NEVADA WILDLIFE ACTION PLAN

Developed by the:
Wildlife Action Plan Team

Final

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Wildlife Action Plan Revision

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The Nevada Wildlife Action Plan revision is the result of the hard work of numerous partners whose contributions range from technical input to text review, to drafting some portion of the plan. This work was a team effort in every sense. However, special recognition goes to Larry Neel, retired Wildlife Diversity Division Staff Specialist for the Nevada Department of Wildlife, for his role in the delivery of this revised Wildlife Action Plan. Larry's vision, commitment and vast knowledge of the wildlife resources of Nevada are evident throughout the plan. During the development of the plan, Larry had a unique talent for integrating predicted habitats changes into wildlife species response and then developing conservation strategies for threats posed by climate change and other agents of change. The revised Wildlife Action Plan is an innovative, progressive blueprint for wildlife conservation in Nevada, thanks in large part to Larry's efforts.

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EXECUTIVE SUMMARY

Congress passed the State Wildlife Grants program (SWG) in 2001 in recognition of the need for funding of wildlife diversity programs. Congress mandated each state and territory to develop a Comprehensive Wildlife Conservation Strategy (now named Wildlife Action Plans) by 2005 in order to continue to receive federal funds through the SWG program. Nevada's Wildlife Action Plan (WAP) was completed and approved by the U.S. Fish and Wildlife Service (USFWS) in 2005. Nevada's WAP has served as a plan of action for state wildlife conservation and funding by targeting the species of greatest conservation need and the key habitats on which they depend. To date, NDOW has received over $11 million in federal dollars through the SWG program.

NDOW has been coordinating and leading a conservation partner planning team to revise Nevada's Wildlife Action Plan to incorporate the potential impacts of emerging and expanding stressors including climate change, accelerated energy development, invasive species, and disease on Nevada's fish, wildlife, and habitats. NDOW partnered with the original Wildlife Action Plan team: The Nevada Natural Heritage Program, The Lahontan Audubon Society, The Nature Conservancy, and also The Great Basin Bird Observatory to develop this revision to the plan.

Among the 50 states, Nevada ranks eleventh in overall biological diversity and is unfortunately ranked fifth in the number of species extinctions. Nevada's diversity of life is derived from its geography; the many mountain ranges are effectively isolated from one another by arid and treeless basins. Nevada's borders encompass about 71 million acres, making it the seventh largest state. The federal government administers 86% of the land base.

Nevada is uniquely challenged in approaching effective wildlife conservation in part because of its arid climate, geography and limited water resources, which has created a unique endemic biota easily subject to threats and stressors. Throughout Nevada, water is a scarce and valuable resource essential for both human needs and maintenance of wildlife and their habitats, thus the alteration of hydrologic resources is a significant source of stress to wildlife resources. Invasive, exotic and feral species are critical problems facing both terrestrial and aquatic species and habitats in Nevada.

NDOW has been coordinating with state, federal, and local agencies, and conservation organizations to gather pertinent information for the plan revision. Public scoping meetings were held the winter of 2012 in Elko, Las Vegas, and Reno. We have been working with multiple stakeholders to assess key habitats and species most likely to be affected by these stressors and have developed effective strategies for managing and mitigating impacts. By identifying key conservation actions, we will be in a stronger position to ensure ecosystem resiliency across the changing landscape for key habitats and species. A major project theme will be "keeping common species common" through the constant assessment of the status and needs of wildlife and their habitat and the initiation of responsive action before critical thresholds are crossed.

This Nevada Wildlife Action Plan Revision (2012) is organized into 11 major sections:

- Introduction
- An Overview of Nevada
- Approach & Methods
- Nevada's Wildlife Heritage
- Challenges in Wildlife Management
- Identification of Species of Conservation Priority
- Defining Nevada's Landscape for Wildlife
- The Conservation Strategies for Nevada's 22 Key Habitats and Their Associated Wildlife

- Key Partnerships and Implementation Mechanisms
- Conservation Education and Watchable Wildlife
- Species Accounts

The sections are intended to complement each other and work together to describe the overwhelming task of comprehensive wildlife conservation in Nevada, the partners expected to participate in its ultimate achievement, and the expectations and methods of implementation.

With the help of experts from all taxonomic fields, the WAP Team identified a total of 256 Species of Conservation Priority. The various ecological systems of the state were organized into 22 key habitat types. Multi-level strategies were devised for these 22 key habitats that integrate conservation needs for species assemblages as well as individual species. Each strategy describes the habitats, their values to wildlife, land uses within the habitat and problems facing the species and habitats. This information provides support to the goals, objectives and actions that follow. The objectives and actions are derived from existing conservation plans, where available, and feedback from multiple meetings with species experts and conservation partners during the revision of the WAP. Each strategy includes a list of key conservation partners, programs, and projects likely to fulfill the objectives for each key habitat, and identifies preliminary focal areas for action through a process that involved coordination with partners and concurrent planning processes.

As in the 2005 plan, it will be the task of Nevada’s wildlife conservation partnership to evaluate the 22 strategies, set priorities, design implementation plans, monitor progress and evaluate the results. The WAP describes work prioritization and quantifiable objectives, key partnerships and implementation mechanisms, including several proposed examples to achieve successful implementation of the WAP. During implementation of Nevada’s WAP, it is critical to recognize the importance of monitoring success and adjusting priorities and actions (adaptive management).

HOW TO USE THIS PLAN

Use of this Plan

The Nevada Wildlife Action Plan (WAP) serves as a comprehensive, landscape level plan, identifying the species of greatest conservation need and the key habitats on which they depend, with the intent to prevent wildlife species from becoming threatened or endangered. The WAP contains conservation actions to provide guidance to successfully conserve Nevada's key habitats and priority species. Many of the conservation actions within the WAP are strategies identified in other existing conservation plans. The WAP's recommended conservation actions in no way represent a mandate or expectation for a given party to carry out or implement these actions. During WAP implementation, conservation actions developed at the state or local level would be used to provide guidance to address site-specific conditions as appropriate. Some of these actions may be applicable at the land use plan level, and some more appropriately applied at an activity plan or site-specific plan level.

The next step in the ongoing implementation phase will be to tier down possible actions identified in the WAP that will form the basis for prioritized work plans, site-specific decisions, and planned actions. Wildlife conservation partners and stakeholders will be encouraged to contribute to and review these implementation processes.

Guiding Principles

Conservation partners from the Governor's Sage-Grouse Conservation Team convened in May 2005 to develop a set of "guiding principles" for the WAP writing team while preparing the Draft Plan. The guiding principles decided upon included:

- the WAP is a guidance document for enhanced conservation, not a de facto regulatory document
- the WAP will function as a usable document incorporating adaptive management theory
- the WAP is a road map linking existing plans into common effort
- the WAP is primarily focused on the conservation of wildlife
- the WAP operates under a collaborative process
- the WAP recognizes all authorities, jurisdictions, and citizen's rights, including property rights
- the WAP is primarily designed to address the needs of species before they become imperiled through the creation and implementation of incentives, services, and benefits
- Regulation is recognized as a sometimes necessary mechanism when voluntary processes fail; regulation should be developed as an open, collaborative, citizen based process.

These guiding principles continue to hold true in this 2012 revision of the Wildlife Action Plan.

2012 Nevada Wildlife Action Plan Revision Structure

The Nevada Wildlife Action Plan Revision (2012) is organized into 11 major sections that are intended to complement each other and work together to describe the overwhelming task of comprehensive wildlife conservation in Nevada, the partners expected to participate in its ultimate achievement, and the expectations and methods of implementation.

- **Introduction** describes the purpose and intent of the WAP, its legislative mandate, and the major guidance provided by Congress.

- **An Overview of Nevada** describes the nature of Nevada's ecological setting, its socioeconomic history, and the land ownership mosaic.

- **Approach & Methods** describes the methodologies that were utilized during the analyses of species of conservation priority, key habitats, climate change effects on wildlife, and developing conservation strategies.

- **Nevada's Wildlife Heritage** describes the state's current wildlife resources as influenced by geological and historical processes – why Nevada has the species it has, and why and how species develop conservation risk. The process for determining the Species of Conservation Priority to be featured in this strategy is described in general terms in this section, with a detailed description of the species prioritization processes used occurring in Appendix D.

- **Challenges in Wildlife Management** describes the issues influencing wildlife conservation, anthroprogenic, and natural in origin. Issues ranging from climate change to invasive species to development are discussed.

- **Identification of Species of Conservation Priority** describes the methodologies that we utilized during the analysis of species of conservation priority. The process for determining the Species of Conservation Priority to be featured in this strategy is described in general terms in this section, with a detailed description of the species prioritization processes used occurring in Appendix D.

- **Defining Nevada's Landscape for Wildlife** discusses the development of the ecological framework for strategy development. Here, the reader can find the process for developing the 22 Key Habitats from Southwest ReGAP habitat type inventory to provide the basic strategy units (the Key Habitats), the process by which we linked Species of Conservation Priority to the 22 Key Habitats to interlock species conservation strategy development with habitat types, and the process by which we identified potential focus areas where conservation strategy for the species and key habitats was likely to be applied. In addition, the reader will find the various landscape scale conservation-based efforts, initiatives, and/or cooperatives that have been developed in recent years to streamline land management efforts throughout Nevada.

- **The Conservation Strategies for Nevada's 22 Key Habitats and Their Associated Wildlife** provides the main description of the conservation task at hand in Nevada. Here the reader will find descriptions of the 22 major habitat groups that occur in the state along with each key habitat's particular importance to wildlife, each key habitat's associated Species of Conservation Priority organized by the important features of the habitat type that most influence the presence of the species ("key habitat elements important to wildlife"). Included in this section are the predicted effects of climate change and wildlife responses to those effects, each key habitat's current condition, current land uses, and current problems in meeting its full contribution to statewide comprehensive wildlife conservation. A Conservation Strategy has been designed for each key habitat, consisting of goals written in terms of desired landscape conditions, directional objectives (increase, decrease, maintain) that are measurable with respect to their overall trend by the end of the planning period, and suggested management actions that could significantly contribute toward the movement of the objectives into the desired direction. While most management actions are habitat-based, working under the assumption that the most effective method for maintaining healthy, diverse wildlife populations is through responsible habitat management, some management actions are non-habitat-based and refer to a single species or sometimes groups of species. While species-based actions could occur across a variety of habitat types, we attempted to present actions in the habitat type that is key to their implementation to avoid redundancy in the text.

- The **Key Partnerships and Implementation Mechanisms** section describes how the conservation strategies from the Key Habitats section will be prioritized, compiled, and integrated into the appropriate planning processes, distributed for local working group implementation, monitored for effectiveness, collectively analyzed and adjusted to meet new perceptions of need. Methods of partnership development of WAP services and products and partnership guidance of overall implementation are discussed in this section.

- The **Conservation Education and Watchable Wildlife** section describes Wildlife Education objectives, Watchable Wildlife objectives, and also implementation mechanisms and effectiveness methodologies for Conservation Education in the WAP.

- For readers with a species-based focus, we have provided a separate section of **Species Accounts** that not only provide status, distribution, and natural history information for each Species of Conservation Priority, but also attempt to capture the conservation strategies from the Key Habitat discussions relevant to a particular species and consolidate them in one place for quick review.

INTRODUCTION

Purpose and Scope of the Nevada Wildlife Action Plan

The Nevada Department of Wildlife (NDOW) was charged with the development of a statewide Comprehensive Wildlife Conservation Plan, now called Nevada's Wildlife Action Plan (WAP). This planning process was required of each state to continue to receive federal funds through the State Wildlife Grants program. Nevada's original Wildlife Action Plan was completed and approved by the U.S. Fish and Wildlife Service (USFWS) in December, 2005. To date, NDOW has received over $11 million in federal dollars through the State Wildlife Grants program.

NDOW has been coordinating and leading a conservation partner planning team to revise Nevada's WAP to incorporate the potential impacts of emerging and expanding stressors including climate change, accelerated energy development, and invasive species on Nevada's fish, wildlife, and habitats. NDOW partnered with the original Wildlife Action Plan team: The Nevada Natural Heritage Program, The Lahontan Audubon Society, The Nature Conservancy, and also The Great Basin Bird Observatory to develop this revision to the plan. This partnership team was awarded a State Lands Question 1 Bond Habitat Conservation Planning grant in order to help fund these efforts.

We have been working with multiple stakeholders to assess key habitats and species most likely to be affected by these stressors and are developing effective strategies for managing and mitigating impacts. By identifying key conservation actions, we will be in a stronger position to ensure ecosystem resiliency across the changing landscape for key habitats and species. The benefit will be healthy and diverse wildlife populations across the state of Nevada. Primary focus will center on proactively preventing species from being listed as threatened or endangered as well as the restoration of species already listed. A major project theme will be "keeping common species common" through the constant assessment of the status and needs of wildlife and their habitat and the initiation of responsive action before critical thresholds are crossed.

The Original Eight Required Elements Addressed in the Nevada Wildlife Action Plan

This WAP sets a strategic vision for wildlife conservation in Nevada. To further clarify the vision, Congress requires addressing these eight elements in the WAP:

1. Information about wildlife species numbers and distribution,
2. Descriptions of key habitats and locations,
3. Descriptions of problems that may affect identified species and research needed to improve the situations,
4. Descriptions of proposed actions for conservation of the identified wildlife and their habitats,
5. Descriptions of how the species and results of the actions will be monitored,
6. Descriptions of how the strategy will be reviewed and updated on a periodic basis,
7. Coordination with federal, state, local agencies and Indian tribes if the plan impacts land managed by these groups, and,
8. Public participation to identify their priorities.

In 2009, the Association of Fish & Wildlife Agencies (AFWA) and U.S. Fish & Wildlife Service produced a series of guidelines for the states and territories with recommendations on how to incorporate climate change during a major revision of the Wildlife Action Plan. All revisions must continue to address the required eight elements as mandated by Congress, hence the guidance document, "*Voluntary Guidance for States to Incorporate Climate Change into State Wildlife Action Plans & Other Management Plans"* (Appendix A). The recommendations on how to incorporate climate change under each required element in this document provided important guidance to the revision of Nevada's Wildlife Action Plan. The Wildlife Action Plan Team also reviewed the "*Preliminary Draft State Wildlife Action Plan Best Practice*s" document being developed by the AFWA Teaming with Wildlife Committee State Wildlife Action Plan Best Practices Working Group, and have incorporated many of the proposed best practices into this plan revision.

NDOW and the Revision Team have been coordinating with state, federal, and local agencies, and conservation organizations to gather pertinent information for the plan revision. An overview of the revision process was provided to the Board of Wildlife Commissioners in December 2011. Public scoping meetings were held the winter of 2012 in Elko, Las Vegas, and Reno. The revised plan is expected to be completed and submitted to the USFWS for approval by summer of 2012.

AN OVERVIEW OF NEVADA

Physical and Natural Setting

Biophysical Regions and Major Habitat Types

Although Nevada is defined on the map by its political boundary, its interconnected landscapes are a subset of four ecoregions of the western United States. 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 communities.” The four ecoregions that overlap Nevada include the Columbia Plateau, Great Basin, Sierra Nevada, and Mojave Desert.

The Columbia Plateau is a broad expanse of sagebrush-covered volcanic plains and valleys in the semi-arid Intermountain West that is crossed by the large riverine systems of the Columbia, Snake, Boise, and Owyhee. The ecoregion covers over 301,000 square kilometers (116,220 square miles) of land – of which 97% is located in Oregon, Idaho, Washington, and Nevada, and the remainder in California, Utah, and Wyoming.

The Columbia Plateau is bordered to the south by the Great Basin ecoregion which encompasses more than 29,137,365 hectares (72 million acres) of semidesert from the east slope of the Sierra Nevada across much of Nevada to the Wasatch Mountains of the western Rocky Mountains in central Utah. Nevada is the most mountainous state in the U.S. with over 300 mountain ranges separated by long, broad valleys. The Great Basin is characterized by salt desert scrub and sagebrush shrublands in the valleys and the lower slopes, and by piñon-juniper woodlands, mountain sagebrush, 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.

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 and piñon-juniper in the lower elevations and an alpine zone characterized by bare rock, permanent snow fields, and a few grass or forb species.

Finally, the Mojave Desert 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.

Climate

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; the Mojave is the smallest of America’s hot deserts. These two physiographic provinces dominate the Nevada landscape. While the Sierra Nevada barely make a physical incursion into Nevada, its physical presence dominates the entire state by dictating rainfall patterns and vegetation patterns, which in turn strongly influence the distribution of wildlife in the state. The Sierra Nevada reaches an elevation of 4,265 m (14,000 ft). Rising in a relatively short distance from the Pacific Ocean, the principal source of moisture for the region, the mountains force westward-moving and moisture-laden air masses upward at a dramatic rate. The rising air masses cool, water condenses and forms droplets, and then precipitates as either snow or rain. Thus, the Sierra Nevada effectively rake the moisture out of storm fronts, collecting the moisture on their own granitic shoulders and growing impressive forests of fir, pine, and cedar. 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).

Average annual precipitation in Nevada is 23 cm (9 inches), making it the driest state in the nation. 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).

The average precipitation figure is misleading in that it masks a tremendous amount of variation across the state. The climate of the Great Basin-Mojave Desert region is one of the most varied and extreme in the world (Hidy and 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 noticeably more precipitation than adjacent basins.

Much of the precipitation that falls in the Great Basin arrives outside of the growing season, a problem that vexed settlers and established 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 gully-washers, 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. A temperature range between winter lows and summer highs of 150 degrees has been recorded in Elko (Trimble, 1989). A temperature swing of 40 degrees in any given summer day is not unusual. In the hot, dry, and usually cloudless summers, evaporation far exceeds precipitation. For example, at Pyramid Lake, evaporation exceeds precipitation by a factor of eight. Water evaporates from the surface of Lake Mead, in the Mojave Desert outside of Las Vegas, at the rate of 2.25 m (88 inches) per year–well above the 0.10 m (4 inches) of rain that falls in an average year in that region of the state.

The Mojave Desert is hotter and drier than the Great Basin. Precipitation here falls more typically as rain, though even more unpredictably than in the Great Basin, and it is just as likely to fall torrentially and run off rapidly. There is also considerable variation in the Mojave region. As with the Great Basin, higher ranges receive more precipitation, and the Spring Mountains outside of Las Vegas are often cloaked in snow during winter months–reliably enough to sustain a small ski resort.

Both the form and timing of precipitation in the Mojave, coupled with warmer temperatures, sustains 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 in order 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.

Geology

With 314 mountain ranges, Nevada's dominant topographic feature is its basin and range topography. Many writers, including John McPhee (1980), have found poetry in the rhythm of this landscape:

> *Each range here is like a warship standing on its own, and the Great Basin is an ocean of loose sediment with these mountain ranges standing in it as if they were members of a fleet without precedent, assembled at Guam to assault Japan. Some of the ranges are forty miles long, others a hundred, a hundred and fifty. They point generally north. The basins that separate them–ten and fifteen miles wide–will run on for fifty, a hundred, two hundred and fifty miles with lone, daisy-petalled windmills standing over sage and wild rye.*

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 that typically are thousands of meters thick and, in some valleys, more than 6,100 m (20,000 ft) thick. 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 this mountain building 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, then, the bedrock in the west and in a central band across the state is igneous in origin, and 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 and ultimately, faunal communities.

The area, that is now the state of Nevada, experienced other past forces that shaped the geological landscape. Several periods of volcanic activity deposited extensive lava flows and ash. The Owyhee Uplands of the Columbia Plateau in northern Nevada are one of the landscapes shaped by this activity. The presence of the landform 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 land's genesis in molten rock.

At various times in its geologic history, extensive parts of the state have either been ocean or lake front property. Until half a billion years ago, most of Nevada did not exist and instead an ocean stretched westward from what was the edge of the North American continent. A broad carbonate reef began to form along the margin of the continent, extending west into the ocean. In a series of events over the next 300 million years, tectonic plates collided with the edge of the continent and progressively added land mass to western North America. At first, oceans receded during the collisions and then advanced, but oceanic sedimentation finally ceased about 200 million years ago.

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 enough and sustained 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 and sedges. The limestones that formed beneath the oceans now form a major regional aquifer beneath much of northeaster, eastern, and southeastern Nevada, and springs flowing from this aquifer are important water sources for plants and animals.

Also during the Pleistocene and related to the formation of Lake Lahontan, 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, acts 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).

The high Sierra Nevada range, which only began its rapid rise 3-5 million years ago, efficiently strips water from east-moving storms and creates the pronounced rain shadow that has produced the characteristically dry climate in Nevada. Yet, to a visitor surveying this arid landscape, it may come as a surprise that water is the dominant force shaping the land. By watching an arroyo following a downpour as it disgorges a viscous sludge that is half earth and half water, one receives an effective demonstration of the power of water to episodically but rapidly shape the landscape.

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. There are two conditions which have supported these unique plant-invertebrate associations. 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., 1998). These sites, in contrast to the surrounding sagebrush-dominated landscape, are characterized by the presence of Jeffrey or ponderosa pine, and many of them harbor an endemic species of buckwheat. 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, are associated with endemic species of bees.

Another specialized soil condition occurs in the network of Holocene era sand dunes scattered across the state. Extraordinary specialization and speciation has occurred in plants and animals at many of these 32 sites. Beetles are the best studied invertebrate group in Nevada's sand dunes, and many new species have been described from these locales. Butterflies, crickets, and a species of weevil are also unique to these habitats. Many of these species are highly endemic and confined to one or a few small dunes (Brussard et al., 1998). As a whole, the invertebrates of Nevada are poorly studied and it is likely that the occurrence of endemism is far more widespread in these groups than is currently documented.

Fish and Wildlife Resources

Among the 50 states, Nevada ranks eleventh in overall biological diversity (Stein, 2002). Unfortunately, the state follows only Hawaii and California in terms of threats to its species, and Nevada is ranked fifth in the number of species extinctions. From a biological point of view, the Great Basin and Mojave Deserts are landscapes of enormous subtlety. The vast and apparently monotonous expanses of sagebrush actually represent a dozen different species, and many more subspecies. Most of the animals accomplished at life in these deserts are colored to blend in with the rocks and vegetation to avoid detection in a land that holds few hiding places. Explorer John C. Frémont declared the region to be "deserving the full examination of a thorough exploration." Nevada does not reveal its nuances to a car traveling 70 miles per hour across Highway 50.

Nevada's tremendous diversity of life is derived from its geography. The many mountain ranges with winter snow pack, trees, meadows, and tumbling streams are effectively isolated 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, and some insects, populations have likewise become isolated from one another on these montane islands. Over time, this isolation has led to the evolution of new subspecies and species.

The principles of island biogeography explain other aspects of the state's diversity 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 species to populate the island); and the smaller the island, the fewer species the island can sustain. The "mainlands" for the Great Basin province 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, ranges such as the Toiyabes and Monitors 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 in their affinity with the Rocky Mountains. A similar pattern has been documented in mammal populations in Nevada.

While mobile species like birds might be expected to be unaffected by the effects of distance and island size, such is not the case. The reduced number of plant species in the interior mountain ranges translates to lower habitat diversity, which in turn, offers fewer niches for birds to occupy, and thus fewer species overall.

One other characteristic of the Nevada landscape and subsequently its wildlife worth noting is that, resources, principally food and water, occur in abundance in only a few noteworthy places. Across the remainder of the state, such resources are widely scattered at a low density. The distribution of wildlife tends to reflect the distribution of food and water resources, and therefore with few exceptions, wildlife species are not found in high densities within their Nevada ranges. This factor does not reduce the value of wildlife to the health of the natural environment, or the value it brings aesthetically or economically to the state.

With the exception of 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 systems (Wuerthner, 1992). In general, they originate at springs on the flanks of mountains, 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 globe was considerably wetter than it is today, and lakes covered significant parts of the state. 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 (pyrgs) and pupfish that once resided in enormous lakes now persist in tiny seeps and springs, each population cut off from its nearest neighbor, often by miles of desert. Over time, these populations have evolved into species, each uniquely adapted to their tiny corner of the world.

Nevada has 46 endemic species of fishes – species occurring nowhere else in the world. With the human reliance on water, nearly all rivers, springs and aquifers are tapped and at some point dewatered, and this natural competition for water has left the state with more endangered fish species than any other state (Wuerthner, 1992). At least seven Nevada fish species are known to have become extinct, while four other species no longer occur in Nevada although other populations persist beyond the state borders.

One famous example of endemism 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 spring itself is actually at the bottom of a hole, a defile in the rock, wherein resides the world’s entire natural population of the Devil’s Hole pupfish. Below Devils Hole and 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, amidst some of the most inhospitable desert found anywhere. This is one of the state’s nuances, and a profound experience for those who visit Devil’s Hole.

Land and Resource Management

Nevada's borders encompass about 28,732,680 hectares (71 million acres), making it the seventh largest state. The federal government manages approximately 24,685,825 hectares (61 million acres), or 86% of the land base. Of the remaining 14% (approximately 4,046,855 hectares; 10 million acres), 11.5% is private, 1.6 percent tribal, and the remaining 0.8 percent is under state or local government ownership. On a percentage basis, Nevada has more federal land than any other state in the Lower 48. Land status is illustrated in Figure 1. At least 90% of the land in Esmeralda, Lander, Lincoln, Nye, and White Pine counties is federally managed, while overall, 50% or more of the land in each county is federally managed, except the two smallest counties (i.e., Storey and Carson City).

The majority of BLM and USFS land in Nevada is managed under multiple use and sustained yield policies mandated by federal statutes. Multiple uses 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, wild horses, biological diversity, forage production, forest health, watershed conditions, wildlife habitat, motorized recreation, and noxious and invasive weeds.

The Bureau of Reclamation has jurisdiction over a large area of the Great Basin and a smaller portion in the Mojave within Nevada. The main area of BOR activities is in the Colorado, Walker, Carson, Truckee, and Humboldt River basins, where there are five operating Reclamation projects and one resource management project.

State land management agencies are similarly mandated to manage resources according to multiple use and sustained yield principles, as defined by state law. State lands include 11 wildlife management areas, 24 state parks, and 500 parcels (91 hectares; 225 acres) of other state lands. There are approximately 3,237,485 hectares (8 million acres) of private land in Nevada. Land uses of private lands are predominantly urban and suburban development and agriculture.

Nevada Stewardship Map

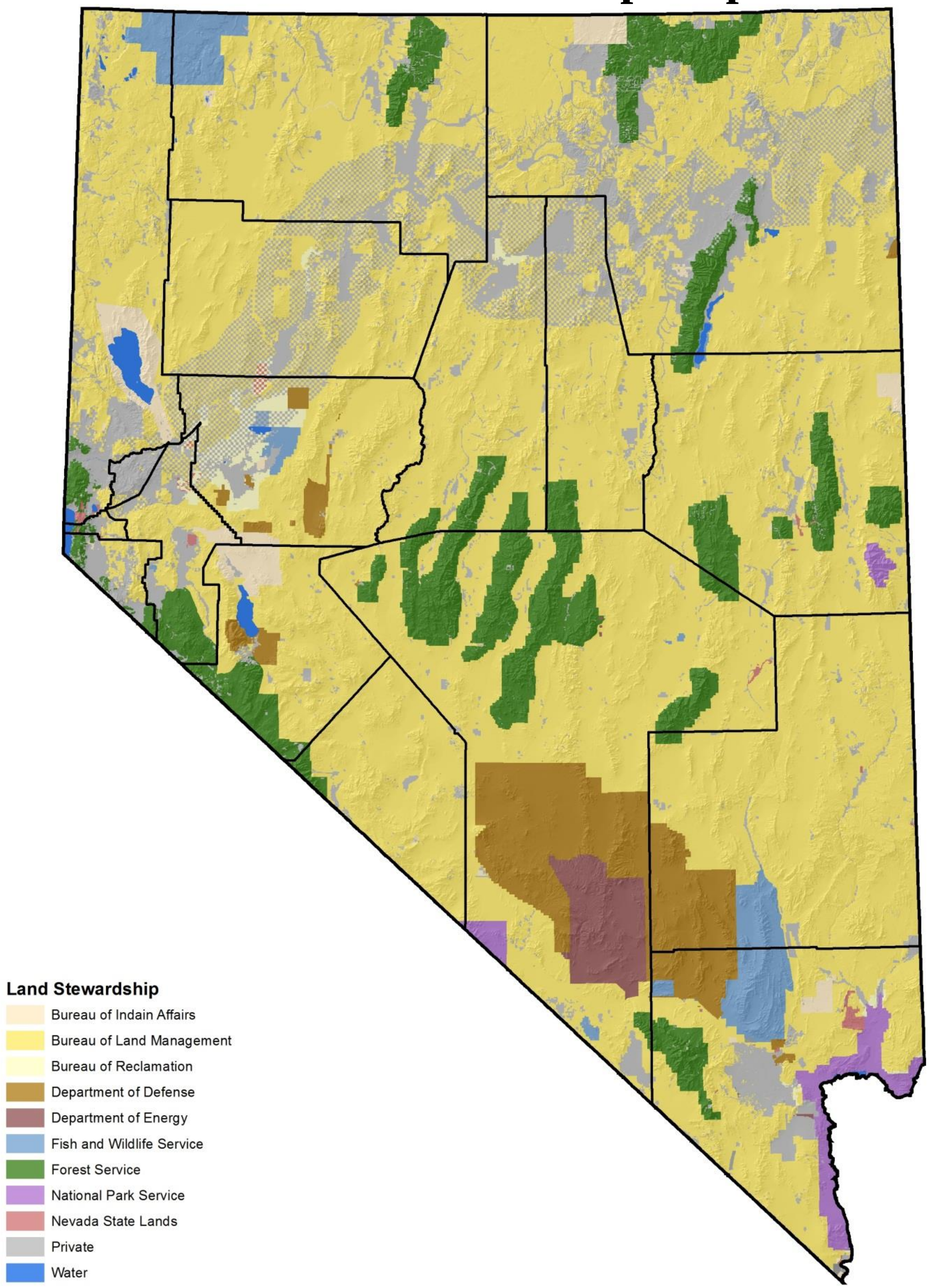


Figure 1. Map of Nevada indicating land ownership/land management patterns.

Human Demographics and Impacts

Up until 2009, Nevada was the fastest growing state in the nation, with three of its most populous cities in the top 20 for growth nationwide. Based on the 2010 U.S. Census study, Nevada experienced a 35% population increase statewide (U.S. Census Bureau, 2010). More specifically, Clark County underwent a 47% population increase (U.S. Census Bureau, 2010) between 2000 and 2010 which also brought about increased infrastructure (roads), housing developments, power lines, and shopping centers, often in areas where wildlife once roamed. Nevada is the most urbanized state in the nation, with nearly ¾ of its 2.7 million human population associated with the cities of Las Vegas, Henderson, and Reno.

Even the once-remote rural areas of the state are impacted by population growth. One of the greatest population increases within the state occurred within Lyon County with a 51% countywide increase, particularly in the rural communities of Fernley, Dayton, and Yerington (U.S. Census Bureau, 2010). Rural communities strain to keep up with the influx of urban dwellers fleeing the cities; out-of-state manufacturers moving into a low tax environment; and energy developers pursuing new technology or areas to develop new resources.

Survey data reported as part of Colorado State University's "Wildlife Values in the West 2004" (Teel and Dayer, 2005) survey project provides a baseline for residents' attitudes about wildlife and threatened species. The survey of 633 residents identified 15 activities that Nevada Department of Wildlife may focus on in the coming years, and asked participants to rank their level of importance. "Protecting fish and wildlife in Nevada that are endangered or at risk of becoming endangered," ranked third overall, after apprehension of wildlife violators (first priority) and promotion of boating safety (second priority). In a survey question where agency fiscal constraints were identified as a limiting factor, and participants were asked to identify which 3 of the 15 activities should be chosen, "Protecting fish and wildlife in Nevada that are endangered or at risk of becoming endangered," rose to the top, with 197 respondents supporting this activity as one of their top three priorities.

In that same survey question, it is worthy to note that the second and third priorities overall were for "Managing for adequate populations of all fish and wildlife in Nevada," (second priority) and "Protecting, restoring or acquiring lands to support many different types of fish and wildlife," (third priority). From these responses, it is clear that not only do Nevadans feel strongly about managing all fish and wildlife species, but that they understand that protection and restoration of lands is an essential part of this process.

APPROACH & METHODS:
Overview

Organizational Structure

Nevada Department of Wildlife identified its Wildlife Action Plan Development Team in August, 2004 through the application for a conservation planning grant from the State of Nevada's Question One Conservation Bond and Resource Protection Grant Program. The partnership to develop the Nevada WAP included The Nature Conservancy's Nevada Chapter, the Lahontan Audubon Society, and the Nevada Natural Heritage Program. The Q1 grant was awarded by Nevada Division of State Lands in October, 2004, and the team commenced work on the deliverables for Phase I of the WAP. The primary objective of Phase I was assembling Nevada's WAP.

Phase II began immediately after Plan approval and focused on implementation of the WAP. Some key achievements of the Nevada Wildlife Action Plan Team that "stepped down" from the WAP included the completion of the Nevada Wetland Priority Conservation Plan led by The Nevada Natural Heritage Program, the completion of the Steptoe Valley Conservation Action Plan, a project led by The Nature Conservancy to demonstrate techniques for stepping down Wildlife Action Planning to local scales, and the revision of Nevada's Partners In Flight Conservation Plan (now the Nevada Comprehensive Bird Conservation Plan) led by Great Basin Bird Observatory. Other stepdown planning efforts included the Springs Conservation Plan, a collaborative effort between Nevada Natural Heritage Program and The Nature Conservancy, and a county-planning/WAP integration project led by Nevada Audubon. All these stepdown planning projects were funded by Question One grants.

The Climate Change Challenge

In anticipation of major climate change policy and funding emanating from Congress, in early 2008, the Association of Fish & Wildlife Agencies (AFWA) encouraged states to update their Wildlife Action Plans to address the predicted effects of climate change in their state. Options were suggested to either add a chapter discussing the effects of climate change or to conduct a full revision of their 2005 Plan. The Nevada Team anticipated the effects of climate change to be somewhat dramatic in Nevada to the point that the Species of Conservation Priority list might significantly change as well as the focus on key habitats based on their predicted responses, so Nevada opted for a full revision with climate change analysis pulled through every aspect of analysis and strategy. The "climate change revision" effort was initiated in May 2008 and plans were made to secure another Q1 grant to fund the revision partnership. NDOW also received State Wildlife Grant funds to support agency staff in the revision of this plan. In addition, the Nevada Team reached out to key representatives of the major federal resource management agencies – Bureau of Land Management, U.S. Forest Service, U.S. Fish and Wildlife Service, and Bureau of Reclamation for membership on the team. All four agencies responded with designees. Major elements of the revision process that the Team developed and funded through the Q1 grant are described by header below:

Habitat Analysis

The Nature Conservancy took on the task of predictive modeling of climate change effects on Nevada's vegetative communities. The methodology used by TNC is Landscape Conservation Forecasting™ (formerly Enhanced-Conservation Action Planning; Low et al., 2010), which consists of:

a) maps of potential and current vegetation obtained from remotely-sensed imagery;
b) state-and-transition computer modeling of alternative management scenarios (for example, without and with climate change effects) applied to each ecological system in the mapped landscape; and
c) return-on-investment analysis of ecological improvement relative to the cumulative cost of management actions comparing the different management scenarios and all managed ecological systems.

The Nature Conservancy measured ecological condition using two landscape-scale metrics for each ecological system: ecological departure from the reference condition and the percentage of high-risk vegetation classes. Additionally, TNC provided results of each vegetation class, which was essential to relate changes in vegetation structure and food availability to the needs of wildlife species. The results of Landscape Conservation Forecasting™ applied to each of Nevada's 13 regions were provided to NDOW in the report, "Climate Change Revisions to Nevada's Wildlife Action Plan: Vegetation Mapping and Modeling"; hereinafter, referred to as the "*TNC Climate Change Report*" (Provencher and Anderson, 2011).

Species Vulnerability Analysis

Concurrent with habitat modeling, the Nevada Natural Heritage Program conducted a wildlife species vulnerability analysis using the NatureServe Climate Change Vulnerability Index evaluation program (Young et al. 2011) to determine which wildlife species exhibited characteristics that might uniquely hinder their adaptation to climate change, including but not limited to general mobility, physiological challenges, dependence on certain vegetation types or plant species, etc. Because of cost concerns, the WAP Revision Team made the decision to limit CCVI analysis to the 2005 Species of Conservation Priority list. Methods and results of the Nevada CCVI are presented in Appendix D, Table 1.

After the first draft of the Nevada CCVI was completed, members of the WAP Revision Team conducted intuitive analysis (i.e., expert opinion) of all terrestrial wildlife species *not* on the Species of Conservation Priority list to look for patterns and similarities between non-priority species and priority species that scored above "presumed stable" in the CCVI. Non-priority species that exhibited traits or habitat limitations similar to CCVI species with elevated scores were then run through CCVI analysis and scores were assigned to them for standardization purposes.

Avian Climate Change Response Modeling

The Great Basin Bird Observatory was contracted through the Q1 grant to provide specific data-supported climate change predictions for Nevada's breeding birds using point-count data from the Nevada Bird Count (NBC), a statistically-rigorous 10-year database with georeferencing and coarse-scale habitat association capability. Avian Species of Conservation Priority occurrences in the NBC were geospatially attached to the LANDFIRE map used by TNC to generate the habitats analysis. Results from the TNC analysis were then evaluated regarding potential consequences to Nevada's breeding birds and avian species responses were predicted. The results of the GBBO report are presented in the report "Bird Population Responses to Projected Effects of Climate Change in Nevada: An Analysis for Revision of the Nevada Wildlife Action Plan" (Appendix E).
Another partner group associated with University of California, Davis, the Connectivity Assessment Group, graciously donated another avian climate change analysis to the WAP revision process that evaluated possible patterns of movement on the landscape of priority birds based on the availability and connectivity of suitable habitats as currently understood versus climate change projections in habitat shifts. This analysis was interpreted and presented geospatially and demonstrated more detailed "stepdown" analysis that could be

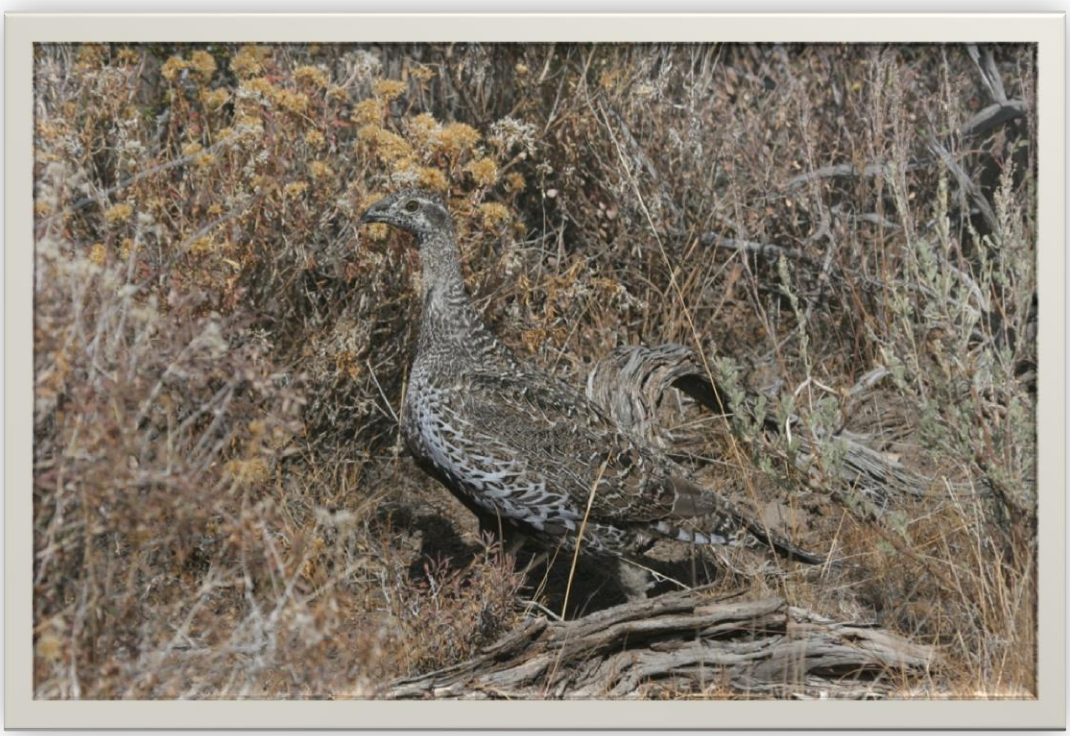
implemented as part of the WAP Adaptive Management framework once the Revision goes into effect. Results from this effort will be presented in the upcoming report "Current and projected future connectivity of habitat for breeding birds in the central Great Basin" (Fleischman et al., *publication pending*).

Pulling It All Together

Once the analytical products were completed, the Revision Team had to fit the results together to ultimately project the future of wildlife on Nevada landscapes over the next 50 years under a changing climate. Seven major tasks were undertaken:

1. Revision of the Species of Conservation Priority List
2. Revision of the ecological framework to fit the new vegetative analysis
3. Analysis of how ecological system changes/shifts were likely to impact living conditions and survival potential for priority species within relevant regional contexts
4. The construction of conservation strategy to maximize the preservation of wildlife diversity within state boundaries
5. Revision of the Focal Area analysis
6. Revision of the Implementation and Adaptive Management Framework
7. Revision of the Wildlife Action Plan itself with meaningful partner/stakeholder participation and review

Each of these tasks and how they were engaged are discussed in the following chapters.



Greater Sage-Grouse Photo Courtesty of A. Gubanich

APPROACH & METHODS:
Revising the Species of Conservation Priority List

The Revision Team started with the Species of Conservation Priority list generated during the 2005 planning process through species risk evaluation tools – one for terrestrial vertebrates, one for fishes and amphibians, and one for mollusks and crustaceans. The Team expressed basic satisfaction in the utility and appropriateness of the 2005 list, and while recognizing that climate change vulnerability had not been strongly evaluated through the 2005 process, opted for an iterative process that fit climate change vulnerability to the existing priority results, rather than go back to the beginning and redesign a completely new tool with climate change vulnerability incorporated in it. For a complete description of the 2005 species prioritization process, please refer to Appendix D.

Once the NNHP Climate Change Vulnerability Index (CCVI) was applied to the 2005 priority species list, a new picture of priority began to emerge, placing much greater concern toward isolated endemic aquatic species with small population sizes, limited mobility and an immitigable dependency on water in nature. Terrestrial vertebrates for the most part exhibited relatively strong adaptability to the nature and degree of climate change being predicted; therefore, a relatively small number of terrestrial vertebrate species ranked at levels of concern more elevated than "presumed stable". All terrestrial vertebrates run through CCVI receiving scores of "moderately vulnerable," "highly vulnerable" or "extremely vulnerable" were automatically retained on the revised priority list.

One priority category that had not functioned as planned in the 2005 Plan was the "stewardship species" concept. In order to gain consensus among all stakeholders as well as recognize the tableau of avian conservation planning that had occurred in the previous decade, a "stewardship birds" category was created in the 2005 WAP to note Nevada's "stewardship responsibility" for birds that had been identified in one of the bird conservation planning efforts (Partners In Flight, U.S. Shorebird Conservation Plan, North American Waterbird Plan) either at the continental or regional scale but which did not otherwise rank as high concern in Nevada. Because the category neither enjoyed full SOCP status nor freedom from concern, most users of the Plan did not know what to do with it. Rather than engender respect and partnership, it mostly just caused confusion. "Stewardship" aquatic species, derived through the application of different criteria, were no more successful. The Revision Team decided to remove the "stewardship" classifications and identify only full-status priority species.

The 2005 Stewardship Bird list was next evaluated for species that should be retained as priorities and those that should be removed. Climate change vulnerability was preliminarily assessed by comparison to species already run through the CCVI. Species similar to birds scoring above "presumed stable" were processed through the CCVI. Species that demonstrated significant population declines in the USGS Breeding Bird Survey results (http://www.mbr-pwrc.usgs.gov/bbs/bbs.html) were also run through the CCVI. The same stepwise evaluation was also performed on all other avian species that were not included on the 2005 list. Since very few birds ranked CCVI scores above "presumed stable", additions to the list were made based on the severity of decline as reported by USGS, or in the case of species such as Golden Eagle, where specific management issues were anticipated to direct agency priority and resources.

Mammals and reptiles that were not on the 2005 priority list were assigned to the TNC Biophysical Settings (key habitats) as per their known habitat preferences and analyzed as to the predicted cumulative effect of climate change on their preferred habitats. Those species that demonstrated cumulative habitat impacts of an elevated nature were then run through the CCVI. Any mammal or reptile species that scored "moderately vulnerable," "highly vulnerable" or "extremely vulnerable" were automatically retained on the revised priority list. Some species that scored "presumed stable" were retained for the priority list because of relevant conservation concerns other than climate change.

As with terrestrial species, the "stewardship species" categorization for fishes was found over time to provide little utility and served primarily to create confusion for partners developing conservation planning priorities. Although the initial CCVI analysis provided a basic assessment of potentially changed vulnerabilities for the existing priority aquatic species list, additional CCVI review was also performed on aquatic species identified in the stewardship classification in 2005 and additional lower-tier native fish species which were not priority-ranked in 2005 but were known to occur in aquatic habitats particularly vulnerable to near-term climate change scenarios such as mid- to low-elevation intermontane stream and river systems. This provided the basic analysis to review and update the aquatic priority species lists with primarily the addition of several endemic fishes with a higher vulnerability resulting from new analysis.

Detailed information on the revision of the species of conservation priority list is found in Appendix D.

Greater Sandhill Crane Photo Courtesy of D. Barrett

APPROACH & METHODS:
Defining Nevada's Landscape for Wildlife

The ecological framework for the 2005 Plan was based on Southwest ReGAP (SWReGAP) ecological systems (vegetative communities) and a very simple four-biome representation of the state – Great Basin, Mojave Desert, Columbia Plateau, and Sierra Nevada. The SWReGAP ecological systems were compiled into 27 broader biophysical groups named "key habitats" that approximated major habitat types as they were commonly perceived by Nevada's resource professionals and conservation community – sagebrush, Mojave shrub, pinyon-juniper, cliffs and canyons, etc. – and conservation strategy was developed for each key habitat and presented in the 2005 Plan in the key habitat chapters.

Terrestrial Ecological Framework

The unique challenges of climate change predictive analysis required the Revision Team to shift its primary ecological framework from SWReGAP to LANDFIRE because LANDFIRE has added classification of vegetation into the "characteristic" and "uncharacteristic" types critical to the measure of ecological departure. Specifically, four sources were used to develop new ecological systems now called "**Biophysical Settings**" or **(BpS's):**

1. LANDFIRE (2010a, b, c) is interpreted Landsat satellite imagery, which for each grid cell (pixel) includes: (1) the BpS type; and (2) the succession class or "S-Class" of the BpS type that currently occupies the grid cell. LANDFIRE's Existing Vegetation Cover (EVC) layer represents the average percent cover of existing vegetation for a 30-m grid cell. This layer was used to inform select non-reference classes from the BpS by S-Class layer.

2. Precipitation map from the PRISM (Parameter-elevation Regressions on Independent Slopes Model) group of Oregon State University that shows the distribution of precipitation across the United States based on modeled extrapolation of weather data among weather stations (Daly et al., 2008). PRISM is the USDA's official climatological data. These data were used to a) divide LANDFIRE's Blackbrush BpS between the thermic and mesic BpS's at the 9 inch precipitation zone and b)divide the big sagebrush complex into Wyoming Big Sagebrush semi-desert BpS (8-10 inch precipitation zone), Big Sagebrush-upland BpS (12-14 inch precipitation zone), and the Montane Sagebrush Steppe-mountain BpS (>14 inch precipitation zone).

3. Nevada Natural Heritage Program (NNHP) developed the Annual Grass Index layer, which is the estimated percent ground cover of non-native annual grasses interpreted from two captures of Landsat satellite imagery and field plots (Peterson, 2005). Also, NNHP's layer of known locations of invasive weeds (other than annual grasses) in Nevada served to inform select non-reference classes from the BpS by S-Class layer.

4. Southwestern Regional Gap Analysis Program landcover layer (Lowry et al., 2005) is interpreted satellite imagery of natural and semi-natural vegetation on the landscape. This layer was used to inform select non-reference classes from the BpS by S-Class layer.

The integration of these sources was accomplished by a three-step process:

1. After a review of all LANDFIRE BpS, minor BpS's were merged with larger ones, or ecologically-compatible BpS's that are difficult to separate by remote sensing were combined (e.g., Black-Low sagebrush and Intermountain Basins Semi-desert Shrub Steppe was nested in Mixed Salt Desert);

2. Then both the "concept" and the mapped distributions of all of the major vegetation (BpS) types that appeared in the LANDFIRE source were evaluated; and then

3. A set of queries or decision rules was written as to how those input data were to be depicted, pixel by pixel, on the output of the single merged map. These queries were designed primarily to inform the non-reference classes using the most current on-the-ground spatial information available.

After some final field-informed adjustments, the BpS's used in the TNC climate change analysis were selected. A short description of each vegetation class by BpS used in the analyses is presented in the TNC Climate Change Report and summarized in Appendix C.

The 27 phytogeographic regions layer acquired from NNHP represented floristically and physiographically similar areas of Nevada. This layer was consolidated from 27 to 14 phytogeographic regions to facilitate modeling (Figure 2). The phytogeographic regions were consolidated into the Mojave, Clover-Delamar, Walker Corridor, Eastern Sierra Nevada, Sierra Nevada, Lahontan Basin, Humboldt Ranges, Toiyabe, Eureka, Calcareous Ranges, Elko, Tonopah, Owyhee Desert, and Black Rock Plateau. The Mojave was consolidated from 7 individual phytogeographic regions to one. The Calcareous region was consolidated from three individual phytogeographic regions, and Elko and Tonopah were both consolidated from two phytogeographic regions. Two phytogeographic regions that were not within the boundaries of Nevada were removed.

Table 1. Description of spatial layers used to develop the new Wildlife Action Plan ecological framework.

Spatial Data	***Spatial Resolution***	***Date***	***Creator***
Biophysical Settings	30 m	2010	LANDFIRE
Succession Class	30 m	2010	LANDFIRE
Precipitation	654 m	2006	PRISM
Landcover	30 m	2004	SWReGAP
Annual Grass Index	28.5 m	2004	NNHP
Weeds	Shapefile	2005	NNHP
Existing Vegetation Cover	30 m	2010	LANDFIRE

Nevada's Phytogeographic Regions

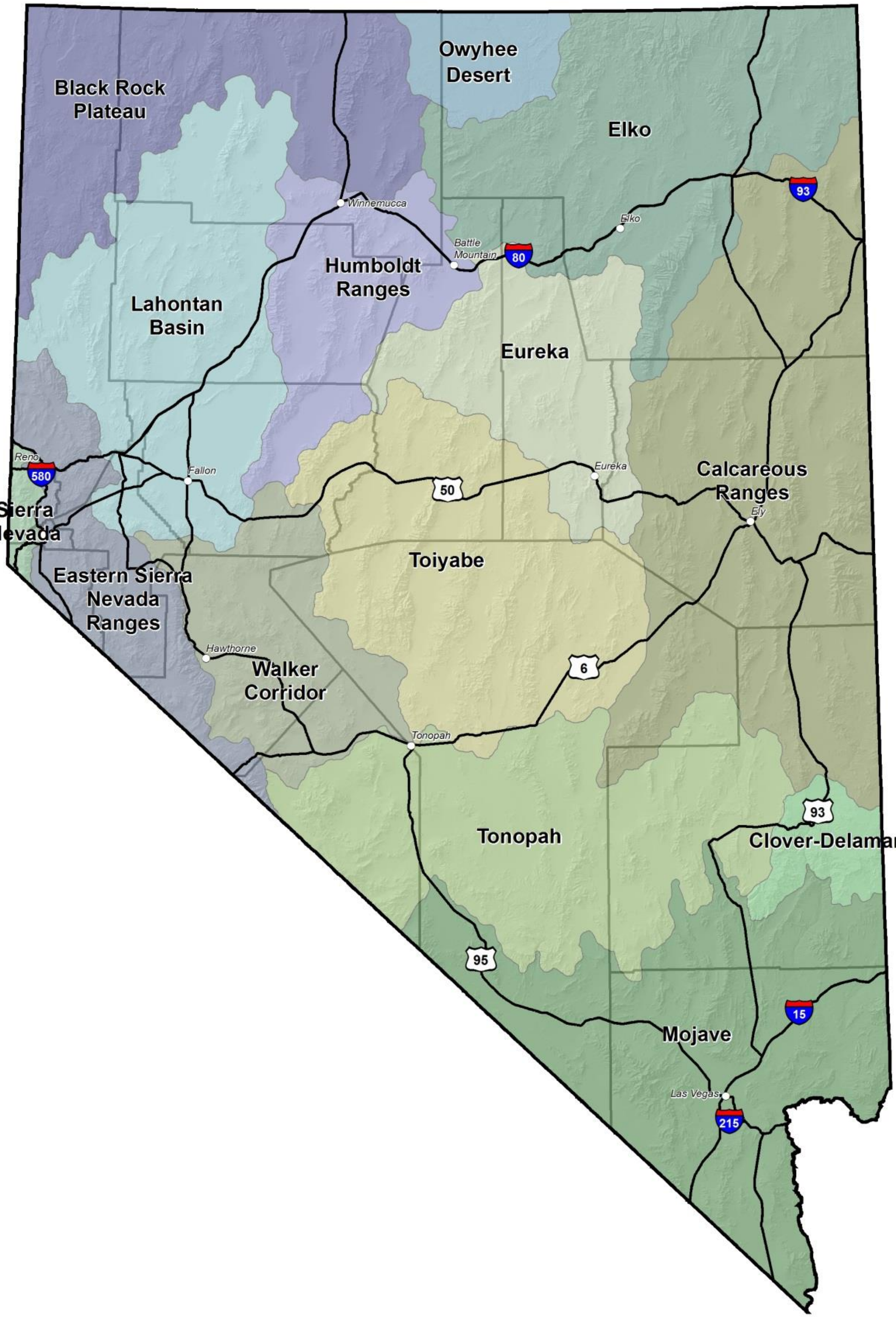


Figure 2. Consolidated phytogeographic regions of Nevada. Based on 27 original regions proposed by the Nevada Natural Heritage Program.

2005 vs. 2012 – Integrating Two Ecological Frameworks

The creation of the TNC phytogeographic regions for climate change analysis created several challenges for the Revision Team regarding the crosswalk between a simple four-ecoregion map with SWReGAP ecological systems to a 14-region map with LANDFIRE BpS's. One problem arose concerning the revision of the Key Habitat acreages reported by ecoregion in each Key Habitat. At the request of federal land management agency Team members, it was decided to continue to report key habitat acreages by the four broad ecoregions from 2005 – Great Basin, Mojave, Columbia Plateau, and Sierra Nevada – which required a clip of LANDFIRE by the four-ecoregion map. A crosswalk between SWReGAP ecological system and LANDFIRE BpS's was also provided for each key habitat chapter.

The revision of ecological systems to biophysical settings necessitated a slight shift in how the key habitats were defined. The 27 key habitats from the 2005 Plan have been reduced to 22 through the following changes:

- Mojave/Sonoran Warm Desert Shrub and Mojave Mid-Elevation Mixed Desert Scrub were combined into one chapter.
- Lower Montane Woodlands and Lower Montane Chaparral were combined into one chapter.
- Intermountain Rivers and Streams, Sierran Rivers and Streams, and Wet Meadows were combined into one chapter.
- Exotic Grasslands and Forblands was eliminated because the vegetative communities were reinterpreted as uncharacteristic classes of many other biophysical settings.

Palmer's Chipmunk Photo Courtesy of C. Klinger

APPROACH & METHODS:
Wildlife Effects Analysis

Integration of Species and Habitat Analysis

The next task was to integrate the species with demonstrated climate change vulnerability to the biophysical settings for the purpose of translating the predicted habitat changes into wildlife species responses. Specific analyses using extensive survey data from the Nevada Bird Count were conducted for birds (see below), but much less habitat-specific data were available for mammals and reptiles, so models were created for them based on general natural history knowledge and expert experience. To the extent possible, we intended to demonstrate how species were particularly challenged by shifts, degradation or losses of their preferred habitats over the next 50 years. Because the TNC climate change analysis focused heavily on “ecological departure” of vegetative systems and the changes attributable to the invasion of exotic plants into native systems, our species-habitat associations also focused on our best estimates of wildlife species responses to the various “uncharacteristic classes” that defined ecological departure. One of the most important research needs identified as a result of this revision has been that of more specific knowledge of wildlife species tolerance/response to changes in their habitats incurred by exotic plant invasion, closing and opening of tree and shrub canopies, and species tolerance of conversion of shrub types to rabbitbrush, a common conversion among systems. This knowledge is critical in the adaptive management tracking and monitoring of climate change once this Revision takes effect.

In the evaluation of mammals and reptiles, we assessed wildlife species tolerance to uncharacteristic classes except in cases where we were fairly certain that the native plant community was severely reduced or replaced and the species in question was known to be strongly dependent on elements of that native plant community for either food or cover (Greater Sage-Grouse in sagebrush as an example). We had to make qualitative judgments as to whether a species would continue to occupy a habitat with low, moderate, or high invasion of exotic plants. We evaluated the species’ response to relative changes in vegetative structure and how those changes would result in exposure to predation and the elements (sun, heat, cold, etc.). In some instances, species’ responses to tree encroachment into non-tree habitats have been better studied than the invasion of annual grasses/forbs into the same habitats, so our predictions were thus better supported by existing research. The results of these analyses are reported in the “Possible Wildlife Responses to Climate Change” sections in each of the Key Habitat chapters.

Avian Responses

Great Basin Bird Observatory Climate Change Analysis

For modeling landbird population change, we used data from the first ten years of the Nevada Bird Count (NBC) and from recent landbird inventory projects in Nevada that used the same point-count design as NBC for assessing bird populations. Analyses were restricted to those priority species of the Wildlife Action Plan that are diurnal landbirds with relatively small breeding territories, because point count surveys are designed to estimate densities for these species. Species with large home ranges, waterbirds, shorebirds, and secretive marshbirds were not included in our analyses, nor were landbird species that were so rare in Nevada that reasonable density estimates could not be derived for their primary breeding habitats.

Bird Habitat Models

For modeling current bird habitat use, we used the raster map of current vegetation conditions from TNC (2011). The landbird data from the NBC and similar projects in Nevada were limited to observations within a 100 m radius distance from each survey point, because detectability of most landbirds decreases rapidly beyond this distance. A 100 m spatial buffer was created around each point and the percentages of each current vegetation cover type within that circle (3.14 ha) were calculated. Because of the heterogeneity of vegetation classes in most 100 m circles, a set of rules governing selection of the circles for use in calculating species densities for individual vegetation classes was created. (To review the point selection rules, please refer to the complete GBBO report within Appendix E.)

Bird density was calculated for each priority landbird species in each habitat type. For this, we calculated the average number of individuals (excluding fly-over observations) detected within 10 minutes and 100 m by taking the mean of multiple visits to each point. These numbers were then averaged over all points assigned to a particular habitat type, and extrapolated to the average detectable density per 40 ha. A working estimate of statewide population size was then estimated by multiplying the densities by the number of hectares currently in each habitat type, and summing over all habitat types in each of the 13 regions from the climate model, which can then be summed for the state. For some statewide habitat types, data for the Mojave region (which for the purpose of this report, included the Clover-Delamar region identified in TNC 2011) were separated from data for the Great Basin region, but most habitat types were largely restricted to one or the other.

Predictions of Climate Change Effects

The Team used current acreages and model projections for future acreages after 50 years of climate change for each condition class within biophysical settings (TNC, 2011) to project expected changes in landbird populations. These predictions carry the same limitations and assumptions as do the predictions for vegetation change, and also assume that habitat change will dictate most changes in bird populations (but see above for cautionary comments).

Projections for bird population change were calculated separately for the 13 regions in Nevada used in this analysis (for details on these regions, see TNC Climate Change Report, 2011). For birds with statewide breeding distributions, we summed habitat acreages across regions for one statewide total. Southern Nevada species were analyzed using only those appropriate regions (usually Mojave and Clover-Delamar). Some condition classes were projected to change greatly due to climate change, but some of these changes were not available in the current map, either because these classes are currently rare or because the available GIS layers cannot delineate them. In these cases, we made qualitative judgments about expected effects on the birds that occupy the changing habitats that were not mapped.

The results of the avian climate change response analyses are completely reported in the GBBO report, and results from the report are included in the "Possible Wildlife Responses to Climate Change" sections in each of the Key Habitat chapters where relevant.

Suitable Habitat Connectivity Climate Change Analysis

A fine-filter analysis of climate change effects on a roster of vegetative and spatial parameters with respect to bird distribution and suitable habitat connectivity was conducted by a team of wildlife and geospatial ecologists operating under the aegis of the University of California, Davis as a special project for this Wildlife Action Plan revision. The objectives of the project were to identify vegetative or landform characteristics that influence bird distribution on a small regional scale; assess the projected changes on those characteristics brought about by climate change; and evaluate the regional landscape's ability to provide alternate suitable habitat in accommodation of species' needs to shift distribution with climate change. The study identified areas most likely to be occupied by breeding birds associated with key habitats given current and potential land cover and climate, particularly areas that are likely to be occupied given a range of possible future conditions. The methods presented could also be applied to any group of animals for which sufficient date are available (Fleischman, et al., 2012).

Aquatic Habitats

Because the available TNC climate change analysis focused primarily on "ecological departure" of vegetative systems and associated changes to native terrestrial habitats, it provided limited utility for assessing changes to aquatic systems and associated effects on resident native aquatic species, particularly fishes. For a number of reasons it was not possible to develop more sophisticated modeling tools for identifying aquatic system effects at a detailed level, and a relatively coarse-filter approach was used to evaluate predicted climate change effects. After identifying watersheds containing priority aquatic species of concern for each key habitat association, available on-line tools were used to assess predicted changes for temperature and precipitation at a Hydrologic Unit (HUC8) level, using High A2 Ensemble Average GCM data sets for percentage departure through 2050, consistent with the analysis approach used for aquatic CCVI assessments. Although precipitation models in particular exhibit high uncertainty across much of the area of analysis this did allow some level of assessment of projected change in key climate change components likely to affect aquatic habitat suitability and allowed some evaluation of potential seasonal changes in aquatic system functions because of projected temporal shifts in precipitation and early spring onset, particularly important for the assessment of future conditions in stream and river habitats. These assessment results at the HUC or hydrologic basin level then were manually interpreted to deductively infer likely future effects on aquatic habitats and aquatic species based on known distributions.

APPROACH & METHODS:
Constructing Conservation Strategy

Once the threats to wildlife conservation posed by climate change or other agents of change were identified, strategies to reverse or mitigate the effects of those threats were solicited from technical expert groups, taken from the 2005 Plan, other conservation plans, or the literature wherever possible. The strategies, activities, treatments, prescriptions, programs, and initiatives were often unchanged from the 2005 Plan for the species persisting on the priority list from 2005. New species sometimes required new creative thinking, but more often than not could be grouped with a species or set of species already prioritized by the Plan. A feature of the TNC habitat analysis was the gathering of regional ecological restoration focus groups to construct restoration, remedial, and preventive prescriptions for action specific to their own regions based on their own expertise and experience.

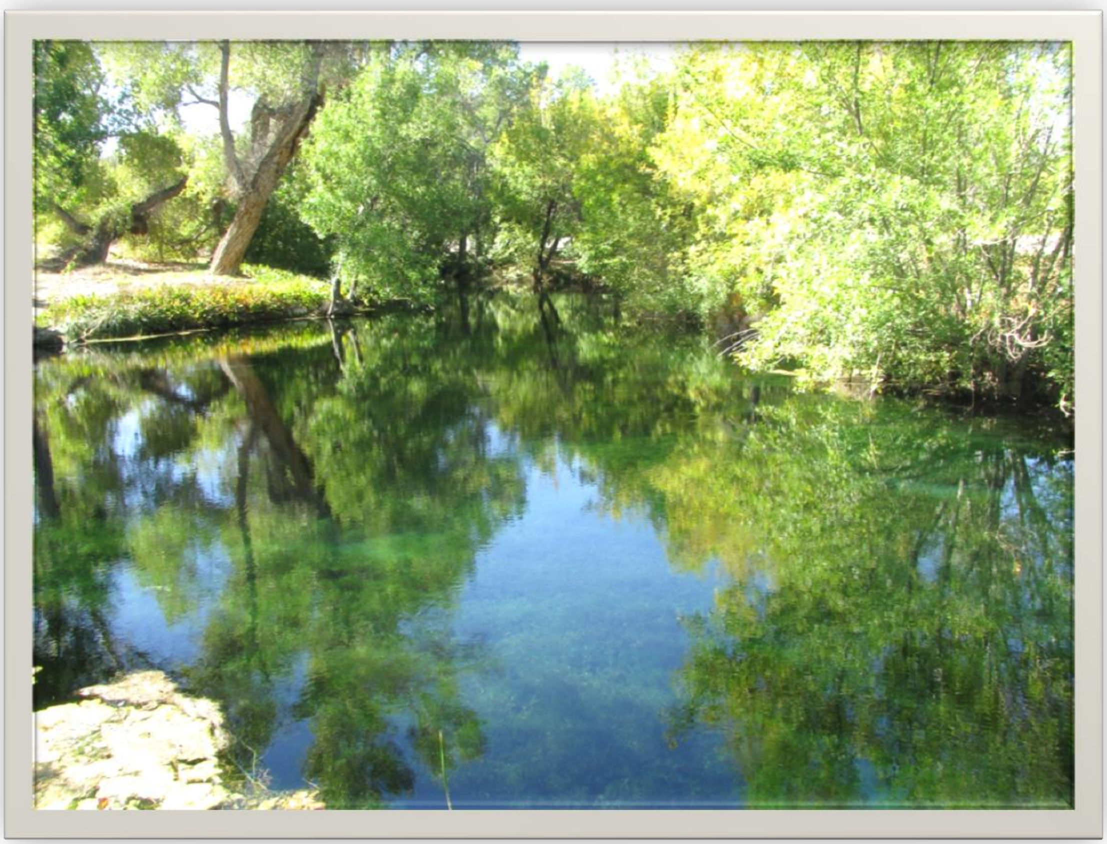
Once the basic prescriptive approaches were identified, the Revision Team strove to set quantified, measurable objectives to set the progress marks for the applications of those prescriptions. Where ecological departure of an ecological system (biophysical setting) was of major concern and had been quantified for the 50-year period of analysis, objectives aimed at reversing, stabilizing, or minimizing the rate of ecological departure of the ecological system were developed for the immediate 10-year period following approval of the Revision (2012-2022). A general finding of the climate change projections was that the period between 40 and 50 years from now would witness the greatest increment of change toward the 50-year projected outcome, and often the first 10-year period (that relevant to this revision) would witness the least. Setting up the monitoring framework to measure climate change effects was much more the need during this first 10-year period, and sometimes in terms of actually observing physical change on the landscape.

We also strove to construct quantified, measurable objectives for species population management in concert with each habitat management strategy. The detail of population information for different taxa controlled our ability to develop detailed objectives. Because our knowledge about the different priority species varies, we had to incorporate quantification parameters in line with the level of detail of our knowledge. The most highly developed population estimates for wildlife in Nevada occur for game mammals that are counted annually out of helicopters for the purpose of informing highly sophisticated harvest models and tag recommendations. Following game mammals, our skills in estimating breeding bird populations have been greatly enhanced by the analysis of 40 years of USGS Breeding Bird Survey data and also the analysis of ten years of Nevada Bird Count data. Both datasets are featured in the “Nevada Comprehensive Bird Conservation Plan” revised by Nevada Partners In Flight (facilitated by Great Basin Bird Observatory) in 2010. For game mammals and many breeding birds on the priority list we were able to construct quantified population objectives based on these survey results, and did so whenever we could.

For bird species where we had adequate data indicating regional or continental trend, but lacked data rigorous enough to project meaningful population estimates for Nevada, we set directional objectives based on increasing, stabilizing, or reversing trend depending on the severity and nature of the reported decline. Priority was usually given to regional trend over continental trend.

Population estimates could not be generated for most nongame mammals and reptiles. However, presence/absence monitoring technology has progressed significantly since 2005 and monitoring protocols that generate “occupancy rates” based on multiple visits to networks of sample sites are becoming more and more useful for understanding and tracking species status. The development of occupancy survey protocols for small mammals in sagebrush (Nevada WAP Sagebrush Indicators Technical Team, 2010) allowed us to develop objectives for "detectable levels" for tracking species status.

As with terrestrial species, strategies, activities, treatments, prescriptions, programs, and initiatives were largely unchanged from those developed for the 2005 Plan for aquatic species carried forward from the 2005 priority list, and new species added from the current analysis generally could be grouped with a species or set of species previously prioritized. The level of degradation of aquatic habitats supporting priority aquatic species in Nevada remains substantial because of both physical alteration and the presence of undesirable non-native species, and specific substantive threats to these habitats identified in the 2005 plan such as future groundwater development and invasive species remain largely unabated. To the extent that potential climate change effects identified in the analysis such as increased thermal input from air temperature rise and altered streamflow regimes resultant from temporal changes in precipitation and modified runoff patterns will modify aquatic habitat quality for priority aquatic species, these will be modifiers that to some extent will just amplify the impacts of existing threats. For this reason in many cases predicted climate change inputs did not substantially alter existing proposed actions, prescriptions and conservation targets, but place increased emphasis on the importance of those targets and prescriptions because their effective implementation generally will increase the resiliency of aquatic systems in the face of projected climate related effects.



Crystal Springs in Pahranagat Valley Photo Courtesy of R. Wilson

APPROACH & METHODS:
Revision and Review Process

Similar to the 2005 WAP draft process, NDOW contracted with the Nevada Audubon Director of Bird Conservation to serve as editor and principal author of the 2012 Revision. Duties of the editor included writing, editing, and draft layout design leadership throughout the draft process. Audubon Society personnel also provided conservation planning and design support as well as performing a major role in the public review. All members of the Revision Team either took on individual writing assignments or first-line text review duties during the creation of the review draft.

Species Vulnerability Assessment Expert Review

Species' range maps and natural history information were obtained from a number of sources including the Nevada Wildlife Action Plan (WAP) (Wildlife Action Plan Team, 2006), the NNHP Biotics database, The Revised Nevada Bat Conservation Plan (Bradley et al., 2006), Atlas of the Breeding Birds of Nevada (Floyd et al., 2007), The Nevada Comprehensive Bird Conservation Plan (GBBO, 2010), NatureServe Explorer, federal agency documents (e.g., USGS professional reports or published studies, USFWS Recovery Plans, Federal Register), field guides, and expert input.

Assessments were completed for a representative group of species within each taxonomic group. After these initial CCVI scores were calculated by NNHP, an expert workshop was held (December 2009 in Reno) to solicit feedback and comments from biologists working throughout Nevada. The two-day workshop was well-attended and included representatives from federal (BLM, EPA, NPS, USFS, and USFWS) and state (NDOW, NNHP) agencies, a non-profit organization (TNC), and academia (UNR). Highly constructive comments and feedback were obtained from the attendees on the scoring of the factors, and additional species information was also obtained to better inform the assessments. All feedback and comments were incorporated into the CCVI for each species and scores were recalculated.

Climate Change Management Strategy Development

TNC and NDOW staff held workshops in Carson City twice, Ely, and Las Vegas to seek expert knowledge on ecological system management for the Calcareous, Eastern Sierra Nevada, Elko, Lahontan, Mojave, and Walker regions. The goal was to develop coarse and representative management strategies to abate detrimental climate change effects and order of magnitude costs for regions belonging to different ecoregions. Ecological systems chosen for management were: aspen-mixed conifer, aspen woodland, blackbrush mesic and thermic, creosote bush-bursage, Jeffrey pine, mixed conifer, low-black sagebrush, montane riparian (non-carbonate), montane sagebrush steppe-mountain site, and Wyoming big sagebrush semi-desert. Proposed management strategies were very variable in type and cost among regions and agencies.

Public Workshops

NDOW and the Revision Team coordinated with state, federal, and local agencies, and conservation organizations to gather pertinent information for the plan revision. To initiate the planning process, NDOW and the Revision Team held a workshop in April, 2009 for NDOW employees and our conservation partners entitled, "Incorporating Climate Change into Nevada's State Wildlife Action Plan". Participants were asked to provide input on the challenges to managing wildlife and fish resources and what information the plan should include to assist in prioritizing wildlife management and conservation actions. An overview of the revision process was provided to the Board of Wildlife Commissioners in December, 2011.

A draft of the revised Wildlife Action Plan was posted on NDOW's website in January 2012 for public review. Public scoping meetings regarding the draft revised plan were held during the winter of 2012 in Elko, Las Vegas, and Reno. The workshops were advertized in the media and over 100 invitations were sent to agencies, industry, NGOs, hunting, fishing and environmental groups. Each of the Native American tribes in Nevada was sent a letter inviting them to the workshops. Follow-up calls were made to tribal members for a personal invitation to the workshops. At each meeting location, an afternoon workshop was held for professional natural resources managers and an evening workshop was held for conservation partners, industry, and the general public. Attendees at the meetings included federal and state resources agencies, county governments, tribes, sportsman's groups, recreation groups, university personnel, and others. Attendees viewed a PowerPoint presentation providing an overview of the draft revised plan and the revision process and an overview of the species and habitat analysis for the plan revision. A facilitate question/answer and input session followed at each workshop. Written comments regarding the draft plan were also accepted. The Revision Team held meetings following the workshops and public input period to review all written and verbal comments, and made adjustments to the draft plan accordingly.

In addition to the public workshops, Revision Team members had individual meetings to discuss the plan revision with a representative of the Nevada Farm Bureau and also with representatives of the Nevada Mining Association. Revision Team members also had a final meeting with the USFWS Ecological Services Nevada Offices in Reno and Las Vegas to review and discuss several items, including the final list of Species of Conservation Priority in the revised plan.

The Revision Team stayed in close contact with agency personnel throughout development of the draft plan. Coordination was maintained with the USFWS office in Reno and Las Vegas, the BLM State Office, and the Humboldt Toiyabe National Forest Supervisors Office. One of the primary strategies of the WAP is to integrate its objectives and actions with other agency planning processes to foster synergistic achievement of wildlife management objectives at a statewide scale.

The coordination of the Nevada WAP with tribal land management strategies continues to be important particularly in light of the federal Tribal Wildlife Grant Program. Tribal coordination will continue to be facilitated through the Nevada Indian Commission, which maintains liaisons with all the Native American tribes in Nevada. The WAP Revision Team will continue to extend its planning experience to tribes wishing to access Tribal Wildlife Grant funds to assist them in identifying priorities, program and project design and development, with the objective of integrating tribal wildlife priorities and management approaches into the Nevada WAP to achieve synergy between the two sister USFWS Federal Assistance programs.

NEVADA'S WILDLIFE HERITAGE

Nevada has rich and varied biodiversity, with all major groups of animals well-represented within its boundaries. Among the 50 states, Nevada ranks eleventh in overall biological diversity and is sixth in the nation for endemics, with 173 species found in Nevada and nowhere else in the world (Stein, 2002). Unfortunately, Nevada also ranks third, behind Hawaii and California, in the number of its species at risk of extinction.

From a wildlife perspective, the Great Basin and Mojave Deserts are landscapes of enormous subtlety. The vast and apparently monotonous expanses of sagebrush actually support dozens of species, and many more subspecies. Most of the animals accomplished at life in these deserts are colored to blend in with the rocks and vegetation to avoid detection in a land that holds few hiding places. Many specialize at being nocturnal to avoid the harshness of the desert sun. Explorer John C. Frémont declared the region as "deserving the full examination of a thorough exploration." One thing is certain - Nevada does not reveal its nuances to a car traveling 70 miles per hour across Highway 50.

Nevada's tremendous diversity of life is derived from its geologic past and its current geography. During the Pleistocene, this region of the globe was considerably wetter than it is today, with lakes covering significant portions of the state. As the Pleistocene waned and the Earth entered a drier, warmer period, these lakes receded and vanished, sometimes completely and sometimes leaving behind only isolated wetlands and remnant springs. Organisms such as springsnails (pyrgs) and pupfish that once resided in enormous lakes now persist in tiny seeps and springs, each population cut off from its nearest neighbor, often by miles of inhospitable desert. Over time, these populations have evolved into unique species and subspecies, each uniquely adapted to their tiny corner of the world and each found nowhere else.

Nevada's geography and climate also contribute to this isolation effect. Nevada is the driest state in the nation and also the most mountainous. The many mountain ranges with winter snow pack, trees, meadows, and tumbling streams are effectively isolated from one another by the arid and treeless basins that lie in between. This juxtaposition of landscapes has effectively created isolated islands of habitat, dubbed sky islands. For the less mobile species of small mammals, reptiles, amphibians, and some insects, populations have likewise become isolated from one another on these montane islands in the sky, and over time, some have evolved into new species or subspecies while others have gone extinct on certain mountain ranges but not on others (Grayson, 1992).

The principles of island biogeography explain other aspects of the state's diversity 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 species to populate the island); and the smaller the island, the fewer species the island can sustain. The "mainlands" for the Great Basin province 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, ranges such as the Toiyabes and Monitors 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 in their affinity with the Rocky Mountains. A similar pattern has been documented in mammal populations in Nevada. Several species of small mammals (termed "boreal mammals" by Brown, 1971) are now more or less completely isolated on the tops of mountain ranges across the Great Basin between the Sierra Nevada and Rocky Mountains, but their current distributions cannot be explained by the "distance to mainland" theorem alone because ingress from the north during the Pleistocene cannot be ruled out (Grayson, 1992).

While mobile species like birds might be expected to be unaffected by the effects of distance and island size, such is not the case. The reduced number of plant species in the interior mountain ranges translates to lower habitat diversity, which in turn, offers fewer niches for birds to occupy, and thus fewer species overall.

Also worth noting is that abundant food and water resources beneficial to wildlife are concentrated in only in a few noteworthy places of the Nevada landscape. Across the remainder of the state, such resources are widely scattered at a low density. The distribution of wildlife tends to reflect this disjunct distribution of food and water resources, and therefore with few exceptions, wildlife species are not found evenly distributed throughout Nevada but only in certain places, and sometimes in quite high densities. This does not mean that Nevada ecosystems are not important to wildlife, only that fewer numbers of individuals can be sustained in any one area. In reality, this widely dispersed distribution pattern makes managing and conserving the state's wildlife diversity all the more important.

Mammals

The Nevada Natural Heritage Program recognizes 136 species of mammals that occur or historically occurred in Nevada. Of those species, American bison, gray wolf, North American lynx, Arizona cotton rat, and grizzly bear are considered to be extirpated (i.e., they no longer occur) in Nevada. Of these, only the Arizona cotton rat was confirmed in Mammals of Nevada (Hall, 1946). Details of the historical occurrences of the other four species are vague to nearly non-existent. One species and one subspecies, wolverine and southwestern otter, have not been confirmed in the state since 1936 and are most likely extirpated. However, a lone wolverine was detected roaming the Sierra Nevada's in California as recently as 2010 (USFWS, 2010) and occasional unconfirmed reports of southwestern otter persist. Two additional subspecies appear to have become extinct despite many recent and thorough surveys; the Ash Meadows montane vole, which was last observed in 1933, and the Hidden Forest Uinta chipmunk, which was last observed in 1931.

Five species (burro, wild horse, Norway rat, black rat, and house mouse) have been introduced into the state through their domestic associations with humans. The Rocky Mountain goat was not native to Nevada, but was introduced into the Ruby Mountains by NDOW in the 1960s as a game animal, and persists in small numbers today in the Ruby Mountains and the East Humboldt Range. One species, the nutria, was reported to have been brought in by fur farmers in the 1930s and released after the fur farming venture failed, however, if a wild population was temporarily established, no populations are known to occur today (J. Curran, NDOW (retired), pers. comm., 2005). The total number of mammal species present in the wild in Nevada today is generally regarded to be 129.

Nevada's native mammals belong to one of six orders – Insectivora (shrews and moles), Chiroptera (bats), Rodentia (squirrels, rats, mice, etc.), Lagomorpha (rabbits, hares, pikas), Carnivora (dogs, cats, weasels), and Artiodactyla (even-toed hoofed mammals or ungulates). Nearly half of Nevada's mammal species are rodents (62 species), followed in number by 23 bats, 21 carnivores, 9 insectivores, 7 lagomorphs, and 4 native ungulates.

As with many of Nevada's animals, current mammalian fauna have been significantly influenced by the past climate of the Basin and Range and Mojave Desert provinces. During the Pleistocene, the holarctic ice cap was much closer and ice occurred on the top of many of Nevada's mountain ranges (Grayson, 1993). This created a cooler, wetter climate that shifted habitat types, and the mammals associated with them, downslope and southward (Brown, 1973). With the advent of our current epoch, the Holocene, the recession of the ice cap left hotter, drier conditions that drove habitat types northward and back upslope, leaving the valley bottoms to species better adapted for drier, warmer conditions except in those cases where remnant wetlands were left behind (e.g., Pahranagat Valley and Ash Meadows). This directly explains the existence of isolated subspecies of montane vole in the two valleys mentioned above (although the Ash Meadows montane vole is now considered extinct), and with more investigation, could easily contribute to the explanation of the existence of several of Nevada's other isolated mammal subspecies, including Humboldt yellow-pine chipmunk, Hidden Forest Uinta chipmunk (now considered extinct), and the San Antonio and Fish Springs pocket gophers. The Palmer's chipmunk, native only to the Spring Mountains, is Nevada's only truly endemic mammal recognized at the separate species level.

Due to Nevada's basin and range topography, many occurrences of various mammals are highly fragmented. For example, multiple chipmunk species and subspecies, pikas, golden-mantled ground squirrels, yellow-bellied marmot, bushy-tailed woodrat, long-tailed vole, and western jumping mouse all have impressively fragmented populations (Brussard et al., 1998). Fragmented populations make these species highly vulnerable to extirpation and ultimate extinction. When these relict mammal populations blink out, often associated with anthropogenic effects, it is difficult if not impossible for other populations to re-colonize, increasing fragmentation even further and increasing vulnerability until eventual extinction occurs. Indeed, many of our mammal populations are shrinking and some sites have become extirpated. These extirpations may also eliminate genetically unique populations (Grayson, 1987).

Twenty-three species of bats occur in Nevada and are found in multiple habitat types including cliffs, mines and caves, trees, bridges, and other man-made structures. The numbers of species found in Nevada represent almost half of all the species found in the U.S. While historic numbers and distribution of bats are not known, it is certain that many of our species are patchy in distribution and have declined or are vulnerable to decline in the future. The Mojave Desert in southern Nevada represents the northernmost extension of the range of several bat species, including Allen's big-eared bat, big free-tailed bat, cave myotis, California leaf-nosed bat, and western mastiff bat. With the emergence of a relatively new disease called white-nose syndrome in the eastern U.S., many of our more common species may be vulnerable and could experience significant mortality if the disease spreads to Nevada. Additionally, as greener energy production is pursued, large-scale wind farms may significantly increase mortality of bats, especially migrating species.

Nevada's largest carnivore is the black bear, present in the Carson Range of the Sierra Nevada (along the north and east shore of Lake Tahoe) and in the Pine Nut Mountains. Mountain lions occur throughout the state and are thriving. Other carnivores include coyote, kit fox, gray fox, and bobcat. The red fox is making serious incursions into previously unoccupied range in eastern Nevada with its distribution generally on the move from northeast to southwest, but very little is known about the status of the Sierra Nevada red fox, a California subspecies that may or may not exist on the Nevada side of Lake Tahoe (a recent confirmed sighting near the Nevada border indicates that it is at least conceivable that the Sierra Nevada red fox might exist in Nevada). Mustelid carnivores include northern river otter, mink, long-tailed weasel, ermine, American badger, striped skunk, spotted skunk, and American marten. Of these, the American marten has experienced the most habitat loss and is now known only from isolated sites in the Sierra Nevada east of Lake Tahoe. Raccoons and ringtails round out Nevada's fairly rich carnivore community.

Mule deer were much less numerous in Nevada until the period between the 1920s and the 1950s, when federal land management agencies were created and a significant release from livestock grazing, mostly sheep, affected a massive montane shrub regeneration event resulting in a mule deer population boom (Wasley, 2004). Today, after a second population peak event in the mid-1980s, mule deer have been on the decline as wildfire has significantly impacted winter ranges throughout the state, reducing native vegetation and facilitating the invasion of exotic grasses and weeds. Bighorn sheep have been returned to much of their pre-settlement range throughout Nevada with significant assistance from an NDOW-sportsmen's organization partnership that has implemented a highly successful transplant program since the 1980s, utilizing capture/relocation techniques supported by an aggressive water development program. Pronghorn are currently enjoying a population boom in positive response to changes in range condition that are shifting from overall shrub dominance to more grass/forb-dominated vegetative communities. Rocky Mountain elk are also currently expanding their range across the state in response to improved range conditions with more significant grass components.

The effects of climate change on mammals are largely unknown, although there has been recent work that indicates a general up-slope and northward movement may be expected. Species of mammals already isolated and at high elevations such as pika may be more vulnerable to climate change than other species more widely distributed. Likewise, species dependent on particular habitat types that are expected to be strongly impacted by climate change, such as pygmy rabbit, may be more vulnerable than species that have greater ability to utilize various habitat-types.

Birds

According to the Nevada Bird Records Committee (NBRC), a total of 487 species of birds have been recorded in Nevada. Of these, about 129 species occur irregularly in the state as accidentals or vagrants (i.e., birds that are well out of the recognized range of the rest of their species). Of the remaining 338 species, 275 are known to breed in the state (Floyd et al., 2007) and a small percentage of our total bird species are year-round residents of the state. The balance migrates through Nevada in spring and/or fall or use the state as their wintering area.

The 487 species on Nevada's checklist of birds represent 49 Families in 17 Orders which is considerable diversity within the Class Aves for the driest state in the Union.

- Waterbirds are well represented here and include members of the Order Gaviformes (loons), Podicipediformes (grebes), Pelecaniformes (pelicans and cormorants), Ciconiiformes (herons, egrets) and Anseriformes (ducks and geese).
- Sixteen species of hawks and falcons of the Order Falconiformes regularly occur in the state.
- Representative of the Galliformes (grouse and quail) can be found almost everywhere in Nevada.
- Wading birds, shorebirds, gulls, and terns are well represented by Gruiformes and Charadriiformes, though the vast majority of the diversity in shorebirds occurs in the state during spring and fall migration.
- Columbiformes include the doves, which range from the Mojave Desert to the higher elevations of the numerous mountain ranges. One recent invader, the Eurasian Collared-Dove, may be the newest bird species on Nevada's list. The Collared-Dove began its incursion into the state in Clark County where it is now seen regularly. The species also appeared recently in Washoe and Elko counties.
- The Cuculiformes include the (Western) Yellow-billed Cuckoo, a candidate for listing under the Endangered Species Act, which was probably once fairly well represented in the state, and the Greater Roadrunner, which remains fairly common in the Mojave Desert.
- Owls of the Order Strigiformes are broadly distributed across Nevada. The Great Horned Owl is probably the most common species in this Order.
- The Caprimulgiformes are also abroad at night, and these include the goatsuckers and nighthawks.
- In the Order Apodiformes, the hummingbirds are surprisingly diverse in Nevada. This order also includes swifts.

- The Belted Kingfisher, found state-wide along streams and rivers in the state, is the single representative of Coraciiformes.
- Piciformes (woodpeckers) are found in Joshua trees and riparian stringers in the Mojave Desert, to the montane forests of the state's higher elevations.
- Finally, the Order Passeriformes includes all of the songbirds, a huge Order. In this Order in Nevada there are numerous species of flycatchers, jays, vireos, swallows, wrens, thrushes, warblers, tanagers, towhees, sparrows, blackbirds, and finches.

No species of bird can be classified as endemic to Nevada–a native occurring here and nowhere else. One species–the Himalayan Snowcock, occurs only in the Ruby Mountains of Nevada and nowhere else in North America. However, this species is non-native, being introduced from Asia, and is managed as a game bird.

Avifaunal diversity in Nevada is linked to a variety of factors, the most dominant of which is the state's geography. With 314 mountain ranges, an elevation range of 150 - 4,000 m (480 - 13,140 ft), two deserts, portions of four ecoregions, seven major habitat types, and 22 "key habitats," the state offers considerable habitat diversity for birds. Other factors affecting bird diversity and linked to geography to varying degrees include precipitation patterns, continental bird migration patterns, and the dominant Basin and Range topography of the state.

With a few noteworthy exceptions, birds in Nevada tend to be distributed at low densities across the landscape. This distribution is probably a reflection of food resources, which likewise tend to be rather widely dispersed in the Great Basin and Mojave Deserts. The exception to this generality usually occurs in the few locations in the state where water also occurs in abundance. In high water years, places like the Lahontan Valley and Franklin Lake Wildlife Management Areas, can teem with remarkable numbers of waterbirds. Ruby Lake National Wildlife Refuge, which has a fairly reliable water supply, supports good numbers of birds throughout the year. A few locales across the state regularly support large numbers of colonial breeding birds. Pinyon Jays, a noisy, conspicuous, and gregarious bird, concentrate in large flocks where piñon pine nut crops are abundant and constitute an exception to the rule of water as the attraction for concentrations of birds.

As we see with other animal groups, the topography of the Great Basin contributes significantly to the distribution and abundance of birds. Nevada's basins tend to be arid expanses of low desert shrub-dominated landscapes. However, some basins hold winter run-off for short periods of time, offering critical stop-over sites for waterbirds in spring migration. Fewer still are the basins that have permanent water sources, and these places offer habitat values to birds that far exceed the small extent of the watered lands.

These arid basins separate the north-south trending mountain ranges, which due to effects of elevation and aspect, tend to be better watered and support forests of piñon-juniper, pine, fir, spruce, oak, and aspen. For less motile species of mammals and reptiles, the basins constitute a significant barrier to movement and can lead to isolated populations and the rise of endemism. But for birds the basins may only be a deterrent to movement on a short term basis, as these landscapes are readily traversed during migration or after juvenile birds disperse from their nests.

Moving from the low-elevation basins to the ridge lines of adjacent mountain ranges it is possible to cross through eight elevationally defined vegetation zones. Each of these zones–Absolute Desert, Lower Mojavean, Blackbrush, Saltbush, Sagebrush, Pygmy Conifer, Montane, and Alpine–have their own characteristic suite of birds. Even the driest and apparently inhospitable landscapes have birds, at least during some portion of the year. Many species of desert birds are adapted to life without access to water. These species meet their water needs through their solid diets of seeds, insects, fruit, reptiles, or small mammals, and also through behavioral and physiological adaptations that help to conserve water.

The bird community of the Mojave Desert of southern Nevada is distinctly different from the Great Basin Desert bird community. The Mojave Desert extends well south from southern Nevada into California and Arizona as do many of the ranges of the bird species that inhabit it. The Greater Roadrunner, Vermilion Flycatcher, Gambel's Quail, Inca Dove, Ladder-backed Woodpecker, and Verdin are a few of the species characteristic of this landscape. Likewise, species like Greater Sage-Grouse and Bobolink that typify parts of the Great Basin landscape are absent from the Mojave. The altitudinal influences on vegetation, and accordingly, bird communities, still holds true for the Mojave.

Two major mountain ranges flank the Great Basin and also influence bird communities. On the western edge of the Great Basin lies the Sierra Nevada Range. Because of their altitude, rainfall, and proximity to the markedly different climate of the Pacific coast states, the Sierras have their own bird community, distinct from what is found elsewhere in the state. Although only a small portion of the Sierras occur in Nevada, the Sierra Nevada Ecoregion is the only place in the state where birds such as Mountain Quail, Red-breasted Sapsucker, White-headed Woodpecker, and Pygmy Nuthatch occur reliably. It is also the locale for even rarer occurrences of species such as the Pileated Woodpecker and the Great Gray Owl.

On the eastern flank of the Great Basin lie the Rocky Mountains. Positioned as they are in eastern Utah, their influence on Nevada's avifauna is moderated by distance. Nonetheless, species in eastern Nevada certainly show a greater affinity with this extensive mountain range. Species such as Black Rosy-Finch and the American Three-toed Woodpecker are a part of the northeastern and east-central Nevada landscape, but have their population centers in the Rocky Mountain states.

Pacific Flyway

Nevada lies within the Pacific Flyway, the primary seasonal movement corridor for waterbirds migrating west of the Rocky Mountains. The majority of waterbird migration in this flyway takes place west of the Sierra Nevada, with another concentration of birds following the Rocky Mountains. However, due to the occurrence of some strategically-located large wetlands (Lahontan Valley, Ruby Lakes), significant numbers of ducks, geese, shorebirds, and wading birds do cross Nevada on their journeys between breeding and wintering grounds.

This particular component of the great migration phenomenon adds significantly to the diversity of species in the state. Birds which breed thousands of miles away in the high arctic or in the bays and coves of the Pacific Coast stop each year at wetlands in Nevada. These migration stop-overs provide foraging and resting opportunities and critical fuel for the extraordinary journeys required of migrants. Positioned as it is in the flyway, Nevada has significant responsibility for the maintenance of these populations.

Raptor and Passerine Migration

Raptors save critical energy in migration by utilizing upwelling air currents generated by air rising up mountain slopes to maintain altitude and north-southward momentum. With 314 mountain ranges nearly all oriented along north-south axes, this orographic effect is widespread in the state. Most mountain ranges in Nevada probably support a raptor migration, although the migration appears to be diffuse across the landscape, in part because mountain ranges are so abundant. The one noteworthy exception to this diffuse pattern of movement is the Goshute Mountains. Here several mountain ranges converge from the north and concentrate raptor movements along the Goshutes, which act like the throat of a funnel. As many as 20,000 raptors of at least 13 species have been recorded passing over the Goshute Mountains by HawkWatch International (Smith and Vekasy, 2001).

Little research has been conducted on migration of the Passeriformes through Nevada. Because the Great Basin is a hostile setting for most songbirds, migration through the Great Basin is fraught with risk. Though major passerine migration routes circumvent the Great Basin by following the Sierra Nevada and Rocky Mountain ranges, significant numbers of passerines do cross Nevada with a surprising degree of diversity. Springs, seeps, streams, and lake shores are critical to sustaining these birds as they cross the desert. North-south trending valleys with surface water, such as Oasis Valley, Meadow Valley Wash, Pahranagat Valley, and the White River Valley likely concentrate migrating songbirds. The evidence for this phenomenon is strong in Oasis Valley (McIvor, 2005), but poorly researched elsewhere.

Climate change could affect birds in a variety of ways, including wide-scale shifts in vegetation type and cover; changes in migration and breeding timing; changes in the availability of food and water, especially critical during the breeding and migration seasons; and direct effects of increasing temperatures and altered precipitation patterns on individual species (GBBO, 2011). Perhaps most troubling are expected "decoupling" of peak food availability with peak breeding season and the expected earlier migration patterns of species that would put them in areas too early for adequate food production; and distributional shifts caused by large scale, extreme events such as fires and disease outbreaks. Research into these topics is on-going, but these effects are currently fairly unknown. Research of these topics is on-going; some of which are featured in the analyses for this Plan Revision.

Reptiles

There are 56 native reptile species recognized in Nevada, consisting of 15 families and 36 genera. Of these 56 species, three species have two recognized subspecies that occur within Nevada's boundaries. The Nevada Natural Heritage Program recognizes one additional species, the Mexican garter snake, based on a historical occurrence, however, it is presumed extinct in Nevada. One lizard, the Mediterranean house gecko, and five turtles are introduced species.

Nevada's native reptiles can be categorized in three major groups: turtles (one species), snakes (26 species), and lizards (24 species). Several species, including the desert horned lizard, western whiptail lizard, long-nosed leopard lizard, gopher snake, and striped whipsnake are quite common, utilize a variety of habitats, and are found essentially throughout the entire state; while others have restricted habitat requirements or are found in small isolated populations in Nevada, such as the northern alligator lizard, western red-tailed skink, Sonoran mountain kingsnake, and the western diamondback rattlesnake.

Many of Nevada's native reptile species can be categorized as either Great Basin or Mojave Desert species. Typical Great Basin reptile species include the western rattlesnake, northern rubber boa, and the greater and pygmy short-horned lizards. The warmer year-round temperatures associated with the Mojave Desert provide habitat for a diversity of numerous heat-tolerant reptile species such as Mojave desert tortoise, chuckwalla, desert iguana, western banded gecko, Smith's black-headed snake, glossy snake, and the sidewinder rattlesnake.

Many of Nevada's reptile species possess unique and varied characteristics and habits. Several lizard species, including the chuckwalla and desert iguana, are chiefly herbivorous, while most other lizard species are omnivorous, and all snakes are carnivorous. Nevada is home to three horned lizard species. The greater and pygmy short-horned lizards occur in the Great Basin and Columbia Plateau, are viviparous, and give birth to live young. The desert horned lizard occurs in the Mojave Desert is oviparous, laying eggs which contain the next generation of lizards.

Most reptile species can be categorized as either diurnal (active during daylight hours) or nocturnal (active at night). The desert night lizard, night snake, and spotted leaf-nosed snake are all nocturnal, while the coachwhip, western yellow-bellied racer, desert spiny lizard, and the Great Basin collared lizard are all examples of diurnal species. The lyre snake, which occurs in the Mojave region, is unique in that it immobilizes its prey via venom directed along grooved teeth. Although venom is usually exclusively associated with rattlesnakes, in addition to the lyre snake, the gila monster, one of only two venomous lizards in the world, also uses this adaptation in their pursuit of food. One Nevada reptile species, the desert tortoise, is currently listed as Threatened on the federal List of Threatened and Endangered Species. This is due primarily to habitat loss and disease.

One subspecies of aquatic reptile, the northwestern pond turtle, may be a Nevada native. The pond turtles' origin remains undetermined as genetic tests have not shown significant differences among the widely distributed populations (Washington state to Baja California). Records do show that pond turtles were present in Nevada near the beginning of the 20th century. More sensitive testing is needed to gain a clear understanding of the genetic affiliation of the Nevada populations.

The body of published literature pertaining to Nevada's reptiles is small. Much work is needed to fill the knowledge gaps for many species. Many snakes and lizards, especially those that are cryptic and/or nocturnal, are difficult to survey; therefore, much information is lacking. In many cases, we are still documenting presence/absence of species, as evidenced by the recent confirmed documentation of the only known Nevada occurrence of the rosy boa (Mulks, 2011). In recent years, considerable knowledge has been gained but this group of animals will remain a group that requires much attention.

While intuitively it may seem that reptiles would be the one group of animals more resilient to climate change as many are already adapted to hot, dry conditions, there is evidence that this may not be the case. For example, in the Mojave Desert, many reptiles are closely tied to the shrub overstory, which provides critical shade habitat during the day. These shrubs are predicted to contract with climate change, thereby fragmenting dependent reptile populations. In addition, in the search for cleaner, alternative energy, large areas of the Mojave Desert are proposed to be developed for large solar producing power plants. These large-scale developments could cause significant habitat fragmentation and the likely extirpation of many populations. In the north, as wildfires increase and the extent of non-native annual grasses increase, loss of habitat is also likely to significantly affect Great Basin reptiles.

Aquatics

Amphibians

Amphibians are typically found associated with aquatic resources in Nevada and are considered important indicators of ecological health in areas where they would normally be expected to occur. Much like other aquatic-dependent biota, their distribution is sporadic in association with the distribution of water resources in this arid environment, and isolation of amphibian species and sub-populations has resulted in a high level of endemism and metapopulation uniqueness in proportion to the small number of amphibian species statewide. This metapopulation isolation and relative scarcity across the landscape also makes Nevada amphibian populations particularly susceptible to localized habitat alterations and short-term climatic changes such as extended drought. Their life history (an aquatic and a terrestrial phase) and very permeable skin also make them highly sensitive to ecological changes.

Fifteen native species of amphibians have been found in the wild in Nevada, all within the order of Anura (six frogs, eight true toads, and one spadefoot toad). One species of frog, the Las Vegas Valley leopard frog is believed to be extinct, and another, the Sierra Nevada yellow-legged frog, is thought to be extirpated from Nevada. The relict leopard frog was once believed to be extirpated from Nevada, but was rediscovered near Lake Mead in the 1990s. Two additional amphibian species found in Nevada are introduced – the tiger salamander and the bullfrog.

Relatively good amphibian distribution data is limited to a few species (Columbia spotted frog, Amargosa toad, and the relict leopard frog). Anecdotal information for some species, such as Pacific chorus frogs and western toads, indicates that their populations are relatively stable, but there is little official documentation. Other species, such as the northern leopard frog appear to have shown declines in statewide distribution compared to historic accounts, but again, documentation is limited. Although worldwide amphibian population declines and extinctions are cause for concern, there is some evidence that detected declines in most Nevada species can be attributed largely to local identifiable factors such as short-term climate cycles and alterations to habitat quality and availability. However, the absence of good data, particularly for widespread and patchily distributed species such as the northern leopard frog, western toad, and chorus frog, makes accurate determination of status and trend for many native amphibian species difficult at best, and limits the ability to develop and implement proactive conservation actions if required.

Because most of Nevada's native amphibian species are closely linked to surface water resources for at least some portion of their life cycles, effects, in some situations substantive, can be anticipated from climate change but those effects will be variable depending on the species and geographic location within the state. True frogs including Columbia spotted and northern leopard frogs in central and northern Nevada are dependent on persistent standing water ponds and perennial streams; shifts in precipitation patterns that may encourage early onset spring runoff and increased summer period temperatures could negatively impact the extent and duration of wetland, montane pool, and perennial stream habitats and could be expected to have a corollary effect on distribution, reproductive success, and metapopulation connectivity for these species. In contrast, some Mojave Desert species, such as red-spotted and Woodhouse toads, are dependent on ephemeral pools for their reproductive strategies. Anticipated shifts in monsoonal precipitation patterns in southern Nevada could actually increase the distribution and duration of reproductive habitats for those species although as for all aquatic species, a high level of uncertainty in available precipitation models makes specific predictions difficult.

Fishes

More so than terrestrial wildlife species, the taxonomic diversity and distribution of Nevada's fishes are influenced by our state's geologic and hydrographic history (Hubbs and Miller, 1948; Hubbs et al., 1974). Throughout the Great Basin ecoregion, glacial and postglacial changes in climate and hydrology have alternately connected and isolated hydrologic systems and their associated biota, creating a globally unique endemic aquatic fauna surprising in its diversity and much at odds with current climatic conditions. Conversely, significant parts of Nevada's land area fall within the larger Colorado River, Snake River, and Bonneville drainages, and support endemic fauna specifically representative of those systems, although frequently also with unique adaptations as a result of isolation from climatic and geologic change.

With settlement and development of Nevada, its endemic aquatic fauna has been augmented with a wide variety of introduced fish species, many from the Mississippi River drainage and associated systems. Dominating many of Nevada's lakes and reservoirs, introduced centrarchid fishes represent challenges for managing endemic species, but support diverse and important sport fisheries. Stream and river systems, particularly in central and northern Nevada, support primarily salmonid fisheries with both native and introduced trout species. Beginning in the early 20th century, aggressive introduction programs established non-native trout species, including brook, brown, and rainbow trout, in many stream and river systems statewide, and the majority of those waters still maintain important recreational fisheries to this day. More recent sport fish management efforts have focused on the conservation and expansion of remaining populations of native salmonids such as cutthroat, redband, and bull trout, while maintaining sport fishing opportunities through the stocking of non-native trout species in appropriate locations.

Although approximately 151 species or subspecies of fishes have been found in the wild in Nevada, at least 37 of these are nuisance introductions of species that have no commercial or recreational value, or are incidental observations of non-native species which may not persist in the wild as viable populations. Twenty species of non-native game fishes, the majority of them occurring from intentional introductions, support a significant part of Nevada's recreational sport fisheries.

Nevada's endemic fish fauna consists of at least 87 described species and subspecies, although the precise number is difficult to determine. Taxonomic and systematic description of this diverse resource is ongoing with a number of potential endemic fish subspecies still poorly defined. The heritage of Nevada's complex geological and hydrographic history is reflected in the systematic and genetic relationships within its native fishes.

Because of the isolated and biologically unique nature of many endemic fish populations, and alterations to aquatic habitats which have occurred over time, a significant proportion of Nevada's endemic fish species are afforded protection under state statutes or the federal Endangered Species Act. Twenty-six Nevada fishes are listed under the ESA (19 as endangered and seven as threatened), and an additional 23 species or subspecies are listed under Nevada Administrative Code (NAC) as protected, endangered, and threatened fish (12) (NAC 503.065) or sensitive fish (11) (NAC 503.067). These 49 species or subspecies represent more than half of Nevada's endemic fish biota as currently defined. Active conservation programs are in place for a majority of these fishes to varying degrees, ranging from a few federally sponsored recovery programs to cooperative working groups and conservation implementation processes under state and partnership leadership. In all cases, significant challenges exist to effective fish conservation, principally from intentionally or illegally introduced aquatic species and the difficulty of addressing and correcting alterations to the landscape and aquatic habitat systems which have occurred over the past 140 years.

As with other aquatic species, climate change effects on Nevada's native fish fauna could be in some cases substantive, but those effects will be highly variable dependent on the species, the nature of the aquatic system, and location within the state. Thermal endemic native fishes occupying spring systems tied to regional carbonate aquifer systems are likely to show the most limited effects at least in the short term, but spring-dependent species reliant on non-carbonate and local recharge regimes such as relict dace, White River spinedace, and many speckled dace subspecies could be subjected to negative changes in available habitat and volume of flows depending on alterations in timing and duration of seasonal precipitation, particularly as altered snowpack conditions affect local recharge regimes. For native salmonid species in particular, but to some extent all endemic fishes occupying intermountain river and stream systems, predicted increases in interannual air temperatures coupled with potential changes in precipitation patterns suggest that modified flow regimes may become more prevalent over the next 20 to 30 years particularly in northern and north-eastern Nevada, characterized by earlier onset of spring runoff, reduced baseflow during mid- to late-summer periods, and associated increases in in-channel seasonal water temperatures. Potential implications for resident fishes include a reduction in suitable habitat quality and availability, impacts on individual fish recruitment, survivorship and reproductive success, additional fragmentation of stream systems that already may have limited connectivity with resultant effects on metapopulation dynamics, and loss of total available habitat in some stream systems particularly at lower elevations.

In Mojave River and stream systems such as the Virgin River, potential effects are less predictable largely because of the higher uncertainty of future precipitation models. However, likely changes in both precipitation and temperature for these systems suggest earlier onset of spring runoff events, reduced early- to mid-summer base flows, and an increase in stochastic flood events associated with shifts in summer monsoonal storm patterns. Although periodic flood events are important for maintaining in-channel habitats in these systems, reduced summer and fall base flows are likely to increase the frequency of instream conditions approaching or exceeding thermal maxima for many native fish species such as Virgin River chub and flannelmouth sucker.

Aquatic Mollusks-Bivalves

Five species of true freshwater mussels (order Unionida) have been reported in Nevada and are assumed to be native. The majority are in the family Unionidae (California Floater, Oregon Floater, Winged Floater, Western Ridged Mussel). The Western Pearlshell belongs to the family Margaritiferidae. Freshwater mussels are found in various aquatic habitats, and have an interesting life history. Some are known to live over 100 years, and many have a unique mechanism for larval dispersal. Freshwater mussels need a fish, or uncommonly an amphibian, host during their early developmental stage. This behavior is unique among bivalve mollusks, and also links the health of their populations to that of their fish hosts. When appropriate hosts are lost from a system, freshwater mussels are unable to reproduce. The majority of freshwater mussel records (which are very few in number) are occurrences of the California Floater in the Humboldt River system. The Western Ridged Mussel has also been documented at a limited number of sites. Discussions with numerous field staff from NDOW, other agencies, and researchers indicate a much wider distribution of freshwater mussels in Nevada, but limited to the northern half of the state. Also, shells have been found at numerous locations, indicating at least historical presence. Since live freshwater mussels are imbedded in the substrate they are not casually detected unless there are mortalities.

Fingernail clams and pea clams, small bivalves usually only a few millimeters or less in size, are not technically freshwater mussels. They belong to the order Veneroida, family Sphaeriidae, and are not dependent on a host. They appear to be widely distributed throughout the state, and hundreds of records are available for them, primarily through scientific collection activity reports supplied to NDOW.

No Nevada mollusks are either federally or state listed. However, the California floater is ranked in Nevada as critically imperiled by the Natural Heritage Program, and has been included on the list of Aquatic Species of Conservation Priority. Little is known about Nevada bivalves, especially historic and current distributions and population trends. Hosts have been identified for relatively few species of freshwater mussels. Genetics of the California Floater and other western mussels are currently being studied to assess whether distinct populations occur within different watersheds (Xerces Society, 2011). Some key questions regarding bivalve mollusks in Nevada are distribution, genetics, and host species. Invasive mussels and clams are highly detrimental to native populations and can cause significant impacts to ecosystems. More information can be found in the invasive species section of this plan.

Aquatic Mollusks-Gastropods

Freshwater, gill-breathing mollusks occur throughout North America, primarily in springs. More species of *Pyrgulopsis*, the largest genus of springsnails (pyrgs), occur in the Great Basin than anywhere else in the U.S.

Most springsnail (pyrg) populations are highly isolated because springs and seeps are widely dispersed and disconnected. Indeed, many species' entire range is in just one small spring. A number of springsnail (pyrg) populations are declining, almost faster than we can learn about them. Their aquatic habitats are rare and sensitive to drought and to the manner in which water resources are used.

Much remains to be learned about the diversity of Nevada's gastropod populations, their distribution, conservation status, and special ecological functions. Over 100 species of freshwater snails have been documented in Nevada. One species of *Pyrgulopsis* was recently added to the federal candidate list (the elongate mud meadows springsnail (*Pyrgulopsis notidicola*) but none are currently afforded state protection. As scientists continue to monitor and survey populations, new species will likely be described and more will be learned about Nevada's exceptional gastropod diversity.

Because native gastropods are largely dependent on isolated, often small but persistent springs and associated spring outflow habitats, climate change effects will vary dependent on the individual springs where they occur and how those springs are associated with various groundwater hydrologic systems. Larger, often thermal, springs associated with regional carbonate aquifer systems are likely to show limited effects from climate change at least in the shorter term over the next 50 years. The future condition of springs associated with non-carbonate aquifers and more local recharge systems is more uncertain, as changes in the timing and duration of precipitation and runoff patterns has the potential for more direct effects on surface water discharge. Regardless, almost all spring outflow systems have the potential for effects from increased air temperatures as this impacts both springbrook lengths and total wetted discharge areas.

Crustaceans

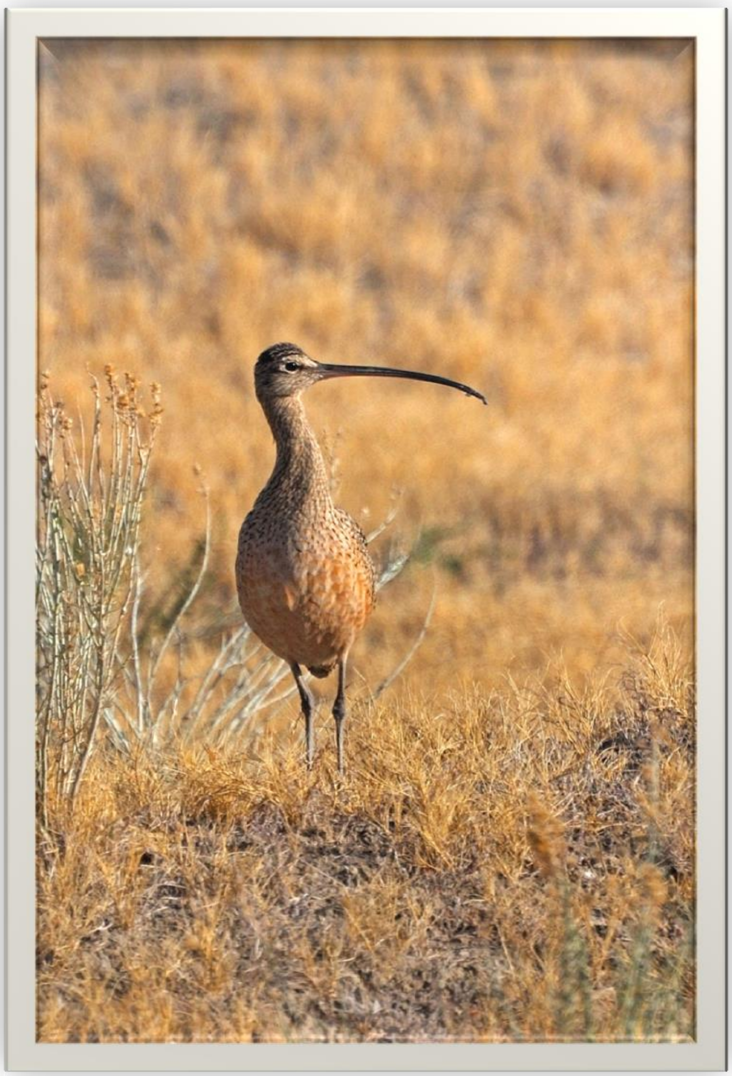
There are approximately 30 identified crustacean species in Nevada, falling into three classes: Malacostraca (crayfish, amphipods, scuds, and others), Ostracoda (ostracods), and Branchiopoda (fairy, clam, and tadpole shrimp). Most crayfish species found in Nevada have been introduced and exist outside their native range; these introduced crayfish are one of the major problems facing many of Nevada's Aquatic Species of Conservation Priority. Some of the main impacts of non-indigenous crayfish to warm water fauna include predation upon early life stages of fish and amphibians, and also on adult life stages of small-bodied fish (most of the ESA-listed fish in Nevada fall into this category). Non-native crayfish also compete for resources at the expense of native species. The emphasis is therefore to prevent the spread of non-native crayfish into areas where they do not yet exist, and control or eradication of introduced crayfish where they threaten other aquatic species that are at risk. Most of the crayfish introductions probably occurred through the release of live bait. Actions have been identified in various conservation plans to reduce or eliminate introductions that have proved detrimental to important native aquatics.

There is little documentation of Nevada's macroinvertebrate crustacean species, many of which are ephemeral pool specialists (e.g., fairy shrimp and tadpole shrimp). In order to survive the temporary, often harsh environments they inhabit, part of their life cycle includes an encysted egg that can survive long periods of desiccation and temperature extremes. These species are not included on the WAP Species of Conservation Priority list because so little is known about them in Nevada.

Aquatic Insects

The Nevada Department of Agriculture has jurisdiction over insects. Their mission is to encourage the advancement and protection of agriculture and related industries for the benefit of Nevada citizens. Their focus, therefore, is on insects detrimental to agriculture. The Nevada Natural Heritage Program tracks sensitive insects. Further information can be found at the Nevada Natural Heritage Program (www.heritage.nv.gov) and on NatureServe Explorer (www.NatureServe.org).

In the 2005 Nevada WAP, it was stated that the WAP Team would convene a working group of key conservation partners from the University of Nevada, Reno (UNR), Great Basin College and other partners to develop a conservation strategy for terrestrial invertebrates as a task in a future phase of WAP development and implementation. Due to the retirement of key partners at UNR, this effort did not come to fruition during the implementation of the 2005 plan and it was not pursued in the 2012 revision. We will however, continue to work closely with key conservation partners such as the USFWS, U.S. Forest Service, Nevada Natural Heritage Program and others in the conservation of terrestrial invertebrates and other sensitive species in landscape-level planning documents such as the Spring Mountains National Recreation Area Conservation Agreement and Strategy.



Challenges in Wildlife Management

Nevada is uniquely challenged in approaching effective wildlife conservation, in part because of its generally arid climate, geography, and relative scarcity of water resources, which has created a unique endemic biota easily subject to threats and stressors. Beyond these inherent conditions, however, human factors including a long history of land use activities altering natural habitats, recent intense urban development, and the widespread occurrence of invasive plant and animal species must be addressed to ensure the effectiveness of conservation actions and the maintenance of wildlife and their habitats into the future. When coupled with natural stressors such as periodic, but unpredictable, drought conditions from short-term climatic variation human related stressors can create a compounding effect which significantly influences the ability of habitats to maintain wildlife diversity on a landscape scale. Although some of these anthropogenic stressors, such as urban development and large-scale modification of hydrologic systems for water supply and flood control, may not be reversible and are necessary costs associated with human settlement and needs, others can be managed or corrected in ways that reduce negative effects or positively assist in implementing conservation.

Although Nevada's unique landforms and natural history are important elements in understanding and addressing the challenges inherent in developing this strategy to comprehensively conserve our wildlife resources, it must be understood that challenges for species and habitats across Nevada are closely tied to anthropogenic land use activities. Any strategy for addressing these challenges and effective conservation must include a definition and attempt to understand the stress on species and their habitats. In the broad sense, the sources of stress can be categorized into actions related to agriculture, hydrology, recreation, natural resources extraction, development, military activities, and a few additional actions which do not fall into these general areas.

Although organized agricultural activities are not a significant broad-scale stressor in Nevada, where they do occur, land-use actions such as agricultural and pasture conversion can influence wildlife through loss of native vegetation communities and species diversity, changes in vegetative structure characteristics, and increased disturbance to wildlife. Improper agricultural practices have the potential for significant local impacts; water and soil pollution can occur from improper waste management in intensive agriculture operations such as feedlots; and improper application of pesticides and herbicides can cause incidental mortality of non-target sensitive species and disruption of physiological processes, including reproduction. Improper soil conservation practices cause soil erosion and sedimentation of streams and floodplains, and the improper application of fertilizers can result in nutrient loading of streams and contamination of animal tissues.

Animal Disease

The principles of disease in wildlife are adherent to the epidemiological triad which states that disease results from the interaction between the host, the environment, and the disease agent (pathogen or chemical). Each of these components (host, environment, and agent) can influence the others and factors within each component may change the contribution of the component to the development of disease. Critical factors which affect the host component include age, sex, genetics, nutritional, physiological and immune status, and prior exposure to pathogens. Environmental factors influencing the host include climate, habitat, and interactions with other species, host densities and aggregation indexes.

The occurrence of disease in wildlife can be a natural phenomenon or anthropogenically driven. Human generated influences that have been tied to wildlife disease events have been broadly divided into three categories; environmental change, climate change, and ecological change. Factors within each of these categories alter other physical and biological processes thus affecting the epidemiological triad and increasing the risk and/or incidence of disease events in wildlife populations across Nevada's eco-regions.

Environmental Change and Disease

- Electromagnetic fields (characterized by low intensity, variety of signals, and long term duration cell phone towers, etc.): Studies of electromagnetic field exposure on wildlife indicate that there may be impacts to behavior, reproductive success, growth and development, physiology and endocrinology, and oxidative stress potentially increasing carcinogenesis.

- Exposure to and accumulation of pollutants (which may lead to reduced habitat quality): Reported and predicted effects include impaired reproduction, impacts to the immune system (primarily a decrease in effectiveness) resulting in an increased incidence of infectious disease or carcinogenesis. Pollutants found in water may be of greatest importance to species within Nevada and toxicity from heavy metals, salts and petrochemicals found in evaporation ponds associated with the mining and energy industry and toxic algal blooms have been documented.

- Ozone depletion: An increase in exposure to UV radiation has been reported to have a detrimental impact on species of amphibians. Negative effects included abnormal development or decreased hatching success due to cellular damage, depression of the immune responses and an increase in cancer development. Impacts appear to vary between species and life stages. It is suspected that the effects of increasing UV radiation will be an additional stressor to taxa that are already in decline due to the impacts of habitat loss and emerging infectious diseases (Chytrid fungus, ranavirus).

Climate Change and Disease

Climate change predictions, such as thermal extremes and weather disasters, can contribute to:

- Changes in vector and pathogen distribution
- Pathogen emergence
- Altered habitats
- Droughts

The interaction between climate change and disease dynamics in wildlife is complex and as yet poorly understood. Vector borne or environmentally transmitted disease pathogens appear to provide the most convincing evidence that a warming climate may be facilitating their spread. Insect vector species can be sensitive to temperature and precipitation fluctuations and these climatic factors are known to impact life-cycle completion times, biting and feeding rates and overwintering survival of important disease vector species. Expanding ranges allow these vectors to encounter native host populations. Parasites that have a free-living life stage may have their development times and transmission windows impacted by increasing temperatures.

There is an increasing trend of novel or introduced pathogens occurring worldwide. This is significant in part because they can result in rapid and devastating population declines that often pose a greater threat to conservation efforts than habitat loss. Global population declines and extinctions have impacted amphibian species due to the chytrid fungus; white nose syndrome caused by the fungus, *Geomyces destructans,* is threatening the persistence of the little brown bat (*Myotis lucifugus)* in eastern North America; and pneumonia complex in bighorn sheep has caused all age die-offs leading to local collapse and extinction of meta-populations across the western states.

Nutritional stress (decreased calories, protein, vitamins, and other essential nutrients) and dehydration can occur secondary to thermal extremes or drought and may decrease the effectiveness of the immune system thereby lowering disease resistance to known or emerging pathogens. Immunodeficiency resulting from malnutrition has been well documented in humans and is strongly related to increased incidence of infectious diseases and infant mortality worldwide. Nutritional stress may impact other physiological processes in addition to immunity such a growth rate and reproduction leading to potential population impacts in vulnerable species.

Ecological Change and Disease

Ecological changes or shifts caused by climate change, such as land degradation and habitat fragmentation, can cause:

- Decreased food/nutrient availability may have a direct effect such as starvation, dehydration, or nutritional deficiencies may secondarily impact physiological processes resulting in an increased susceptibility to infectious disease.

- Restricted movement of animals due to loss of habitat corridors may isolate populations leading to decreased gene flow, inbreeding, and loss of genetic diversity. This may impact immune system responses and reproductive rates within these isolated populations.

- Increased rates of contact with humans or domestic animals can lead directly to increased pathogen transmission. If domestic species and wildlife are competing for the same decreasing resources at certain periods during the year this may place wildlife at an increased risk of disease. Most domestic livestock receive supplemental feed during part of the year thus their nutritional and physiological needs are met. Wildlife species competing on the range for limited resources may already be in a negative nutritional state with a compromised immune status and thus more vulnerable to disease transmission.

Determining the effects of anthropogenic influences, in particular climate change, on host–pathogen interactions is a challenge as these relationships are already complex. The impact of increasing population densities coupled with decreasing habitat resources are generally felt to facilitate disease transmission; however, some diseases have shown increasing incidence with decreasing population density and, with some interactions, it is believed that host population isolation secondary to the effects of climate change may lead to pathogen extinctions. Isolation of populations of desert bighorn sheep produced by herds moving to higher elevations across their range (as lower elevations are no longer habitable due to a warmer and drier landscape) has been hypothesized as a model of the effects of climate change, leading to a decline in population viability in the face of decreasing disease transmission. Initial concentration of individuals may increase the incidence of disease within the population; however, as metapopulations become increasingly isolated the chance of disease spread between populations declines and certain diseases may not persist.

With the possible exception of desert tortoises and bighorn sheep, extensive surveillance for and documentation of diseases in Nevada's wildlife has not been conducted. Extrapolations from studies conducted on species with ranges that overlap into Nevada (primarily those species along the Sierra Nevada) contribute to the current body of information; however, further efforts are needed to establish a baseline of health data within the state's wildlife populations. Such a baseline of data would assist wildlife managers in defining which components of the epidemiological triad currently influence disease distributions and prevalence in Nevada's wildlife thus increasing the our understanding of which components, impacted by a changing climate, may influence future disease events.

Climate Change

A growing body of evidence has linked changing climate with observed changes in fish and wildlife and their habitats. Climate change has likely increased the size and number of wildfires, insect outbreaks, disease outbreaks and tree mortality in the interior West and Southwest. In the aquatic environment, evidence is growing that higher temperatures are negatively impacting cold and cool water fish populations across the country (USFWS, 2010).

Climate is changing at an accelerated rate and science strongly support the findings that the underlying cause of these changes are largely the result of human–generated greenhouse gas concentration in the atmosphere caused by increasing human development and population growth (USFWS, 2010). Global temperatures are expected to continue to rise through the 21st century, dependent on the continued accumulation of heat-trapping gas emissions and the sensitivity of regional climates.

Average air temperature worldwide has risen steadily over several decades and dramatically since the 1950s. The first decade of the 21st century has proven to be the hottest decade since scientists began recording global temperatures in the 1880s, with the 1990s following close on its heels as the second hottest. In September, 2011, the polar ice cap set a new record low for area frozen at the end of summer, a trend that has been on a downward track for over a decade. Reports from all over the world of glacier melt, disrupted plant community phenological cycles, and disrupted bird migrations continue to mount. The average rate of sea level rise has doubled in just the last 20 years, and projections made just five years ago are already out of date, with actual change more accelerated than predicted.

Rainfall patterns around the world will be affected. Rising temperature causes water to evaporate faster, resulting in more water in the atmosphere. While scientists predict that global average annual precipitation will increase as a result, the increases will not be distributed evenly across the globe. Rainfall in many regions will increase in range of variability. Rain storms will become more intense but less frequent. Also, in some areas snowfall will shift to rain, with major implications for streamflows and seasonal availability of water for wildlife, fish, and people.

As the concern for climate change and its impact grows, federal, state, and local agencies and conservation organizations have been developing guidance documents for wildlife-related climate response. The USFWS developed the document: "*Rising to the Urgent Challenge: A Strategic Plan for Responding to Accelerating Climate Change*", in 2010. The Western Governors' Association published the document, *"Climate Adaptation Priorities for the Western States: Scoping Report",* in 2010. Very recently, the USDA Forest Service released the publication, "*Responding to Climate Change in National Forests: A Guidebook for Developing Adaptation Options"*. In 2011, The National Wildlife Federation published "*Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment".* In addition, a team of federal, state and tribal nations have developed the Public Review Draft of the "*National Fish, Wildlife and Plants Climate Adaptation Strategy",* which should be completed in 2012.

The AFWA/FWS document, "*Voluntary Guidance for States to Incorporate Climate Change into State Wildlife Action Plans & Other Management Plans*", includes recommended steps for developing and implementing adaptation strategies in the face of climate change:

1. Engage diverse partners and coordinate across state and regional boundaries.

2. Take action on strategies effective under both current and future climates.
    - Managers should focus on conservation actions likely to be beneficial regardless of future climate conditions. This can include reducing non-climate stressors, managing for ecological function and protection of diverse species assemblages, and maintaining and restoring connectivity.

3. Clearly define goals and objectives in the context of future climate conditions.
    - Goals and objectives should address whether they aim to resist the impacts of climate change, promote resilience, and/or facilitate changing conditions.

4. Consider appropriate spatial and temporal scales.

5. Consider several likely/probable scenarios of future climate and ecological conditions.

6. Use adaptive management to help cope with climate change uncertainty.

The documents and principles listed above were used as guidance in the development of this revision of the WAP. NDOW also serves on the AFWA and Western Association of Wildlife Agencies (WAFWA) Climate Change Committees to stay updated on national and regional wildlife issues related to climate change.

Climate Change in Nevada

Primarily using the climate change predictive tools available through the Climate Wizard (www.climatewizard.org), the Revision Team led by The Nature Conservancy's vegetation modeling team settled on the A2 Emissions Scenario from the *Climate Change 2007: Impacts, Adaptation, and Vulnerability* report (IPCC, 2007) for climate change modeling. The general deductions made from following the A2 scenario were that Nevada would increase in temperature about 3° C with greater greenhouse gas concentration, but with the same total amount of average precipitation. This prediction is highly dependent on the influence of the Pacific Ocean. The greatest uncertainty for future climate forecasting (high divergence among Global Circulation Models) will be for a western shift of the western boundary for the monsoonal effect (i.e., summer precipitation). For the purposes of modeling vegetation response, it was assumed that the eastern Nevada regions would experience a greater amount of summer precipitation and therefore less drought.

More specific hypotheses of change that developed as a result of our analysis were:

- Increased dispersal of non-native species caused by CO_2 fertilization of plant growth during wetter than average years

- Decreased dispersal of non-native species during drier than average years regardless of CO_2 concentrations

- Higher tree mortality during longer growing season droughts

- Longer period of low flows caused by earlier snowmelt
- Greater severe flood variability due to greater frequency of rain-on-snow events, which would favor cottonwood and willow recruitment on currently regulated rivers and creeks
- Longer period of groundwater recharge during colder months with low evapotranspiration and greater percentage of rain *versus* snow (more effective recharge)
- More stable discharge (buffered from precipitation) for springs, seeps, wet meadows, creeks, and rivers on carbonate geology and, conversely, less stable discharge on non-carbonate geology
- More frequent, larger fires in forested systems
- Increased growth and recruitment of subalpine trees due to increased tree line temperature regardless of CO2 fertilization
- Longer fire return intervals in shrubland systems due to increased drought frequency preventing fine fuel build up
- Greater conifer and deciduous tree species recruitment and growth in wetlands/riparian due to drought and CO2 fertilization
- Impaired recruitment of willow and cottonwood due to descending peak flows occurring one month earlier and limited ability of these species to flower one month earlier in cold drainages; and
- Faster growth of fast-growing native tree species.

Compared to scenarios without climate change, the climate change effects predicted over the next 50 years yielded consistent differences that resulted in both detrimental and beneficial ecological responses that varied by region; therefore we were able to conclude that climate change would contribute specific impacts over and above the natural rate of change assisted by other human-induced impacts.

Energy Development

The status of our current economy has had great influence upon land use within Nevada. Nevada with its large percentage of public land makes it a good choice for the purposes of developing an infrastructure for renewable energy. This development is being viewed as a means of diversifying our state's economy, a source for new job creation and as a native source for renewable energy production. Nevada has great potential for both solar and geothermal energy production and to a lesser degree, wind and biomass energy development. Each of these energy resources rely upon characteristics at a specific location (whether its sunlight intensity, consistent wind, or geothermal heat sources) that make a location desirable for development. The viability that makes these locations "work" for development includes its access, its proximity in relation to the electric grid, and the ease of which that site could be developed. That ease depends upon land ownership, zoning, or land designation for development and the ability to overcome or compensate for the environmental constraints of the site.

It has been well documented that energy projects have the potential to result in a loss of wildlife habitat (both permanent and temporary), habitat fragmentation and a host of indirect impacts such as disturbance created by human activity, vehicle traffic, noise, and noxious/invasive weed introductions. Technology has developed to treat many of these constraints and the success of reclaiming for the temporary loss of habitat has certainly made great advances. Yet the constraints are real, political decisions sometimes outweigh the need to make the best environmental decision and the challenges to wildlife conservation remain.

The best tool that land and resource managing agencies have is a detailed and current database of the resources that may be impacted by energy development. NDOW and NNHP have over the years worked on the development of GIS databases that provide spatial information on the resources. These data are used in a series of models that analyze management schemes and priorities for protection. In regards to energy development, the spatial information is used to aid in the siting of facilities and for comparing project alternatives.

Agencies have been stressing the importance of applying wildlife resource data in the siting of proposed facilities in an attempt to avoid high quality habitat and large undisturbed areas. The priority for land use would be to site on already disturbed ground, to site new facilities near existing facilities, and to avoid priority wildlife habitat. Unfortunately, not all projects request or use the resource data soon enough in the development of their plans to apply avoidance even though NEPA requires its application as the first effort in minimizing the impacts of development

Challenges for Wildlife Conservation

- Encouraging developers to use wildlife resource data early enough in the process to influence facility siting to avoid high quality wildlife habitat
- Developing and updating best management practices as mitigation to address potential impacts from energy projects and their changing technology
- Conducting sufficient research and pre-construction monitoring to best assess the impacts of energy development on wildlife
- Identification of sufficient project location alternatives to avoid impacts of concern
- Identification of high value wildlife habitat for avoidance and to identify areas of low quality wildlife habitat as opportunities for development
- The ability to identify areas unaffected by future proposed projects for application of offsite mitigation
- Ability to receive compensation for the loss of habitat which could take many years (sometimes upward of 25 years in sagebrush habitat) to recover to pre-disturbance conditions
- Ability to prevent the establishment of invasive plant species, particularly noxious weeds, from becoming established in areas where soils have been disturbed
- Ability to prevent wildlife mortality, in toxic evaporation or cooling ponds and other water impoundments
- The ability to avoid habitat fragmentation caused by linear projects incorporating new roads, powerlines, or pipelines
- Planning for the closing, termination or cessation of energy projects, the removal of facilities, and other decommissioning actions and site restoration activities

Actions Associated with Energy Projects to Advance Wildlife Conservation

- Programmatic Environmental Impact Statements which have addressed the issues common to energy development on Public Lands in a general sense and have identified some of the issues which are common to those projects. Those documents include: Wind Energy Development PEIS, Geothermal Energy Development PEIS and the Solar PEIS
- Guidelines developed by the USFWS for the siting of Wind Energy Development Projects
- Guidelines, Recovery Plans, and Habitat Protection Plans developed for specific species or habitats to identify or require protection including: Guidelines for Golden Eagles, and Greater Sage Grouse, the Clark County Multiple Species Habitat Protection Plan, to name a few
- Issuance of the Standards for Energy Development in Sage Grouse Habitat by the Governor's Sage Grouse Committee
- Development of standards and best management practices to reduce predation by aerial predators utilizing high voltage electric transmission lines including application of anti-perching and anti-nesting devices
- Guy wire covers and other anti-collision devices which make guy wires and static wires more visible to reduce bird collisons
- Studies funded by project developers which increase the science of how wildlife reacts to energy developments. The Falcon to Gondor 345kV Project funded sage grouse study has provided some essential interaction and behavioral data

Direct Human Effects

Another anthropogenic effect and source of stress is direct negative human interaction with wildlife, specifically, overexploitation of species through illegal activities such as poaching, illegal collection or killing, excessive harvest of species for commercial or scientific research purposes, and habitat destruction associated with collection activities. Although difficult to demonstrate in a quantitative sense, such activities have the potential to present significant threats at a local level, particularly for rare and geographically isolated Species of Conservation Priority.

Grazing

Livestock grazing on the Nevada range has a long history and remains one of the state's important industries. Livestock managers make and implement grazing management decisions to achieve a variety of goals, including profitable livestock production, keeping working ranches and farms in the family, and wildlife habitat enhancement. Grazing management plays a pivotal role in the quality and extent of wildlife habitat. Livestock grazing is the most widespread activity overseen by federal land management agencies in Nevada and affects a large portion of the Nevada landscape.

Livestock grazing now competes with more uses than it did in the past, as other industries and the general public look to public lands as sources of both conventional and renewable energy and as places for outdoor recreational opportunities, including off-highway vehicle use. This competition for land use is a sign of the times across the West, and debates over livestock and wildlife values should be placed within this broader context. Ranchers and wildlife conservationists know that debates over grazing and animal management units (AMUs) are of little importance if rangelands continue to be lost, degraded, or fragmented because of development, the dominance of exotic species, catastrophic wildfire, or restructuring of water allocations. Still, domestic grazing that reduces land values via reduced productivity and habitat quality can also lead to habitat conversion, alternative land uses, and suspension of permitted leases for not meeting minimum land health standards.

With increased use of public lands, wildlife is increasingly coming into contact with ranching and farming operations which may lead to neutral, beneficial or incompatible interactions depending on the type and magnitude of interaction.

Grazing management was initially designed to increase productivity and reduce soil erosion by controlling grazing through both fencing and water projects and by conducting forage surveys to balance forage demands with the land's productivity ("carrying capacity"). Over time, public expectations for the management of public lands continues to rise and includes new challenges such as: global climate change, severe wildfires, invasive plant species, and dramatic population increases, including associated rural residential development. These challenges add to the management challenges for both wildlife and livestock grazing.

Consequently, livestock grazing has shifted management objectives and priorities over the years to better manage and conserve specific rangeland resources, such as riparian areas, threatened and endangered species, sensitive plant species, and cultural or historical objects. Currently, grazing is managed with the goal of achieving and maintaining public land health using rangeland health standards and guidelines that were developed in the 1990s with input from citizen-based Resource Advisory Councils across the West.

Livestock facilities such as springs developments, water pipelines, and fencing have distributed livestock use over areas that were sporadically or lightly used prior to agricultural development. Distribution of livestock over a greater area, can also reduce impacts associated with concentrated livestock – trampling, soil compaction, eroding trails, etc. Water diversions (surface or excessive ground water withdrawal) are the most common threat to fish and other aquatic species in Nevada. Water diversions create functional changes in the spring system by decreasing water volume and reducing soil moisture. Riparian vegetation can be affected when excessive groundwater withdrawals lower the water table.

The loss of natural water resources threatens wildlife, but domestic livestock also require water to survive. Since the advent of commercial grazing on rangeland, ranchers have improved existing water supplies and developed new water systems for their livestock. Wildlife managers also develop water resources specifically for wildlife, and increasingly, livestock and wildlife water developments replace or augment diminishing natural sources in many areas and have become crucial for many species, especially during times of drought or unseasonably high temperatures. The presence of livestock water developments can also improve the quality of surrounding habitat, allowing wildlife species to expand into previously unoccupied areas. Pronghorn antelope generally require permanent water sources at intervals of less than five miles within their home range. Ranchers have become increasingly interested in, with the help of various federal programs, developing water systems that are wildlife friendly (e.g., wildlife escape ladders, using structures of different size, shape or position to enhance wildlife use). Strategically placed water developments that are managed to eliminate excessive diversion and that incorporate wildlife friendly features can be used to enhance rangeland for both livestock and wildlife.

Grazing has positive or negative effects depending on current and historic timing and intensity of grazing, soil conditions, precipitation, plant communities, and specific habitat (e.g. riparian) features under consideration.

Fortunately, habitat needs of many wildlife species are known and these requirements provide the "sideboards" necessary to develop guidance for grazing strategies for maintaining or enhancing wildlife. Food, cover, and space are habitat needs for both wildlife and livestock. Grazing management can be focused to managing livestock in a manner that supports these basic habitat elements while maintaining native plant community integrity – the plant communities to which native wildlife have adapted.

Invasive Species

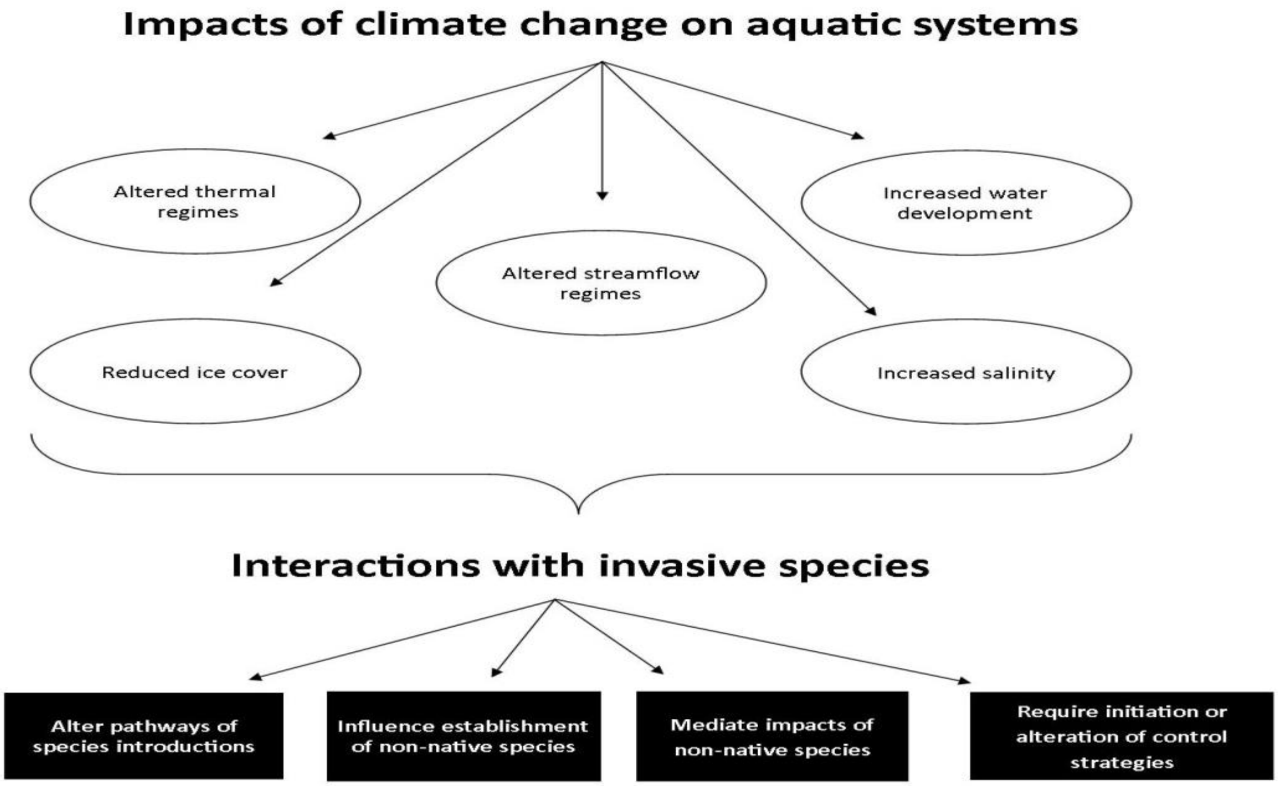
A number of other sources of stress for wildlife and habitats exist and are not well connected to land use per se, but are primarily of human origin. Invasive, exotic, and feral species are one of the most significant and difficult problems facing both terrestrial and aquatic species and habitats in Nevada. These non-native species, through their invasive natures can outcompete native species and decrease the complexity of the native ecological communities, thus contributing to localized loss of species and overall reductions in wildlife diversity. They can also alter natural ecological processes through changes in fire regime, resulting in self-sustaining exotic communities with little prospect of restoration back to natural communities or stability in naturally dynamic and changeable aquatic habitat substrates. The presence of exotic animal species can disrupt natural community dynamics through competition for resources, and can cause direct conflict and predation resulting in displacement, mortality and extirpation of native species. Invasive and exotic species can introduce alien diseases into non-resistant native populations.

Aquatic Invasive Species

Non-native species that have been intentionally or unintentionally released into new environments can become aquatic invasive species, causing environmental, economic, and human health harm (EPA, 2007). The National Invasive Species Council defines an invasive species as "an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health." It should be noted, however, that not all non-native species are harmful or will become invasive. For example, it has been found that 28% of non-indigenous fishes have had beneficial effects (OTA, 1993; EPA, 2007). For those species that do become invasive and cause ecological and/or economic damage, their impact can be devastating to an ecosystem. Invasive species are considered a major cause of extinctions worldwide accounting for 25% of fish extinctions, 42% of reptile extinctions, 22% of bird extinctions and 20% of mammal extinctions (Cox, 1999; EPA, 2007). In the U.S., damage and losses from invasive species are estimated to be valued at approximately $120 billion annually (Pimentel et al., 2005). Aquatic invasive species (AIS), in particular, can have a wide range of ecological impacts including loss of native biodiversity, altered habitats, changes in water chemistry, altered biogeochemical processes, hydrological modifications, and altered food webs (EPA, 2007).

Evaluating the relationship between AIS resulting from changes in climate is relatively unknown and research needs to be conducted to clarify the impact. However, generally accepted changes are expected to impact aquatic systems in several major ways including increasing water temperatures, altering stream flow patterns, and increasing storm events (Poff et al, 2002). These changes will have profound impacts on aquatic ecosystems including altered thermal regimes, reduced ice cover, altered stream flow regimes, increased salinity and increased water development activities. Aquatic ecosystems and their respective organisms will be vulnerable to a changing environment and in many cases open the door for new introductions and increased spreading of AIS. Figure 3 (Rahel, Frank J. et al., 2008) depicts characteristics of aquatic systems that will be altered by climate change and how these changes will affect AIS.

Figure 3. Characteristics of aquatic systems that will be altered by climate change (Rahel, Frank J. et al., 2008)



Climate change is expected to alter the thermal regimes of much of the Earth's surface resulting in increased water temperatures. As the water warms, it is expected that warm-water aquaculture, tropical fish culture, and outdoor water gardens will expand providing new opportunities for unintentional AIS introductions that are capable of becoming established in historically colder water systems (Rahls, 2007). Suitable thermal habitat for warm-water fishes is predicted to increase by 31% across the U.S. due to climate change (Mohseni et al., 2003, Rahls et al., 2007). In addition, climate warming is predicted to allow for expansion of invasive coldwater species into new areas. For example, native bull trout have a competitive advantage over non-native brook trout in the "coldest" streams in the Rocky Mountains. As these streams warm, brook trout are expected to achieve competitive superiority and thus displace native bull trout from their habitat (Rahls et al., 2007).

Climate change is also expected to reduce the extent of ice cover on lakes which may influence the invasion process by increasing light levels for aquatic plants, reducing the occurrence of low oxygen conditions in winter, and thus exposing aquatic organisms to longer periods of predation from terrestrial predators (Rahl et al., 2007). In addition, the loss of winter hypoxia could also foster the expansion of quagga and zebra mussel populations in cold water lakes whereby the habitat would become more suitable for AIS establishment and rapid reproduction.

Climate driven changes to the flow regime is expected to influence the magnitude, frequency, duration, and timing of floods, droughts, and intermittent flows that are the primary drivers of ecological structure and function in aquatic ecosystem (Poff et al., 1997). Increases in flood conditions could increase the frequency of escapes from aquaculture during overflow events and also increase the dispersal of AIS through transportation through flooded streams (Havel et al., 2005; Rahl et al., 2007). During drought conditions, AIS (e.g., such as New

Zealand mud snails) can tolerate frequent and prolonged droughts and are tolerant of desiccation, thereby striving in harsh environments. Freshwater fish with opportunistic life-history strategies such as mosquito fish, guppies, and red shiners are also likely to increase in distribution and abundance (Olden et al., 2006; Rahl et al., 2007).

As the climate changes, arid regions are expected to experience increases in desiccation and alter the salinity of freshwater ecosystems (Seager et al., 2007). In addition, increases in water diversion and withdrawals that can provide new and altered pathways of introduction of AIS. Shifts are expected to occur due to salinity and increased water development activities that could lead to a decline of native fish species and the proliferation of invasive species that are salt and drought tolerant. Salt tolerant species such as red shiner, western mosquitofish, plains killifish, and invasive plant species (i.e, salt cedar) could successfully establish and dominate in the changed environment.

Identifying, preventing and eradicating AIS threats in a changing environment will require diligent state management and response plans that are capable of changing as the climate and AIS threats change. In addition, climate change impacts to existing or threatening AIS in Nevada will require additional research and site specific assessments. The ability of aquatic ecosystems to adapt to climate change is also limited in that expected rates of climate change are probably too great to allow adaptation through natural genetic selection and many types of habitat will be diminished or possibly lost entirely (Poff et al., 2002). In addition, human activities in response to climate change have the potential to severely modify many aquatic ecosystems. AIS species already established in Nevada, such as quagga mussels, Eurasian milfoil, Asian clams, and curly leaf pondweed, in addition to newer threats, such as Asian carp and other warm-water fish and plant species, will more than likely have the potential to spread into new habitat and regions within the state as water temperatures increase.

Terrestrial Invasive Plants

Invasive plants, such as noxious weeds, have become a major ecological and environmental concern throughout Nevada over the last couple decades. Noxious weed species are species that have been identified by the State of Nevada as plant species that are "injurious to the environment, economics, and public health." Some of more prevalent noxious weed species include tall whitetop (perennial pepperweed), tamarisk (salt cedar), yellow starthistle, various noxious thistles, several knapweed species, including Russian knapweed, and annual invasive grasses, such as medusahead rye. Other invasive plants, such as cheatgrass and red brome, are equally as threatening to native plant communities but are not officially designated as "noxious" because of these species prevalence and inability to achieve complete eradication.

Medusahead rye has increasingly expanded its range throughout northern Nevada over the last five years. Range landscapes, particularly in the Santa Rosa Range, Humboldt sink, Carson Range, and Washoe County, have become invaded with this species. Several factors make medusahead extremely competitive. It produces many seeds that germinate quickly year round. It also has roots that grow in winter. The plant litter is slow to decompose due to this plant's ability to uptake silica from the soil and this inhibits seedlings of other plants. This litter also creates fuel for intense, damaging fires.

There are many tools in the "integrated plant management" toolbox; however, one of the greatest tools that can be used against invasive plants is early detection, rapid response (EDRR). EDRR can be utilized by land and resource managers to quickly identify invasive plant expansion or newly invading plants. Once a species has been identified, immediate response (i.e., weed treatment or removal) shall be conducted to expeditiously eradicate and remove the plant from the location. Prevention is key to effective invasive species management; therefore, EDRR is an exceptional tool for the long-term management of invasive plants in Nevada.

Land Development

Until recently, Nevada was one of the fastest growing states in the nation in human population, and both the Reno and Las Vegas metropolitan areas far exceeded average values for population growth, creating a concurrent need for additional development into existing open space and supporting urban infrastructure. Urban and suburban development, even when well controlled and regulated, cause permanent habitat loss and conversion; direct mortality of wildlife attributed to construction; habitat fragmentation and increased erosion; and sedimentation and nutrient or toxin loading associated with urban runoff. Right-of-way fences associated with roads interrupt wildlife movements and contribute to direct wildlife mortality. Important secondary effects of the urban/wildland interface can include increased local recreation from motorized and non-motorized sources, negative interactions between pets and wildlife, and increased potential for the spread of exotic species and illegal woodcutting. Existing landfills subject to the burdens of increased urban populations can result in local soil and groundwater contamination and unnatural support for generalist predators (e.g., corvids, gulls). Largely associated with urban and suburban development, industrial development creates many of the same potential stresses, including habitat loss and fragmentation, and soil or groundwater contamination from improper disposal and discharge of toxins and hazardous materials. To the degree that such impacts cannot be adequately regulated, airborne pollutants and nutrients can reduce habitat structure, composition, and quality.

Outside of areas of significant urban or suburban development and their wildland interfaces, effects associated with development have been and will continue to be problems for wildlife and habitats. Utility rights-of-way and associated developments such as wind energy farms can cause mortality through collisions and electrocutions. Habitat alteration follows facility and road construction, operation, and maintenance. Direct effects to wildlife may occur through disturbance and alteration of behavior and movement patterns. Infrastructure also provides more perch sites for avian predators in sensitive areas (e.g., desert tortoise habitat and sage grouse strutting grounds). Rights-of-way can serve as conduits for invasive species.

Road development, both in association with development projects and as a stand-alone independent effect, can cause habitat fragmentation, direct mortality, and disturbance of wildlife, and impacts from runoff including erosion, sedimentation, and contamination. The improper placement of road developments in riparian corridors and meadows can compound the core effects of this activity, and roads of any kind serve as conduits for invasive species.

Military Activities

Nevada has a lengthy history of assistance to the nation's military and its mission, in particular because of the availability and access to broad areas of public lands for military training, maneuvers, and testing. Military installations in Nevada are closed to most non-defense related land uses (that have resulted in conservation of key habitats elsewhere), and thus serve as potential reference areas for ecological studies (e.g., Mt. Grant on the Hawthorne Army Depot, reptile studies on the Nevada National Security Site, formerly Nevada Test Site). Defense-related activities, however, also come with an associated cost and are potential sources of stress to wildlife habitats that may include habitat alteration at target sites and military training areas, habitat modification from facilities construction and maintenance, and soil or groundwater contamination from mission and infrastructure by-products. However, the exclusion of the public on military lands does allow for the property to act as a refuge for wildlife.

Mining

Resource extraction for minerals and non-minerals has a rich history in Nevada and remains one of Nevada's premier industries. Historic mining predominantly involved the excavation of subterranean shafts, adits, and tunnels that left minimum impact on surface habitats, but opened up extensive new habitats underground. Dating as far back as the 1850s, these underground areas have been populated by wildlife, most notably used as roosts, maternity areas, and hibernacula for many of Nevada's bat species. Since their abandonment, the openings of these underground workings pose significant risk to human safety if left unprotected. To relieve the concerns of public safety, many mine openings have been closed with earthen fill. When this permanent closure technique is implemented without an assessment of the value of the underground wildlife resource, serious losses can occur.

Today's open-pit mining techniques leave a much more significant footprint on the surface landscape. The habitat present before a mine pit is excavated is lost temporarily or permanently and wildlife that lived on the site are temporarily or permanently displaced. Mining companies strive to implement the latest, most aggressive reclamation techniques, but even under the best of circumstances are often only able to stabilize the site in a permanently altered state. There remains considerable opportunity for collaboration between biologists and reclamation engineers to incorporate innovative, yet realistic wildlife goals and objectives into reclamation design based on each site's reclamation potential.

Recreational Activities

The characteristics and extent of recreational activities vary tremendously across the spectrum of Nevada's wildlife habitats, dictated by factors such as access and proximity to urban development as well as the aesthetic appeal of individual habitat types to recreationists. Stresses include wildlife displacement, altered movements, decreased reproductive success, erosion, and direct habitat alteration and destruction. Recreational participants can act unknowingly as conduits for weed invasion. Motorized recreation, including off-highway vehicles, snowmobiles, watercraft, and other devices can result in noise disturbance to wildlife, thus affecting movements, behavior, and reproductive success. Improperly operated, these vehicles can accelerate erosion, and accelerate the invasion of weeds. In particular, improper operation in sensitive areas at the sensitive times of year (e.g., during the snowmelt season), or in desert washes, have potential to cause significant damage. Even non-motorized recreation, activities such as trail development, hiking, mountain biking, horse riding, cross-country skiing, rock-climbing, and spelunking, can cause habitat fragmentation and disturbance to wildlife. Although physical recreation development, for projects such as ski areas, snow parks, developed campgrounds and day-use areas, boat access, and organized event staging areas are likely not a large-scale source of stress across Nevada, these types of actions can cause localized disturbance from human activity and result in soil compaction and vegetation loss.

Timber Harvest

Nevada's forest resources are not extensive and must be managed carefully to achieve the many objectives expected of them. Improper forestry practices and management can create significant stress from actions such as tractor logging on steep slopes, resulting in accelerated erosion and sedimentation; the alteration of wildlife habitat including insufficient habitat structure left after timber harvest (e.g., old growth stand characteristics, snags, dead and down woody material); loss of species and stand age diversity; increased vulnerability to insect outbreaks creating self-sustaining second-growth stand characteristics; inappropriate timber harvest in stream environment zones (subjecting these zones to modification processes); and unauthorized or excessive wood cutting.

Water Management or Water Resources

Throughout Nevada, water is a scarce and valuable resource essential for both human needs and the maintenance of wildlife and their habitats, thus the development and alteration of hydrologic resources is a significant source of stress to wildlife resources. The development and operation of dams and impoundments at all scales, ranging from major reservoirs on the Colorado River to small-scale impoundments for water storage and flood control throughout the state, is an obvious human-induced change to the landscape. These structures modify hydrologic regimes and interrupt natural flow dynamics that result in modified channel and floodplain processes both upstream and downstream from dams and their impoundments. Dams play a key role in the fragmentation of aquatic habitats and modify the nature of both aquatic and terrestrial habitats through inundation upstream and de-watering downstream, frequently creating conditions more favorable to non-native plant and animal species.

Channel modification to lotic (flowing water) aquatic systems, through ditching, diking, and diversion is another significant source of stress to wildlife resources. The effect of these activities on aquatic and associated riparian habitats may include loss or modification of substrate diversity and structure, loss of streambank vegetation and increasing risk of erosion, loss of connectivity between channel and floodplain and within lotic systems by creating barriers to later movement by aquatic species; and actual dewatering and desiccation of aquatic habitats, which can cause direct mortality, reductions in habitat availability, and fragmentation or loss of connectivity within or between aquatic systems.

The development of springs and seeps, a common historic practice for livestock watering, domestic water supply and other purposes, is of concern, given the critical importance of spring resources widely distributed across Nevada's landscape as sources of surface water for terrestrial wildlife, and also because many springs and seeps of all sizes support unique endemic aquatic biota. The development and modification of spring sources and source pools directly alters or removes important aquatic habitats; modifications can limit access to remaining surface water by wildlife; and the diversion of water away from outflow channels can modify, reduce, or destroy associated riparian and wetland habitat, as well as limit or eliminate flowing water habitats for endemic species associated with springbrooks.

Although not directly related to the development and alteration of spring systems, groundwater development has been a historic source of stress for Nevada wildlife and habitats and continues to represent a significant ongoing problem. 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 to plant communities and surface flow of groundwater from springs and seeps. These effects are often not well understood and can vary considerably depending on local geology, the characteristics of groundwater development actions, and the nature of the groundwater resources being accessed.

Wild Horse & Burro

Background

In passing the Wild Free-Roaming Wild Horses and Burros Act of 1971 (WFRHBA) (Public Law 92-195), Congress found that "Wild-free roaming wild horses and burros are living symbols of the historic and pioneer spirit of the West." The WFRHBA further states that wild free-roaming wild horses are to be considered in the area where presently found, and as an integral part of the natural ecosystem.

At the time of the passage of the WFRHBA, herd areas (HA's) were established for BLM-managed lands with known populations of wild horses. Herd Management Areas, or HMAs, were established later for those HA's through a land use planning process that set the initial and estimated herd size that could be managed while still preserving and maintaining a thriving natural ecological balance and multiple-use relationships for the area. To be designated as an HMA, the area must have four essential habitat components including forage, water, cover, and space (BLM, 2010). The allocation of forage for wildlife, wild horses, and livestock was established, which set the Animal Unit Months (AUMs) for each category. An AUM is the amount of forage necessary to maintain one adult horse for one month (about 800 pounds of air dried forage) (BLM, 2010).

Management Actions and Constraints

The Secretary of the Interior was directed to "manage wild free-roaming wild horses and burros in a manner that is designed to achieve and maintain a thriving natural ecological balance on the public lands." Program emphasis has recently shifted management from a removal of excess animals and adoptions to actions that include: increasing fertility control, reducing population growth rates, adjusting sex ratios and collecting genetic baseline data to support genetic health assessments.

The Wild Horse and Burro Program has also shifted management objectives and priorities over the years to better manage and conserve specific rangeland resources, such as riparian areas, habitats for threatened and endangered species, and sensitive plant species. Similar to requirements set forth for livestock grazing, HMAs are to be managed with the goal of achieving and maintaining public land health by achieving and maintaining rangeland health standards and guidelines.

NV BLM manages 85 HMAs covering 14.7 million acres for a statewide Appropriate Management Level (AML) of approximately 12,700 wild horses and burros. Nevada has a current population estimate of 19,000 to 21,000 wild horses and burros not including foals born in 2011. Over the last five years (2007-2011), NV BLM has maintained an average population size of roughly 17,000 wild horses and burros based on average annual removals of excess animals of nearly 3,800 statewide.

Within the program spending, the holding and care of excess wild horses and burros accounted for nearly 75% of that budget, with the balance directed at on-the-ground management, gathers and preparing horses and burros for adoption, sale, or placement on long-term grassland pastures.

Since 1971, approximately 230,000 wild horses and burros have been adopted. The number of animals that have been removed from the range for management purposes far outweigh adoption and sale demand. Last year, adoptions fell below 3,500 animals, down from an average of 6,300 per year in the 1990s. The decline in adoptions and sales can be contributed to the current weak economy and large numbers of available domestic horses as well as a shift towards a more urbanized culture.

On-the-Ground Management

A variety of management practices have been in use since the passage of the WFRHBA. The BLM's goal is to ensure and maintain healthy wild horse populations on healthy public lands. To do this, the BLM works to achieve the AML – the point at which wild horse and burro herd populations are consistent with the land's capacity to support them.

1. Population Inventory

The BLM needs population estimates to determine whether and where excess wild horses and burros exist, and, if there is an excess, how many animals need to be removed from public rangelands. Population estimates also guide the BLM in applying fertility control to mares and adjusting herd sex ratios in favor of stallions or geldings to reduce on-the-range births. The BLM works to ensure that horse populations are in balance with other rangeland resources and authorized uses of the public lands.

Most BLM field offices base their population estimates on the counting of each wild horse and burro actually seen during direct counts from either a helicopter or fixed-wing aircraft. In addition to collecting information about the location and condition of herds within HMAs, the BLM compiles basic data about the land, such as the amount and quality of forage and the availability of water.

2. Population Growth Suppression

Under the WFRHBA, the BLM is required to maintain herd populations at AMLs and protect the range from deterioration from overpopulation. The BLM is directed to determine whether AMLs should be achieved by removal or humane destruction of excess animals or other options (such as sterilization or natural controls on population levels). In order to reduce or limit population growth rates the BLM has begun investigating and researching several possible growth rate suppression techniques.

a. Contraception

The BLM has supported the development of an effective contraceptive agent for wild horses since 1978. Currently the most promising agent is a vaccine known as porcine zona pellucida (PZP) that was developed in the 1990s. The BLM uses PZP under an investigational new animal drug exemption issued by the Food and Drug Administration and held by The Humane Society of the United States (HSUS).

The most effective is a one-year liquid vaccine that must be re-administered annually. However, it is not feasible to gather wild horse herds every year to administer this form of the vaccine. The BLM uses the longer lasting 22-month pelleted PZP agent (PZP-22). Maximum effectiveness of PZP-22 is achieved when the mares are treated during a three- to four-month window prior to foaling.

Since 2004, the BLM has administered the pelleted PZP vaccine to more than 2,800 mares on 79 of its 179 HMAs, but significant reductions in the rate of population increase have not yet been apparent. Analysis of data from the McCullough Peaks herd, which was treated in 2004, indicates that treated mares had an average foaling rate of 32% in the two years following treatment, compared with a 75% foaling rate in untreated mares.

b. Sex Ratio Adjustment

One way to potentially slow population growth and extend the time between gathers in wild horse herds is to adjust herd sex ratios to include more males than females. BLM rangeland managers can use this option following a gather by releasing more stallions or geldings than mares back to the range. The larger proportion of males mean there will be fewer mares in the breeding population, resulting in fewer births. Sex ratio adjustment is mostly applicable to larger HMAs and is also most practical after the AML has been achieved.

c. Sterilization

Consistent with the WFRHBA’s mandate and authority, the BLM can apply temporary or permanent sterilization to decrease herd growth rates while maintaining a herd's ability to sustain itself. When implementing this type of population growth suppression, animals can be captured, sterilized, and returned to the range. Castration (gelding) is a safe, effective, humane, and efficient method of sterilizing stallions. For this reason, the BLM is beginning to return geldings to HMAs in the place of mares to reduce the number of breeding mares within the population.

Spaying and other means of sterilizing mares are being considered by the BLM but has not been applied as a management tool on the range.

Impacts to Wildlife and their Habitat

Wild horse and burro populations that have increased over the upper limit of the AML can have long-term adverse effects to wildlife resources. By achieving and maintaining appropriate population levels, the health of the rangeland resources used by wildlife would be protected from habitat degradation associated with wild horse overpopulation. Reduced competition for forage, water, cover, and space would provide diverse plant communities that meet applicable life cycle requirements for all wildlife species. Unfortunately, many of the herds currently exceed the upper limit of AML.

The overall impact wild horses and burros have on any type of ecosystem depends on intensity and duration of use, timing, and the health and resilience of the area. Plant diversity can decrease and habitat structure can be altered if the AML is exceeded over time and vegetation and water sources are over-utilized (Beever & Brussard, 2000). A less diverse plant community can be vulnerable to wildfire and invasive grasses such as cheatgrass. Cheatgrass displaces native perennial plants by germinating earlier and quicker. It is also adapted to frequent fires perpetuated by the fine fuels it creates. Beever et al. (2008) studied vegetation response to removal of wild horses and found sites without wild horses had greater shrub cover, total plant cover, plant species richness, and native grass cover than sites with wild horses.

Wild horses will use areas that have more grasses because they are primarily grazers. Sage-Grouse habitat can be adversely affected if grasses are over-utilized because horse populations are above the AML. Sage-Grouse require specific amounts of grass cover for optimal nesting habitat, an abundance of forbs for brood-rearing habitat, and water with sufficient vegetation to support insects and to provide cover (Connelly et al., 2000). Decreased cover and diversity of grasses and shrubs as well as decreased mammal burrow density have been documented at water sources used by wild horses (Beever & Brussard, 2000; Ganskop & Vavra, 1986). Small mammals are prey for many species and less prey could negatively affect raptors and carnivores that inhabit the area.

Nevada is the driest state in the U.S. and water resources are critical to the existence and management of all species. Year-round use of riparian areas by wild horses and burros can result in long-term or permanent habitat impacts through soil compaction and increased erosion as well as impacting water quality and quantity. Furthermore, wild horse and burro competition for limited water at seeps and springs during the critical hot summer months can have a significant impact on native wildlife. Wild horses and burros tend to have a dominant status within in the social interactions at these watering areas. Though there may not be aggressive behavior between wild horses and burros, deer, and bighorn sheep, their mere presence at these limited sources may affect the distribution of native species and their use of the habitat.

Wildland Fire

Wildland fire is a natural process and plays an important role in the creation and maintenance of Nevada's terrestrial habitats and vegetative communities. Fire plays an important role in the restoration and management of those communities and habitats; however, fire management must be implemented with full consideration of all of its aspects and consequences. Improperly applied, fire suppression has altered natural ecological processes through the build-up of fuels; increased risk of catastrophic wildfire resulting in permanent loss of habitat values; accelerated conversion to alien plant communities; increased erosion and sedimentation; and increased fire frequency and spread of self-sustaining non-native communities. Further community-level effects can include the disruption of successional cycles; the unnatural maintenance of successional stages and vegetation structure and condition; and tree community encroachment into shrub and grassland habitats. Improper fire restoration policy can compound the effects of fires and fire suppression, through exotic plant introductions from seed mixes, improper early grazing access to restored areas, and inadequate response to post-fire restoration needs, including "no action" after a fire. Finally, while the application of prescribed fire to maintain habitat health is appropriate and necessary in certain situations, this land management technique must be applied with irrefutable knowledge of the fire history of the habitat type, its response mechanisms and fire return interval. Misapplication of prescribed fire in habitats where these characteristics are misinterpreted or not well-understood can have irrevocable impacts on the landscape. All in all, the discussion of applying prescribed fire to the landscape is a sensitive topic in Nevada and it is important that management theory, design, and implementation be carried forward by consensus with full participation of all stakeholders.

Ruby Mountains Photo Courtesy of R. Wilson

IDENTIFICATION OF SPECIES OF CONSERVATION PRIORITY

Climate Change Vulnerability Assessment of Conservation Priority Species

Overview of the NatureServe Climate Change Vulnerability Index (CCVI)

The Nevada Natural Heritage Program (NNHP) assessed the relative vulnerability, and the relative importance of factors contributing to that vulnerability, for Nevada's Species of Conservation Priority (SOCP) using the NatureServe Climate Change Vulnerability Index (CCVI). The CCVI was chosen for this project for a number of reasons: 1) it was designed as a rapid way of assessing a large number of species in a relatively short period of time; 2) it is cost-effective (free tool provided by NatureServe); 3) it is packaged as a programmed Excel workbook and is easy to use; 4) it was not overly technical; it was designed to be used by any person with a science background; and, 5) the results are presented in a way that allows the user to group taxa by their relative risk or by specific sensitivity factors, which helps direct management and adaptation.

The CCVI uses a scoring system that integrates a species' predicted *exposure* (direct and indirect) to climate change within the assessment area (i.e., the state of Nevada) and a series of factors, all supported by published studies, associated with a species' *sensitivity* to changes in climate. The tool also incorporates documented or modeled response to climate change, if available. The tool weighs each sensitivity score depending on the magnitude of projected climate change, incorporates any documented or modeled responses, and calculates a final vulnerability index score.

Direct exposure is the magnitude of projected temperature and moisture change across the species' range within the assessment area. For this project, direct exposure was measured using climate data obtained from The Climate Wizard. The Climate Wizard uses base climate projections previously downscaled by Maurer et al. (2007). As recommended in NatureServe's Guidelines for Using the NatureServe Climate Change Vulnerability Index (Young et al., 2011), a mid-century time line, Medium A1B emissions scenario, and ensemble average of 16 general circulation models were used for the species' vulnerability assessments. Predicted moisture changes were based on the Hamon AET:PET Moisture Metric, also developed by The Climate Wizard team. This metric integrates temperature and precipitation through a ratio of actual evapotranspiration (AET) to potential evapotranspiration (PET) with consideration of total daylight hours and saturated vapor pressure (Young et al., 2011).

Indirect exposure includes phenomena such as sea level rise (not a factor in Nevada), the presence of natural and/or anthropogenic barriers that would hinder or prevent a species from dispersing to a new area with a favorable climate envelope, or human-induced land use changes designed to mitigate greenhouse gases (e.g., the construction of renewable energy projects such as wind farms or solar arrays may remove key habitats or create barriers).

There are six **species-specific sensitivity** factors considered by the CCVI. These factors are listed below with a brief summary/explanation.

1. *Dispersal and movements* – species with poor dispersal abilities may not be able to track shifting favorable climate envelopes.

2. *Predicted sensitivity to temperature and moisture changes* – species requiring specific moisture and temperature regimes may be less likely to find similar areas as the climate changes and previously-

associated temperature and precipitation patterns uncouple. Four separate factors are scored here as listed below in a through d:

a. Historical and physiological sensitivity to changes in temperature.
b. Historical and physiological sensitivity to changes in precipitation, hydrology, or moisture regime.
c. Dependence on a specific disturbance regime likely to be impacted by climate change – species dependent on habitats that are maintained by regular disturbances (e.g., fires or flooding) are vulnerable to climate change-induced changes in the frequency and intensity of these disturbances.
d. Dependence on ice, ice-edge, or snow-cover habitats – the extent of oceanic ice sheets and mountain snow fields are decreasing as temperatures increase, imperiling species dependent on these habitats.

3. *Restriction to uncommon geological features or derivatives* – species requiring specific substrates, soils, or physical features such as caves, cliffs, or sand dunes may become vulnerable to climate change if their favored climate conditions shift to areas without these physical elements.

4. *Reliance on interspecific interactions* – because species will react idiosyncratically to climate change, those with tight relationships with other species may be threatened. A series of five factors are scored within this category as listed below in a through e:

a. Dependence on other species to generate habitat.
b. Dietary versatility (animals only).
c. Pollinator versatility (plants only).
d. Dependence on other species for propagule dispersal.
e. Forms part of an interspecific interaction not covered above.

5. *Genetic factors* – a species' ability to evolve adaptations to environmental conditions brought about by climate change is largely dependent on its existing genetic variation. Two factors are included in this category:

a. Measured genetic variation.
b. Occurrence of bottlenecks in recent evolutionary history.

6. Phenological response to changing seasonal temperature and precipitation dynamics – research suggests that some phylogenetic groups are declining due to lack of response to changing annual temperature dynamics (e.g., earlier onset of spring, longer growing season), including some bird species that have not advanced their migration times, and some temperate zone plants that are not moving their flowering times.

The final section of the CCVI incorporates any available data on **documented or modeled response** to climate change. This is an optional section and is not required for the CCVI to calculate a vulnerability score. If peer-reviewed, published data are available related to a species response to climate change (e.g., range shifts, range contraction, or phenology mismatches), the species response would be scored in this section. Additionally, the results of available species-specific models can be incorporated in this section.

After all of the appropriate factors are scored, an overall CCVI score is automatically calculated by the tool (i.e., Extremely Vulnerable, Highly Vulnerable, Moderately Vulnerable, Not Vulnerable/Presumed Stable, or Not Vulnerable/Increase Likely), and a measure of confidence of the score (Very High, High, Moderate, Low) is provided. This confidence relates specifically to the level of uncertainty indicated by the assessor based on the range of values given for each factor. Checking a range of values for particular factors tends to decrease confidence in species information.

The CCVI does not include factors that are already considered in existing conservation status assessments. Conservation status ranks assess a species vulnerability to extinction from a wide variety of factors such as population size, range size, threats, and demographic factors. These types of factors are not repeated in the CCVI. The CCVI only takes into consideration those factors that are related to a species vulnerability to climate change. The goal is for the CCVI to complement NatureServe Conservation Status Ranks and not to partially duplicate factors. Ideally, CCVI scores and Conservation Status Ranks should be used in concert.

Complex interactions such as shifts in competitive, predator-prey, or host-parasite interactions are likely to be important as well, but they are not included in this rapid assessment because of the difficulty and unpredictability inherent in simultaneous evaluation of climate change on interacting species.

Applying the CCVI to Nevada's Species of Conservation Priority

Species' range maps and natural history information were obtained from a number of sources including the Nevada Wildlife Action Plan (WAP) (Wildlife Action Plan Team, 2006), the NNHP Biotics database, The Revised Nevada Bat Conservation Plan (Bradley et al., 2006), Atlas of the Breeding Birds of Nevada (Floyd et al., 2007), The Nevada Comprehensive Bird Conservation Plan (GBBO, 2010), NatureServe Explorer, federal agency documents (e.g., USGS professional reports or published studies, USFWS Recovery Plans, Federal Register), field guides, and expert input.

In addition, once available, the results of habitat modeling for certain key habitats conducted by TNC (TNC, 2011), and the results of bird population modeling conducted by GBBO (GBBO, 2011) were incorporated into the CCVI tool to score the appropriate factors for certain species.

Assessments were completed for a representative group of species within each taxonomic group. After these initial CCVI scores were calculated by NNHP, an expert workshop was held (December 2009 in Reno) to solicit feedback and comments from biologists working throughout Nevada. The two-day workshop was well-attended and included representatives from federal (BLM, EPA, NPS, USFS, and USFWS) and state (NDOW, NNHP) agencies, a non-profit organization (TNC), and academia (UNR). Highly constructive comments and feedback were obtained from the attendees on the scoring of the factors, and additional species information was also obtained to better inform the assessments. All feedback and comments were incorporated into the CCVI for each species and scores were recalculated.

In total, 340+ species were assessed using the CCVI, 256 of which are included in this WAP as Nevada SOCP. The results of the CCVI assessments for the SOCP, including CCVI scores and the factors contributing to the species vulnerability (if applicable), were used in the development of the Species Accounts. A detailed table of CCVI results, including the scores for each factor, the overall vulnerability score, and confidence for each SOCP, is included in Appendix D, Table 1.

2012 Species of Conservation Priority Lists

The following is the listing of the Species of Conservation Priority for the Nevada Wildlife Action (WAP) Revision (2012). Some species from the 2005 list remain while new species were added and are distinguished by the *green, italicized font*.

Aquatics

Mollusks

Common Name	Scientific Name
California floater	*Anodonta californiensis*

Gastropods

Common Name	Scientific Name
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*
Butterfield pyrg	*Pyrgulopsis lata*
Camp Valley pyrg	*Pyrgulopsis montana*
Corn Creek pyrg	*Pyrgulopsis fausta*
Crystal Spring pyrg	*Pyrgulopsis crystalis*
Distal-gland pyrg	*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 pyrg	*Pyrgulopsis isolata*
Emigrant pyrg	*Pyrgulopsis gracilis*
Fairbanks pyrg	*Pyrgulopsis fairbanksensis*
Flag pyrg	*Pyrgulopsis breviloba*
flat-topped Steptoe pyrg	*Pyrgulopsis planulata*
Fly Ranch pyrg	*Pyrgulopsis bruesi*
grated tryonia	*Tryonia clathrata*
Hardy pyrg	*Pyrgulopsis marcida*
Hubbs pyrg	*Pyrgulopsis hubbsi*
Humboldt pyrg	*Pyrgulopsis humboldtensis*

Common Name	Scientific Name
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 Nevada pyrg	*Pyrgulopsis pisteri*
minute tryonia	*Tryonia ericae*
Moapa pebblesnail	*Pyrgulopsis avernalis*
Moapa Valley pyrg	*Pyrgulopsis carinifera*
monitor tryonia	*Tryonia monitorae*
neritiform Steptoe Ranch pyrg	*Pyrgulopsis neritella*
northern Soldier Meadow pyrg	*Pyrgulopsis militaris*
northern Steptoe pyrg	*Pyrgulopsis serrata*
northwest Bonneville pyrg	*Pyrgulopsis variegata*
Oasis Valley pyrg	*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*
Sada’s pyrg	*Pyrgulopsis sadai*
small gland Carico pyrg	*Pyrgulopsis bifurcata*
smooth juga	*Juga interioris*
southeast Nevada pyrg	*Pyrgulopsis turbatrix*
southern Duckwater pyrg	*Pyrgulopsis anatina*
southern Soldier Meadow pyrg	*Pyrgulopsis umbilicata*
southern Steptoe pyrg	*Pyrgulopsis sulcata*
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*
transverse gland pyrg	*Pyrgulopsis cruciglans*
turban pebblesnail	*Fluminicola turbiniformis*
Twentyone Mile pyrg	*Pyrgulopsis millenaria*
Upper Thousand Spring pyrg	*Pyrgulopsis hovinghi*
Vinyards pyrg	*Pyrgulopsis vinyardi*
Virginia Mountains pebblesnail	*Fluminicola virginius*

Common Name	Scientific Name
White River Valley pyrg	*Pyrgulopsis sathos*
Wong's pyrg	*Pyrgulopsis wongi*

Fishes

Common Name	Scientific Name
Alvord chub	*Gila alvordensis*
Ash Meadows Amargosa pupfish	*Cyprinodon nevadensis mionectes*
Ash Meadows speckled dace	*Rhinichthys osculus nevadensis*
Big Smoky Valley speckled dace	*Rhinichthys osculus lariversi*
Big Smoky Valley tui chub	*Gila bicolor ssp.* (unnamed)
Big Spring spinedace	*Lepidomeda mollispinis pratensis*
bonytail chub	*Gila elegans*
bull trout (Jarbidge River basin pop)	*Salvelinus confluentus pop. 4*
Clover Valley speckled dace	*Rhinichthys osculus oligoporus*
Cui-ui	*Chasmistes cujus*
desert dace	*Eremichthys acros*
Devils Hole pupfish	*Cyprinodon diabolis*
Diamond Valley speckled dace	*Rhinichthys osculus ssp.* (unnamed)
Fish Lake Valley tui chub	*Gila bicolor ssp.* (unnamed)
flannelmouth sucker	*Catostomus latipinnis*
Hiko White River springfish	*Crenichthys baileyi grandis*
Independence Valley speckled dace	*Rhinichthys osculus lethoporus*
Independence Valley tui chub	*Gila bicolor isolata*
Lahontan cutthroat trout	*Oncorhynchus clarkii henshawi*
Little Fish Lake Valley tui chub	*Gila bicolor ssp.* (unnamed)
Meadow Valley speckled dace	*Rhinichthys osculus ssp.* (unnamed)
Meadow Valley Wash desert sucker	*Catostomus clarkii ssp.* (unnamed)
Moapa dace	*Moapa coriacea*
Moapa speckled dace	*Rhinichthys osculus moapae*
Moapa White River springfish	*Crenichthys baileyi moapae*
Monitor Valley speckled dace	*Rhinichthys osculus ssp.* (unnamed)
Moorman White River springfish	*Crenichthys baileyi thermophilus*
mountain whitefish	*Prosopium williamsoni*
Oasis Valley speckled dace	*Rhinichthys osculus ssp.* (unnamed)
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	*Gila bicolor ssp.* (unnamed)

Common Name	Scientific Name
razorback sucker	*Xyrauchen texanus*
relict dace	*Relictus solitarius*
Sheldon tui chub	*Gila bicolor eurysoma*
tui chub of Dixie Valley	*Gila bicolor ssp. 9*
Virgin River chub	*Gila seminuda*
Virgin River chub (Muddy River pop.)	*Gila seminuda pop. 2*
Virgin River spinedace	*Lepidomeda mollispinis mollispinis*
Wall Canyon sucker	*Catostomus sp.*
Warm Springs Amargosa pupfish	*Cyprinodon nevadensis pectoralis*
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*

Amphibians

Common Name	Scientific Name
Amargosa toad	*Anaxyrus nelsoni*
Arizona toad	*Anaxyrus microscaphus*
Columbia spotted frog (Great Basin pop)	*Rana luteiventris pop. 3*
Great Basin spadefoot	*Spea intermontana*
Great Plains toad	*Anaxyrus cognatus*
northern leopard frog	*Lithobates pipiens*
relict leopard frog	*Lithobates onca*
Sierra Nevada yellow-legged frog*	Rana sierra*
western toad	*Anaxyrus boreas*

Terrestrial

Reptiles

Common Name	Scientific Name
chuckwalla	*Sauromalus ater*
desert night lizard	*Xantusia vigilis*
desert horned lizard	*Phrynosoma platyrhinos*
desert iguana	*Dipsosaurus dorsalis*
desert tortoise (Mojave Desert pop.)	*Gopherus agassizii*
Gila monster	*Heloderma suspectum*
long-nosed leopard lizard	*Gambelia wislizenii*

Common Name	Scientific Name
Great Basin collared lizard	*Crotaphytus bicinctores*
greater short-horned lizard	*Phrynosoma hernandesi*
northwestern pond turtle	*Actinemys marmorata marmorata*
northern rubber boa	*Charina bottae*
pygmy short-horned lizard	*Phrynosoma douglasii*
Panamint alligator lizard	*Elgaria panamintina*
ring-necked snake	*Diadophis punctatus*
rosy boa	*Lichanura trivirgata*
Shasta alligator lizard	*Elgaria coerulea shastensis*
sidewinder	*Crotalus cerastes*
Sierra alligator lizard	*Elgaria coerulea palmeri*
Smith's black-headed snake	*Tantilla hobartsmithi*
Sonoran mountain kingsnake	*Lampropeltis pyromelana*
spotted leaf-nosed snake	*Phyllorhynchus decurtatus*
western banded gecko	*Coleonyx variegatus*
western brush lizard	*Urosaurus graciosus*
western red-tailed skink	*Plestiodon gilberti rubricaudatus*
Mojave shovel-nosed snake	*Chionactis occipitalis*
western threadsnake	*Rena humilis*

Birds

Common Name	Scientific Name
American Avocet	*Recurvirostra americana*
American Bittern	*Botaurus lentiginosus*
American White Pelican	*Pelecanus erythrorhynchos*
Bell's Vireo	*Vireo bellii*
Bald Eagle (Contiguous US Pop)	*Haliaeetus leucocephalus*
Bank Swallow	*Riparia riparia*
Bendire's Thrasher	*Toxostoma bendirei*
Black Rosy-Finch	*Leucosticte atrata*
Black Tern	*Chlidonias niger*
Black-chinned Sparrow	*Spizella atrogularis*
Bobolink	*Dolichonyx oryzivorus*
Brewer's Sparrow	*Spizella breweri*
California Spotted Owl	*Strix occidentalis occidentalis*
Canvasback	*Aythya valisineria*
Cassin's Finch	*Carpodacus cassinii*
Columbian Sharp-tailed Grouse	*Tympanuchus phasianellus columbianus*
Common Loon	*Gavia immer*

Common Name	Scientific Name
Common Nighthawk	*Chordeiles minor*
Dusky Grouse	*Dendragapus obscurus*
Ferruginous Hawk	*Buteo regalis*
Flammulated Owl	*Otus flammeolus*
Gilded Flicker	*Colaptes chrysoides*
Golden Eagle	*Aquila chrysaetos*
Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*
Great Basin Willow Flycatcher	*Empidonax traillii adastus*
Greater Sage-Grouse	*Centrocercus urophasianus*
Greater Sandhill Crane	*Grus canadensis tabida*
Le Conte's Thrasher	*Toxostoma lecontei*
Lewis's Woodpecker	*Melanerpes lewis*
Loggerhead Shrike	*Lanius ludovicianus*
Long-billed Curlew	*Numenius americanus*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Mountain Quail	*Oreortyx pictus*
Northern Goshawk	*Accipiter gentilis*
Northern Pintail	*Anas acuta*
Olive-sided Flycatcher	*Contopus cooperi*
Peregrine Falcon	*Falco peregrinus*
Pinyon Jay	*Gymnorhinus cyanocephalus*
Prairie Falcon	*Falco mexicanus*
Redhead	*Aythya americana*
Red-necked Phalarope	*Phalaropus lobatus*
Rufous Hummingbird	*Selasphorus rufus*
Sage Sparrow	*Amphispiza belli*
Sage Thrasher	*Oreoscoptes montanus*
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*
Tricolored Blackbird	*Agelaius tricolor*
Virginia's Warbler	*Vermivora virginiae*
Western Burrowing Owl	*Athene cunicularia hypugaea*
Western Least Bittern	*Ixobrychus exilis hesperis*
Western Sandpiper	*Calidris mauri*
Western Snowy Plover	*Charadrius alexandrinus nivosus*
Western Yellow-billed Cuckoo	*Coccyzus americanus occidentalis*
White-faced Ibis	*Plegadis chihi*

Common Name	Scientific Name
White-headed Woodpecker	*Picoides albolarvatus*
Wilson's Phalarope	*Phalaropus tricolor*
Yuma Clapper Rail	*Rallus longirostris yumanensis*

Mammals

Common Name	Scientific Name
Allen's big-eared bat	*Idionycteris phyllotis*
American marten	*Martes americana*
American pika	*Ochotona princeps*
American water shrew	Sorex palustris
bighorn sheep	*Ovis canadensis*
Botta's pocket gopher	*Thomomys bottae*
California leaf-nosed bat	*Macrotus californicus*
cave myotis	*Myotis velifer*
dark kangaroo mouse	*Microdipodops megacephalus*
desert kangaroo rat	*Dipodomys deserti*
desert pocket mouse	*Chaetodipus penicillatus*
fringed myotis	*Myotis thysanodes*
hoary bat	*Lasiurus cinereus*
Humboldt yellow-pine chipmunk	*Neotamias amoenus celeris*
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*
Mono Basin mountain beaver	*Aplodontia rufa californica*
montane shrew	*Sorex monticolus*
mountain pocket gopher	*Thomomys monticola*
mule deer	*Odocoileus hemionus*
northern flying squirrel	*Glaucomys sabrinus*
northern river otter	Lontra canadensis
Pahranagat Valley montane vole	*Microtus montanus fucosus*
pale kangaroo mouse	*Microdipodops pallidus*
Palmer's chipmunk	*Neotamias palmeri*
Preble's shrew	*Sorex preblei*
pygmy rabbit	*Brachylagus idahoensis*
sagebrush vole	*Lemmiscus curtatus*
shadow (Allen's) chipmunk	*Neotamias senex*
Sierra Nevada snowshoe hare	*Lepus americanus tahoensis*
silver-haired bat	*Lasionycteris noctivagans*

Common Name	Scientific Name
spotted bat	*Euderma maculatum*
Townsend's big-eared bat	*Corynorhinus townsendii*
western jumping mouse	*Zapus princeps*
western red bat	*Lasiurus blossevillii*
western small-footed myotis	*Myotis ciliolabrum*
Wyoming ground squirrel	*Spermophilus elegans nevadensis*

**Species common and/or scientific name have changed since 2005 plan.*

Rationale for Adding New Species of Conservation Priority

The following aquatic and terrestrial species were added to the SOCP list based on climate change analysis through the CCVI or other demonstrated conservation concern for the species. For additional information, please refer to the Species Accounts section of this plan.

Aquatic Species

Blue point pyrg

The Blue Point springsnail was added as an SOCP due to its unknown status, highly localized habitat, and susceptibility to threats such as water issues and exotic species invasion.

Alvord chub

Occupies low-elevation, moderate gradient montane stream habitats subject to projected higher level climate change effects from increased thermal load and altered seasonal runoff patterns including reduced, late warm season, base flows.

Little Fish Lake Valley tui chub

Occupies sub-montane (valley floor) isolated spring/pool and wetland habitats which are subject to accelerated effects from climate change, including increased thermal loads. These habitat types are dependent on non-carbonate aquifers and local recharge which are also subject to the effects from changes in seasonal precipitation and early spring onset of runoff events.

Meadow Valley speckled dace

Occupies mid to low-elevation montane streams. May be impacted by groundwater development and projected climate change effects, such as increased thermal inputs and greater frequency in stochastic flow events (e.g. changed monsoonal storm patterns) affecting habitat quality and distribution.

Meadow Valley Wash desert sucker

Occupies mid to low-elevation montane streams, may be impacted from groundwater development and projected climate change effects from increased thermal inputs and greater frequency in stochastic flow events (e.g. changed monsoonal storm patterns) affecting habitat quality and distribution.

Mountain whitefish

Occupies mid- to high-elevation montane stream and river habitats conspecific with native trout species. Projected effects from climate change are similar to Lahontan Cutthroat Trout (LCT) and other native cutthroat trout and include impacts from increased thermal loads, reductions in total habitat suitability and linear extent and negative habitat changes from modified runoff patterns and reduced late summer base flows.

Relict dace

Occupies isolated spring, springbrook, and wetland habitats. Specific impacts are projected on some populations from proposed groundwater development projects. Thermal effects from climate change are anticipated to restrict total available habitat and distribution for populations; populations that occur in non-carbonate aquatic systems which are subject to a higher degree of climate change related flow effects.

Sheldon tui chub

Occupies low-elevation (valley floor) spring/pool and stream habitats that are subject to projected higher level climate change effects, such as increased thermal load and altered seasonal runoff patterns, including reduces late warm season base flows.

Warner Valley redband trout

Occupies mid-elevation montane stream systems with projected impacts from climate change including increased thermal loading and shifts in temporal stream flow patterns affecting habitat suitability and habitat distribution

Yellowstone cutthroat trout

Occupies mid- to high-elevation montane stream systems with projected impacts from climate change through increased thermal loading and shifts in temporal stream flow patterns affecting habitat suitability and habitat distribution

Great Basin spadefoot

New species because of disease concerns and potential effects from climate change on amphibians in general due to life history requirements. Could be threatened by large scale habitat conversion.

Western toad

Although this species is common throughout the Great Basin, there are potentially isolated and endemic species that need more certain taxonomic delineation.

Terrestrial Species

American Bittern

This was added to the SOCP because of perceived population declines in the U.S. and western region. This species is moderately vulnerable to climate change and its preferred habitat is sensitive and vulnerable to degradation.

Bank Swallow

This was added to the SOCP list due to continental population declines and continued concern in California. This species is moderately vulnerable to climate change.

Common Nighthawk

This was added to the SOCP list due to significant declining trends in the U.S., western region, and the Great Basin.

Flammulated Owl

This was added as a new WAP species due to rangewide population declines and concerns over conifer habitat with respect to climate change.

Gilded Flicker

This was added to the SOCP list due to its restricted range in Nevada and declining trend rangewide.

Golden Eagle

This was added to the SOCP list due to its inclusion in the Bald & Golden Eagle Protection Act. There are also concerns with conflicts with renewable energy development.

Prairie Falcon

This was added to the SOCP list due to potential conflicts with renewable energy development.

Sage Thrasher

This was added to the SOCP list because it is moderately vulnerable to climate change and due to the possibility of large scale sagebrush habitat conversion and loss.

Scott's Oriole

This was added to the SOCP list due to declining population trends in Nevada and because its preferred Joshua tree habitat is vulnerable to climate change.

Western Sandpiper

This was added as an SOCP in the WAP due to its declining rangewide population trend and Nevada's stewardship responsibility for this species during migration.

Wilson's Phalarope

This species was added to the SOCP list because it is moderately vulnerable to climate change. Its preferred breeding habitat is sensitive and vulnerable to degradation. Nevada also has migration stewardship responsibility.

Northern rubber boa

This species was added to the SOCP list because it requires mesic microhabitats in the Great Basin that are vulnerable to drying due to climate change and reliant upon aspen riparian areas, a vulnerable habitat type.

Ring-necked snake

This species was added to the SOCP list because it requires mesic microhabitats in the Mojave Desert that are vulnerable to drying due to climate change.

Rosy boa

This was added as a new WAP species because it occurs in isolated populations that leave the species vulnerable to decline especially with respect to climate change and collection. In addition, it is only found in one location within Nevada.

Sidewinder

This species was added to the SOCP list because of current and increasing habitat development and fragmentation, especially in consideration of alternative energy development and large scale solar power plants.

Smith's blackhead snake

This species was added to the SOCP list because it has fragmented populations and its habitat is vulnerable to deterioration especially with respect to climate change.

Spotted leaf-nosed snake

This species was added to the SOCP list because of current and increasing habitat fragmentation, especially in consideration of alternative energy development and large scale solar power plants.

Western threadsnake

This was added as a new WAP species because it requires mesic microhabitats in the Mojave Desert that are vulnerable to drying due to climate change.

Mojave shovel-nosed snake

This species was added to the SOCP list because of current and increasing habitat fragmentation, especially in consideration of alternative energy development and large scale solar power plants.

Mexican free-tailed bat

This was added as an SOCP in the WAP because of this species' habit of roosting in large colonies and its vulnerability to decline due to energy development.

Sierra Nevada snowshoe hare

This species was added to the SOCP list because it is an isolated subpopulation with limited habitat connectivity and shared stewardship with California.

Silver-haired bat

This species was added to the SOCP list because of regional population concerns and is especially vulnerable to wind turbine collision/mortality.

DEFINING NEVADA'S LANDSCAPE FOR WILDLIFE

For the Nevada Wildlife Action Plan (WAP), an ecological framework for strategy development was devised for initial analyses using ecoregions and modified Bailey's sections. Modified Bailey's sections are divisions within an ecoregion that are defined by similarities of geomorphic process, surface geology, soils, drainage networks, and regional climate patterns. Four ecoregions and 10 modified Bailey's sections overlap Nevada (Figure 4) (CPET 1999; MDEPT 2001; Nachlinger et al., 2001).

Although there are several different ecoregional classifications in use in the United States, there is a great deal of overlap in all of the maps and scrutiny reveals more similarities than differences (Groves, 2003). Ecoregional boundaries should not be taken too literally because there is typically a gradual transition from one major ecosystem type to another and only rarely are ecoregional boundaries represented by distinct edges. In addition, most ecoregions contain patches of habitats that are more representative of adjacent ecoregions. We also recognize that ecological classification is not a panacea for categorizing all taxa or biological features. As the Nevada WAP evolved, the complexity and often redundant nature of attempting to create a strategic plan using modified Bailey's sections as our units of planning became evident. Specifically, key habitat types for wildlife occur across multiple sections and ecoregions. The complexity of forcing aquatic species and their habitats into a mostly terrestrial-based system was also problematic.

Aquatic species and their habitats are more easily categorized into a system defined by hydrologic factors. The aquatic framework is more appropriately defined by ecological drainage units which are aggregations of fourth level hydrologic unit codes (HUCs). Ecological drainage units can be subdivided into fifth and sixth level HUCs (subbasin or watershed scale) which refines the aquatic framework to a more focused, smaller scale and is particularly important for the discussion and planning for many of the isolated aquatic species found throughout Nevada. Currently, HUCs defined at the eighth level are easily available for Nevada. However, since most Nevada Aquatic Species of Conservation Priority are geographically isolated populations, it became evident that developing a finer-level system would be a very useful tool for identifying and managing key populations.

For hydrologic analysis and water planning and management purposes, the U.S. Geological Survey (USGS) and the Nevada Division of Water Resources (NDWR), Department of Conservation and Natural Resources, have divided the state of Nevada into 256 Hydrographic Areas and Sub-Areas. This smaller hydrologic unit typically comprises a valley, a portion of a valley, or terminal basin. It would be beneficial to aquatic species conservation for NDOW to partner with NDWR, USGS, the Nevada Department of Environmental Protection, universities, conservation groups, and other aquatic resource planning bodies to develop and incorporate a standardized hydrologic unit system at this scale that would aid in exchange of information.

While the four major ecoregions in Nevada are readily recognizable to most partners, Bailey sections were not an intuitive framework for the development of aquatic species conservation strategies. For aquatic species, much of the structure for conservation delivery is already in place in the form of county or multi-county species conservation working groups. . In this context, partner feedback indicated that framing objectives and actions by key habitat type would offer an effective approach.

As a result, the Nevada WAP provides a user-friendly format to the multiple partners that will be involved in its implementation. A framework based on modified Bailey's sections will likely be useful in the terrestrial ecological linkage for future partnership development with California, Oregon, Idaho, Utah, and Arizona. The use of HUCs that by their nature overlap state boundaries will be useful in linking aquatic conservation efforts among neighboring states. Multi-state implementation of WAPs will facilitate the identification of common priorities. Collaboration among western states will also promote cooperative studies for wildlife and their key habitats that will address objectives across ecologically based units rather than geopolitical boundaries.

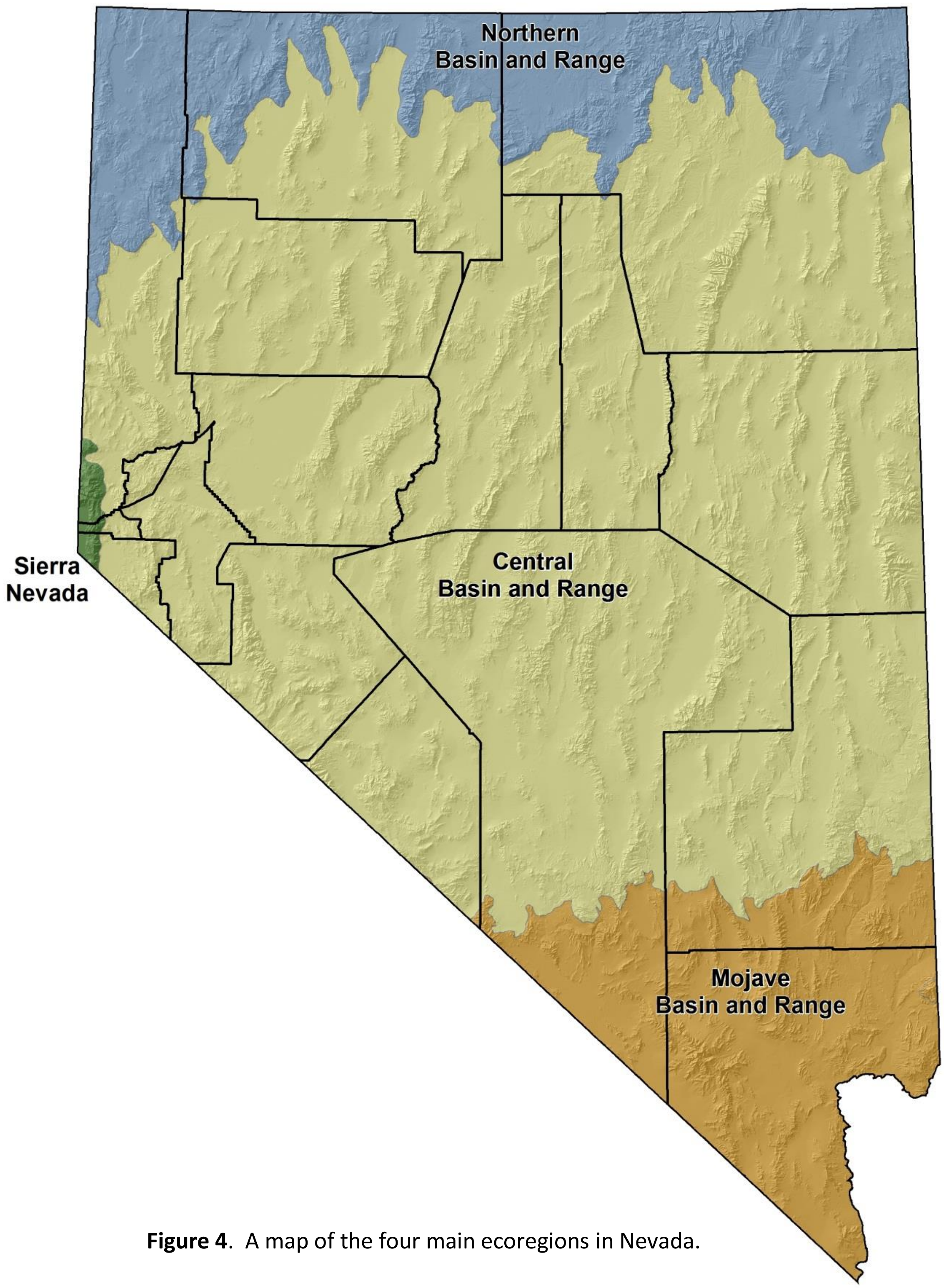


Figure 4. A map of the four main ecoregions in Nevada.

Key Habitats

Aquatic Habitat Information

Because of the absence of an easily definable aquatic habitat geospatial data layer which fit into the developed structure of this process, the WAP team chose a hybrid approach to incorporating aquatic habitat information. Rather than develop an entirely separate, HUC based, aquatic habitat definition structure, which would have been duplicative of much of the information contained in associated terrestrial habitat definitions, aquatic habitats have been incorporated into their associated terrestrial key habitat groups. This applies primarily to flowing water (stream or lotic) habitats, and also to smaller standing water (lentic) aquatic habitats such as montane pools and marshes. Where the ability exists to more clearly define aquatic features on the landscape, these have been presented as the unique key habitat groups, Lakes and Reservoirs and Spring and Springbrook aquatic habitats. This structure has the benefit of closely linking aquatic and terrestrial habitat strategies for those key habitats, such as stream systems, where conservation and management approaches must integrate aquatic and terrestrial components to ensure these systems are fully functional and supporting diverse species assemblages at their full potential.

Linking Nevada's Species of Conservation Priority to 22 Key Habitats

After identifying the Species of Conservation Priority and describing the habitat framework for which the conservation strategies will be developed, the next step was to link the priority species to the habitat framework so that the strategies will be relevant to species conservation. The assumption in effecting the species-habitat linkage is that species occur in habitats based on the availability of key structural elements that satisfy a species' most basic needs for food, cover, and reproductive needs (nesting, denning, etc.). Enough is known about the basic life history needs of most vertebrate species in Nevada that they can be roughly characterized and categorized by the key habitat elements to which they respond. For example, birds that feed on insects in the canopies of cottonwood trees are characterized as "overstory/canopy" species; while many reptiles respond positively to the rocky landscape features in their habitats ("rocks/canyons"). Species that respond to the same set of habitat features were grouped together in species assemblages – literally, species assembled together by similar habitat needs.

Conservation strategies for habitat management were written toward the needs of these species assemblages by addressing the conservation issues associated with the maintenance of the key habitat features. For example, one of the 22 Key Habitats is Intermountain Conifer Forests and Woodlands. Goals and objectives for this habitat address natural processes to maintain the structure but they also incorporate the value of this habitat to Nevada's WAP Species of Conservation Priority. Structural attributes of intermountain conifer forests and woodlands important to wildlife such as a mature overstory or the presence of snags and cavities were identified and species were grouped within these features ("species assemblages"). For aquatic species, cold versus hot springs or ephemeral versus permanent water sources are important distinctions for setting conservation objectives. However, for many key habitat types incorporating aquatic species, assemblages of those species are driven as much by the isolation and local endemism of those species as they are by specific structural characteristics of individual aquatic habitats within the key type. Species assemblages are identified for each of the 22 Key Habitats and were formulated through a series of workshops and interviews with species experts in Nevada, supplemented by information available in the literature describing species requirements.

In addition to habitat-based strategies addressing the needs of species assemblages, actions for individual species are identified. This was necessary when the required action is not habitat-based, or when it involves species-based research or monitoring. Even though the species in question might have broad habitat use patterns, an attempt was made to attach the species-based action to the Key Habitat strategy where it was most likely to have relevance. This was purely an organizational decision that was made to avoid the need to write a separate section for species-based action.

Many of the species-based conservation actions call for the development of species/habitat relationships models. These studies and the resultant models basically describe the species-habitat linkage through key habitat features that are used to inform conservation strategy development in this plan. The refinement of knowledge of these relationships will allow better understanding of the habitat features influencing species' distribution on the landscape, create better-informed species assemblages, and develop a more critically-focused conservation strategy with better prospects for success.

See Figure 5 and Table 2 for additional information on the ecological system groups and associated key habitats.

The WAP Conservation Landscape and Focal Areas

The second required element for Nevada's WAP includes describing the locations of key areas essential to the conservation of fish and wildlife species of concern. Addressing this element began with a landscape analysis that identified areas in Nevada that represented the highest biodiversity of WAP Species of Conservation Priority.

Focal areas were identified as discrete landscape units using the natural basin and range geography of the Nevada landscape. These units were prioritized using biodiversity and species richness measures based upon NDOW and NNHP observations and element occurrences for species of conservation priority. Focal areas were initially determined be those basin and range units that captured as least one documented occurrence of at least 90% of the species of conservation priority. Basin and range units were then added manually such that at least one occurrence of the remaining 10% of the species of conservation priority (e.g. localized, endemic populations) were represented. Landscape units were also added to include Audubon Important Bird Areas (2012), NNHP Scorecard sites (2006), significant spring landscapes (NNHP, 2011), greater sage-grouse preliminary priority habitat (NDOW, 2012), crucial mule deer habitat (NDOW, 2009), and crucial bighorn sheep habitat (NDOW, 2010) that were not already represented by the basin and range units with high biodiversity (see Appendix G).

The resulting focal areas map (Figure 1 in Appendix G) provides information about the location of biologically diverse areas in Nevada, highlights landscapes containing endemic species, and recognizes important areas identified in prior conservation planning efforts. The map does not provide a prioritization of individual landscapes but is intended as an informational resource for strategy development and implementation. Each key habitat strategy in the Nevada WAP includes a list of associated focal areas based upon the landscape assessment described above. Focal areas provide a general overview of key areas for fish and wildlife but by no means are intended to imply that conservation action should be restricted to these areas. Prioritization of key areas in the conservation landscape will be carried out by local working groups during WAP implementation. The focal areas provide a framework for evaluating Nevada's WAP in a statewide context to help determine the extent to which conservation actions identified in the 22 key habitat strategies are benefiting the WAP Species of Conservation Priority.

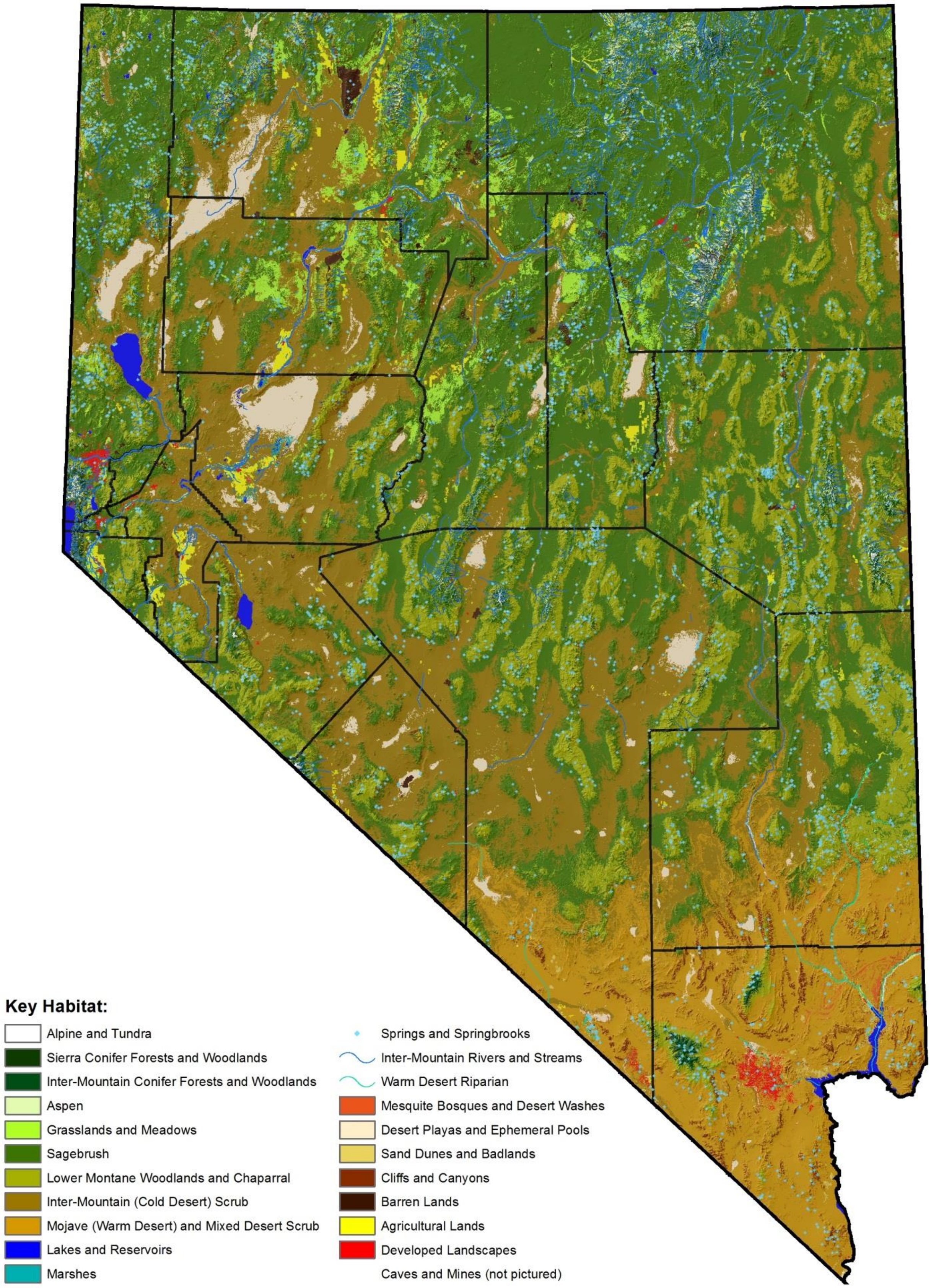


Figure 5. Ecological Systems Groups incorporated into the Nevada WAP.

Table 2. Nevada's Ecological Systems, Key Habitats, and Ecological System Groups

Ecological System Group	Key Habitat	Ecological System
Basins and Desert Scrub	Intermountain (cold desert) scrub	Intermountain Basins Greasewood Flat
		Intermountain Basins Mixed Salt Desert Scrub
		Intermountain Basins Semi-desert Shrub Steppe
		Intermountain Basins Wash
	Mojave mid-elevation mixed desert scrub	Colorado Plateau Blackbrush-Mormon tea Shrubland
		Mojave Mid-elevation Mixed Desert Scrub
	Mojave/Sonoran (warm desert) scrub	Sonora-Mojave Creosote bush-White Bursage Desert Scrub
		Sonora-Mojave Mixed Salt Desert Scrub
		Sonora-Mojave-Baja Semi-Desert Chaparral
Developed Lands and Agriculture	Agricultural lands	Agriculture
	Developed landscapes	Developed, Medium - High Density
		Developed, Open Space - Low Intensity
Lower Montane	Lower montane chaparral	Great Basin Semi-Desert Chaparral
		Mogollon Chaparral
	Lower montane woodlands	Great Basin Piñon-Juniper Woodland
		Intermountain Basins Juniper Savanna
		Intermountain Basins Mountain Mahogany Woodland and Shrubland
		Rocky Mountain Gambel Oak-Mixed Montane Shrubland
Riparian and Wetlands	Desert playas & ephemeral pools	Intermountain Basins Playa
		North American Warm Desert Playa
	Intermountain rivers and streams	Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland
		Rocky Mountain Subalpine-Montane Riparian Shrubland
		Rocky Mountain Subalpine-Montane Riparian Woodland
	Lakes and Reservoirs	Open Water
	Marshes	North American Aid West Emergent Marsh
	Mesquite bosques and desert washes	North American Warm Desert Riparian Mesquite Bosque
		North American Warm Desert Wash
	Mojave rivers and streams	Invasive Southwest Riparian Woodland and Shrubland
		North American Warm Desert Lower Montane Riparian Woodland and Shrubland
		North American Warm Desert Riparian Woodland and Shrubland
	Wet Meadows	Mediterranean California Subalpine-Montane Fen
		Rocky Mountain Alpine-Montane Wet Meadow

Ecological System Group	Key Habitat	Ecological System
		Temperate Pacific Montane Wet Meadow
Sagebrush Semidesert	Sagebrush	Great Basin Xeric Mixed Sagebrush Shrubland
		Intermountain Basins Big Sagebrush Shrubland
		Intermountain BasinsBig Sagebrush Steppe
		Intermountain Basins Montane Sagebrush Steppe
Sand Dunes and Badlands	Cliffs and Canyon	Colorado Plateau Mixed Bedrock Canyon and Tableland
		Intermountain Basins Cliff and Canyon
		North American Warm Desert Bedrock Cliff and Outcrop
		North American Warm Desert Volcanic Rockland
		Sierra Nevada Cliff and Canyon
	Sand dunes and badlands	Intermountain Basins Active and Stabilized Dune
		North American Warm Desert Active and Stabilized Dune
		North American Warm Desert Badland
		North American Warm Desert Pavement
Montane to Alpine	Alpine and tundra	Mediterranean California Alpine Bedrock and Scree
		Rocky Mountain Alpine Bedrock and Scree
		Rocky Mountain Dry Tundra
	Aspen woodland	Intermountain West Aspen-Mixed Conifer Forest and Woodland Complex
		Rocky Mountain Aspen Forest and Woodland
	Grasslands and meadows	Intermountain Basins Semi-Desert Grassland
		North Pacific Montane Grassland
		Rocky Mountain Subalpine Mesic Meadow
		Southern Rocky Mountain Montane-Subalpine Grassland
	Intermountain conifer forests and woodlands	Intermountain Basins Subalpine Limber-Bristlecone Pine Woodland
		Rocky Mountain Bigtooth Maple Ravine Woodland
		Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland
		Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland
		Rocky Mountain Ponderosa Pine Woodland
		Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland
		Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland
		Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland
	Sierra conifer forests and	Mediterranean California Dry-Mesic Mixed Conifer

Ecological System Group	Key Habitat	Ecological System
	woodlands	Forest and Woodland
		Mediterranean California Ponderosa-Jeffrey Pine Forest and Woodland
		Mediterranean California Red Fir Forest and Woodland
		Northern Pacific Mesic Subalpine Woodland
		Sierra Nevada Subalpine Lodgepole Pine Forest and Woodland
Other	Barren landscapes	Barren Lands, non-specific
		Recently Burned
		Recently Mined or Quarried
	Invasive grasslands and forblands	Invasive Annual and Biennial Forbland
		Invasive Annual Grassland
		Invasive Perennial Grassland