic principles, geology, climate, seasonality, the size and depth of the groundwater contained in the aquifer, and sometimes anthropogenic factors. Gains in scientific knowledge about the contribution of spring habitats to biodiversity, the longevity of ancient water supply sources, the importance of groundwater to springs, and the distribution and morphology of underground flow systems have drawn attention to spring conservation and management.

Existing Environment

Habitat Conditions

For millennia and generations, springs have helped sustain complex ecological processes and have supported a wide range of wildlife species and human communities. Native peoples, including the Paiute of the Mojave Desert, considered springs as sacred living landscapes that provided a place for people, plants, animals, and all living things. The location of springs in Nevada has been fairly well documented since they are relatively easy to identify in desert landscapes. Some springs have been extensively studied, monitored, and/or utilized over time, whereas, for many smaller, isolated springs and seeps, little is known about their condition or changes to them that may have occurred over time. And while some springs are still considered pristine and properly functioning, many springs and spring systems have been altered or modified to some degree from historic conditions through changes due to either natural processes and events, or as a result of anthropogenic actions, and some springs have ceased flowing altogether. Additionally, unlike other aquatic habitat stream and riverine systems that are subject to natural, recurring dynamic water cycles and rejuvenating events (e.g., flooding and scouring), springs systems are more fixed, and usually cannot recover following significant alteration or modification and are wholly dependent on geology, groundwater, and other factors to function properly.

Habitat Threats

Desert springs are among the most threatened ecosystems on earth. Springs, surrounding habitats, and associated species are primarily threatened by water diversion, modification to springheads and surrounding geology, livestock grazing, groundwater depletion, recreation, dewatering related to mining (including lithium), geothermal power development, drought, increasing temperatures, and invasive species.

Historically many springs in Nevada were developed and altered by the piping of outflows or construction of spring head boxes to divert the natural flow of water from the source to distant troughs and stock tanks to water domestic sheep and cattle. Some springs no longer function properly, or at all, and have essentially dried up following intensive modifications (some of which involved the use of explosives or heavy earth-moving machinery) intended to improve or increase spring flow, but which ultimately resulted in detrimental permanent damage to the geology and hydrology of the spring. These practices eliminate or significantly modify spring pools and also may eliminate or limit access to important surface water locations for use by resident wildlife species. Diversion of water away from outflow channels may modify, reduce, or eliminate associated riparian and wetland habitats. Improper grazing by cattle can also cause significant damage to riparian vegetation due to trampling and compaction.

Although not directly related to specific modification and alteration of some spring systems, groundwater development, including geothermal power production, has been a historic stressor on Nevada wildlife and habitats and continues to represent a significant ongoing threat. As demonstrated in areas such as Ash Meadows and Pahrump Valley in southern Nevada, excessive groundwater withdrawal can alter groundwater flow and recharge patterns, resulting in loss of connectivity between groundwater and surface water habitats and concurrent impacts on vegetative communities. These impacts are often not well-understood and can vary considerably depending on local geology, the nature of the groundwater resources being accessed, and the characteristics of groundwater development actions. In some basins, groundwater pumping has led to depressed spring flow and a small number of larger regional springs have demonstrated temporary or permanent dewatering as a result of groundwater development activities.

The introduction of non-native aquatic organisms into spring habitats, particularly the establishment of thermally tolerant invasive aquarium fish species (e.g., mosquito fish, cichlids, goldfish, and mollies) into warm spring systems, has significantly impacted resident endemic species through competition and predation and represents the single greatest threat to many threatened and endangered aquatic species of greatest conservation need. The establishment of emergent invasive plant species such as bulrush and phragmites in spring pools and outflows has severely modified and altered some spring habitat and flow characteristics. Other detrimental introduced plant and animal species include salt cedar, purple loosestrife, Canada thistle, knapweed, tall whitetop, bullfrogs, crayfish, snails, and several introduced sport fish (e.g., rainbow trout and largemouth bass).

Springs, particularly larger regional complexes, are also popular centers of human recreational activities. Although recreation can be managed to minimize effects on spring ecosystems in most cases, uncontrolled or poorly planned recreational use can have significant negative effects on spring habitats and biota. Recreational use impacts include soap and other chemicals added to the springs, soil compaction, removal of vegetation and resulting erosion due to ingress/egress from spring pools and camping along the edges of springs, and manipulation of spring flow by installing tubs or other water diversions. Springs are also susceptible to pollution because they are often supplied by shallow aquifers that can easily become polluted if spilled chemicals percolate from the surface through rock fractures or joints.

Predicted Climate Change Effects

Spring and seep ecosystems are sensitive to climate stressors that alter groundwater recharge and discharge, including changes in precipitation and snowpack, drought severity, frequency and duration, and evapotranspiration and soil moisture (Saito et al., 2022). Individual springs will be affected differently depending on the spring type and the aquifer that supports them. In general, drier future conditions will likely reduce the rate and magnitude of groundwater recharge and discharge, impacting plants and animals associated with seep and spring ecosystems and potentially leading to shifts in community composition or type (Sims et al., 2019).

The potential effect of climate change on groundwater recharge and subsequent surface discharge will, to a great extent, be dependent on the underlying geology. Great Basin hydrogeology is complex and impacts on individual spring systems will be dependent not only on their specific correlation to the local or regional groundwater aquifers but also on the physical location and elevation of individual sites within a given basin system or watershed. Large (often thermal) springs and spring complexes tied to regional water aquifer flow systems are likely to show minimal effects and respond more slowly to projected changes in seasonal precipitation patterns and increasing air temperatures in the coming decades. Big Warm Spring in Railroad Valley, Hot Creek in White River Valley, and Ash Spring in Pahranagat Valley are examples of these types of spring systems which are characterized by their connection to deep regional aquifers encompassing multiple valley basins and discharge of old water at warmer temperatures because of the depth of the connection to groundwater. Where effects can be associated with these regional springs, it primarily will be expected in the outflow components of the systems where increased air temperatures and transpiration could have potential effects on springbrook length, total wetted area, and thermal characteristics of the habitats which may affect habitat suitability and persistence for certain species.

However, most springs in Nevada are not directly associated with deep regional flow systems, but rather are more dependent on local recharge and short-term changes in precipitation and runoff patterns. Both valley bottom springs associated with local aquifers and intermediate and higher elevation, mountain block springs are generally characterized by discharge of younger (often less than 60 years old)(WAPT, 2012) water and are highly dependent on groundwater recharge from winter precipitation in local mountain systems to maintain flows. Even under existing climatic conditions, these springs can show inter-annual variability in discharge greater than that typically shown by deeper, older water represented in regional springs. Because these spring systems are much more dependent on relatively shallow groundwater flow and local recharge, the anticipated effects of climate change will be substantially greater. Warming air temperatures will affect not only the characteristics of spring outflow habitats but have the potential to modify precipitation characteristics. Increased snowline elevations, early spring onset, and temporal changes in precipitation timing all have the potential to alter groundwater recharge characteristics with corollary effects on individual spring total discharge and increased interannual flow variability.

Climate change-induced protracted warmer, drier conditions will likely increase the wildlife's dependence on spring ecosystems; however, predicting future natural conditions for springs is difficult due to the complex mechanisms that affect groundwater recharge, discharge, and quality. Response of groundwater to climate will be highly variable and dependent upon many factors, including local geology, aquifer type, specific characteristics of the aquifer and water chemistry, hydrologic regime, existing habitat types, land use, and other anthropogenic factors.

Conservation Strategy

Objective 1: Compile known spring distribution information into a single comprehensive and accessible database and identify data gaps.

- Action: Assess and map, where needed, the current functional status of Nevada's springs. Work with existing efforts to capture this information. Compile and document historical condition, desired condition, and restoration potential.
- Action: Create and foster working relationships with public and private landowners to ensure recognition and a comprehensive understanding of the importance of spring habitats.

Objective 2: Identify and reduce known and potential threats to spring systems and their associated habitats and wildlife that depend on them.

- Action: Develop and implement standardized habitat and risk assessment protocols for spring sites and systems including a monitoring program for habitat quality that identifies new or previously unrecognized risks or threats.
- Action: To the extent feasible, remove or reduce current risks, and monitor and evaluate springs to ensure the continued health and functionality of each system.
- Action: Prioritize management and work towards identifying threats to habitats and restoring degraded springs and associated riparian areas.
- Action: Actively pursue strategies to prevent the introduction of nuisance/exotic invasive aquatic plant and animal species, including educational campaigns targeted at pet stores, classrooms, researchers, and the public.
- Action: Support research on innovative methods and strategies for the control and removal of invasive and nuisance animal species from spring systems.
- Action: Encourage the application of land management practices to exceed minimal proper functioning condition standards for springs and associated riparian areas, utilizing existing guidance and standards.

- Action: Encourage and support the establishment of conservation easements, Safe Harbor Agreements, and Candidate Conservation Agreements with willing landowners, or acquire key habitats and water rights and maintain them for the benefit of wildlife.

Priority Research Needs

- Understanding impacts of groundwater withdrawals on a regional scale.
- Determining groundwater inter-basin connections and recharge intervals.
- Understanding invertebrate adaptability to alterations in water level, water chemistry, and other tolerance parameters.
- Develop effective methods for control and removal of invasive and non-native animal species, particularly in larger regional spring systems where flow and physical characteristics make conventional physical and chemical control methods impractical.
- Develop effective methods for restoration and reconstruction of fully functioning spring habitats.

Key SGCN Species

- Amargosa toad (*Anaxyrus nelsoni*)
- Columbia spotted frog (*Rana luteiventris*)
- Dixie Valley toad (*Anaxyrus williamsi*)
- Hot Creek toad (*Anaxyrus monfontanus*)
- Northern leopard frog (*Lithobates pipiens*)
- Railroad Valley toad (*Anaxyrus nevadensis*)
- Red-spotted toad (*Anaxyrus punctatus*)
- Relict leopard frog (*Lithobates onca*)
- Western toad (*Anaxyrus boreas*)
- Costa's hummingbird (*Calypte costae*)
- Ash Meadows amargosa pupfish (*Cyprinodon nevadensis mionectes*)
- Ash Meadows speckled dace (*Rhinichthys osculus nevadensis*)
- Big Smokey Valley speckled dace (*Rhinichthys osculus lariversi*)
- Big Smokey Valley tui chub (*Siphateles bicolor ssp. 8*)
- Big Spring spinedace (*Lepidomeda mollispinis pratensis*)
- Clover Valley speckled dace (*Rhinichthys osculus oligoporus*)
- Desert dace (*Eremichthys acros*)
- Devils Hole pupfish (*Cyprinodon diabolis*)
- Fish Creek Springs tui chub (*Siphateles bicolor euchila*)
- Fish Lake Valley tui chub (*Siphateles bicolor ssp. 4*)
- Hiko White River springfish (*Crenichthys baileyi grandis*)
- Independence Valley speckled dace (*Rhinichthys osculus lethoporus*)
- Independence Valley tui chub (*Siphateles bicolor isolata*)
- Little Fish Lake Valley tui chub (*Siphateles bicolor ssp. 6*)
- Moapa dace (*Moapa coriacea*)
- Moapa speckled dace (*Rhinichthys osculus moapae*)
- Moapa White River springfish (*Crenichthys baileyi moapae*)
- Monitor Valley speckled dace (*Rhinichthys osculus ssp. 5*)
- Moorman White River springfish (*Crenichthys baileyi thermophilus*)
- Oasis Valley speckled dace (*Rhinichthys osculus ssp. 6*)

- Pahranagat roundtail chub (*Gila robusta jordani*)
- Pahranagat speckled dace (*Rhinichthys osculus velifer*)
- Pahrump poolfish (*Empetrichthys latos latos*)
- Preston White River springfish (*Crenichthys baileyi albivallis*)
- Railroad Valley springfish (*Crenichthys nevadae*)
- Railroad Valley tui chub (*Siphateles bicolor ssp. 7*)
- Relict dace (*Relictus solitarius*)
- Sheldon tui chub (*Siphateles bicolor eurysoma*)
- Tui chub in Dixie Valley (*Siphateles bicolor ssp. 9*)
- Warm Springs pupfish (*Cyprinodon nevadensis pectoralis*)
- White River Desert sucker (*Catostomus clarkii intermedius*)
- White River speckled dace (*Rhinichthys osculus ssp. 7*)
- White River spinedace (*Lepidomeda albivallis*)
- White River springfish (*Crenichthys baileyi baileyi*)
- Curved filament snail (*Pyrgulopsis licina*)
- Sanchez pyrg (*Pyrgulopsis sanchezi*)
- Shasta pebblesnail (*Pyrgulopsis licina*)
- Amargosa tryonia (*Tryonia variegata*)
- Antelope Valley pyrg (*Pyrgulopsis pellita*)
- Ash Meadows pebblesnail (*Pyrgulopsis erythropoma*)
- Bifid duct pyrg (*Pyrgulopsis peculiaris*)
- Big Warm Spring pyrg (*Pyrgulopsis papillata*)
- Blue Point pyrg (*Pyrgulopsis coloradensis*)
- Blue Point Springs tryonia (*Tryonia infernalis*)
- Butterfield pyrg (*Pyrgulopsis lata*)
- Camp Valley pyrg (*Pyrgulopsis montana*)
- Carinate duckwater pyrg (*Pyrgulopsis carinata*)
- Corn Creek pyrg (*Pyrgulopsis fausta*)
- Cortez Hills pebblesnail (*Pyrgulopsis bryantwalkeri*)
- Crittenden pyrg (*Pyrgulopsis lentiglans*)
- Crystal springsnail (*Pyrgulopsis crystalis*)
- Desert tryonia (*Tryonia porrecta*)
- Distal-gland springsnail (*Pyrgulopsis nanus*)
- Dixie Valley pyrg (*Pyrgulopsis dixensis*)
- Duckwater pyrg (*Pyrgulopsis aloba*)
- Duckwater Warm Springs pyrg (*Pyrgulopsis villacampae*)
- Elko pyrg (*Pyrgulopsis leporina*)
- Elongate Cain Spring pyrg (*Pyrgulopsis augustae*)
- Elongate Mud Meadows pyrg (*Pyrgulopsis notidicola*)
- Elongate-gland springsnail (*Pyrgulopsis isolata*)
- Emigrant pyrg (*Pyrgulopsis gracilis*)
- Fairbanks springsnail (*Pyrgulopsis fairbanksensis*)
- Fish Lake Valley pyrg (*Pyrgulopsis ruinosa*)
- Flag pyrg (*Pyrgulopsis breviloba*)
- Flat-topped Steptoe pyrg (*Pyrgulopsis planulata*)
- Fly Ranch pyrg (*Pyrgulopsis bruesi*)
- Grand Wash springsnail (*Pyrgulopsis bacchus*)
- Grated tryonia (*Tryonia clathrata*)

- Hamlin Valley pyrg (*Pyrgulopsis hamlinensis*)
- Hardy pyrg (*Pyrgulopsis marcida*)
- Hubbs pyrg (*Pyrgulopsis hubbsi*)
- Humboldt pyrg (*Pyrgulopsis humboldtensis*)
- Kings River pyrg (*Pyrgulopsis imperialis*)
- Lake Valley pyrg (*Pyrgulopsis sublata*)
- Landyes pyrg (*Pyrgulopsis landyei*)
- Large gland carico pyrg (*Pyrgulopsis basiglans*)
- Lockes pyrg (*Pyrgulopsis lockensis*)
- Longitudinal gland pyrg (*Pyrgulopsis anguina*)
- Median-gland springsnail (*Pyrgulopsis pisteri*)
- Minute tryonia (*Tryonia ericae*)
- Moapa pebblesnail (*Pyrgulopsis avernalis*)
- Moapa Valley pyrg (*Pyrgulopsis carinifera*)
- Monitor tryonia (*Tryonia monitorae*)
- Nature pyrg (*Pyrgulopsis cybele*)
- Neritiform Steptoe Ranch pyrg (*Pyrgulopsis neritella*)
- Northern Soldier Meadow pyrg (*Pyrgulopsis militaris*)
- Northern Steptoe pyrg (*Pyrgulopsis serrata*)
- Northwest Bonneville pyrg (*Pyrgulopsis variegata*)
- Oasis Valley springsnail (*Pyrgulopsis micrococcus*)
- Ovate Cain Spring pyrg (*Pyrgulopsis pictilis*)
- Pahranagat pebblesnail (*Pyrgulopsis merriami*)
- Pleasant Valley pyrg (*Pyrgulopsis aurata*)
- Point of Rocks tryonia (*Tryonia elata*)
- Pyramid Lake pebblesnail (*Fluminicola dalli*)
- Sadas pyrg (*Pyrgulopsis sadai*)
- Small gland carico pyrg (*Pyrgulopsis bifurcata*)
- Smooth juga (*Juga acutifilosa*)
- Southern duckwater pyrg (*Pyrgulopsis anatina*)
- Southern Soldier Meadow pyrg (*Pyrgulopsis umbilicata*)
- Southern Steptoe pyrg (*Pyrgulopsis sulcata*)
- Southwest Nevada Pyrg (*Pyrgulopsis turbatrix*)
- Sportinggoods tryonia (*Tryonia angulata*)
- Spring Mountains pyrg (*Pyrgulopsis deaconi*)
- Squat Mud Meadows pyrg (*Pyrgulopsis limaria*)
- Steptoe hydrobe (*Eremopyrgus eganensis*)
- Sterile Basin pyrg (*Pyrgulopsis sterilis*)
- Sub-globose Steptoe Ranch pyrg (*Pyrgulopsis orbiculata*)
- Surprise Valley pyrg (*Pyrgulopsis gibba*)
- Toquerville springsnail (*Pyrgulopsis kolobensis*)
- Transverse gland pyrg (*Pyrgulopsis cruciglans*)
- Turban pebblesnail (*Fluminicola turbiniformis*)
- Twentyone mile pyrg (*Pyrgulopsis millenaria*)
- Upper Thousand Spring pyrg (*Pyrgulopsis hovinghi*)
- Varners pyrg (*Pyrgulopsis varneri*)
- Vinyards pyrg (*Pyrgulopsis vinyardi*)
- Virginia Mountains pebblesnail (*Fluminicola virginius*)
- Western Lahontan pyrg (*Pyrgulopsis longiglans*)
- White River Valley pyrg (*Pyrgulopsis sathos*)
- Wong's springsnail (*Pyrgulopsis wongi*)

- Mule deer (*Odocoileus hemionus*)
- San Antonio pocket gopher (*Thomomys bottae curtatus*)
- Sonoran Mountain kingsnake (*Lampropeltis pyromelana*)
- Ash Meadows naucorid (*Ambrysus amargosus*)
- Baking Powder Flat blue (*Euphilotes bernardino minuta*)
- Bleached sandhill skipper (*Polites sabuleti sinemaculata*)
- Carson Valley wood nymph (*Cercyonis pegala carsonensis*)
- Checkered white (*Pontia protodice*)
- Eunus skipper (*Pseudocopaeodes eunus alinea*)
- Eunus skipper (*Pseudocopaeodes eunus flavus*)
- Large marble (*Euchloe ausonides*)
- Melissa blue (*Plebejus melissa*)
- Monarch (*Danaus plexippus plexippus*)
- Nokomis fritillary (*Argynnis nokomis carsonensis*)
- Northern crescent (*Phyciodes cocyta arenacolor*)
- Railroad Valley skipper (*Hesperia uncas fulvapalla*)
- Sandhill skipper (*Polites sabuleti*)
- Sara orangetip (*Anthocharis sara*)
- Small wood-nymph (*Cercyonis oetus alkalorum*)
- West Coast lady (*Vanessa annabella*)
- Western tailed-blue (*Cupido amyntula*)

Source: NDOW

Other Critical Habitats: Alpine and Tundra

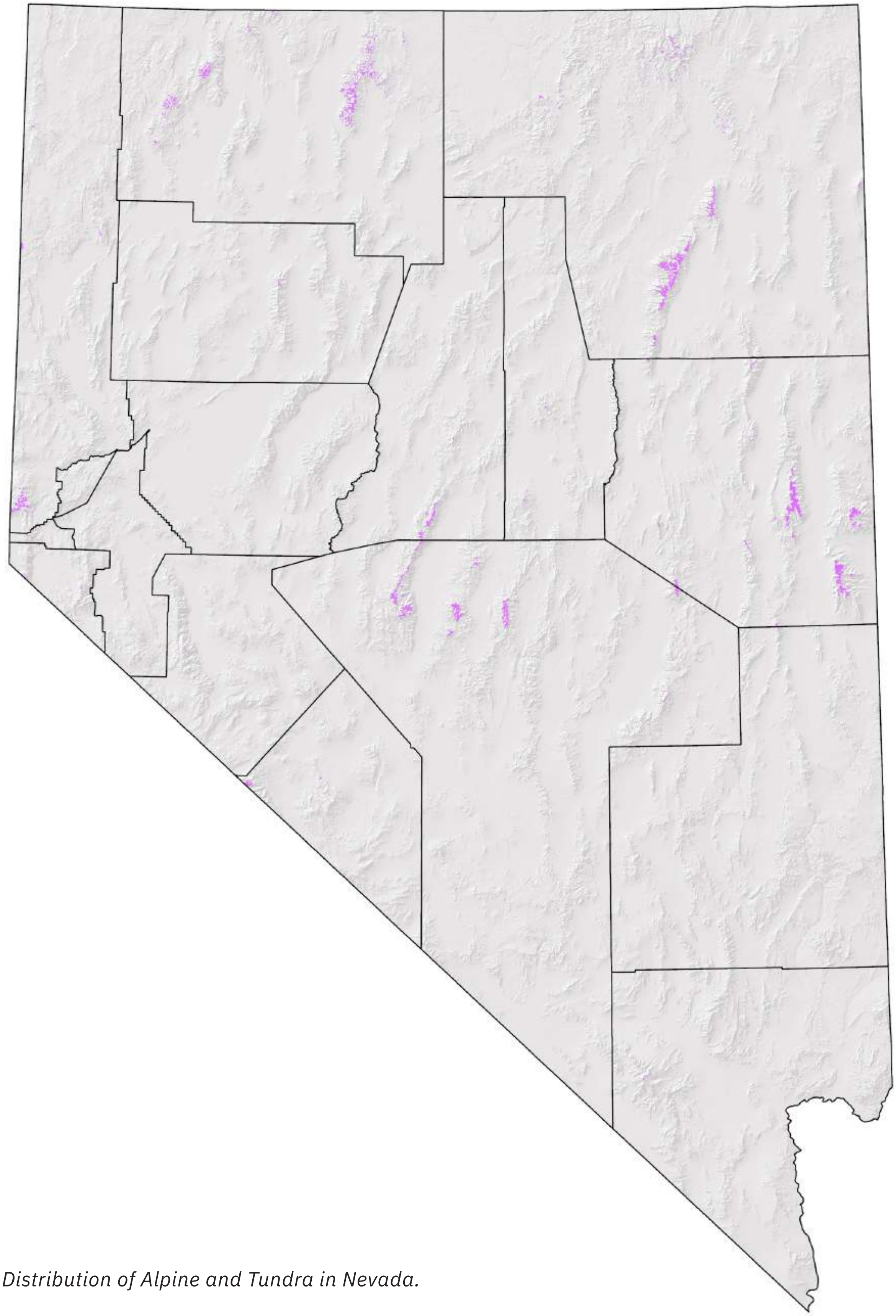


Figure 58. Distribution of Alpine and Tundra in Nevada.

Key Habitat Description and Elements of Alpine and Tundra

Vegetation and Abiotic Environment

Nevada's alpine and tundra habitats are restricted to the highest elevations, 10,600-13,140 feet. Alpine and tundra occur on the highest montane slopes within the Eastern Sierra and Intermountain Ranges of the Great Basin including the White Mountains, Toiyabe, Toquima, Table Mountain Ranges, the Ruby Mountains, and the Jarbidge Mountains. Plant communities of alpine and tundra habitats of Nevada are typically influenced by short growing seasons and exposure to extreme weather conditions including periods of high winds, desiccation, intense snow, and drifting snow and lack of snow from wind events (NatureServe, 2018).

Alpine ecological systems are composed of barren and sparsely vegetated substrates, which typically include both bedrock outcrop and scree slopes (sometimes unstable) and are dominated by non-vascular plant communities. Whereas tundra is found on gentle to moderate slopes, flat ridges, valleys, and basins where the soil has become relatively stable, water supply is constant, and permafrost is present. Both habitat types are exposed to desiccating winds and limited by short growing seasons. A common feature of pristine areas of alpine habitat is thin biological soil crusts covering the ground surface. These crusts are composed of varying proportions of lichens, mosses, cyanobacteria, and fungi, depending upon the environment and degree of crust development. These cryptogamic crusts vary in thickness, from just a few millimeters to more than a few centimeters, and enhance the availability of soil nutrients, dampen erosion by wind and water and help retain soil moisture. These combined qualities enhance seedling establishment of the sparsely distributed forbs, grasses, and low shrubs. Dominant herbaceous species include shrubby cinquefoil (*Dasiphora fruticose*), tufted hairgrass (*Deschampsia cespitosa*), Shasta sedge (*Carex straminiformis*), spring sedge (*Carex caryophyllea*), alpine timothy (*Phleum alpinum*), alpine avens (*Geum montanum*), and cushion phlox (*Phlox pulvinata*). In contrast, tundra is characterized by a dense cover of low-growing, perennial grasses and forbs with rhizomatous, sod-forming sedges dominating the grasses, and prostrate and mat-forming forbs having thick rootstocks or taproots (NatureServe, 2018).

Vascular vegetation communities are typically dominated by caespitose and dwarf vegetation that is influenced by the timing and duration of soil moisture from snowmelt and/or isolated precipitation events. Forbs, grasses, lichens, and low shrubs are sparsely distributed in true alpine habitats. The highest elevation/most exposed montane slopes are identified by exposed bedrock and scree slopes with vegetation stature increasing nearer treeline and in mode-protected microsites. Dominant vascular species include King's sandwort (*Arenaria kingii*), whitestem goldenbush (*Ericameria discoidea*), low sagebrush (*Artemisia arbuscula*), prickly phlox (*Leptodactylon pungens*), Phlox sp., wax currant (*Ribes cereum*), draba sp., mountain sorrel (*Oxyria digyna*), Nevada buckwheat (*Eriogonum umbellatum ssp. nevadense*), sedge (*Carex sp.*), and other graminoids, forbs and shrubs (Landfire, 2020).

General Wildlife Values

Alpine and tundra habitats are valuable to wildlife seeking high-elevation features such as wetted areas on the tundra, talus slopes, or animal prey species. Some mammal species found in these habitats have limited to no capability of dispersal between mountain ranges because of the isolating nature of intervening valleys. As a result, these populations may be genetically unique and specially adapted to local conditions. Seeds, insects, and emergent vegetation are important food sources for wildlife in alpine and tundra habitats. In addition, special features of these habitats provide wildlife foraging microhabitats for resident and migratory species. For example, black rosy finches (*Leucosticte atrata*) forage on snowfield surfaces and on wet soil and meadow edges of snowbanks, where receding snow releases insects and seeds and uncovers other previously concealed food items. Finches concentrate foraging activity in snow patches, rocky meadows, and fell fields with some occasional use of shrubs, trees, and grassy meadows. In the winter, they feed in alpine and tundra habitats during fair weather when the ground is blown free of snow (Johnson, 2002). Another alpine finch species, gray-crowned rosy finch (*Leucosticte tephrocotis*), usually forages on open ground, among rocks on talus, and open snowfields and glaciers in alpine habitats (MacDougall-Shackleton et al., 2000). American pika (*Ochotona princeps*) prefers the talus slopes for foraging, protection from predators, and thermal cover (WAPT, 2012).

Existing Environment

Dominant Biophysical Settings

The dominant biophysical Settings comprising alpine and tundra habitats are dominated by sparsely vegetated systems, Sierra Nevada Alpine Dwarf-Shrublands, Rocky Mountain Alpine Turf, Perennial Ice and Snow, and Alpine Fell Fields/Dry Tundra.

Table 41: Dominant biophysical settings comprising Alpine and Tundra key habitats in Nevada. Roughly 10,564 acres of Nevada may have historically supported alpine and tundra vegetation communities (excluding scree slopes and barren lands) based on biophysical setting analysis.

ALPINE AND TUNDRA	10,564 ACRES
Rocky Mountain Alpine/ Montane Sparsely Vegetated Systems	8,761 acres
Sierra Nevada Alpine Dwarf-Shrubland	645 acres
Rocky Mountain Alpine Turf	629 acres
Perennial Ice/Snow	370 acres
Mediterranean California Alpine Fell-Fields and Dry Tundra	158 acres

Habitat Conditions

Alpine and tundra communities have been receding during the warm and dry climatic conditions of the last 10,000 years. Since the passage of the Nevada Wilderness Protection Act of 1989, many alpine and tundra areas have received special designations that restrict certain land uses practices, which largely benefits alpine and tundra habitats and wildlife species. Due to their remoteness and difficulty of access, alpine and tundra habitats in Nevada are generally in good condition.

Habitat Threats

Global climate change and recreation have been identified as the primary problems facing alpine and tundra communities in Nevada (personal communication, Humboldt-Toiyabe National Forest personnel, December 2004). Warmer temperatures resulting from climate change may have long-term impacts on alpine habitats and their species through the fragmentation and loss of habitat. Many high-elevation habitats in Nevada are within established Wilderness Areas or other undeveloped areas where non-motorized recreation is the most common use. Off-highway vehicle use is typically concentrated at the lower elevations; however, incursions of off-highway vehicles and snowmobiles into alpine areas can disturb wildlife or damage alpine vegetation, which is slow to recover. Ski area development and operation have localized effects on alpine habitats and the associated plant and wildlife species in the Carson Range and the Spring Mountains. Development of communication sites (e.g., radio towers) on mountain tops results in habitat loss, fragmentation, and disturbance.

Predicted Climate Change Effects

Measurements from alpine SnoTel sites within the Western United States show a decline in snow water equivalent over the past several decades with expected continued declines in the near future (Fyfe et al., 2017). Soil moisture in montane systems within the Western United States is highly correlated with snowmelt timing and is expected to shift significantly in basin and range ecoregions under future climate scenarios (Harpold & Molotch, 2015). These shifts, along with changes to the snow-precipitation ratio and changes in primary climate drivers, are expected to cause complex responses from species in the alpine-tundra zone as species distributions are both climactically and abiotically filtered (Kulonen et al., 2018).

Conservation Strategy

Objective: Manage alpine and tundra habitats to not exceed 10% loss to type conversion through 2032.

- Action: Support ongoing monitoring of alpine vegetation communities to assess changes in distribution and abundance of species ranges.
- Action: Support ongoing monitoring to assess the distribution and health of lichen species.
- Action: Avoid and minimize recreational impacts on sensitive alpine communities through continued monitoring and coordination with land management agencies.

Priority Research Needs

- Continued assessment of potential climatic shifts impacting alpine-specific vegetation communities and associated wildlife species.
- Long-term monitoring to track elevational shifts of alpine and tundra habitat-related plant species.

Key SGCN Species

- Black rosy-finch (*Leucosticte atrata*)
- Gray-crowned rosy-finch (*Leucosticte tephrocotis*)
- American pika (*Ochotona princeps*)
- Montane shrew (*Sorex monticolus*)
- White Mountains skipper (*Hesperia miriamae longaevicola*)

Other Critical Habitats, Barren and Sparsely Vegetated Lands: Playas and Ephemeral Pools, Sand Dunes and Badlands, Cliffs and Canyons

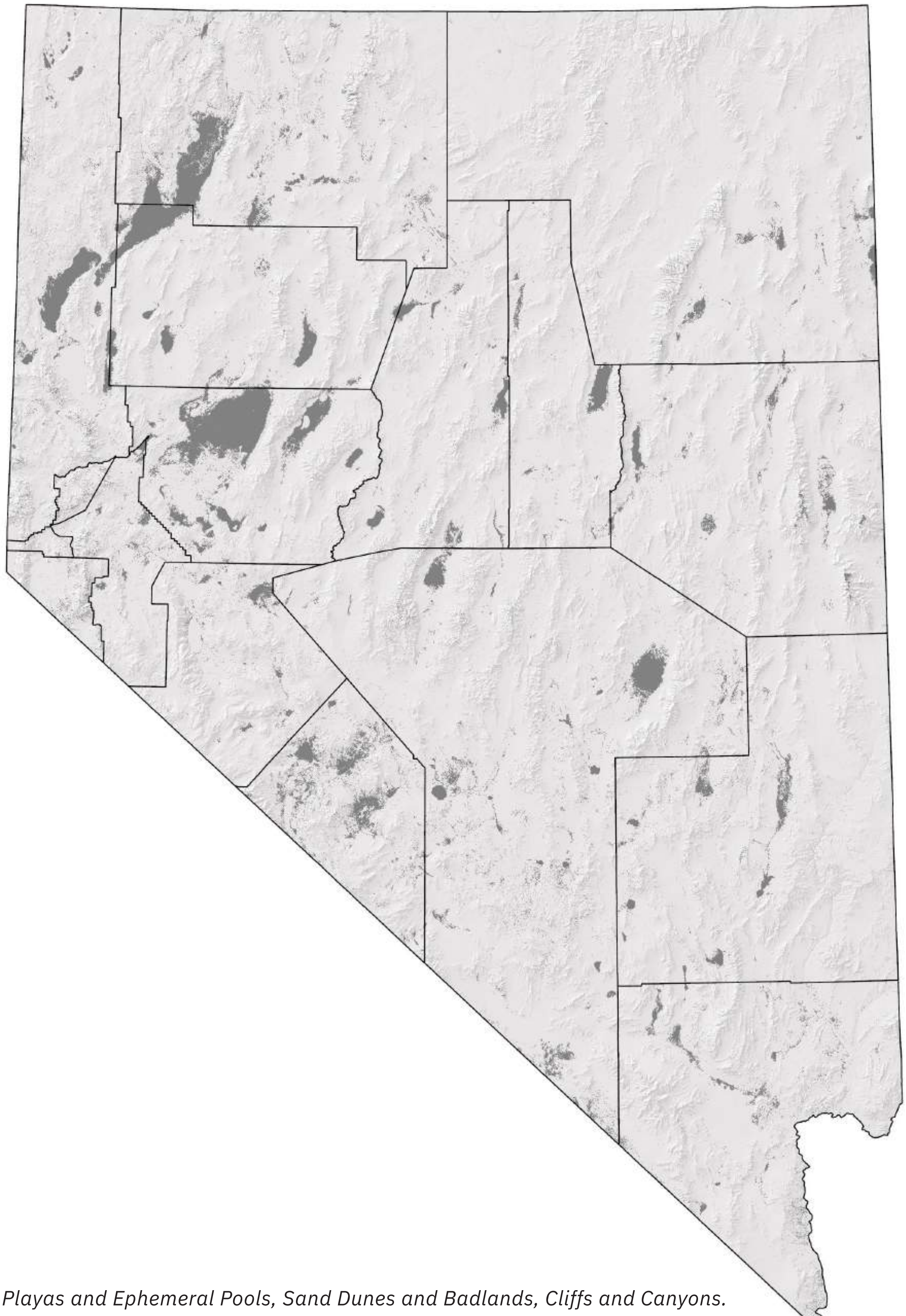


Figure 59. Playas and Ephemeral Pools, Sand Dunes and Badlands, Cliffs and Canyons.

Key Habitat Description and Elements for Other Critical Habitats, Barren and Sparsely Vegetated Lands

Vegetation and Abiotic Environment:

Cliffs and Canyons

Vertical and near-vertical cliff lands are scattered throughout Nevada and often harbor unique biodiversity (Nachlinger et al., 2001). These are barren and sparsely vegetated habitats (less than 10% plant cover) of cliff faces, narrow canyons, and smaller rock outcrops of various igneous, sedimentary, and metamorphic bedrock. Unstable scree and talus slopes typically occur below cliff faces (NatureServe, 2004). Cliffs and canyons are often associated with the uplift of normal faults. Cliffs may also occur in steep-sided, deeply eroded valleys and at the edges of eroded remnants of volcanic flows and sedimentary rock outliers at low to high elevations. In Nevada, cliffs range in elevation from the Colorado River canyons starting at approximately 500 feet above sea level to alpine habitats above 13,000 feet on Boundary Peak and Wheeler Peak in northern Nevada (Neel, 1999). Cliff, crevice, and talus habitats are extremely variable but rather simple in nature. Cliffs can be from a few feet to over 3,000 feet high. Talus slopes can be less than an acre to several thousand acres in size (Bradley et al., 2004). Due to the linear nature of cliff and canyon habitats, they comprise a relatively small fraction of Nevada's total land area. Since cliffs are at variable elevations and experience a broad range of climatic conditions, dominant plant species can be quite different among these habitats and may include various associations of conifers, shrubs, succulents, lichens, and herbaceous species (NatureServe, 2004; WAPT, 2012).

Playas and Ephemeral Pools

This key habitat is composed of mostly barren or sparsely vegetated playas typically found on the valley bottoms of terminal basin drainages in the intermountain and warm desert regions. Because of the flatness of much of the Columbia Plateau, playas can also form on the tops of its buttes and plateaus, such as can be seen on the Sheldon National Wildlife Refuge. Playas are formed by intermittent flooding and evaporation that precipitates fine soils and mineral salts onto the lowest flat depressions until an impermeable layer of sodic clay is lain down (Rosen, 1994). Playas in Nevada also often interact with groundwater (Rosen, 1994). Soil salinity varies greatly with soil moisture and, along with climatic regimes, forms gradients that greatly influence the plant species present within playas of the Great Basin and Mojave and Sonoran Deserts (NatureServe, 2018). Desert playas may be significant sources of dust with aeolian (wind-associated) dynamics of deposition and erosion on desert playas being heavily impacted by short and long-term weather and climate patterns (Hahnenberger & Nicoll, 2014).

Salinity and soil texture form sharp gradients that control perennial and ephemeral vegetation associated with playas and playa margins (Comstock & Ehleringer, 1992). Dry playas are often barren of vegetation from their center out to their outer margins, where desert saltgrass (*Distichlis spicata*), pickleweed (Allenrolfia occidentalis, Salicornia spp.), or stunted greasewood (*Sarcobatus vermiculates*) maintains a foothold on the fresher soils. Typical salt desert shrub species are often associated with playa margins where soils are not seasonally inundated. Mojave warm desert playas may be associated with winter annual vegetation in years of favorable water availability although they are typically barren of vegetation (Lichvar et al., 1998). Although rare, when soils are kept moist but short of saturation over several weeks or months, Baltic rush (*Juncus balticus*), smartweed (*Polygonum sp.*), sedges (*Carex sp.*), and spikerushes (*Eleocharis palustris*) emerge, in progressive order of wetness. With prolonged saturation more substantial emergent vegetation is established, including cattails (*Typha latifolia*), hardstem bulrushes (*Schoenoplectus acutus*), and alkali bulrushes (known locally as nutgrasses; *Bolboschoenus maritimus*). These plants range from 3-10 feet tall and can grow sufficiently thick to render a site impenetrable. Long-term inundation will facilitate the establishment of a submergent plant community, typically characterized by pondweed; in more saline conditions, widgeon grass (*Ruppia cirrhosa*); and in fresher conditions arrowhead (*Sagittaria cuneata*) (Rosen, 1994).

Sand Dunes and Badlands

Dunes and badlands are ecological systems ostensibly defined by substrate characteristics. They include aeolian (wind-carried) sand deposits, relict bedrock outcrops, weathered soil patches, and variously similar areas dominated by substrates rather than by vegetative cover. Sand dunes and badlands present unique habitats and support endemic plants and animals, as well as provide habitat for generalist species (Nachlinger et al., 2001).

Nevada's sand dunes mainly formed during the Holocene epoch and are regionally unique habitats because they are of relatively recent origin, rare, small, and spatially dynamic (Brussard et al., 1999; Lancaster & Mahan, 2012). Sand dune habitats vary in biological diversity respective to the degree of stabilization by vegetation and other underlying environmental factors made obvious by the dynamics of partially stabilized and actively moving dunes (Lancaster & Mahan, 2012; Munroe et al., 2017). As landforms, sand dunes occur between elevations of 1,050 and 6,500 feet on young alluvium-colluvium deposits or aeolian sand. They are constantly being eroded and reformed by locally prevailing winds which may result in sparse plant cover. Water is held for long periods of time just under the surface, allowing shrubs to successfully root and persist through long droughts (Nachlinger et al., 2001;). Unlike many soils in desert basins, sand dunes are well-drained and non-saline. Hence, associated vegetation differs considerably from the surrounding basin or bajada. Sand dune habitats are dynamic and reliant upon large-scale patterns and ecosystem processes that include wind and sand corridors (Barrow, 1996).

Badlands are found at all elevations, although more commonly on low to moderate elevations, on steep bedrock outcroppings, ridgetops, windswept barrens, or alluvial and colluvial deposits (Nachlinger et al., 2001). Vegetation on badlands is often dominated by unique plant assemblages or by non-vascular lichens and cryptogamic species (Boettinger et al., 2010). Altered andesite soils are a special case of hydrothermally altered badlands in the western Great Basin where vegetation is dominated by relict conifer species. Here, conifers have a competitive advantage in the nutrient-poor and acidic soils over typical Great Basin shrublands and woodlands (Billings, 1990). Ecological services provided by badland systems may include serving as natural barriers to weed invasion and fire since they have little vegetation to burn.

General Wildlife Values

Cliffs and Canyons

Cliff and canyon habitats are important to wildlife because they provide structure for nesting, roosting, or denning; protection from predators; and areas for foraging. Most cliffs, crevices, and talus slopes provide suitable maternity and night roosting habitats for bats and nesting habitats for birds in the summer. These sights are generally too exposed to provide significant hibernation roost sites in northern Nevada, but there is strong evidence that rock crevices provide wintering habitat in the Mojave Desert ecoregion in southern Nevada (Bradley et al., 2004). Reptiles use rocks and crevices in cliff and canyon habitats for burrowing, overwintering, and protective cover. South and west facing slopes are important areas for reptile brumation, while north and east facing slopes are important for aestivation. Rocks and crevices provide extremely important microhabitats that enable reptiles to thermoregulate, create suitable nests, and escape predators. These habitats also provide foraging habitats for other species including big game (WAPT, 2012).

Playas and Ephemeral Pools

Most playas in Nevada do not have permanent sources of water; therefore, the value of playas to wildlife is largely ephemera. When playas are watered for the proper period, they can produce not only lush growth of emergent and submergent vegetation, but also prodigious volumes of aquatic invertebrates attracting a myriad of waterfowl, shorebirds, and small water birds. Submergent plants in these systems can build such thick mats that they finally break the water's surface and present a structure sufficient to support the nests of black terns (*Chlidonias niger*) and American avocets (*Recurvirostra americana*). When inundated and loaded with invertebrates during spring or late summer, Nevada's ephemeral playas may contribute significantly as stopovers during waterfowl and shorebird migrations.

Sand Dunes and Badlands

Sand dunes and badlands often define unique habitats and support endemic plants and animals, as well as provide habitat for generalist species. The sparsely vegetated to bare nature of these habitats may provide alternative ecological services including natural barriers to invasive species and fire. Numerous species associated with sand dunes and badlands are endemic to locales with unusual biological and physical conditions. Many sand dune systems in Nevada have a high diversity of dune invertebrates including beetles, solitary bees, crickets, and ants, some of which are sand dune obligates (Nachlinger et al., 2001). Terrestrial invertebrates, specifically beetles and solitary bees, are the best-studied dune-associated animals and many depend on dune vegetation for adult or larval forage, mating sites, and protective cover (Brussard et al., 1999).

Existing Environment

These three habitat types are a small portion of the overall habitats found across Nevada and combined makeup approximately 3,321,441 acres, or roughly 4.7% of Nevada's habitat.

Habitat Conditions

Cliffs and Canyons

The inaccessibility of cliffs and instability and ruggedness of talus slopes affords some protection to this key habitat and its associated wildlife species, but there are some human influences on cliff and canyon habitats in Nevada. Mineral extraction, recreational rock climbing, and spring development may have localized effects on cliff and canyon habitat (e.g., damage or removal of the substrate) or wildlife species (e.g., disturbance during nesting or roosting), but the degree of these effects is unknown. Localized impacts have occurred; however, terrain ruggedness generally limits disturbance impacts on cliffs and talus slopes (WAPT, 2012).

Playas and Ephemeral Pools

These systems are generally stable but can be influenced by the diversion of water, and anthropogenic development. Anthropogenic disturbance from recreation, water diversion, and other sources is associated with increased wind erosion of playa soils (Gill, 1996).

Sand Dunes and Badlands

Conditions of sand dune and badland habitats in Nevada are influenced mostly by off-highway vehicle use, which contributes to the loss of vegetation (i.e., wildlife habitat), soil disturbance, and potential transport of noxious weeds in heavy use areas. In 2000, off-highway vehicles represented 10% (408,703 visitor days) of the total visitor days for all recreation activities on BLM lands in Nevada (Newmark et al., 2002), and much of this use was likely concentrated in sand dune and badland habitats. Wildlife habitat conditions in many of Nevada's dune systems have been degraded by repeated vehicle incursions, although most dunes continue to retain connectivity to their sand sources (personal communication, J. Nachlinger, Director of Conservation Planning, The Nature Conservancy of Nevada, June 2005).

Habitat Threats

Cliffs and Canyons

Recreational rock climbing has increased dramatically over the past 30 years, with southern Nevada receiving the highest recreational climbing levels in the state. Climbers occasionally abandon climbing equipment and may briefly disturb cliff denizens, but their activities normally do not significantly alter the habitat. Increased human disturbance is expected to have altered some cliff and crevice habitats, though limited research is available to determine the degree to which climbing activities have affected cliffs and their associated species (Bradley et al., 2004). Gold mining activities can also result in the removal of some cliffs with high microscopic ore content. Renewable energy development (e.g., wind, solar, geothermal, hydro) has the potential to affect wildlife and habitat in proximity to cliffs, canyons, and talus slopes. (WAPT, 2012)

Playas and Ephemeral Pools

Playas are generally immune to the typical threats seen across Nevada, except for land uses that potentially alter normal hydrologic function. Ephemeral pools have a higher potential for alteration because of their limited size and a poor understanding of their importance to the maintenance of arid land ecosystem function (WAPT, 2012). Ephemeral pools can be impacted by surface and groundwater disturbance from anthropogenic activities such as agriculture or mining development.

Sand Dunes and Badlands

Off-highway vehicles present a significant risk to these communities. Studies in other states have documented the loss of vertebrate and invertebrate species richness, a reduction in vertebrate and invertebrate populations, and a disruption of mating behaviors in insects that depend on dune-margin vegetation (Hardy & Andrews, 1979; Luckenbach & Bury, 1983). Additionally, heavy use or misuse of off-highway vehicles on sand dune and badland habitats reduces vegetative cover and sets the stage for invasive plant species invasions.

Predicted Climate Change Effects

Cliffs and Canyons

Structural aspects of cliffs and canyons are not expected to be impacted directly by climate change; therefore, the species that are specifically attracted to vertical rock walls or other qualities of rocky substrates are not likely to be impacted by changes to those substrates in and of themselves. As annual water yield and flow are impacted (particularly in non-carbonate geology), the quality of the canyon bottom ecotone with the riparian zone may be impacted by alterations in high flow regimes, the duration of mesic microhabitats, sumps, seeps, and possibly even vegetation changes (WAPT, 2012).

Playas and Ephemeral Pools

Playas and ephemeral pools provide critical wildlife habitats but may be impacted by intensifying droughts and previous hydrologic modifications. Recent studies on playas in the Great Basin using 30 years of remotely sensed surface water data have projected inundation probabilities decreasing from 22% under average conditions to 11% under extreme drought conditions (Russell et al., 2020). Climate-change impacts on biodiversity may be driven by changes in wetland hydroperiods (Russell et al., 2020). In some cases, climate-change effects on wetland inundation may interact with legacy effects from past land-management practices, including unintentional effects such as compaction to intentional manipulation of hydrology or geomorphology from diverting water or creating ditches. As climate conditions change, some localized areas may change more gradually and thus serve as climatic refugia (Morelli et al., 2016), though areas providing refugia have generally been larger and have been modified (Russell et al., 2020).

Sand Dunes and Badlands

Sand dunes and badlands have not been specifically targeted for habitat climate change analysis, which is often focused solely on vegetative communities, but some previous analysis has indicated that bare ground would increase as certain vegetation systems were increasingly subjected to annual grass invasion and changes in fire regime (WAPT, 2012). Some research is ongoing relative to how climate change may influence sand dunes and badlands in Nevada; however, more studies are needed to better understand how climate change will affect these habitats. Most research has occurred in larger systems such as in the Kalahari Desert or deserts of Australia.

Conservation Strategy

Objective: Manage cliffs and canyons, sand dunes and badlands, playas, and proximal habitats to maintain wildlife habitat values and ecosystem functions when and where possible. Identify areas of proximal habitat degradation and change that may result in changed or decreased overall value.

- Action: Assess cliffs and canyons and proximal habitat to better understand anthropogenic development exposure.
- Action: Work with land management agencies to manage anthropogenic developments to avoid, minimize, and mitigate impacts.
- Action: Identify/establish designated-use zones for off-highway vehicles in non-sensitive areas in collaboration with federal land management agencies.
- Action: Increase public outreach and develop and implement guidelines for user capacity at popular recreation sites.
- Action: Avoid or minimize disturbance to wildlife and habitat in sensitive areas.

Priority Research Needs

Cliffs and Canyons

- A statewide health assessment of cliffs and canyons and exposure to anthropogenic activities.
- Analysis of anticipated shifts in proximal habitat distribution in relation to cliffs and canyons with differing climate regimes.

Playas and Ephemeral Pools

- A statewide inventory and condition assessment of playas and ephemeral pools and exposure to anthropogenic activities.

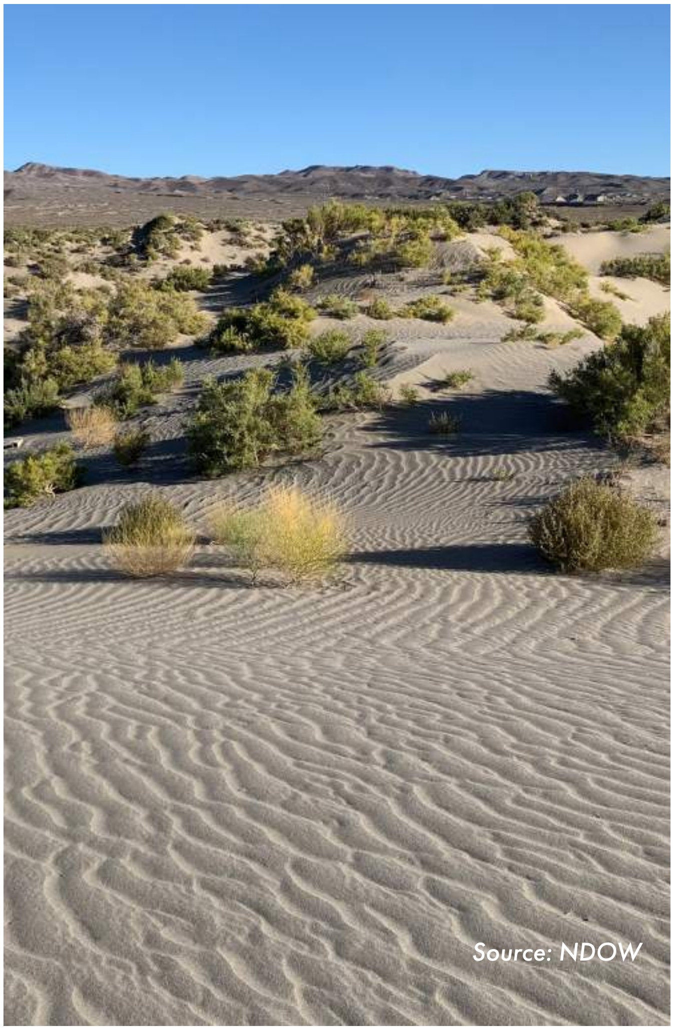
Sand Dunes and Badlands

- The effects of sand dune spatial dynamics on sand dune biological communities.
- Ecological effects of OHV use on sand dunes and badlands.
- The effects of climate change on sand dune ecology.

Key SGCN Species

- Amargosa toad (*Anaxyrus nelsoni*)
- Railroad Valley toad (*Anaxyrus nevadensis*)
- American avocet (*Recurvirostra americana*)
- Bald eagle (*Haliaeetus leucocephalus*)
- Black-necked stilt (*Himantopus mexicanus*)
- Golden eagle (*Aquila chrysaetos*)
- Long-billed curlew (*Numenius americanus*)
- Long-billed dowitcher (*Limnodromus scolopaceus*)
- Peregrine falcon (*Falco peregrinus*)
- Prairie falcon (*Falco mexicanus*)
- Western snowy plover (*Charadrius nivosus*)
- White-throated swift (*Aeronautes saxatilis*)
- Wilson’s phalarope (*Phalaropus tricolor*)
- Allen’s big-eared bat (*Idionycteris phyllotis*)
- Bighorn sheep (*Ovis canadensis*)
- Canyon bat (*Parastrellus hesperus*)
- Dark kangaroo mouse (*Microdipodops megacephalus*)

- Desert kangaroo rat (*Dipodomys deserti*)
- Fringed myotis (*Myotis thysanodes*)
- Greater bonneted bat (*Eumops perotis*)
- Little brown myotis (*Myotis lucifugus*)
- Pale kangaroo mouse (*Microdipodops pallidus*)
- Spotted bat (*Euderma maculatum*)
- Yuma myotis (*Myotis yumanensis*)
- Common chuckwalla (*Sauromalus ater*)
- Desert horned lizard (*Phrynosoma platyrhinos*)
- Desert iguana (*Dipsosaurus dorsalis*)
- Mojave fringe-toed lizard (*Uma scoparia*)
- Mojave shovel-nosed snake (*Chionactis occipitalis*)
- Sidewinder (*Crotalus cerastes*)
- Sonoran Mountain kingsnake (*Lampropeltis pyromelana*)
- a digger bee (*Anthophora forbesi*)
- a wool-carder bee (*Anthidium rodecki*)
- Arizona powdered-skipper (*Systasea zampa*)
- Baking Powder Flat blue (*Euphilotes bernardino minuta*)
- Bleached sandhill skipper (*Polites sabuleti sinemaculata*)
- Carson wandering skipper (*Pseudocopaeodes eunus obscurus*)
- Checkered white (*Pontia protodice*)
- Eunus skipper (*Pseudocopaeodes eunus alinea*)
- Eunus skipper (*Pseudocopaeodes eunus flavus*)
- Mojave blue (*Euphilotes mojave virginensis*)
- Mojave gypsum bee (*Andrena balsamorhizae*)
- Monarch (*Danaus plexippus plexippus*)
- Northern crescent (*Phyciodes cocyta arenacolor*)
- Railroad Valley skipper (*Hesperia uncas fulvapalla*)
- Rice's blue (*Euphilotes pallescens ricei*)
- Sand Mountain blue (*Euphilotes pallescens arenamontana*)
- Sandhill skipper (*Polites sabuleti*)
- Small wood-nymph (*Cercyonis oetus alkalorum*)
- Small wood-nymph (*Cercyonis oetus pallescens*)
- Uncas skipper (*Hesperia uncas grandiosa*)
- West Coast lady (*Vanessa annabella*)


Source: NDOW

Caves and Mines

Vegetation and Abiotic Environment

Natural caves are found throughout Nevada. The highest concentration of caves is in sedimentary deposits, particularly those where limestone solution processes have carved caverns in the parent rock. Igneous deposits, primarily volcanic deposits, also contain a substantial number of natural caves or hollow tubes formed by flowing lava and natural fracturing. Terrestrial and aquatic habitats are present in caves. Terrestrial habitats are typically composed of flood debris (e.g., logs, leaves, and other organic surface matter) found along the cave floors, walls, and ceilings. Aquatic habitats may be comprised of streams, springs, or drip pools and seeps.

Historic and active mines are also found throughout the state wherever hard rock mining districts occur. Historical mine distribution does not mirror natural cave distribution and occurs in almost all rock types. As compared to the surrounding landscape, caves, shafts, and adits (horizontal mine workings) are the rarest of all wildlife habitat types in the Intermountain West and likely comprise less than 1% of the total habitat available. Cave, shaft, and adit habitats range in elevation from 150 meters along the Colorado River in southern Nevada to nearly 4,000 meters on Boundary and Wheeler peaks in central Nevada. In complex systems, warm air traps can vary from 20-30°F below outside ambient temperature in the summer or above outside ambient temperature in the winter. Multiple entrances can result in greater airflow into and through the structure, affecting the internal microclimate. Geothermal heating can also affect internal microclimate. With the exception of algae growth in some artificially lighted caves, plants do not occur in cave or mine habitat types. Both caves and mines can be important habitat features to several bat species and various birds throughout the year, and many other species of wildlife take advantage of cave and mine openings for shelter.

General Wildlife Values

The relatively protected nature of most caves and mines with generally low disturbance risk and stable microclimates can provide valuable roosting opportunities for many of Nevada's species of bats and some birds. Tunnel mines that were excavated since the mid-1800s provide potential roosting sites for at least 19 of Nevada's bat species, although relatively few support significant colonies (Brussard et al. 1999). Because they are only patchily available across the landscape, suitable subterranean habitats for roosting bats are particularly valuable. The longer adits and mine systems with multiple horizontal connections to the surface seem to be preferred by bats, especially for hibernating and maternity sites. While caves and mines are extremely valuable and a limiting resource to many of our bat species, they also are important for several bird species (e.g., black and gray-crowned rosy-finches, barn owls, and Say's phoebe) and several larger vertebrates seek shelter closer to surface openings (e.g., Mojave desert tortoise and bighorn sheep).

Habitat Conditions

The relative inaccessibility of many of our caves and mines affords some protection to this important habitat and its associated wildlife species, but there are some human influences to these habitats in Nevada. Renewed mineral extraction at historical mine systems, recreational spelunking and exploration of mines, and vandalism all may have localized effects on cave and mine habitat (e.g., damage or destroy openings and internal tunnels) or wildlife species (e.g., disturbance during hibernation or roosting). However, the degree of these effects is often unknown. Many localized disturbances can be temporary, but the repeated disturbance of sensitive species during a critical life stage can be highly detrimental. More permanent impacts stem from renewed mining at historical features, with modern techniques often completely subsuming shafts and adits or backfilling other sites.

Habitat Threats

Structurally, artificially created mine features are less stable on the landscape than naturally created caves, with surface erosion and internal settling altering or destroying mine openings in relatively short timeframes. Modern mineral and hard rock mining practices can heavily alter or destroy caves and mines with serious impacts on wildlife species that rely on them. While not a threat to the habitats themselves, white-nose syndrome (WNS) is a disease that primarily impacts hibernating bats in caves and mines and is caused by the fungus Pseudogymnoascus destructans. WNS has not yet been detected in Nevada but has been spreading across North America since its discovery in New York in 2006. Susceptible bat species, particularly those from the genus Myotis, are especially vulnerable in locations where they hibernate in large numbers and in close proximity to one another.

Predicted Climate Change Effects

Structural aspects of caves and mines are not expected to be impacted directly by climate change, although water levels and relative humidity in caves may be impacted depending on changes in precipitation timing and form.

Source: NDOW

The various bat and bird species that utilize these features are more likely to be impacted by other changes such as threats to insect and other terrestrial invertebrate populations based on reduced surface water, diminishing snowbanks, and degraded vegetation. The species that are specifically attracted to these isolated and protected substrates are not likely to be impacted by climate-induced changes to those substrates themselves.

Key SGCN Species

- Black rosy-finch (*Leucosticte atrata*)
- Gray-crowned rosy-Finch (*Leucosticte tephrocotis*)
- California leaf-nosed bat (*Macrotus californicus*)
- Canyon bat (*Parastrellus hesperus*)
- Cave myotis (*Myotis velifer*)
- Fringed myotis (*Myotis thysanodes*)
- Little brown myotis (*Myotis lucifugus*)
- Long-eared myotis (*Myotis volans*)
- Mexican free-tailed bat (*Tadarida brasiliensis*)
- Pallid bat (*Antrozous pallidus*)
- Townsend's big-eared bat (*Corynorhinus townsendii*)
- Western small-footed myotis (*Myotis ciliolabrum*)

Chapter 5

Implementation and Monitoring

Source: NDOW

Developing and Deploying Effective Conservation Actions through Research and Monitoring

The Nevada Department of Wildlife (NDOW) engages in multiple monitoring efforts across a wide variety of taxa to track the status and trend of wildlife populations and the habitats they rely on. Monitoring efforts as undertaken by NDOW are built upon best practices as informed by species/taxa-specific literature and commonly accepted monitoring efforts. When possible, monitoring efforts are tied to those of other resource agencies so that data and reporting metrics are comparable and sharable for use in a variety of workflows including planning, forecasting, technical review, and assessments. NDOW also engages in collaborative research efforts with university, NGO, and agency partners to develop an increased understanding of the ecological underpinnings of species and habitat trends, the threats they face, and conservation actions intended to address those threats and bolster populations.

Ultimately, research and monitoring efforts that NDOW carries out attempt to address where species and their habitat occur, the status or trend of species and their habitats, and the effectiveness of current and past conservation actions. These efforts are focused on informing and implementing effective conservation actions now and into the future and developing a better understanding of species distribution and various populations across the state. Population and habitat monitoring not only answer questions about how wildlife species are faring within the state but also assist with informing the management of wide-ranging and migratory species throughout the West in cooperation with other state and federal agencies (Stein et al., 2018).

Monitoring the Effectiveness of Conservation Actions

Wildlife Monitoring

Ongoing and recent wildlife monitoring efforts (listed in Table 42) are important for monitoring the effectiveness of wildlife and habitat-based conservation actions. Through these activities, NDOW collects data and information that is used to evaluate population numbers, community assemblages, and the distribution of species. Tracking wildlife presence, population trends, and distribution is crucial for understanding the impact and success of habitat management actions. Pairing wildlife assessments (pre- and post-restoration) with habitat assessments during habitat restoration projects is a critical component of many conservation actions that is essential for monitoring project effectiveness.

Nevada's wildlife monitoring employs existing surveys and inventories, including monitoring conducted by NDOW and conservation partners (Table 44). For many of our highest priority SGCN, long-term monitoring efforts are ongoing. For some SGCN, additional monitoring and research needs have been identified as conservation actions to gain a better understanding of those species' existing status and threats. Necessary first steps for species with very limited current knowledge in Nevada can include taxonomic species/subspecies clarification and basic inventory efforts to delineate distribution before considering population status assessment and trend monitoring. Inventory and monitoring efforts undertaken by NDOW will rely on established methods when those approaches are deemed appropriate to answer specific demographic questions addressing recognized threats to species or species groups. However, we expect to develop and adopt new approaches to remain current with technological advances and to address our unique challenges most effectively.

Based in part on funding and staffing limitations, monitoring schemes may often be episodic, periodic, or location-specific, as opposed to long-term monitoring sufficient to track population health for all SGCN over time. Wildlife-specific survey and monitoring approaches will be implemented with the primary goal of understanding and tracking species' population status to support the objectives of conserving Nevada's wildlife, maintaining healthy populations, and tracking population change over time. An additional goal will be to integrate wildlife surveys with habitat monitoring approaches to help track habitat conditions and trends and the effectiveness of conservation actions and habitat treatment projects. Metrics used to evaluate monitoring approaches and the effectiveness of conservation actions will include how prioritized actions address the calculated threats to species' population health and habitat condition.

Table 42: A representation of NDOW's existing and recent monitoring efforts by species group. Methods may change over time, and adaptive management approaches to species conservation dictate that strategies remain flexible relative to population status and trend, goals and objectives associated with habitat monitoring and restoration programs, water management needs, and other considerations. As such, this is not a comprehensive nor restrictive list of approaches to wildlife monitoring, but rather a sample of tools that NDOW and partners have used or are currently using.

MAJOR SPECIES GROUP	MINOR SPECIES GROUP	FOCUS	TOOLS AND METHODOLOGIES
Amphibian	Frogs and Toads	Multi-species	• Visual and auditory encounter surveys • Mark-recapture surveys • PIT tag arrays and transect surveys • Detect/non-detect environmental DNA (eDNA) surveys • Egg mass surveys
Bird	Migratory Waterfowl	Multi-species	• Helicopter/aerial surveys • Banding and tracking via transmitter
Bird	Owl	Single-species	• Call-broadcast surveys (California spotted owl) • Point count surveys (short-eared owl) • Auditory and acoustic recording surveys (burrowing owl) • Banding and tracking via transmitter (burrowing owl)
Bird	Passerine	Single-species	• Area search surveys (pinyon jay) • Standardized site monitoring, banding as possible (southwestern willow flycatcher) • Call-broadcast surveys (southwestern willow flycatcher, yellow-billed cuckoo)
Bird	Passerine	Multi-species	• Breeding Bird Surveys (BBS) • Road route surveys (Breeding Bird Surveys, nightjars)
Bird	Raptor	Single-species	• Territory breeding surveys (golden eagle, ferruginous hawk, northern goshawk) • Territory/site occupancy assessment (peregrine falcon) • Call-broadcast surveys (northern goshawk, peregrine falcon) • Shoreline surveys (bald eagle, osprey) • Banding and tracking via transmitter
Bird	Raptor	Multi-species	• Road and shoreline linear surveys (winter raptor species) • Helicopter/aerial surveys tailored to habitat type or land feature (e.g., cliffs, isolated riparian systems, sagebrush/pinyon-juniper woodland ecotone)
Bird	Shorebird and Marsh Bird	Multi-species	• Linear or point visual surveys (shorebirds, colonial nesting waterbirds) • Call playback point counts (marsh bird species)

MAJOR SPECIES GROUP	MINOR SPECIES GROUP	FOCUS	TOOLS AND METHODOLOGIES
Bird	Upland Game Bird	Single-species	• Lek surveys (greater sage-grouse, Columbian sharp-tailed grouse) • Banding and tracking via transmitter (greater sage-grouse) • Wing collection during hunting season (greater sage-grouse) • Call boxes & video cameras (mountain quail) • Habitat-based call-broadcast surveys (dusky grouse)
Fish	Fish	Multi-species	• Catch per unit effort including snorkel, trapping, and netting • Mark-recapture surveys • Electrofishing surveys • PIT tag array utilization for distribution, population estimates, and detection surveys • Direct counting census • eDNA sampling
Mollusk	Gastropod and Bivalve	Multi-species	• Presence/absence (springsnails) • Quadrant/transect counts
Mammal	Bat	Multi-species	• Stationary or mobile acoustic monitoring • Cave and mine exit counts • Visual surveys of abandoned mine lands • Mist netting over water sources • Disease surveillance (white-nose syndrome)
Mammal	Bat	Single-species	• Banding and tracking via transmitter • Mist netting over water sources • Beam-break system at roost sites
Mammal	Big Game	Single-species	• Helicopter/aerial surveys (bighorn sheep, mule deer) • Tracking via transmitter • Ground counts at water sources (bighorn sheep) • Harvest metrics (mule deer) • Trail camera monitoring (mule deer)
Mammal	Small Mammal	Single-species	• Talus patch visual and auditory surveys (American pika) • Burrow and transit system visual and camera trap surveys (Sierra Nevada mountain beaver) • Small mammal trapping grids (pale and dark kangaroo mouse, shrews) • Rabbit crepuscular road routes (jackrabbits and cottontail rabbits)

Mammal	Upland Game	Single-species	• Burrow monitoring (pygmy rabbit) • Tracking via transmitter (pygmy rabbit)
Mammal	Mammal, other	Single-species	• Camera trapping (Pacific marten, Sierra Nevada snowshoe hare, Humboldt flying squirrel)
Reptile	Reptile	Single-species	• Tracking via telemetry (Mojave desert tortoise, Gila monster, western pond turtle) • Sand dune surveys (Mojave fringe-toed lizard); • Camera trapping (Gila monster) • eDNA sampling (western pond turtle)
Reptile	Reptile	Multi-species	• Road-cruising surveys (nocturnal reptiles) • Local bio-blitzes

Habitat Monitoring

Pre- and Post-Project Monitoring and Habitat Trend and Condition Monitoring

To monitor the major habitat types identified in Chapter 4, NDOW monitors habitat condition and trend, treatment effectiveness, and land health. NDOW's habitat monitoring efforts track biotic and abiotic factors at multiple temporal and spatial scales to understand both habitat condition and trend and the effectiveness of conservation actions. These efforts also assist with understanding the extent and influence of human disturbance on the landscape that ultimately impacts wildlife habitat.

NDOW utilizes a variety of methodologies to accomplish these goals, including remote sensing, qualitative and PhotoPoint data, point monitoring using a robust sample design, land health assessments, and threats-based mapping and analysis. Through these monitoring strategies, NDOW collects data that allow the Department to track habitat condition and trend through time as well as the affects of project implementation.

Broad- (remote sensing, tracking treatment metrics), mid- (drone,etc.), and fine- (intensive point-based) scale efforts are utilized to accomplish the goals of the program. Habitat monitoring carried out by NDOW is congruous with the five guiding principles developed by the Assessment, Inventory, and Monitoring Program (AIM) program since its inception in 2011. Monitoring should rely on 1) standardized field methods and indicators, 2) modern data management and stewardship, 3) appropriate sample designs, 4) integration with remote sensing, and 5) structured implementation (Kachergis et al., 2022). NDOW's Land Health Assessment (LHA) program specifically utilizes approaches developed by the Jornada Experimental Range at New Mexico State University, the BLM's AIM staff and National Operations Center, and many partners involved with developing consistent methodologies and informatics approaches. The LHA program was conceptualized and standardized in 2011 and is an important piece of building long-term datasets on Nevada's vegetation, soils, and ecological indicators (Turner et al., 2011).

Broad-Scale Monitoring, Analysis, and Reporting

The increasing availability of remote sensing imagery, products, and computing resources over the past several decades has allowed agencies to track landscape health metrics at scales useful for state-wide and cross-jurisdictional planning purposes. Data layers derived from the classification of remote imagery are routinely utilized to identify vegetation functional groups (e.g., invasive annual species) and other metrics (e.g., burn severity) to inform on-the-ground actions such as post-wildfire treatments. NDOW also utilizes threats-based mapping (e.g., following the SageCon methods) for key habitats, temporal analysis of products from Landfire and other efforts, and modeling to understand and track issues such as urbanization, non-native plant species invasions, and landscape connectivity for siting and prioritizing restoration and rehabilitation efforts.

NDOW has also instituted a project planning and monitoring database, the Habitat Conservation Framework Project Portal, for tracking and reporting on NDOW and partner efforts. The Portal is spatially explicit and tracks important metrics, such as acres treated and treatment method(s), year-over-year to inform landscape conditions and efforts through time.

Mid-Scale Monitoring, Analysis, and Reporting

Mid-scale efforts, in terms of spatial extent and/or time investment, are meant to be finer-grained and more detailed than broad-scale approaches but less costly and intensive than fine-scale efforts. Examples of mid-scale monitoring include drone monitoring of riparian habitats, greenline width, and semi-quantitative and qualitative monitoring of spring and upland habitats to inform general condition and/or treatment effectiveness. These methodologies capture finer detail than can be currently obtained through remote sensing and are generally meant to address condition and trend and/or conservation action effectiveness over tens to thousands of acres.

Fine-Scale Monitoring, Analysis, and Reporting

Fine-scale point-based efforts are coordinated through NDOW's Land Health Assessment program (formerly known as the Nevada Partners for Conservation and Development). Metrics captured through the LHA program are tied to national core indicators that other resource management agencies such as BLM, USFS, and NRCS rely upon (Herrick et al., 2017). By utilizing the framework and reporting metrics that agency partners rely upon, NDOW can provide seamless data on vegetation for important habitat treatments when partnering and planning with these agencies. LHA data are consistent with BLM Emergency Stabilization and Rehabilitation (ESR), BLM Assessment, Inventory and Monitoring (AIM), USFS Burned Area Emergency Stabilization, and NRCS Natural Resource Inventory data among others. Data at this level, which is collected based on robust, statistically and ecologicall rigorous sample designs, also allow NDOW and partners to track changes in species distributions and land cover over time and to attribute these changes to various factors impacting the landscape.

Each scale of monitoring described above may be utilized to feed into and inform one another. For example, point-based monitoring data may be aggregated or stratified at the ecoregional level as appropriate or may be analyzed at the level of a single treatment boundary. The concept of scale can be applied to both questions at hand and monitoring techniques utilized to answer those questions.

Project Monitoring and Reporting

The Department has also implemented a spatially explicit projects database to plan and track project implementation metrics through time.

The database is currently available at hcf.ndow.org; full implementation (expected 2023) of the database will allow the department to capture and track tabular and spatial data in a centralized location for easy reporting and data-sharing with partner agencies. This hub will also serve as a planning portal to ensure projects are properly cited and planned with external agency and other partners and will assist with archiving information for future use.

Opportunities and Actions for Species and Habitat Monitoring

As part of the SWAP revision, NDOW completed an internal assessment of monitoring efforts across the Department to identify gaps and develop a plan for addressing those gaps. The team identified increased coordination across divisions as a key area for strengthening the overall efficiency and effectiveness of the Department's species and habitat monitoring. As part of our ongoing adaptive management strategy, NDOW will continue to review and assess our monitoring strategies in accordance with changing conditions and scientific and technological developments. The specific monitoring needs and actions to address them are listed below:

Table 43: Monitoring needs and actions

MONITORING NEEDS	MONITORING ACTIONS
1. Better ability to crosswalk wildlife and habitat data to inform management	• Identify species with habitat associations that need monitoring and consider species that don't benefit from single species management as key targets to consider. • Proactively partner with habitat efforts to collect corresponding habitat data when NDOW staff are conducting wildlife surveys.
2. Reference sites that have intact or higher quality habitat and wildlife species richness or diversity	• Identify sites that are relatively intact that would benefit from restoration and protection. • Identify sites that are not intact but are in a state where they could be improved through management actions; site evaluation could be strengthened with quantifiable wildlife data.
3. Better bridge between terrestrial and aquatic efforts	• Leverage tools, remote sensing, and partners to more frequently assess wet areas and capture these assessments in a consistent framework. • Target project design toward data collection with consideration of sensitive aquatic species (e.g., fish or aquatic invertebrates), stream course/shoreline habitat characteristics, and associated terrestrial species (e.g., riparian birds, American water shrew, amphibians, etc.).
4. Centralized storage and tracking of NDOW data, forms, and monitoring efforts	• Develop data management protocol for consistent reporting and for storing data and information, across divisions and for all taxa.

Implementing Actions

NDOW is fully committed to collaborating with its many partners to apply and implement the conservation actions in the 2022 SWAP. Although NDOW is the lead agency for the Nevada Wildlife Action Plan, the SWAP is not a single-agency strategy. Ultimately, success in preserving and managing Nevada's fish, wildlife, and habitats depends on many organizations working together across borders and jurisdictions.

Partnering Opportunities and Leveraging Existing Management Plans

Coordination with external partners is important to minimize redundancy, strengthen partnerships, develop improved monitoring approaches, and help fill existing monitoring gaps. NDOW will continue to build upon existing relationships with partner agencies and organizations, which can provide the needed capacity to implement the monitoring and data collection strategies identified. For example, in 2021, NDOW signed a cooperative agreement with the University of Nevada, Reno (UNR), U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service (USFWS), and the Wildlife Management Institute (WMI) to establish a new Cooperative Fish and Wildlife Research Unit at UNR. This will enhance NDOW's capacity to investigate needed wildlife information and research and help develop defensible projects and tools to increase monitoring efforts of key species and habitats.

The following key types of partners and opportunities for coordination and collaboration on future monitoring efforts were identified:

Table 44: Monitoring key partners and opportunities for coordination

KEY PARTNERS	OPPORTUNITIES FOR COORDINATION
FEDERAL AGENCIES	
• Bureau of Land Management • Forest Service • Fish and Wildlife Service • National Park Service • Geological Survey • Natural Resources Conservation Service • Bureau of Reclamation • Department of Defense (Nellis Air Force Base) • Department of Defense (Fallon Naval Air Station) • Department of Defense (Hawthorne Army Munitions Depot)	• Link NDOW's efforts to other agencies' land use and water management plans • Consider wildlife in NEPA and other permitting processes for land development • Leverage research and monitoring capabilities to develop survey, mitigation, restoration, and threats analysis approaches among others • Leverage various tools available to select agencies to improve conservation outcomes (e.g., candidate conservation agreements with assurances)
STATE AGENCIES	
• Nevada Department of Wildlife • Nevada Department of Agriculture • Nevada Sagebrush Ecosystem Program • Nevada Conservation Districts Program • Nevada Division of Forestry	• Monitor public perspectives on conservation • Partner and support other state agencies' efforts, such as the Nevada Division of Natural Heritage's development of a new community science program targeting rare plants and terrestrial invertebrates

KEY PARTNERS	OPPORTUNITIES FOR COORDINATION
• Nevada Division of Natural Heritage • Nevada Division of State Parks • Nevada Division of Minerals	• Partner with agencies (e.g., Nevada State Parks) to promote wildlife conservation and citizens' connections to nature
NATIVE AMERICAN TRIBES	
• Confederated Tribes of the Goshute Reservation (Nevada and Utah) • Duckwater Shoshone Tribe of the Duckwater Reservation • Ely Shoshone Tribe of Nevada • Fort McDermitt Paiute and Shoshone Tribes of the Fort McDermitt Indian Reservation (Nevada and Oregon) • Fort Mojave Indian Tribe (Arizona, California, and Nevada) • Las Vegas Tribe of Paiute Indians of the Las Vegas Indian Colony • Lovelock Paiute Tribe of the Lovelock Indian Colony • Moapa Band of Paiute Indians of the Moapa River Indian Reservation • Paiute-Shoshone Tribe of the Fallon Reservation and Colony • Pyramid Lake Paiute Tribe of the Pyramid Lake Reservation • Reno-Sparks Indian Colony • Shoshone-Paiute Tribes of the Duck Valley Reservation • Summit Lake Paiute Tribe of Nevada • Te-Moak Tribe of Western Shoshone Indians of Nevada (Four constituent bands: Battle Mountain Band; Elko Band; South Fork Band; Wells Band) • Walker River Paiute Tribe of the Walker River Reservation • Washoe Tribe (Nevada and California) (Carson Colony, Dresslerville Colony, Woodfords Community, Stewart Community, and Washoe Ranches) • Winnemucca Indian Colony of Nevada • Yerington Paiute Tribe of the Yerington Colony & Campbell Ranch • Yomba Shoshone Tribe of the Yomba Reservation	• Coordinate and consult with tribes to include traditional ecological knowledge (TEK) in monitoring plans • Engage in broader collaboration with tribes for wildlife and habitat monitoring programs on tribal lands

KEY PARTNERS	OPPORTUNITIES FOR COORDINATION
CITIZEN SCIENCE/PUBLIC ENGAGEMENT	
• Many private individuals, corporations, and non-governmental organizations	• Develop new programs such as “Adopt a Spring Source” for monitoring conditions • Develop targeted Bio-blitzes in priority areas • Various species-specific investigations • Develop community-driven urban nest box programs (e.g., American kestrel, cavity-nesting owls) • Engage partners in building new programming and nature tourism opportunities such as the Nevada Discovery Trail
CONSERVATION ORGANIZATIONS, ACADEMIC/RESEARCH INSTITUTIONS, AND OTHER PARTNERS	
• Great Basin Bird Observatory • National Audubon Society/Lahontan Audubon Society/Red Rock Audubon Society • Canvasback Gun Club • Coalition for Nevada’s Wildlife • Ducks Unlimited • Eastern Nevada Landscape Coalition • Fraternity of the Desert Bighorn • Greenhead Hunting Club • Humboldt Watershed Cooperative Weed Management Area • Nevada Bighorns Unlimited • Nevada Waterfowl Association • Nevada Wilderness Coalition (Friends of Nevada Wilderness, Nevada Wilderness Project) • Northeastern Nevada Stewardship Group • Partners In Flight North American Land Bird Conservation Plan • Rocky Mountain Elk Foundation • Sierra Club • The Nature Conservancy • Trout Unlimited • University of Nevada Cooperative Extension	• Coordinate and leverage outside expertise on remote sensing • Leverage the expertise of outside specialists to recruit participants, develop inventory/monitoring/research projects, and implement project activities • Set up program(s) with the Nevada System of Higher Education to create opportunities for students to learn and collect important data for wildlife and habitat conservation (e.g., the new Cooperative Research Unit with UNR) • Partner to update specific taxa conservation plans such as the Nevada Bird Atlas

KEY PARTNERS	OPPORTUNITIES FOR COORDINATION
CONSERVATION ORGANIZATIONS, ACADEMIC/RESEARCH INSTITUTIONS, AND OTHER PARTNERS	
• University of Nevada (UNR Biological Research Center; Natural Resources and Environmental Sciences; Cooperative Extension; UNLV Department of Biological Sciences) • Tahoe Regional Planning Agency • Truckee Meadows Regional Planning Agency • Tortoise Group/San Diego Zoo • Intermountain West Joint Venture • Pheasants Forever • Western Bat Working Group • Counties • Tribes • Desert Research Institute • Southern Nevada Water Authority • Truckee-Carson Irrigation District • Walker River Irrigation District • Incline Village General Improvement District Sewer Treatment Wetland • Mining Industry/Nevada Mining Association • Wildlife Habitat Improvement of Nevada (WHIN)	
EXAMPLES OF PARTNER-BASED RESTORATION AND MANAGEMENT EFFORTS	
• Nevada Native Seed Partnership • Nevada Shared Stewardship • Nevada Collaborative Conservation Network • Mojave Desert Native Plant Program • Forest Stewardship Program • Various Local Area Work Groups	• Collaborations to develop and implement habitat restoration, stream enhancement projects, and/or broad ecosystem management outcomes.

Management Plans

Table 45 includes a representation of existing habitat and wildlife management plans enacted by various governmental and non-governmental partners. The bulk of these management plans have been developed by various partnering agencies and include direct NDOW involvement in many cases. These plans represent ways in which the SWAP can work in tandem with existing plans to maximize the conservation of Nevada's wildlife and natural places. Coordination between these plans and Nevada's SWAP will maximize implementation of conservation actions, minimize redundancy, promote responsible use of available funding, and strengthen partnerships that are critical for conserving Nevada's natural heritage. The table is broken into two sections. The first section lists select management plans that have broad applicability to multiple species and/or habitats. The second section includes select key species-specific conservation plans. We only include current plans and acknowledge that this is not an exhaustive list of all management and conservation plans that NDOW and our partners implement. In addition to plans listed below, NDOW develops and implements species specific management plans for several species, including mule deer and bighorn sheep.

Table 45: A representation of some existing habitat and wildlife management plans enacted by various governmental and nongovernmental partners.

MANAGEMENT PLANS		
MANAGEMENT PLANS	**ENTITIES INVOLVED**	**TAXA/HABITAT COVERED**
Clark County Multi-Species Habitat Conservation Plan	Clark County, U.S. Fish and Wildlife Service and partners	• Various terrestrial and aquatic sensitive species in Clark County (e.g., Mojave desert tortoise, Las Vegas bearpoppy, Nevada admiral)
Comprehensive Nevada Bird Conservation Plan	Great Basin Bird Observatory and partners	• Conservation strategy and needs for Nevada birds
Conservation Strategy for Springsnails in Nevada and Utah	NDOW, UDWR (Utah) and TNC	• SGCN Springsnails
Intermountain West Waterbird Conservation Plan	U.S. Fish and Wildlife Service and partners	• Various aquatic-associated birds and their habitats
Lincoln County Multi-Species Habitat Conservation Plan	Lincoln County, U.S. Fish and Wildlife Service and partners	• Various sensitive species within southeastern Lincoln County
Lower Colorado River Multi-Species Conservation Program: Habitat Conservation Plan	Bureau of Reclamation and partners	• Various species and habitats found along the lower Colorado River (e.g., razorback sucker, various songbirds, Arizona cotton rat)

MANAGEMENT PLANS		
MANAGEMENT PLANS	**ENTITIES INVOLVED**	**TAXA/HABITAT COVERED**
Naval Air Station Fallon Integrated Natural Resources Management Plan	U.S. Navy and partners	• Various species and natural resources found within the Naval Air Station Fallon and associated training grounds
Nellis Air Force Base Integrated Natural Resource Management Plan	U.S. Air Force and partners	• Various species and natural resources found within the Nevada Test and Training Range, Nellis Air Force Base, and Creech Air Force Base
Nevada Forest, Range & Watershed Action Plan	Nevada Division of Forestry and partners	• Sensitive species, watersheds, and forestry management needs
BLM Strategic Plan for Pollinator Conservation (June 2022)	Bureau of Land Management	• Pollinating invertebrates across BLM lands
Nevada Springs Conservation Plan (2011)	Springs Conservation Plan Working Group and partners	• Springs and associated wetlands
Sagebrush Conservation Strategy	Western Association of Fish and Wildlife Agencies/Western States	• Sage-grouse and other sensitive sagebrush obligates such as sage thrasher, sage sparrow, etc.
Southern Nye County Multiple Species Habitat Conservation Plan	Nye County, U.S. Fish and Wildlife Service and partners	• Various sensitive species within southern Nye County
Strategic Habitat Framework	NDOW	• Priority habitats and associated restoration/management actions
The Science and Traditional Ecological Knowledge Strategic Plan	Great Basin Landscape Conservation Cooperative and partners	• Strategic plan identifying science and TEK needs for landscape conservation
TNC Corridors and Climate Plan (in development)	The Nature Conservancy and partners	• Seven focal species vulnerable to changing climates and range shifts
Integrated Watershed Plan for the Lower Virgin River in Arizona and Nevada	Virgin River Coalition (NDOW, numerous federal, state, and local agencies, and numerous NGOs)	• Collaborative plan promoting interdisciplinary use and management of the lower Virgin River watershed
SELECT SPECIES SPECIFIC CONSERVATION/MANAGEMENT PLANS		
Lahontan Cutthroat Trout Recovery Plan (2019)	Lahontan Cutthroat Trout Management Oversight Group	• Lahontan cutthroat trout

MANAGEMENT PLANS		
MANAGEMENT PLANS	**ENTITIES INVOLVED**	**TAXA/HABITAT COVERED**
Recovery Plan for the Southwestern Willow Flycatcher	U.S. Fish and Wildlife Service	• Southwestern willow flycatcher
Revised Recovery Plan for the Yuma Clapper Rail (draft)	U.S. Fish and Wildlife Service	• Yuma Ridgway's rail
Western Monarch Conservation Strategy	Western Association of Fish and Wildlife Agencies/Western States	• Monarch butterflies and other sensitive pollinator species
Conservation Strategy for the Pinyon Jay	U.S. Fish and Wildlife Service, Partners in Flight, and partners	• Pinyon jays and associated breeding and foraging habitats
Columbia Spotted Frog Conservation Agreement and Strategy	U.S. Fish and Wildlife Service, U.S. Forest Service, NDOW, and partners	• Columbia spotted frog
Relict Leopard Frog Conservation Agreement and Strategy	U.S. Fish and Wildlife Service, U.S. Forest Service, NDOW, and partners	• Relict leopard frog
Revised recovery plan for the Mojave population of the desert tortoise (*Gopherus agassizii*) (2011).	U.S. Fish and Wildlife Service, Pacific Southwest Region	• Mojave desert tortoise
Western Pond Turtle Range-wide Management Strategy	NDOW with other state and federal agencies	• Western pond turtle
The Revised Nevada Bat Conservation Plan (2006)	Nevada Bat Working Group	• All bats occurring in Nevada
Recovery Plan for the Endangered and Threatened Species of Ash Meadows	U.S. Fish and Wildlife Service	• Devils Hole Pupfish, Warm Springs Pupfish, Ash Meadows Amargosa Pupfish, Ash Meadows Speckled Dace
Cui-ui Recovery Plan, Second Revision	U.S. Fish and Wildlife Service	• Cui-ui
Desert dace recovery plan (1997)	U.S. Fish and Wildlife Service	• Desert dace

MANAGEMENT PLANS		
MANAGEMENT PLANS	ENTITIES INVOLVED	TAXA/HABITAT COVERED
Pyramid Lake Paiute Tribe Water Quality Control Plan	Pyramid Lake Paiute Tribe	• Cui-ui
Truckee River Operating Agreement	Federal agencies, Nevada, Pyramid Lake Paiute Tribe, Water agencies, PUDs, local municipalities	• Cui-ui
Range-wide Conservation Agreement for Roundtail Chub, Bluehead Sucker, and Flannelmouth Sucker	Utah Department of Natural Resources, Colorado River Fish and Wildlife Council, and numerous state and federal partners	• Flannelmouth sucker
Big Spring Spinedace Recovery Plan	U.S. Fish and Wildlife Service	• Big Spring spinedace
Bonytail Recovery Plan	U.S. Fish and Wildlife Service	• Bonytail
Recovery Plan for the Rare Aquatic Species of the Muddy River Ecosystem	U.S. Fish and Wildlife Service	• Moapa dace
Recovery Plan for the Aquatic and Riparian Species of Pahranagat Valley	U.S. Fish and Wildlife Service	• Pahranagat roundtail chub, White River springfish, Hiko White River springfish
Recovery Plan for Pahrump Killifish	U.S. Fish and Wildlife Service	• Pahrump poolfish
Razorback Sucker Recovery Plan	U.S. Fish and Wildlife Service	• Razorback sucker
Railroad Valley Springfish Recovery Plan	U.S. Fish and Wildlife Service	• Railroad Valley springfish
Virgin River Fishes Recovery Plan	U.S. Fish and Wildlife Service	• Woundfin and Virgin River chub
White River Spinedace Recovery Plan	U.S. Fish and Wildlife Service	• White River spinedace
Conservation Strategy for Interior Redband Trout	States of Nevada, California, Idaho, Montana, Oregon and Washington, Federal Agencies, Tribes, and Trout Unlimited	• Columbia Basin redband trout

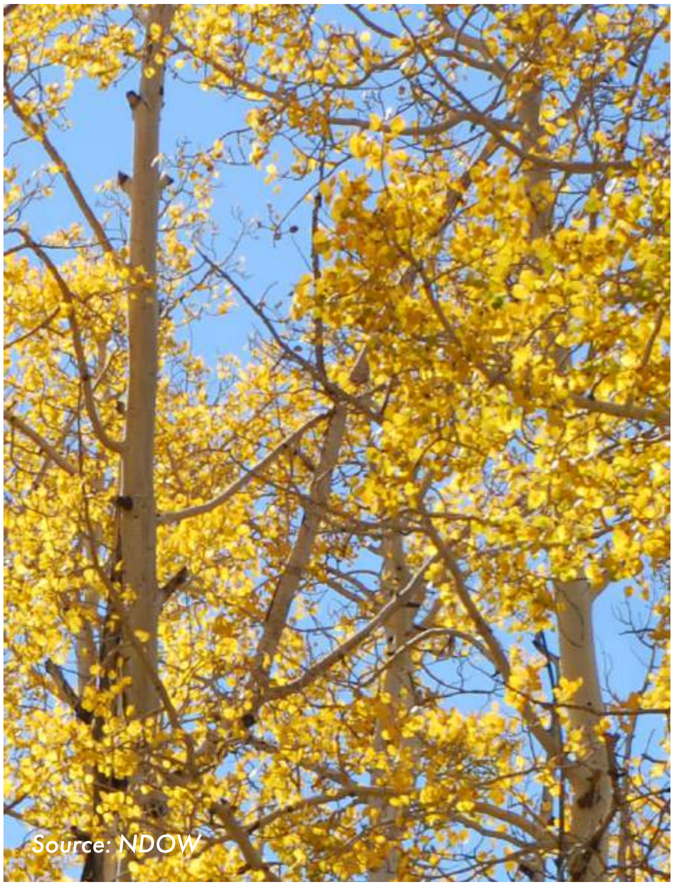
MANAGEMENT PLANS		
MANAGEMENT PLANS	**ENTITIES INVOLVED**	**TAXA/HABITAT COVERED**
Bonneville Cutthroat Trout Range-wide Conservation Agreement and Strategy	States of Nevada, Idaho, Utah, and Wyoming, Federal Agencies, and Tribes.	• Bonneville cutthroat trout
Conservation Agreement and Strategy for Northern Leatherside Chub	States of Nevada, Utah, Idaho and Wyoming, Federal Agencies, and Tribes	• Northern leatherside chub
Recovery Plan for the Coterminous United States Population of Bull Trout	U.S. Fish and Wildlife Service	• Bull trout
Bighorn Sheep Management Plan	NDOW	• Bighorn Sheep
Pacific Flyway Management Plans, working groups, and/or recommendations	Pacific Flyway Council	• Band-tailed Pigeon • Trumpeter Swan • Multiple species actions or working groups such as shorebirds

Citizen Science and Public Engagement

Engagement with the public and utilizing citizen scientists not only helps promote wildlife management issues, conservation of natural places, and the relevance of NDOW's mission but also involves tapping into a relatively underutilized group of eager participants during the implementation of Nevada's SWAP (see Chapter 7). While this type of engagement is important for educating Nevada's public about the importance of wildlife conservation and fostering long-lasting connections with wildlife and nature, leveraging volunteer opportunities can also be critical for successfully implementing monitoring projects. Examples include using volunteer hours and travel to match federal and other funding opportunities and accessing a skilled labor force to complete projects that otherwise would not be completed based on limited professional biologist availability and funding (e.g., standardized bird and reptile surveys, enactment of habitat restoration projects).

Traditional Ecological Knowledge (TEK)

Central to broad collaboration and partnership is incorporating traditional ecological knowledge (TEK), which enhances our understanding of and ability to conserve our natural systems. TEK reflects the traditional values and cultures of Native peoples who share an accumulated knowledge and understanding of natural systems through generations of connection with the environment. Observations, sustainable practices, and active resource management have built knowledge and understanding and a deep and holistic connection to ecosystems. Incorporating this knowledge can provide a broader view of natural systems, insight into long term patterns, and richer data sets that can improve conservation outcomes (Hatfield, 2017). Incorporating TEK is part of a collaboration that invites diverse populations to contribute to our knowledge, understanding, and shared stewardship responsibilities (Whyte, 2013). Incorporating TEK in NDOW's monitoring and implementation of conservation actions



Source: NDOW

involves embracing the evolving knowledge acquired by indigenous groups over generations through direct contact and engagement with the local environment. Involving TEK concepts in our approach to wildlife and habitat conservation will help build partnerships with Native American Tribes, engage an important segment of our local population in environmental stewardship, and help ensure that lessons learned over thousands of years will not be lost and will enhance a holistic approach toward managing Nevada's wildlife. Examples of how TEK can benefit the conservation of Nevada's wildlife and habitat include understanding population dynamics over time, considering aquatic and terrestrial species adaptation to drought, and accounting for observed predator-prey dynamics, among many other topic areas.

Adaptive Management

The proceeding monitoring and implementation strategies make clear that much of the adaptive management approach will occur by integrating the SWAP into existing and forthcoming plans. This plan is intended to be an umbrella action plan providing programmatic structure to NDOW and broader guidance to the Nevada wildlife conservation community. The structure of this plan will remain throughout the planning period; however, it is important to note that project and strategy flexibility is needed as new information is available. Essentially, the SWAP will provide the overall framework and direction while project goals and objectives change under an adaptive management approach. Project development will adjust as conditions change, and we recognize the need to incorporate and adapt to new information and work with partners to accommodate and provide input to other conservation plans and programs. As such, it is important to continue and expand on cross-divisional coordination and maintain regular coordination between agencies, NGOs, and various other conservation and research groups to ensure perceived threats are current and identified conservation actions are those best designed to realize the most effective and efficient conservation of Nevada's wildlife.

Chapter 6

Regional Coordination

Source: NDOW

Introduction

On a national scale, there is growing recognition of the importance of regional coordination and collaboration to maximize the effectiveness of fish and wildlife conservation on a landscape scale. For example, guidance from the Association of Fish and Wildlife Agencies (AFWA) recognizes that landscape-scale, cross-jurisdictional collaborations are valuable for fish and wildlife agencies in achieving statutorily required conservation of fish, wildlife, and their habitats (Association of Fish and Wildlife Agencies, 2021). State Wildlife Action Plans (SWAPs) can provide a vehicle and serve as the foundation for regional and landscape scale coordination toward shared conservation goals and priorities, including goals that scale beyond state or other jurisdictional boundaries.

Arizona-Nevada Collaboration

The State of Nevada partnered with the State of Arizona in a pilot program to foster the development and implementation of a cross-jurisdictional approach to conservation in the southwest. The program was designed so that each state's SWAP moves forward on a path that meets both the individual state needs of Nevada and Arizona while coordinating between the two states to consider needs beyond state boundaries.

The Arizona Game and Fish Department (AZGFD) and NDOW were both preparing to initiate their SWAP revision processes on a similar timeframe, with completion dates expected in August and September of 2022, respectively. This shared timeline created an opportunity for both state wildlife agencies to collaborate on various elements of the SWAP. The U.S. Fish and Wildlife Service (USFWS) was also a critical partner in supporting this regional coordination effort and provided funding for this partnership through a grant from the USFWS Science Applications program.

From November 2021 through August 2022, the SWAP technical leads for AZGFD and NDOW met nine times. Through this engagement, Nevada and Arizona coordinated in aligning key aspects of each respective SWAP. Initial discussions centered on identifying shared priority species and understanding what currently threatens them. While the two states identified 51 shared species, 47 were identified as providing opportunity for collaboration, particularly through predictive modeling (Table 46). This shared priority list is the basis for regional conservation goals. In addition, both states defined and characterized threats and actions using common lexicon based on Salafsky et al. (2008) and IUCN (2022) frameworks. Aligning terminology and actions facilitates continued conservation work as each plan is implemented over the next ten years.

One area of continued discussion and coordination is centered around climate change. This overarching threat is a key topic that benefits from regional approaches. Both states, along with other southwestern states, are continuing to discuss this threat and how we could approach the issue through regional collaboration. Such actions center around shared assessments of vulnerability, using climate projection models across regions, and partnering with climate science centers to develop projects that assist each state in addressing this threat. For example, utilizing tools such as the NatureServe Habitat Climate Change Vulnerability Index (see Chapter 4) and updating assessments on the vulnerability of individual species as tools become available have been identified as areas for regional collaboration in the future.

One of the primary outcomes of this regional coordination is additional predictive modeling of shared SGCN species (i.e., amphibians, birds, mammals, and reptiles). As part of their SWAP, Arizona contracted New York Natural Heritage Program (NY Heritage) to develop species distribution models for 281 SGCN. Through their collaboration, Arizona and Nevada identified 47 shared terrestrial species on their designated SGCN lists to expand these models to include both states. Using data from various datasets within both states, NY Heritage used an ensemble modeling approach to develop predictive models that include both Arizona and Nevada for these 47 shared SGCN species. The full list of shared SGCN species that were modeled is included in Table 42 below. The value of engaging across state borders has been recognized to develop more effective conservation actions and consider full life cycle conservation for more mobile species like birds and bats. In the future, neighboring states can participate in this shared modeling to increase our understanding of regional species distributions. At the time of this writing, these models are under development and will be included in a future appendix. These models are expected to help foster coordination and collaboration between states and help guide project development and implementation for shared species.

Table 46: SGCN shared by Arizona and Nevada shown by taxonomical group

ARIZONA AND NEVADA SHARED SGCN SPECIES (MODELED)			
SCIENTIFIC NAME	COMMON NAME	MAJOR GROUP	MINOR GROUP
Anaxyrus microscaphus	Arizona Toad	Amphibian	Amphibian
Lithobates pipiens	Northern Leopard Frog	Amphibian	Amphibian
Lithobates onca	Relict Leopard Frog	Amphibian	Amphibian
Patagioenas fasciata	Band-tailed Pigeon	Bird	Migratory
Psiloscops flammeolus	Flammulated Owl	Bird	Owl
Asio otus	Long-eared Owl	Bird	Owl
Glaucidium gnoma	Northern Pygmy-Owl	Bird	Owl
Athene cunicularia hypugaea	Western Burrowing Owl	Bird	Owl
Toxostoma bendirei	Bendire's Thrasher	Bird	Passerine, etc.
Setophaga nigrescens	Black-throated Gray Warbler	Bird	Passerine, etc.
Spizella breweri	Brewer's Sparrow	Bird	Passerine, etc.
Haemorhous cassinii	Cassin's Finch	Bird	Passerine, etc.
Chordeiles minor	Common Nighthawk	Bird	Passerine, etc.
Colaptes chrysoides	Gilded Flicker	Bird	Passerine, etc.
Setophaga graciae	Grace's Warbler	Bird	Passerine, etc.
Toxostoma lecontei	LeConte's Thrasher	Bird	Passerine, etc.
Melanerpes lewis	Lewis's Woodpecker	Bird	Passerine, etc.
Melospiza lincolnii	Lincoln's Sparrow	Bird	Passerine, etc.
Lanius ludovicianus	Loggerhead Shrike	Bird	Passerine, etc.
Contopus cooperi	Olive-sided Flycatcher	Bird	Passerine, etc.
Gymnorhinus cyanocephalus	Pinyon Jay	Bird	Passerine, etc.
Oreoscoptes montanus	Sage Thrasher	Bird	Passerine, etc.
Icterus parisorum	Scott's Oriole	Bird	Passerine, etc.
Empidonax traillii extimus	Southwestern Willow Flycatcher	Bird	Passerine, etc.
Coccyzus americanus occidentalis	Yellow-billed Cuckoo	Bird	Passerine, etc.
Falco sparverius	American Kestrel	Bird	Raptor
Haliaeetus leucocephalus	Bald Eagle	Bird	Raptor
Buteo regalis	Ferruginous Hawk	Bird	Raptor
Aquila chrysaetos	Golden Eagle	Bird	Raptor
Accipiter gentilis	Northern Goshawk	Bird	Raptor
Falco peregrinus	Peregrine Falcon	Bird	Raptor
Falco mexicanus	Prairie Falcon	Bird	Raptor
Buteo swainsoni	Swainson's Hawk	Bird	Raptor
Dendragapus obscurus	Dusky Grouse	Bird	Upland Game
Rallus obsoletus yumanensis	Yuma Ridgway's Rail	Bird	Water bird
Idionycteris phyllotis	Allen's Big-eared Bat	Mammal	Bat
Nyctinomops macrotis	Big Free-tailed Bat	Mammal	Bat

ARIZONA AND NEVADA SHARED SGCN SPECIES (MODELED)			
SCIENTIFIC NAME	COMMON NAME	MAJOR GROUP	MINOR GROUP
Macrotus californicus	California Leaf-nosed Bat	Mammal	Bat
Myotis thysanodes	Fringed Myotis	Mammal	Bat
Eumops perotis	Greater Bonneted Bat	Mammal	Bat
Lasiurus cinereus	Hoary Bat	Mammal	Bat
Tadarida brasiliensis	Mexican Free-tailed Bat	Mammal	Bat
Euderma maculatum	Spotted Bat	Mammal	Bat
Lasiurus blossevillii	Western Red Bat	Mammal	Bat
Heloderma suspectum	Gila Monster	Reptile	Reptile
Gopherus agassizii	Mojave Desert Tortoise	Reptile	Reptile
Uma scoparia	Mojave fringe-toed Lizard	Reptile	Reptile

Shared Ecoregions and Common Habitat Conservation Goals

As discussed in Chapter 2, ecoregions are areas where ecosystems are similar and possess common characteristics such as ecosystem quality and quantity of the environmental resource. This ecological framework divides the landscape into regions with similarities in physical and biological characteristics including geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. Nevada and Arizona share the Mojave Basin and Range and Arizona/New Mexico Plateau ecoregions. Each state relied on different methodologies to define respective habitat types at a fine scale. Although ecoregions are at a coarser scale, it does provide universal habitat categories that can be used across state boundaries. Below is a table showing the key or major habitat types that each state identifies within the two shared ecoregions.

Table 47: Major Habitat Types for Arizona and Nevada that are part of the two shared Ecoregions

ECOREGION	NEVADA KEY HABITAT TYPES	ARIZONA KEY HABITAT TYPES
Mojave Basin and Range	• Lower Montane Woodlands and Chaparral • Mojave Mid-Elevation Mixed Desert Scrub • Mojave Warm Desert • Montane Shrublands • Pinyon-Juniper Woodland • Riparian and Wetland • Upper Montane Coniferous Forest and Woodland	• Mojave Desert Scrub • Chapparal
Arizona/New Mexico Plateau	• Lower Montane Woodlands and Chaparral • Mojave Mid-Elevation Mixed Desert Scrub • Pinyon-Juniper Woodland	• Great Basin Conifer Woodland • Great Basin Desert Scrub • Mojave Desert Scrub • Plains and Great Basin Grassland


Source: NDOW


Source: NDOW

Common Goals for Habitat Conservation and Management:

- Collaborate and partner with State, Federal, and private entities (including agricultural producers and private landowners) to provide information on wildlife habitat status and input on grazing plans, generate opportunities to improve rangeland health by creating suitable habitat for wildlife, and enhance habitat to benefit both livestock and wildlife.
- Improve the quality of altered ecosystems by restoring and maintaining native plant species.
- Coordinate with partners to protect and maintain native grassland characteristics and wildlife habitat requirements by utilizing fire, improving diversity, eradicating invasive species, and managing grazing regimes to encourage natural reseeding of native grasses and forbs.
- Encourage and promote federal land management agencies, state agencies, and partners to proactively manage forests through thinning, prescribed burning, or other forestry practices to improve forest health and create healthy habitats that are less prone to catastrophic wildfires and resilient to drought and insect infestations.

Other examples of collaboration between AZ-NV

Bighorn Sheep

The Nevada Department of Wildlife (NDOW), Arizona Game and Fish Department (AZGFD), Nevada Department of Transportation (NDOT), and the Regional Transportation Commission of Southern Nevada (RTC) have partnered to conserve desert bighorn sheep in southern Nevada. Throughout the Southwest, including Nevada, many desert bighorn sheep populations are isolated and small (<100) and therefore are vulnerable to extirpation if the number of individuals is less than 50. In part, sheep population declines can be attributed to anthropogenic causes such as roadways, railways, canals, and housing developments. Although wildlife crossing structures have been constructed to reduce roadway impacts on desert bighorn sheep populations, few studies have documented the efficacy of these structures. One long-term study conducted by AZGFD found that sheep utilized wildlife overpasses to cross roadways more than bridges and culverts. These findings led the Boulder City Bypass Phase II (BCB-2) planners to add a wildlife overpass to the roadway's array of large bridges, all of which would be designed to function as wildlife crossing structures. The planners also arranged for AZGFD to collaborate with NDOW, NDOT, and RTC to assist designers, engineers, and contractors during the project's design and construction phases. Currently, AZGFD is conducting post-construction monitoring to determine the efficacy of the constructed wildlife crossing structures and to date has documented more than 20,900 animals comprised of 22 species using the structures. Of these, AZGFD documented 15,778 desert bighorn sheep using the BCB-2 wildlife overpasses and bridges to safely cross Interstate-11.

Razorback Sucker and Bonytail

Management efforts focused on razorback sucker and bonytail benefit from an active and diverse group of regional stakeholders. The Lower Colorado River Multi-Species Conservation Program (MSCP) is a collaboration of state agencies (including NDOW and AZGFD), federal agencies, and local entities. The MSCP and its partners perform long-term monitoring of population size and genetic variation throughout the lower Colorado River system. A large fish augmentation plan for both species was developed by the MSCP with goals of stocking 660,000 razorback sucker and 620,000 bonytail within 50 years. This augmentation plan is implemented through a coordinated network of state and federal fish hatcheries located in Nevada, Arizona, and New Mexico.

Relict Leopard Frog

The Relict Leopard Frog Conservation Team consists of NDOW, AZGFD, U.S. Fish and Wildlife Service, National Park Service, and other local entities. This conservation team coordinates conservation actions for the relict leopard frog in Nevada and Arizona. Populations in Nevada and Arizona have been or are maintained through a 'headstarting program' in which partners from the University of Nevada Las Vegas collect wild eggs, rear them at NDOW's Lake Mead Hatchery, and then release frogs at varying life stages into wild habitats.

Next Steps

Both states will continue to collaborate and work together on the implementation of the shared conservation goals and actions outlined in each plan and continue collaborating to improve the effectiveness, accessibility, and relevance of their SWAPs for partners, stakeholders, and the public.

Source: NDOW

For example, both states aim to develop web-enabled versions of the SWAP to make it easy for partners to access the information contained in this document.

Arizona and Nevada have also engaged with other southwestern states that are preparing to complete major revisions of their SWAPs. These grassroots efforts have grown out of the recognition that cross-border collaboration can add value and bolster each state's efforts to achieve shared conservation priorities. For example, an integrated and regional approach may aid in the effectiveness of addressing threats and conservation actions for regional endemics and addressing region-wide threats such as climate change, as well as conservation opportunities. Nevada and Arizona will continue exploring the potential to work with other states in the region to advance shared conservation goals and priorities.

Source: NDOW

Chapter 7

Enhancing Conservation of SGCN and their Habitats through Citizen Science, Education, and Wildlife Viewing

Source: NDOW

Introduction

Nevada is a state full of sweeping landscapes, rare habitats, and charismatic wildlife species. It is also a state with flourishing urban population centers that continue to see an increase in population year after year. With more people in the state, education and outreach on Nevada's wildlife species and habitats have never been more important. Connecting citizens to their wildlife resources and viewing opportunities is essential for conserving wildlife and habitats. Getting vital information on Nevada's wildlife resources and the work that is being done to conserve these species to people who can both benefit from these resources and impact them the most is a top priority. The conservation issues facing Nevada's wildlife are complex. Through existing and new programming, the Nevada Department of Wildlife (NDOW) will form strong partnerships with the public to work toward the conservation and resolution of stressors impacting Species of Greatest Conservation Need (SGCN), their habitats, and all wildlife in the state.

Numerous studies have documented how important connections to nature are for human health as well as for increasing support for and interest in conservation. The Nature of Americans report (Case & Kellert, 2017), America's Wildlife Values study (Manfredo et al., 2018), Nevada's Wildlife Values studies (Manfredo et al., 2018), and the Fish and Wildlife Relevancy Roadmap (AFWA, 2019) are providing critical context and framing for Nevada's approach to building relevancy for NDOW and support for conservation of SGCN and their habitats.

To address the needs of our state's growing and diverse populations and wildlife resources, NDOW will take several education and outreach approaches. We will expand our Wildlife

Education programming for both classroom and public audiences, create a state-wide wildlife viewing program to connect people to the many wild areas where they can experience nature and contribute to community science, and implement a multi-media outreach approach to inform the public about our sensitive species and species of greatest conservation need.

Education and outreach programming is vital to improving conservation outcomes. Many Nevada citizens are unaware of the conservation work currently being conducted by NDOW and our partners. Connecting people to this current work, as well as expanding programming that is relevant and meaningful to a diverse set of constituents is a key goal of NDOW. Utilizing SGCN conservation to educate the next generation and targeting outreach to new and existing audiences will lead to a more informed and connected public that is supportive of conservation measures.

Furthermore, fish and wildlife organizations must become relevant to a broader set of constituents. This has been a long-recognized need that was formally expressed by the Association of Fish and Wildlife Agencies (AFWA) Blue Ribbon Panel on Sustaining America's Diverse Fish and Wildlife Resources. The Blue Ribbon Panel recognized that society is changing and the values and attitudes of people towards wildlife are likewise changing. They recommended that agencies and organizations explore the impact and develop recommendations on how agencies and their programs might transform to engage and serve broader constituencies, specifically those constituencies who are currently not engaged in conservation or with a conservation agency.

In 2019, AFWA approved the Relevancy Roadmap, a document developed by a team of staff from state and federal agencies, tribes, non-governmental organizations, and private industry. The Relevancy Roadmap identifies five categories of barriers that potentially impact an agency's ability to connect with underserved constituents: agency culture, agency capacity, constituent culture, constituent capacity, and political and legal constraints.

Each of the five categories of barriers can be addressed to some degree by Nevada's State Wildlife Action Plan. In particular, wildlife education programming, outreach efforts, and the development of new nature tourism opportunities address constituent culture and capacity barriers. For example, NDOW can address the perception that we only care about and serve hunters and anglers by developing programming that is relevant to all the citizens of Nevada. Similarly, by providing training and guided experiences, NDOW can begin to address the barrier that constituents have fears, concerns, or beliefs that prevent them from engaging with nature. By learning about Nevada citizen's desires and interests in the outdoors, NDOW can develop programming that meets new constituents where they are and can begin to build lasting partnerships based on shared interests, that provide equitable access to nature and overcomes perceived barriers such as economics, cultural norms, nature-based values, and access limitations. Finally, SGCN are species that can spark interest in a diverse constituency and provide a rich opportunity to share conservation stewardship through citizen science and volunteer stewardship projects.


Source: NDOW


Source: NDOW

Setting Conservation Objectives

NDOW recognizes that the conservation of SGCN and their key habitats will be enhanced by connecting people to their natural resources and promoting conservation on a broad scale. Many SGCN and their habitats offer unique opportunities for storytelling, citizen science engagement, and learning about the unique flora and fauna of the state.

Overall objectives for conservation education fall into four categories:

- Kindergarten to Grade 12 (K-12) Wildlife Education Programs
- Interpretive Centers and Wildlife Education
- Urban Wildlife and Living with Wildlife Programs
- Wildlife Viewing and Nature Tourism

Applicable to all four objectives are NDOW's statewide Outdoor Connection Plan and the associated Outdoor Connection Coordinator position. This effort is aimed at increasing our relevancy with currently underserved communities, building programming that promotes connecting people to nature, improving human health through those connections, and enhancing wildlife conservation.

Partnerships with counties, local governments, tribal governments, non-profit groups, school districts, universities, private companies, and state and federal resource partners are critical to support these education and outreach actions. In addition, these objectives will be communicated within a variety of interagency planning processes, including ongoing US Fish and Wildlife Service, US Forest Service, and Bureau of Land Management planning processes. In addition to the actions described in this plan, a new department-wide strategic plan has been developed which supports connecting citizens to wildlife and to the agency.

Objectives to Enhance the Conservation of SGCN and their Habitat

In addition to the goals and objectives outlined later in this chapter for each of the identified four priority areas, NDOW has also identified education and outreach objectives that tie to the habitat threats and the conservation of sensitive species. Management actions for these threats and species are further detailed in the previous chapters. The objectives below focus on ways to use citizen science, education, and wildlife viewing to help enhance conservation.

Habitat Loss/Destruction

Nevada's growth in population and expansion in urban areas has undoubtedly caused extensive habitat loss and degradation. Suburbs continue to expand into mostly undisturbed habitats in both northern and southern Nevada affecting many different species such as mule deer, sage grouse, pygmy rabbit, desert tortoise, and sensitive aquatic species. In addition to urbanization, Nevada is experiencing a large boom in land being used to develop renewable energies. Solar energy projects and resource extraction for renewable energy can significantly affect wildlife populations and their habitats. Due largely to invasive species and climate change, wildfires have also increased across Nevada's landscape, further fragmenting and impacting natural resources.

Communications to increase understanding of these issues and how it affects wildlife will help gain public support for conservation actions. Implementing best practices, proactive planning that minimizes impacts from development, and working with partners to develop shared stewardship goals, can ensure the conservation of wildlife and habitats are actively being considered. Identified outreach and communication goals have been grouped by stressors or specific species groups and areas where citizen science projects can be particularly useful are highlighted.

Wildfire

- Increase public knowledge of wildfire threats to habitats.
- Develop outreach to inform the public on the most common causes of wildfire and actions people can take to decrease their risk of starting fires in vulnerable habitats.

Renewable Energy

- Increase public knowledge of the trade offs of renewable energy development which has global benefits but local impacts to habitat and wildlife.
- Work collaboratively with partners to invest in critical energy development in ways that are less impactful to wildlife and their habitats.

Development and Infrastructure

- Increase monitoring and input into local government planning processes to support planning for habitat and wildlife.
- Increase public knowledge on the impacts specific development activities have on wildlife and wildlife habitats.
- Develop citizen science programs that monitor urban wildlife such as backyard birds or pollinators.

Climate Change

Climate change is a major stressor to habitats and species across Nevada and conservation planning and public education and outreach efforts are critical to not only keep the public informed but to encourage voluntary actions that help reduce and address this stressor.

Climate change is often not well understood by general audiences and is often a polarizing topic creating a difficult environment for garnering support for wildlife affected by climate change. A dedicated, sensitive, and well-informed communication approach is essential to engage the public and key stakeholders to educate them on how climate change is impacting wildlife. Outreach goals include:

- Engage the public in dedicated education and outreach efforts on how climate change is impacting wildlife and habitats in Nevada.

Aquatic Invasive Species

NDOW has developed a coordinated statewide aquatic invasive species (AIS) management plan and program to control and prevent species like quagga mussels, New Zealand mudsnails, Asian clams, curly leaf pondweed, northern pike, and many others.

Several important bodies of water in the state are already infested with harmful AIS. For example, Lake Mead in southern Nevada is infested with quagga mussels, Lake Tahoe is infested with Asian clams, and the Truckee River is infested with Asian clams and New Zealand mudsnails. Communications to increase the understanding of invasive species issues will help gain public support for changes in behavior to prevent the spread and new introduction of AIS. Outreach goals include:

- Educate boaters to clean, drain, and dry boats between every use.
- Inform anglers about the practice of clean angling.
- Increase outreach to the public regarding the impacts of released non-native species.
- Create a communications plan to respond to new invasive species threats accurately and efficiently.

Sensitive Species

Nevada ranks third nationwide in the percentage of species at risk of extinction. Many residents are completely unaware of the number of sensitive species and what can be done to protect them. More educational programs to familiarize the public with the value of SGCN species and their habitats are needed. As people learn more about the life history and habitat needs of these sensitive species, they'll be more prepared, and more likely to get involved in decisions affecting those species. Programming to address sensitive species and ecosystems issues include, but is not limited to the following:

Endemic Fishes

- Increase public knowledge of species' life history.
- Increase understanding of how human impacts from recreation, habitat fragmentation, urbanization, and dewatering affect endemic fishes.
- Increase understanding of how exotic competitors affect native habitats and species.

Mollusks and other Aquatic Species

- Invite volunteers and the public to provide input on mollusk and amphibian population management and participate in citizen science monitoring programs.
- Increase awareness of aquatic nuisance species and their impacts on state waters.
- Increase awareness of issues related to releasing pets or other non-native species into the wild.

Bats

- Increase understanding and appreciation of bats.
- Increase understanding of the importance

of mines and caves for bat species.

- Build partnerships to support bats and bat conservation in the state.
- Support bat education in the schools.

Reptiles and Amphibian

- Increase understanding and appreciation of reptiles and amphibians.
- Expand existing, and develop new, citizen scientist and volunteer opportunities.

Nesting Birds and Raptors

- Increase public knowledge of basic breeding and nesting characteristics of birds
- Invite volunteers and partner organizations to assist in monitoring through citizen science opportunities, including Breeding Bird Surveys, the annual Winter Raptor Survey and others.

Nevada Habitats

- Increase understanding and value of all SWAP habitats within our state and how our wildlife is connected to them.

K-12 Wildlife Education Programs

The Wildlife Education Program works to engage both the public and K-12 classroom students in comprehensive programming to connect Nevadans and visitors to our wildlife resources. Wildlife Education also serves to support educators in Nevada through professional development trainings and serves as a resource for wildlife conservation content and materials. Fostering concern for the conservation of our native wildlife is important for both youth and adults. The goal of the Wildlife Education Program is to cultivate the long-term support of conservation efforts and the knowledge to make informed decisions concerning wildlife.

Source: NDOW

Source: NDOW

Classroom Programming

Currently, the Wildlife Education Program facilitates statewide classroom programming for grades K-12, with targeted programs specific to fourth grade, sixth through eighth grade, and high school age students. These programs are aligned to Nevada Academic Content Standards in science, social studies, math, and English language arts.

Current statewide K-12 classroom programming includes:

- Nevada Knockout
- Know Your Nevada
- Wildlife Badges
- Project WILD

Upcoming statewide K-12 classroom pilot programs include:

- Wildlife Trunks
- Unpacking Urban Wildlife

Our objective is to continue to evaluate and grow our existing programs. Through communication with teachers and educators, content specialists, and school district administrators, we will make necessary changes to keep programming relevant to classroom teachers, homeschool teachers, and other diverse groups utilizing these programs. Communication with school district staff will also be important in creating new state-wide content and discovering where more content is needed. Working with tribes to incorporate appropriate Traditional Ecological Knowledge into our existing programs will be important moving forward. Growing and expanding these programs to get them in as many classrooms across Nevada as possible is a top priority. Staff capacity and physical distance from schools are our major hurdles. Expanding our volunteer instructor base, implementing virtual programming where and when appropriate, and calling on various environmental education partner organizations to assist with programming will be essential in growing these programs and ensuring we can expand programming to underserved and rural classrooms.

Interpretive Centers and Wildlife Education

Public Interpretive Programming

The Wildlife Education program engages the public through interpretive programming held in public spaces or virtually and is open to all ages. These programs cover a wide range of wildlife topics including but not limited to aquatic species, mammals, birding, nature hikes, bats, living with wildlife, and native plants. The goals of these programs are to connect people to nature in ways that are meaningful to citizens, whether it be through exposure to various wildlife, different forms of recreation, or even developing wildlife-friendly backyards and urban spaces.

NDOW currently has two interpretive centers in Reno: Verdi Nature Center and Oxbow Nature Study Area, and a newly updated Lake Mead Hatchery and Visitor Center in Las Vegas. These centers serve to connect the public to nature and the work that NDOW conducts. These centers also serve as locations for classroom programming in the form of field experiences, public interpretive programs and events, and passive interpretation through interpretive trails and signs throughout the sites. These centers are currently highly valued by the public but expanding and updating content will be important to continue attracting both new and return visitors into the future.

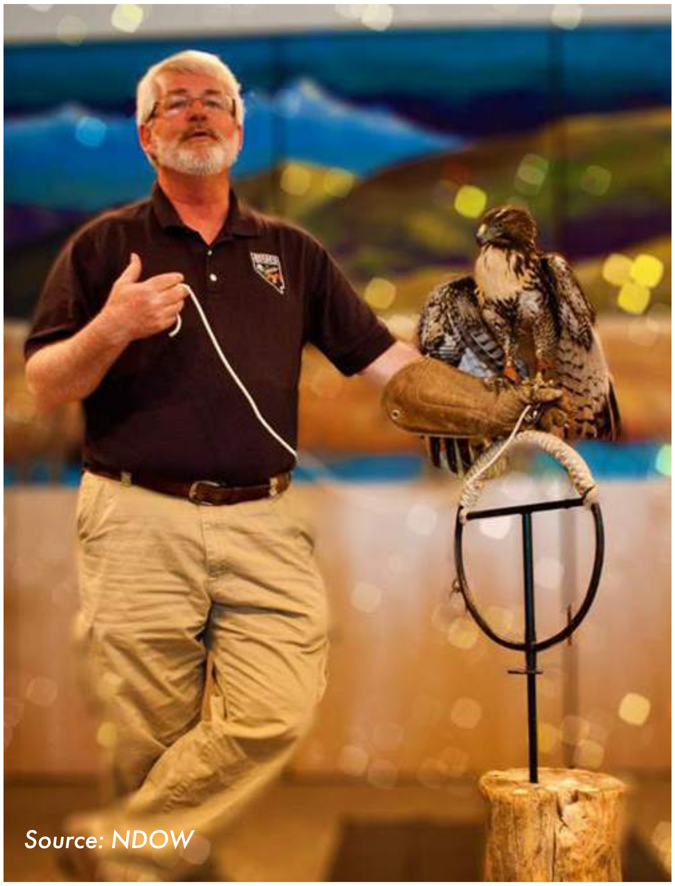
Equally important is developing new interpretive centers throughout the state to connect with Nevadans in their own cities and regions. NDOW aims to have at least one major interpretive center in each of the three administrative regions of the state. The eastern region lacks an interpretive center focused on wildlife and natural resources so this will be a priority area to target for development.

The southern region only has a small interpretive site at NDOW's hatchery, but this region has the largest urban population in the state, so it is a priority to develop a large center, similar to the western region sites. Finally, all regions have additional small-scale opportunities to develop interpretive sites to connect with a variety of urban and rural communities.

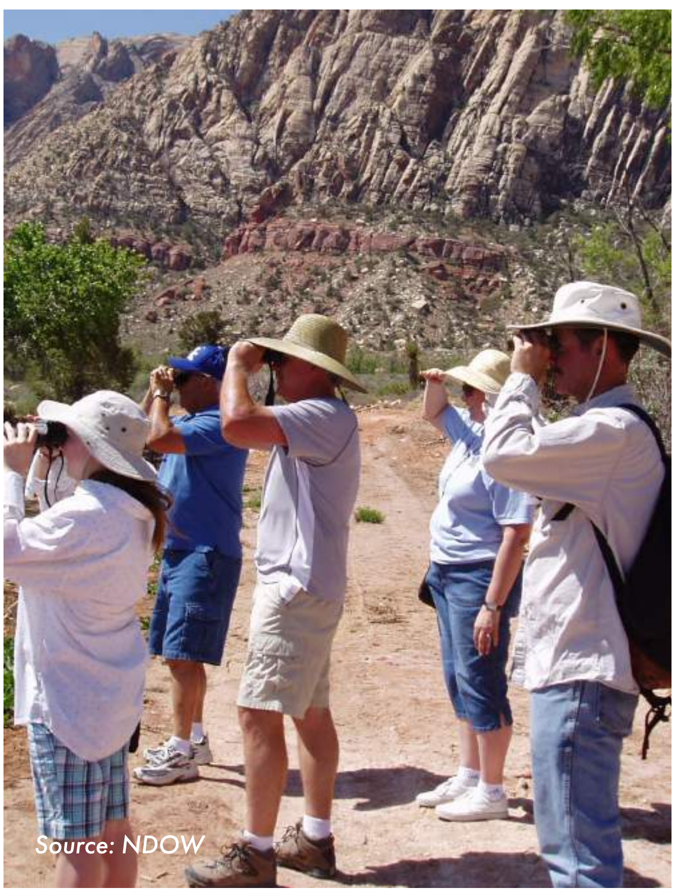
Interpretive trails around the community are a passive way to connect the public to their wildlife resources. NDOW staff not only maintains interpretive trail signs at our own sites, but also advises on, creates, and funds interpretive signage on partners' sites. These sites include popular wildlife viewing locations such as Hemenway Park and Clark County Wetlands Park in Southern Nevada.

Below are NDOW's objectives for public interpretive programming:

- Recruit and train more instructor volunteers to grow these programs. Staff capacity is our biggest hurdle to expanding and diversifying our offerings.
- Grow and nurture existing and future partnerships with non-governmental organizations (NGOs), other state agencies, and federal agencies to help expand interpretive programs, identify desirable locations for programming, expand capacity for programming, and enable NDOW to reach a larger, more diverse audience.
- Continue to evaluate website content to keep refreshed and engaging educational content available and targeted.
- Utilize new tools to diversify how programs are produced and distributed to the public to keep our interpretive programming relevant. Virtual products such as Zoom webinars will continue to be employed and new ways to use the platform to engage the public in interpretive programming will be developed. Other technologies such as trail cam footage, live webcams, and virtual apps such as Goose Chase and Agents of Discovery are options to enhance our interpretive programming.
- Explore new ways to offer our programming to non-English speakers and use English Language Learners (ELL) teaching strategies and closed-captioning technology in virtual programming.
- Update current interpretive centers to make the experience at those locations more relevant and more conducive to wildlife viewing, especially to diverse audiences.
- Identify appropriate locations for more interpretive centers across the state to make our messaging more consistent and provide more equal interpretive opportunities across the state.
- Identify appropriate locations to develop interpretive trails around urban areas to help passively inform the public about wildlife in the areas they choose to recreate in and create lasting connections to nature.
- Develop or update signs on new and existing trails to keep them accessible to diverse audiences, relevant, and in good condition.
- Continually develop new and engaging materials and programming to encourage constituents to continue to engage with NDOW as well as appeal to currently underserved groups.



Source: NDOW



Source: NDOW

Outreach and Public Wildlife Education

While Nevada's population has grown, the state has become increasingly more diverse. Diversity has increased in race, ethnicity, language spoken, and values among other categories.

For example, today 69.8% of Nevada's population speak only English with 30.16% speaking languages other than English. The most common languages spoken other than English are Spanish and Tagalog respectively. Tailoring our outreach programming to be applicable and engaging to our diverse audiences is essential to getting our conservation messages across.

Remaining relevant to our growing and changing population is essential for effective outreach. Using new outlets such as a variety of different online tools, social media, podcasts, videos, and apps to connect with currently underserved constituents will be important moving into the future. Equally as important is making sure these multi-media outreach materials are accessible to diverse populations, and that we're creating these materials with specific audiences in mind.

Effective outreach will utilize many different types of media such as print, television, and radio, in addition to new social media and online tools. These outreach campaigns will vary in topic but will consistently include the following goals:

- Connect citizens to nature and the value of wildlife as an important quality of life component
- Provide information in languages other than English
- Enhance public understanding of the interconnectedness of wildlife and the ecosystems upon which they rely, including connections to human health and well-being (OneHealth)

- Engender support for wildlife and the programs that support wildlife.

We will employ the following general strategies and objectives:

- Utilize data from surveys to determine what media outlets are being consumed the most by our current constituents and new audiences and develop tailored materials based on this information.
- Proactively learn about new media apps/ tools and their best practices as it applies to wildlife agencies.
- Prioritize sharing news and stories of the full array of work NDOW engages in across all divisions, species, and habitat types.
- Include diverse types of news outlets to our list for press releases to ensure that stories and content are widely available.
- Invest in high-quality video equipment and expertise to build engaging video series that can be multi-use, including long and short formats for various platforms.
- Increase the promotion of the Nevada Wild podcast, expand and diversify topics covered, and invite diverse guest speakers.
- Target outreach to specific communities that we have built relationships with to ensure enduring partnerships are developed.
- Identify and address potential barriers that are hindering connections to diverse audiences.
- Provide support and training for agency staff to tell the conservation story.
- Engage in meaningful ways with the audiences and communities we would like to add to our constituency by inviting participation and partnership opportunities.

Urban Wildlife and Living With Wildlife Programs

The increase in urbanization and development within Nevada has led to encroachment on wildlife habitats. As a result of this, we've seen a large increase in the number of encounters between humans and wildlife. As an agency, we are often the first point of contact in the event of a wildlife encounter in an urban area. Not all encounters are negative, but many of the calls we respond to are a result of a person lacking information about wildlife in our urban corridors.

Urban Wildlife Programming

The Urban Wildlife program is designed to address this issue and falls under the Wildlife Education programming. The goals of the program are focused on mitigating and reducing human-wildlife conflicts, as well as empowering the general population to make good wildlife decisions in and around their homes. This sector of education and interpretation is especially important in conserving wildlife and habitats because of the increased interaction of people with wildlife.

This program utilizes K-12 classroom and interpretive programming, and outreach campaigns, as detailed above, as well as staff to respond to human-wildlife conflicts. This program was created in 2016 and utilizes staff from several different divisions within NDOW. Educators, Law Enforcement, and Biologists all play a role in responding to calls and educating the public.

Objectives for this program include:

- Grow a well-trained volunteer force to assist with responding to calls in the field and facilitating education programs.
- Utilize wildlife log data to target education campaigns based on community and species.

- Expand and diversify public programming.
- Utilize social media applications, such as Facebook and Nextdoor, to target communities with tailored campaigns.
- Partner with wildlife services, animal control, and private pest control companies to ensure correct and appropriate information on wildlife and wildlife conflict is being given to the public.
- Continue to evaluate website content to keep refreshed and engaging content available and targeted Living with Wildlife content available to assist with public inquiries and concerns.
- Increase education on wildlife corridors and migration corridors, especially as they relate to urban landscapes.
- Empower the public to independently prevent and mitigate human-wildlife conflicts in ways that benefit wildlife and themselves.
- Create a communications plan to accurately and efficiently provide information to the public in emergency human-wildlife conflict situations.

Wildlife Viewing and Nature Tourism

Building a dedicated watchable wildlife program called the Nevada Wildlife Discovery Program, is a crucial element in informing and connecting Nevadans to their wildlife resources and building conservation support. With over 90% of Nevada residents living in urban areas, much of Nevada's population is unaware of the area's wildlife, ways to enjoy it, and the impacts they have on it. Therefore, there is a need to offer opportunities for viewing and learning about Nevada's natural wildlife resources.

The Nevada Wildlife Discovery Trail

An engaging wildlife viewing program would enable the public to guide their own recreation and learning using print and online tools, bioblitzes and community science, and interpretive centers and trails. The overarching goal is to tie interpretive trails, print materials, and public spaces together to create a statewide wildlife and birding trail called the Nevada Wildlife Discovery Trail. By doing this, NDOW will facilitate recreational opportunities to view and enjoy wildlife in both rural and urban environments at locations across the state, connect Nevadans with nature in a variety of ways, and encourage personal stewardship in conservation.

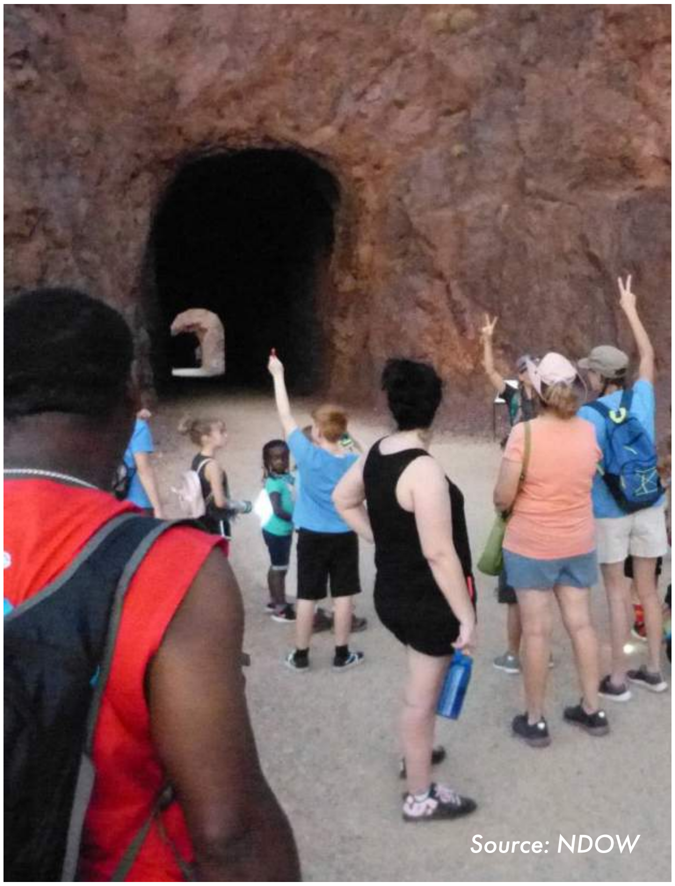
The Nevada Wildlife Discovery Trail will be the thread that ties together our wildlife viewing efforts. This 'trail' will be a series of wildlife viewing and birding hotspots throughout the state. NDOW Wildlife Management Areas, hatcheries, and interpretive centers will be featured as sites along the trail; however, any space open to the public that provides a great location for wildlife will be considered as a potential site, including partner areas such as city, state, and federal parks. Discovery Trail sites will be featured in publications, primarily web but print as well, that will help guide people to the location, inform them on what can be seen and when, what amenities are available, and what recreational activities are allowed.

NDOW will create educational and interpretive support materials based on the regions identified for the trail such as birding checklists, animal track guides, plant guides, leave no trace information, and living with wildlife information. These materials will be offered both in physical form, on kiosks and interpretive signs, and using web-based tools. Web-based tools will be in the form of the NDOW website, partner websites as appropriate, and a watchable wildlife app. Educational and interpretive in-person programming at identified hotspots entices people to visit these locations as well as offers an immersive opportunity to learn about and view their wildlife.

The trail will also be used to engage Nevadans in volunteering and community science projects. Through our volunteer program, we will deploy trained volunteers to trail sites to provide stewardship as well as monitor sites for wildlife sightings. These sightings will be logged in the appropriate community science project data collection apps such as iNaturalist and eBird. We will use trail sites as locations for new wildlife education events such as bioblitzes as well as sites to promote existing events put on by our partners.

The following are objectives to complete and enhance the trail:

- Create various partnerships to build the Discovery Trail
- Build and implement a wildlife viewing app that not only directs people to various opportunities but allows reporting on site conditions and through partnerships with iNaturalist and eBird, also reports on wildlife sightings.
- Continue to evaluate website content to keep refreshed and engaging targeted wildlife viewing and recreation content available to assist with public inquiries and concerns.
- Work closely with Travel Nevada to avoid duplication of materials and create storylines that are synchronous with their already existing promotions.
- Partner with and expand the Nevada Naturalists University of Nevada Reno Extension volunteer program to deploy qualified volunteer stewards at trail sites.


Source: NDOW


Source: NDOW

- Build strong relationships with NGO, state, tribal, and federal land management.
- Build strong relationships with tourism in counties and cities where appropriate.
- Partner with appropriate organizations, such as Audubon chapters, to create relevant educational materials, such as regional bird checklists.
- Coordinate with other state and federal agencies to incorporate existing sites and programming into The Nevada Wildlife Discovery Trail.
- Identify and establish dedicated funding sources for trail maintenance, expansion, and associated support materials.
- Identify what species would benefit from community science projects at specific sites and build projects around identified needs.
- Build a diverse, relevant, and accessible cadre of outreach outlets and materials to promote the trail and recreational opportunities to all Nevadans, including currently underserved constituents.

Watchable Wildlife Programs

In addition to conservation benefits, there are economic benefits, especially in rural areas, from expanding watchable wildlife programs. According to the 2016 USFWS National Wildlife Recreation Survey, 101.6 million Americans over the age of 16, or 40% of the U.S. population, engaged in some form of fishing, hunting, or wildlife-associated recreation. These individuals spent roughly $156.3 billion, or 1% of the U.S. Gross Domestic Product, on expenditures related to these activities. The most notable increase in these activities is the number of Americans partaking in wildlife viewing. Over 86 million people aged 16 and older participated in wildlife watching in some form including feeding, photographing, or observing wildlife in 2016, spending $75.9 billion on related expenditures. This is an 18% increase since the survey was conducted in 2011. The Wildlife Discovery program would prove beneficial in the following ways:

- Increase broad-based support for conservation efforts.
- Increase support for public funding mechanisms (including tourism and support for local economies).
- Increased understanding of urgent conservation and human impact issues.
- Increase in positive constituent culture and capacity to inform and improve policies that affect species of greatest conservation need through establishing relationships with existing communities of naturalists (iNaturalist, eBird).

Implementation and Effectiveness Monitoring

While the Conservation Education division of NDOW is generally the lead in developing programming and implementing the goals and objectives as outlined here, NDOW recognizes that all staff can increase the relevancy of the agency and connect Nevadans with wildlife and their habitats. Additionally, strong partnerships with state, federal, tribal, and NGO partners are critical to the success of implementing these actions. Throughout the implementation of the SWAP, NDOW will seek opportunities to create lasting partnerships that build connections with underserved constituents and increase the knowledge and stewardship of Nevada's wildlife and wild places.

NDOW will track and monitor the number of classroom students engaged and the number of participants attending wildlife education programming and send regular teacher surveys to evaluate whether education goals and objectives are being met. Our success in achieving outreach objectives will be measured by using a suite of tools to evaluate our online presence across our social media platforms and our website. Online survey mechanisms, focus group surveys via telephone and print, and regional focus groups, will be applied as necessary to help identify which outreach, education, and watchable wildlife goals and objectives are being met. Additional metrics for measuring success include the numbers of new interpretive sites developed, visitor usage of sites, and progress on the development of the Nevada Discovery Trail.


Source: NDOW

Source: NDOW

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