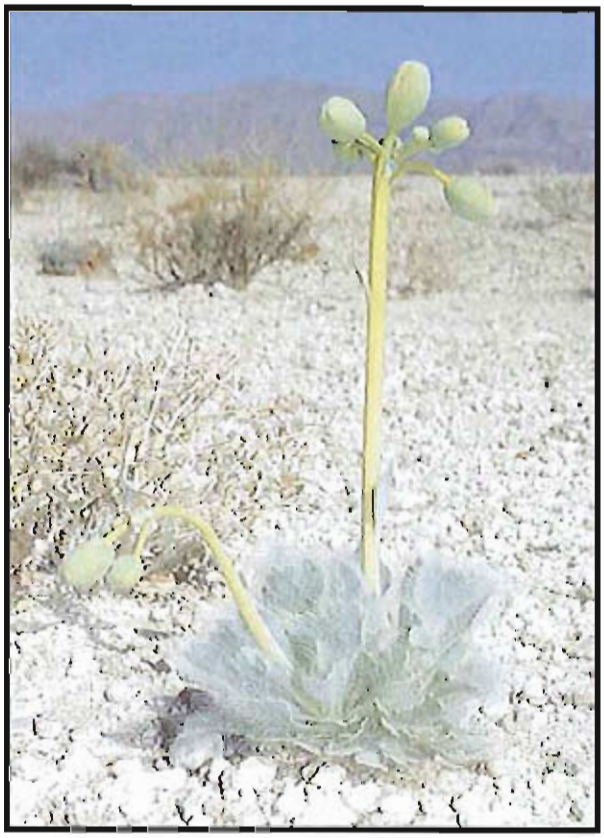
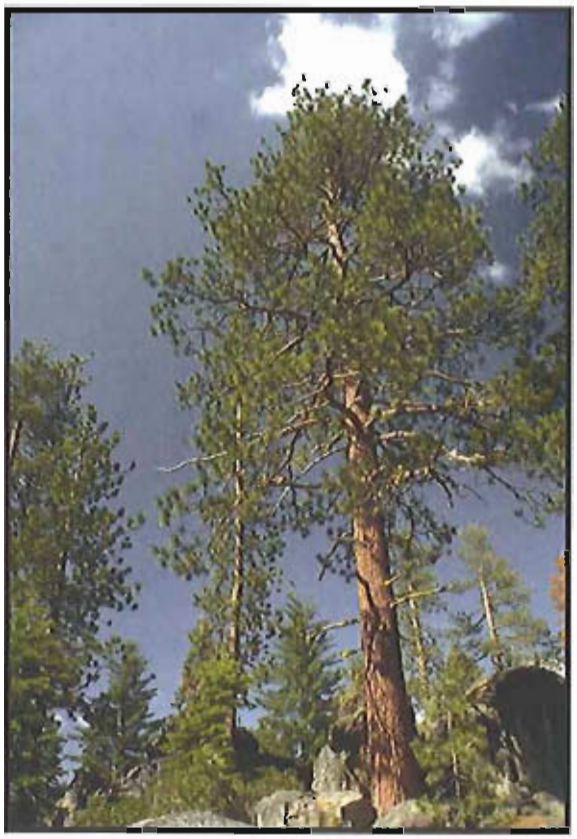
Nevada
Natural Resources Status Report

June 2002





Nevada Department of Conservation and Natural Resources

Notes to the Reader

The Nevada Natural Resources Status Report is the second technical report produced as part of the Nevada Natural Resources Plan (NNRP). Improving coordination to enhance conservation and management of the biological, land, water, air, and recreation resources is the purpose of the NNRP. The NNRP is a strategic planning process coordinated through the Nevada Department of Conservation and Natural Resources (DCNR) with the Divisions of the DCNR, the Nevada Department of Agriculture and Nevada Division of Minerals. Goals of the NNRP process emphasize intergovernmental coordination, public awareness and involvement, dissemination of resource information, and recommending strategies to resolve priority resource issues. As the process proceeds, the NNRP Technical Working Group will prepare and distribute other technical reports about natural resources, their management, and priority issues in Nevada. The Status Report can be viewed on the Internet, at the DCNR home page (below). Contact information for the DCNR Divisions is provided below.

Divisions and Special Programs	Address	Phone	Website Address
Conservation Districts	333 W. Nye Lane, Room 126, Carson City, NV 89706	775.687.6977	http://www.state.nv.us/cnr/conv01.htm
Environmental Protection	333 W. Nye Lane, Room 138, Carson City, NV 89706	775.687.4670	http://www.ndep.state.nv.us/index.htm
Forestry	1201 Johnson Street, Suite D, Carson City, NV 89706	775.684.2500	http://www.state.nv.us/cnr/forestry
State Lands	333 W. Nye Lane, Room 118, Carson City, NV 89706	775.687.4364	http://www.state.nv.us/lands/
State Parks	1300 S. Curry Street, Carson City, NV 89703	775.687.4370	http://www.state.nv.us/stparks/
Water Resources	123 W. Nye Lane, Carson City, NV 89706	775.687.4380	http://ndwr.state.nv.us/
Wildlife	1100 Valley Road, PO Box 10678, Reno, NV 89520	775.688.1500	http://www.nevadadivisionofwildlife.org
Natural Heritage Program	1550 E. College Parkway, Rm. 145, Carson City, NV 89706	775.687.4245	http://www.state.nv.us/nvnhp/
Commission for the Preservation of Wild Horses	885 Eastlake Boulevard, Carson City, NV 89704	775.849.3625	http://state.nv.us/cnr/horse01.htm

Should you have questions or comments about this report or the Nevada Natural Resources Plan, please contact us at:

NEVADA DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
123 West Nye Lane, Room 230
Carson City, Nevada 89706
Telephone: (775) 687-4361, ext. 225
FAX: (775) 687-6122
Internet Home Page: http://www.state.nv.us/cnr/
E-mail: skudlarek@dcnr.state.nv.us

Left cover photo. *Arctomecon californica* (Las Vegas bearpoppy) inhabits gypsum-rich soil with Mojave Desert shrubs in southeastern Nevada. Photo by Joan G. Wright, for Clark County Multi-Species Habitat Conservation Plan.
Right cover photo. *Pinus washoensis* (Washoe pine) grows in mixed conifer forest slopes on the east side of the Carson Range in western Nevada. Photo by Robert Potts, California Academy of Sciences.

Kenny C. Guinn, Governor
STATE OF NEVADA

Nevada
Natural Resources Status Report

June 2002

Technical Report 2
Nevada Natural Resources Plan

R. Michael Turnipseed, P.E., Director
Department of Conservation and Natural Resources

Preparers Notes

The Department of Conservation and Natural Resource's Technical Working Group (TWG) prepared the Nevada Natural Resources Status Report under the guidance of the NNRP Steering Committee. The Steering Committee includes the director and assistant director of the Nevada Department of Conservation and Natural Resources, and the administrators of the divisions and special programs within the Department. The TWG members who are participating in the development and implementation of the NNRP planning process include:

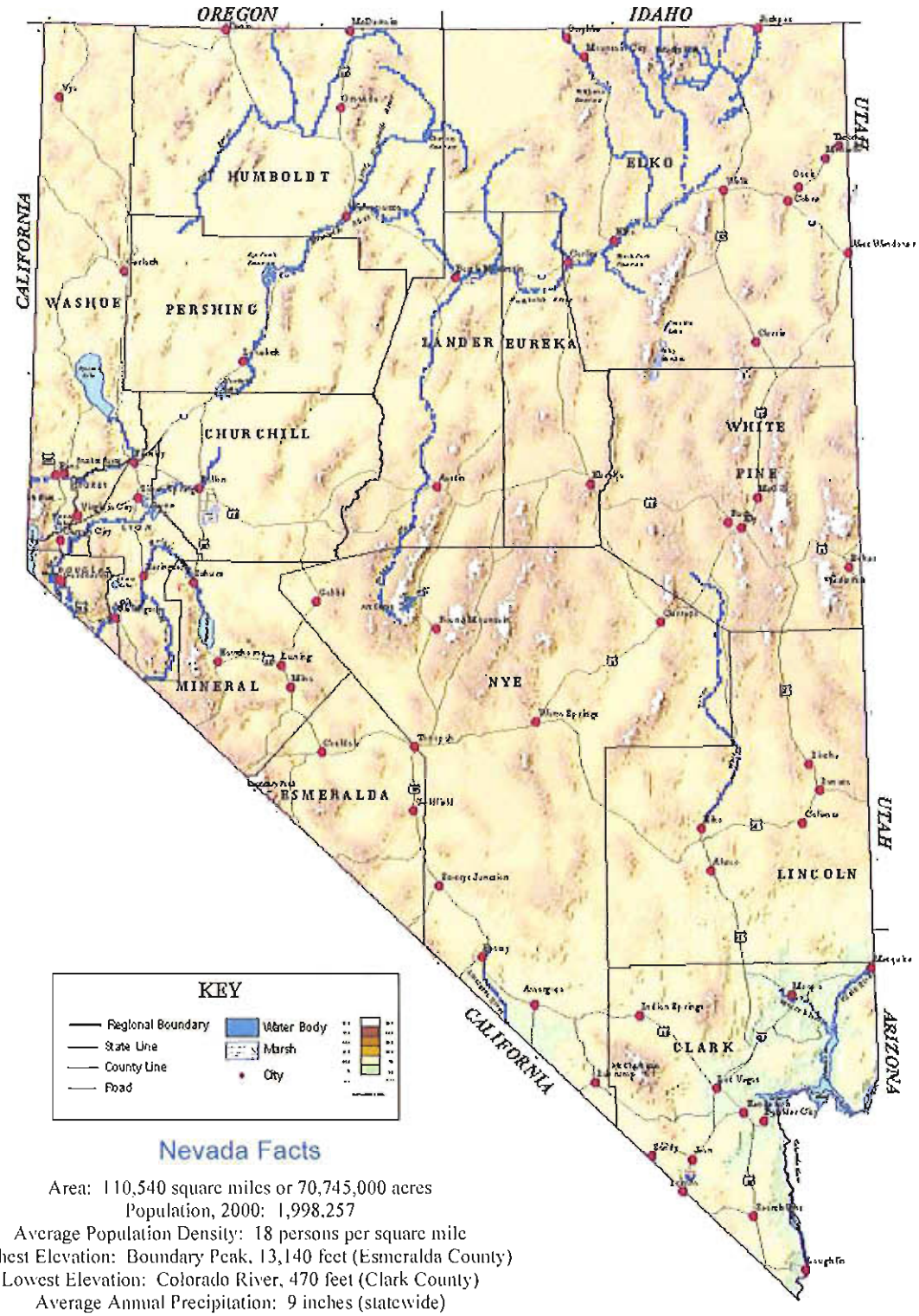
Jennifer Newmark	Natural Heritage Program
John Walker	Division of Environmental Protection
Verne Rosse	Division of Environmental Protection
David Cowperthwaite	Division of Environmental Protection
Steve Weaver	Division of State Parks
Mark Farman	Division of State Lands
Mike Del Grosso	Division of State Lands
Denise Adkins	Division of Conservation Districts
Doug Driesner	Division of Minerals
Anita Cook	Division of Wildlife
Jason King	Division of Water Resources
Rich Harvey	Division of Forestry
Chuck Moses	Department of Agriculture
Don Henderson	Department of Agriculture
Ed Skudlarek	Department of Conservation and Natural Resources

In addition to assistance provided by many hard working people throughout the Department of Conservation and Natural Resources, we are very grateful for the time, effort, and contributions from other state and federal agencies. The state draft Natural Resources Status Report could not have been prepared without special efforts by those agencies that take the important step of making their databases, maps, and technical reports available to the public. We extend a special thanks to these people at the:

Nevada Department of Agriculture
Nevada Division of Minerals, Commission on Mineral Resources
Nevada Bureau of Health Protection Services, Heath Division
Nevada State Historic Preservation Office
Nevada Department of Transportation
Nevada Energy Office
Nevada Commission on Economic Development
Nevada Public Utilities Commission
U.S. Bureau of Land Management, Nevada State Office
U.S. Fish and Wildlife, Nevada State Office
U.S. Forest Service, Humboldt Toiyabe National Forest Supervisor's Office
U.S. Natural Resources Conservation Service
U.S. Geological Survey
U.S. Department of Defense
U.S. Department of Energy

Table of Contents

State of Nevada



Nevada Facts

Area: 110,540 square miles or 70,745,000 acres
Population, 2000: 1,998,257
Average Population Density: 18 persons per square mile
Highest Elevation: Boundary Peak, 13,140 feet (Esmeralda County)
Lowest Elevation: Colorado River, 470 feet (Clark County)
Average Annual Precipitation: 9 inches (statewide)
Mountain Ranges: 314, 25 with summits over 10,000 feet
Groundwater Basins: 256
Native Plants and Animal Species: > 4600, 309 unique to Nevada
Public Outdoor Recreation Land: 57 million acres

About the Nevada Natural Resources Status Report

The Nevada Natural Resources Status Report was prepared by the Department of Conservation and Natural Resources as part of the agency's ongoing process to develop a Natural Resources Plan. The report gives a big picture view of the resources about which Nevadans care deeply: clean water and air; wildlife diversity; healthy aquatic, rangeland and forest ecosystems; outdoor recreation opportunities; and the natural beauty of wide-open desert and mountain wildlands. These are the essential elements of healthful, enjoyable, and productive communities. The focus of the report is the current state of these and other natural resources within the state.

Nevada's population and economy continues to expand. Understanding growth related impacts on environmental quality and consumption of natural resources is a central issue the report attempts to address. Where are the state's resources strained or showing resilience? How are natural systems responding to larger pollutant loads? What is being done to manage resources so that current and future needs can be met? The report provides information that may assist in answering these and related questions.

However, the Natural Resources Status Report is not an exhaustive assessment of all resources. The report presents the information that agencies made available to characterize environmental and resource conditions and the impacts of programs. To some degree the report focuses attention on high profile issues identified through public meetings and a survey of resource management agencies. Foremost areas of concern throughout the state include:

- Environmental quality and natural open space in urbanizing areas;
- Biodiversity and wildlife habitat;
- Ecological health of aquatic, rangeland and forest ecosystems;
- Non-native flora and fauna;
- Management of livestock, wild horses, and wildlife;
- Wildland fire effects on native ecosystems and property; and,
- Quality and quantity of outdoor recreation resources.

Nevada's resources are managed and monitored by many different agencies within an array of overlapping land and resource management units. Because the purpose of the report is to take a step towards developing an integrated, comprehensive set of natural resource indicators, available data and information was sought from many agencies and published reports. Many agencies responsible for resource management and environmental protection gather a substantial amount of data. However, in general, agencies can do more to use available data to assess the impact their protection and management efforts have on natural resources and the effectiveness of related program activities. Agencies and public and private decisions makers would benefit by increased efforts to disseminate information generated by resource scientists and program managers. Interagency coordination has improved in recent years, as suggested by the number of ongoing collaborative planning events addressing priority resource issues. These efforts present an opportunity to improve data analysis, information sharing, and public reporting.

This is the department's initial attempt to provide a comprehensive report on the state of the environment in Nevada. Hopefully the information assists government agencies, elected officials, industry, and citizens in becoming more familiar with our state's natural resources and aware of achievements and needed improvements in sustaining our natural resources. The Natural Resources Status Report can be viewed on the Internet at http://www.state.nv.us/cnr/nrp/status.htm. Comments may be mailed to eskudlar@govmail.state.nv.us.

Acronyms

BIA	Bureau of Indian Affairs (U.S.)
BLM	Bureau of Land Management (U.S.)
BOR	Bureau of Reclamation (U.S.)
BAQ	Bureau of Air Quality (Nevada)
CD	Conservation Districts
CRMP	Coordinated Resource Management Plan
DCNR	Department of Conservation and Natural Resources (Nevada)
DOD	Department of Defense (U.S.)
DOI	Department of Interior (U.S.)
EPA	Environmental Protection Agency (U.S.)
ESA	Endangered Species Act
FWS	Fish and Wildlife Service (U.S.)
HA	Hydrographic Area
HCP	Habitat Conservation Plan
HMA	Herd Management Area
HTNF	Humboldt-Toiyabe National Forest
LCT	Lahontan Cutthroat Trout
NBMG	Nevada Bureau of Mines and Geology
NCA	National Conservation Area
NDCD	Nevada Division of Conservation Districts
NDEP	Nevada Division of Environmental Protection
NDF	Nevada Division of Forestry
NDOW	Nevada Division of Wildlife
NDOA	Nevada Department of Agriculture
NDOM	Nevada Division of Minerals
NDSL	Nevada Division of State Lands
NDSP	Nevada Division of State Parks
NDWR	Nevada Division of Water Resources
NNHP	Nevada Natural Heritage Program
NNRP	Nevada Natural Resources Plan
NPIF	Nevada Partners in Flight
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRS	Nevada Revised Statutes
SDWA	Safe Drinking Water Act
SHPO	State Historic Preservation Office (Nevada)
SNPLMA	Southern Nevada Public Land Management Act
TNC	The Nature Conservancy
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WSA	Wilderness Study Area
WMA	Wildlife Management Area

Figures

Tables

Overview of State Characteristics

Population

The population of Nevada grew by 66 percent during the 1990's, indicating many people find the Silver State to be a desirable place to live, work, and enjoy vast open spaces. In 2000, the state's population surpassed the two million mark (Table 1-1). Migration contributed to about 81percent of the growth. The rate of growth in Nevada (51%) was the highest among all states (Nevada State Demographer's Office, 2000). The state's population rank rose from 39 in 1990 to 35 in 2000. Neighboring states are growing rapidly also. By comparison, during the 1990's, the population of Arizona increased by 40 percent, Utah by 30, Idaho by 28 and Oregon by 20 percent. The population of California increased 14 percent, approaching 34 million in 2000 (U.S. Census Bureau, 2000a). By 2015, the population of Nevada and neighboring states is projected to increase from 48 million to 55 million (U.S. Census Bureau, 2000b).

Table 1-1. Population Change in Nevada from 1990 to 2000 and Projected Change to 2010

Population Rank	% State Population	County	Population		Population Change 1990 to 2000		Projected Change 2000 to 2010	
2000	2000		2000	1990	Number	%	Increase	%
1	68.8	Clark	1,375,765	741,459	634,306	86	484,230	35
2	17.0	Washoe	339,486	254,667	84,819	33	66,792	20
3	2.6	Carson City	52,457	40,443	12,014	30	10,895	21
4	2.3	Elko	45,291	33,530	11,761	35	9,535	21
5	2.1	Douglas	41,259	27,637	13,622	49	18,122	44
6	1.7	Lyon	34,501	20,001	14,500	72	14,840	43
7	1.6	Nye	32,485	17,781	14,704	83	24,967	77
8	1.2	Churchill	23,982	17,938	6,044	34	10,737	45
9	0.81	Humboldt	16,106	12,844	3,262	25	1,888	12
10	0.46	White Pine	9,181	9,264	-83	-1	-2,775	-30
11	0.33	Pershing	6,693	4,336	2,357	54	3,080	46
12	0.29	Lander	5,794	6,266	-472	-8	400	7
13	0.25	Mineral	5,071	6,475	-1,404	-22	-604	-12
14	0.21	Lincoln	4,165	3,775	390	10	30	1
15	0.17	Storey	3,399	2,526	873	35	989	29
16	0.08	Eureka	1,651	1,547	104	7	193	12
17	0.05	Esmeralda	971	1,344	-373	-28	145	15
		Nevada	**1,998,257**	**1,201,833**	**796,424**	**66.3**	**643,874**	**32.2**

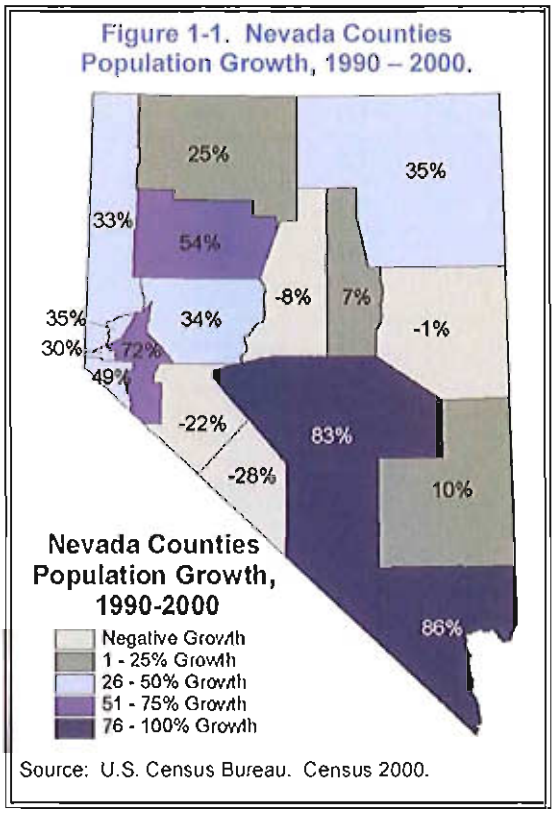
Sources: 1. U.S. Census Bureau, Census 2000 Redistricting Data (P.L. 94-171) Summary File, Table PL1, and 1990 Census. (Http://www.census.gov/population/projections/state/stpjpop.txt). 2. State Demographer's Office, *Nevada County Population Projections 2000 to 2010*. June 2000.

Nevada has become highly urbanized, meaning most people live within a few metropolitan areas. The average population density of the entire state is 18 persons per square mile, but nearly 86 percent reside in major population centers within Clark (69%) and Washoe (17%) counties. Of the five largest cities, three are located in Clark County (i.e., Las Vegas, Henderson, and North Las Vegas) and the others are in Washoe County (i.e., Reno and Sparks). Urbanization is no longer confined just to these cities. In western and southern Nevada, regional-scale urbanization has emerged. The urbanizing western region encompasses southern Washoe, Carson City, Douglas, Lyon, and Storey counties, with a combined population of about 470,000 in 1999. In the south, the regional scope of urbanization encompasses Clark County and southern Nye and Lincoln counties. Population exceeds 1.4 million in the southern region. In the urban regions, and some rural areas, more residential, commercial, industrial, and public service developments are being built outside "urban" boundaries. Urban sprawl expands the "urban/wildland interface," adding to environmental pressures and placing more demands on state resource agencies.

Urban (or suburban) sprawl is difficult to quantify. It can be described as a development cycle that starts with subdivisions built outside urban boundaries and ends with a blanket of residential and commercial buildings. In fast growing areas, consideration of systematically conserving open space for important ecological functions and socioeconomic values may be an afterthought. Eventually floodplain, wildlife habitat, or forest patches may be retained, often as parks, but a piecemeal approach relinquishes many of the natural values. From a long-run socioeconomic viewpoint, sprawl is an inefficient consumption of land and raises costs of municipal and utility services. Negative consequences of sprawl place greater demand on state and local agencies to mitigate additional issues, such as air and water quality deterioration; wildfire threats at the urban/wildland interface; fragmentation of wildlife habitat; threats to vulnerable plant and animal species; over-development of floodplains; loss of wetlands and riparian resources; and loss of public land access. More urban and suburban communities in are taking interest in retaining and improving management of open space and prime agricultural land, indicating the importance of this issue in our owing state.

A large number of rural communities are spread throughout the state's valleys and mountains. Even the state's four "urban" counties (i.e., Carson City, Clark, Douglas, and Washoe) contain large rural areas. The population density of rural Nevada is about 1.4 persons per square mile. Towns are widely spaced, connected to land and water resources suitable for farming, ranching, mining, and military installations. Rural county growth rates fluctuate, often a response to national or global economic factors that depress precious metals production. Rural communities with a strong agricultural base are more resilient. Seven rural counties grew 25 percent or more and the population in four counties declined during the 1990's (Figure 1-1). Two counties, Esmeralda and Mineral, experienced population losses greater than 20 percent (U.S. Census Bureau, 2000c). Supplies of high quality water are limited and mining has been the leading employer in both. Increasingly, rural area resources will be sought to meet urban area needs for water supply, waste disposal sites, and industries with large pollutant discharges, and outdoor recreation.

Figure 1-1. Nevada Counties Population Growth, 1990 – 2000.



Source: U.S. Census Bureau. Census 2000.

The Nevada State Demographer's Office projects the statewide annual growth rate will average 2.6 percent from 2002 to 2010, essentially adding another city each year the size of Carson City. By 2010, the state's population is anticipated to increase by another 644,000. Counties projected to grow an average of three percent or more each year are Douglas, Nye,

Lyon, Churchill, and Pershing. Clark County is expected to add about 484,000 more residents by 2010, and Washoe County about 67,000. Combined, these two counties account for 86 percent of the projected growth over the first decade of the new millennium (Nevada State Demographer's Office, 2000). The projections suggest the factors that made Nevada the most urbanized state will continue to strongly influence where people and businesses move here. Region-wide urbanization will challenge local governments and resource management agencies to coordinate their individual efforts to assess and mitigate the variety of ways growth can impact limited and valuable resources.

Economy

During the 1990's, Nevada's economy grew dramatically, as indicated by an increase in the labor force of 320,000 workers. As of January 2001, industrial employment (defined as number of jobs by place of work) stood at just over 1 million. Most jobs are in the service sector (about 43 percent) followed by wholesale and retail trade, government, construction, and manufacturing. In rural Nevada, government, mining, and agriculture dominate local economies. In metropolitan areas of Las Vegas and Reno, tourism drives the hotel gaming and recreation sectors. Over 30 million tourists visit the state each year.

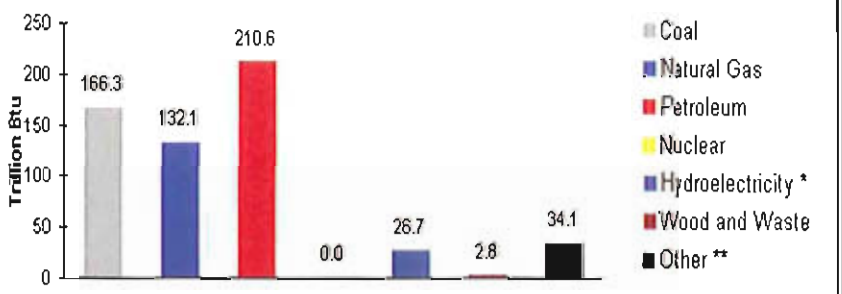
Nevada's tourism based economy has proven vulnerable to down turns in the national economy. Over the past year for example, hotel, gaming, and recreation employment, has grown less than one percent. Visitor counts in Reno and Las Vegas have also flattened as the gross gaming win has averaged little or no growth. The overall reduction in gaming activity can be expected to linger as long as the U.S. and global economies continue to struggle and California's high energy prices impact discretionary income. The growing number of gaming establishments on tribal lands in California also is expected to affect Nevada gaming and associated tourism revenues. While Nevada's overall economy remains robust, changes in the national economy will continue to affect tourism in Nevada.

Total output from the primary natural resource based industries increased, but not in proportion to the gross state product, which doubled to $63.044 billion from 1990 to 1998. Overall agricultural productivity rose 41 percent to $444 million. However, the farm production component fell 3 percent to $142 million. Mining productivity (i.e., metal, nonmetallic, and oil and gas extraction) grew $100 million during the same period to $1.529 billion. Despite the downturn in gold prices and drop in mining activity, almost all of the mining productivity increase was due to metals mining. Oil and gas productivity declined $31 million. The proportionate contribution from the agriculture and mining industries to the state total economy declined from 5.3 percent in 1990 to 3.1 percent in 1998 (U.S. Bureau of Economic Analysis, 2000).

Energy

Energy use involves fuel choices and consumption habits that affect air, water, and land resources in many ways. The state relies on a mix of all major types of energy resources, except nuclear power. Most of the energy consumed comes from the combustion of coal, natural gas, and oil (Figure 1-2). About 7 percent comes from non-fossil fuel sources, primarily hydropower and geothermal resources. In 2000, Nevada geothermal plants generated about 1.3 million mega-watt hours of electricity. Oil is the

Figure 1-2. Primary Energy (Btu) Consumed in Nevada by Source, 1997



Source. U.S. Energy Information Administration website: www.eia.doe.gov
*May not include net imported electricity from this source.
**Geothermal, wind, photovoltaic, and solar.

Nevada's oil production in 2000 was 620,651 barrels (0.01% of U.S. total), down from the 1992 high of 1.86 million barrels. Year 2000 production came from 99 wells located in Nye and Eureka Counties. About 1 million acres is under federal oil and gas leases in Nevada. This typical scene of a pump jack at an oil well is located in Pine Valley, Eureka County. 1990. Photo by Jon Price.

only fossil fuel extracted from Nevada's geologic resources. Recent yearly oil production ranged from 1.86 million in 1992 to 0.62 million barrels in 2000 (Nevada Bureau of Mines and Geology, 2001).

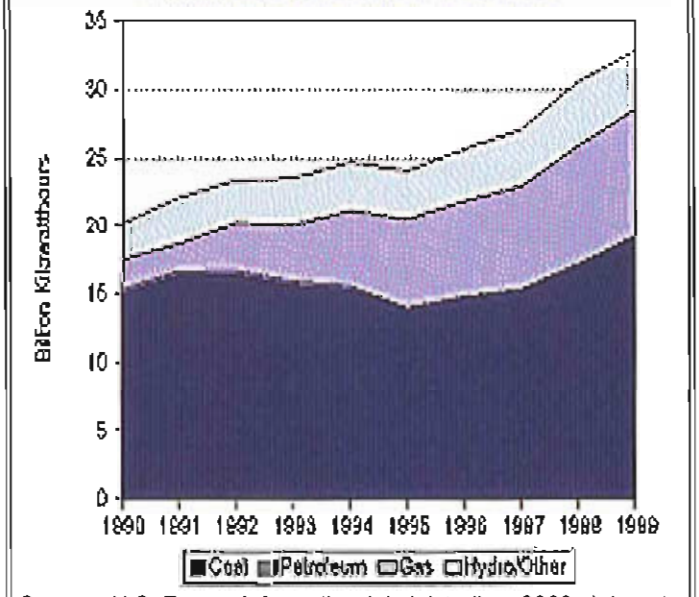
Total state energy consumption in 1997 was 572.6 trillion British thermal units (Btu), increasing 41% between 1991 and 1997, closely following the rate of population growth. Per capita energy consumption basically remained unchanged, fluctuating between 328 and 346 million Btu during the period. The use of energy per Nevada resident is close to the national average of 352 million Btu per person. By comparison, in the late 1970's per capita consumption ranged from 377 to 391 million Btu (U.S. Energy Information Agency, 1999b). Statewide, overall energy efficiency improved only slightly since the 1970's. Little, if any, gains in efficiency were made during the 1990s.

Electric Power

Generation of electricity in Nevada requires enormous inputs of fossil fuels, all imported. In 1997, 7.261 million short tons of coal, 52 billion cubic feet of natural gas, and 69 thousand barrels of oil were burned at power plants in Nevada. The primary generating fuel is coal. The state's geologic formations yield small quantities of crude oil, a smaller amount of natural gas coincident with oil production, and no coal. However, Nevada has enormous reservoirs of renewable energy (e.g., solar, wind, and geothermal), of which only a small fraction has been tapped. Fossil fuel fired plants make up 90 percent of the electric generating capacity in Nevada.

The total electric generating capacity of power plants in Nevada is about 6,400 megawatts (MW). Figure 1-3 shows the amount of fuel types used to generate electricity at Nevada power plants during the 1990's. Petroleum makes up a small fraction of fuel used to produce power. Though the coal-fired capacity (2,806 MW) makes up 40 percent of the total generating capacity, 67 percent of the fuel burned was coal in 1997 (U.S. Energy Information Agency, 2000). Natural gas is gradually becoming a larger part of the fuel mix (22 percent), replacing oil combustion at dual fueled plants. Lower air pollutant emissions are one reason for higher natural gas use, especially at generating stations within and nearby

Figure 1-3. Nevada Utility Generation of Electricity by Primary Energy Source, 1988-1998



Source. U.S. Energy Information Administration, 2000. Internet address: www.eia.doe.gov

Table1-2. Types of Generation Plants Proposed for Construction in Nevada, 2002			
Generation Type		Capacity (MW)	Percent of Total
Combined Cycle (fossil)		9,321	91.3
Peaking	fossil	130	1.3
	hydro	400	3.9
Wind		350	3.4
Geothermal		12	0.1
TOTAL		10,213	100.0
Source: Nevada Public Utility Commission, 2002. Internet address: http://puc.state.nv.us/electric/			

urban areas with impaired air quality. Natural gas fired technologies consume less water than other fossil-fuel options.

Many power projects have been proposed in Nevada to meet growing electricity demand in Nevada and other western states. The Public Utilities Commission of Nevada (PUCN) has received applications to construct 19 new generating facilities, all but two in the southern region. Most of the proposed plants are natural gas fired (Table 1-2). The additional units may place cumulative, long-term stress on water resources, aquatic ecosystems, air quality, and wildlife habitat. Only 3.5 percent of the additional capacity would use renewable resources that could avoid or minimize water consumption and other resource issues. If in the coming years Nevada is to host a number of new fossil-fueled power plants, there is a need to study the potential cumulative, long term effects on the affected environment and resources, so appropriate conservation strategies can be evaluated and implemented should the need arise.

The State's Utility Environmental Protection Act (NRS 704.825) requires environmental review by the Nevada Division Environmental Protection (NDEP) of individual power proposals. The Nevada Division of Water Resources (NDWR) reviews applications for appropriation of water and for changes in the point of diversion, place of use, or manner of use. The NDWR has authority to approve, conditionally approve, or deny applications using criteria that may include related environmental concerns. In 2001, the Governor's Nevada Electric Energy Policy Committee acknowledging concern about competition for the state's scarce water resources, advised that preference should be given to air-cooled plants, sites with access to reclaimed water, or sites where water is more abundant, perhaps in other geographic areas (Public Utility Commission of Nevada, 2001).

Steam plumes rising from cooling towers, boiler stacks, and cooling pond at Tracy Generating Station east of Sparks. Huge volumes of water are used to operate steam electric power plants. New power plants using air-cooled and hybrid-cooling towers can reduce cooling water use by 98%, conserving the state's limited water and protecting aquatic ecosystems. Photo © Mark Savage 2000.

Transportation Fuels

Transportation related energy use makes up about 31 percent of the state total. Population and economic growth corresponds to more vehicles and more miles driven. The Nevada Department of Transportation estimates that vehicle miles traveled grew 65 percent from 1990 to 1997. During this period, the national corporate average fuel economy (CAFÉ – measured in average miles per gallon) for autos and light trucks decreased slightly. Overall vehicle fuel efficiency also dropped, in part because of increasing use of sport utility vehicles. The combination of a rapid increase in the number of people driving more miles in less-efficient vehicles drives pollutant emissions upward. Rapid growth and sprawling development patterns can result in a backlog of road construction projects, exacerbating

congestion and urban air quality concerns. The Clark County Department of Comprehensive Planning estimates that vehicle emissions are the principal cause for episodes of unhealthful carbon monoxide levels in Las Vegas Valley (Nevada State Energy Office, 2000).

The use of alternative transportation fuels increased slightly from 1990 to 1997. However, in Clark County, natural gas used to operate vehicles rose 55 percent, from 1.068 to 1.650 million gallons equivalent between 1996 and 2001 (Nevada Division of Environmental Protection, 2002). The inventory of alternative fueled vehicles operated in Nevada grew substantially to 3,719 in 1999 (U.S. Energy Information Agency, 1999a). In Clark County, the number of natural gas vehicles increased from 362 in 1993 to 2,200 in 2001. Alternative fueled vehicles include those fueled with liquefied petroleum gas (544), natural gas (3,702), ethanol (78), and electric power (25) (U.S. Energy Information Administration, 2000b). The larger number of alternative fueled vehicles does not correspond well with data on the use of alternative vehicle fuels, suggesting conventional gasoline fuel is used in dual-fueled vehicles.

Renewable Energy

The State Energy Office and the National Renewable Energy Lab ranks Nevada as one of the best areas in the country for solar electric and solar thermal power as well as substantial wind and geothermal energy potential. Geothermal and hydropower plants provide all of the renewable energy generated in Nevada today. Fourteen geothermal power plants have been built since the mid-1980's, with a combined capacity of 236 MW's (3.7 percent share of total in-state capacity). The primary hydroelectric resource is the Nevada share of power produced from the Colorado River at Hoover, Parker and Davis dams (about 417 megawatts). Six hydropower units run on seasonal Truckee River diversions west of Reno and near Lahontan Reservoir. Hydropower provides 6.8 percent of the state's total capacity.

The projected shortfall in the western region's electric generating capacity produced very modest interest in developing renewable resources in Nevada. Of the additional 10,200 MW of generating capacity that electric power companies proposed in 2000 and 2001 to the Nevada Public Utility Commission, only 3.5 percent would expand use of renewable resources (350 MW wind, 12 MW geothermal). Small-scale solar photovoltaic use for residential, small commercial and public facilities has increased in recent years.

The legislature has enacted two statutes encouraging renewable energy use and development. The "net metering" program enables utility rate payers to earn credits that lower their power bill proportionate to the electricity generated by small, grid connected solar or wind generators. The "renewable portfolio standard" requires Nevada's electric utilities to generate or acquire a minimum of 5 percent of electricity sold to retail customers from renewable energy systems in 2003 and 2004, and increases the standard by 2 percent biennially to 15 percent by 2013.

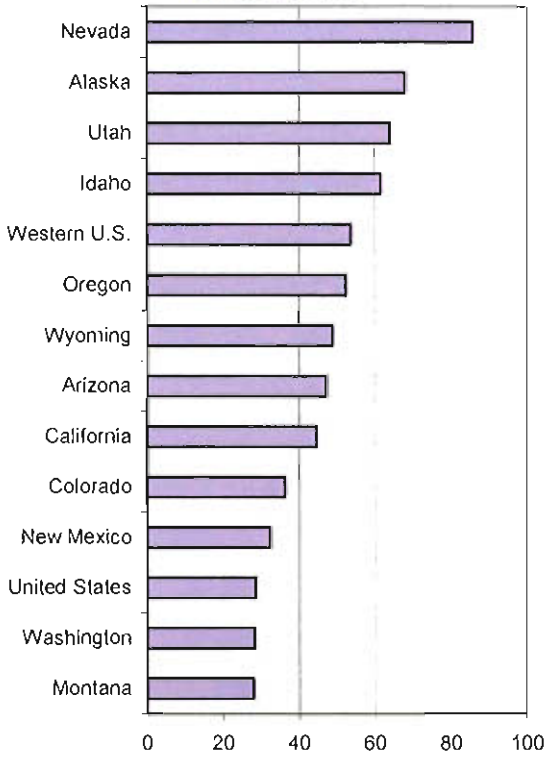
Land and Management Status

Land Status

Nevada's borders enclose about 70,745,600 acres, making it the seventh largest state. The federal government controls 60,863,345 acres, or 86.1 percent of the land (Table 1-3). Of the remaining 13.9 percent (or 9,882,250 acres), 11.5 percent is privately owned, 1.6 percent tribal, 0.4 percent local, and 0.4 percent state government owned. On a percentage basis, Nevada has more federal land than any other state (Figure 1-4). Tribal land is not federally owned, but is held in trust by the federal government for the tribes. Federal land status by county is shown in Figure 1-5. At least 90 percent of the land in Esmeralda, Lander, Lincoln, Nye, and White Pine counties is federally managed. Fifty percent or more of the land in each county is federally managed, except the two smallest (i.e., Storey and Carson City).

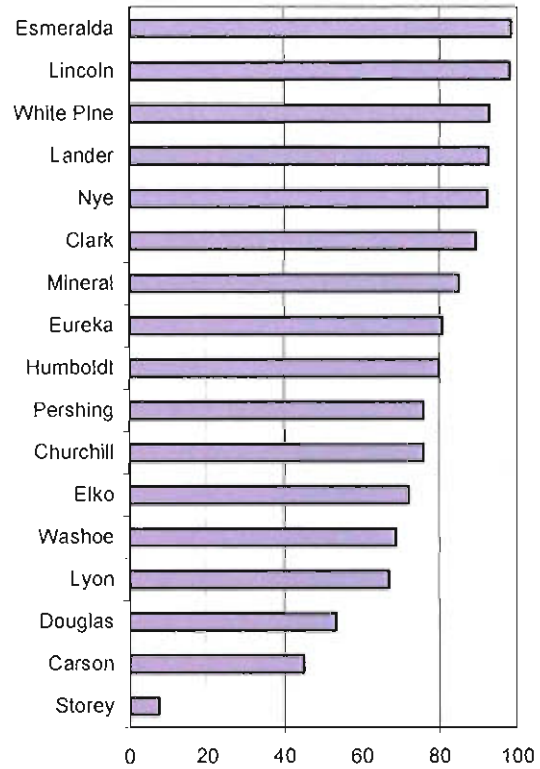
At the time of statehood in 1864, Nevada was granted 3.9 million acres, consisting of the 16th and 36th sections of each township. However, most of these sections of land were isolated from the state's 30,000 residents and were not surveyed. Under the Exchange Act of 1880, Congress agreed to let Nevada exchange its 3.9 million acres for 2 million acres selected by the state. Thus, Nevada relinquished about

Figure 1-4. Percent of Land Managed by Federal Agencies in Nevada and Other Western States



Source: Nevada data from NDSL, 2001. Others from BLM, 1993.

Figure 1-5. Percent of Land Managed by Federal Agencies in Each County



Source: NDSL estimate using data from various agencies, 2001.

half of the state grant land in order to select surveyed land and more desirable locations. The selected land generally was located near existing settlements and reliable surface water resources. Almost all state grant lands were patented to private landowners.

Additional private land for Nevada was obtained in the 1860's when the federal government granted the Central Pacific Railroad Company the odd numbered sections (each about one square mile) in a corridor extending twenty miles on each side of the railroad. This public land transfer totaled 5,086,683 acres, making this the primary source of private land in Nevada. The "checkerboard pattern" is evident on land status maps as a 40-mile wide corridor of alternating private and public sections of land that meanders from the eastern to the western borders of the state. The corridor straddles the Humboldt and Truckee rivers, and generally follows present day Interstate Highway 80. The checkerboard pattern of public and private land complicates land development and natural resource management. Development has been somewhat limited, favoring livestock grazing and farming. Several productive farm districts lie within the checkerboard lands.

There are approximately 8,182,000 acres of private land in Nevada today, an area close to the size of New Hampshire. Assuming all Nevada residents live on private land, the estimated population density is about 150 persons per square mile of private land. (New Hampshire's statewide population density is about 137 persons per square mile.) Data from the Nevada Department of Taxation indicate that local government entities (municipal, county, and schools) own approximately 264,600 acres (Nevada Department of Taxation, 2001).

Land ownership patterns in the state have changed little since 1985. Since then, the federal public land base and state owned land base increased about 0.2 and 0.1 percent, respectively (Table 1-3.) An

assumption in Table 1-3 values is that the federal land increase resulted in reduction of private land. Therefore, the decrease in private and local government owned land is calculated to be 0.3 percent, or about 212,000 acres.

Table1-3. Estimated Nevada Land Status, 1985 and Recent (1995/2000/2001)

Government Entity	1985		1995/2000/2001		Change in %
	Acres	% Of State	Acres	% Of State	
Federally Managed Land Total (a)	60,755,598	85.9	60,909,973	86.1	0.2
U.S. Department of Agriculture, Forest Service	5,149,684	7.3	5,805,129	8.2	
U.S. Department of Interior	51,183,400	72.4	50,786,530	71.8	
Fish & Wildlife Service	2,202,297	3.1	2,218,411	3.2	
Bureau of Indian Affairs	6,244	<0.1	3,982	<0.1	
Bureau of Land Management	48,281,508	68.3	47,701,393	67.4	
National Park Service	742,757	1.1	819,297	1.2	
Bureau of Reclamation	429,213	0.6	88,075	0.1	
U.S. Departments of Defense Total	3,115,874	4.4	3,297,057	4.7	
Air Force	2,896,954	4.1	2,903,606	4.1	
Army	155,266	0.2	152,659	0.2	
Navy	63,654	0.1	240,792	0.3	
U.S. Department of Energy	823,989	1.2	806,653	1.1	
Other Federal Agencies (b)	2,016	<0.1	2,000	<0.1	
Tribal Land Total (Held in Trust by Federal Government) (c)	1,152,672	1.6	1,161,685	1.6	<0.1
State Land Total (d)	199,528	0.3	273,861	0.4	0.1
University of Nevada & Community Colleges	-	-	24,990	<0.1	
Colorado River Commission	-	-	9,113	<0.1	
Nevada Department of Transportation	-	-	300	<0.1	
Division of State Lands (includes Divisions of State Parks and Wildlife)	-	-	239,458	0.3	
Local Government Land Total (e)	8,639,818	12.2	264,585	0.4	–0.3
Private Land Total (f)			8,137,496	11.5	
Statewide Total	**70,745,600**	**100**	**70,745,600**	**100**	

Notes: Acre values are most recent estimates from various sources. (a) BLM acres are from 9/2000 BLM estimate. Except recently updated Navy acres, all other federal values are from a 1995 BLM and Division of State Lands estimate using BLM Fiscal Year 1995 data, U.S. General Services Administration data, and other sources. (b) Other federal agencies include U.S. Geological Survey, Bureau of Mines, Postal Service, and others. (c) The 1985 value is from the *1983 Nevada Indian Commission Directory* and the most recent values are from *2001-2002 Nevada Indian Commission Directory*. (d) Division of State Lands. (e) *2000-01 Statistical Analysis of the Roll*, Nevada Department of Taxation. (f) Private Land Total calculated as the difference between the Statewide Total and the sum of all other categories.

Two of the most significant single land ownership changes involve federal government transactions. In 1989, approximately 660,000 acres was transferred from the U.S. Bureau of Land Management (BLM) to the U.S. Forest Service (USFS) under the Nevada National Forest and BLM Enhancement Act. In 1985,

the Navy added 177,000 acres to the Fallon Naval Air Station land base to accommodate an expanded military mission. Today, land transactions are focused mainly on consolidating private and public lands to more effectively and prudently conserve, manage, and develop land and water resources. The level of activity involving public and private land sales and exchanges has intensified in recent years, primarily in and around cities and urbanizing towns.

The BLM, through the normal land disposal process (authorized by the federal Recreation and Public Purposes Act) and through a special process provided for in the Southern Nevada Public Land Management Act (SNPLMA) of 1998, has undertaken the most land transactions of any federal agency. In addition to the disposal (i.e., land sale and transfer to a nonfederal owner) of public land for development in Las Vegas Valley, the SNPLMA process involves acquisition of environmentally sensitive private parcels throughout the state.

Table 1-4. Recent and Pending BLM Land Transactions in Nevada

Location	Transaction	Acres
Clark County, Southern Nevada Public Land Management Act (SNPLMA)	Disposal	8,773
	Acquisition	914
Lincoln County and Northeast Clark County (Mesquite)*	Disposal	25,000
Nye County*	Disposal	400
Washoe and Storey Counties, Laborde Exchange	Disposal	731
	Acquisition	11,600
Ivanpah Airport, Clark County*	Disposal	6,200
Timbisha Homeland Transfer, Esmeralda and Nye Counties*	Transfer	5,800

Note: *Activities approved by Congress, 1999-2000 session, for implementation in the near future. Source: Nevada BLM, 2001.

Other federal agencies participating in the SNPLMA land acquisition process are the USFS, National Park Service (NPS), and Fish and Wildlife Service (FWS). State and local governments are participating as well by advising the federal agencies during the SNPLMA process. Recent and upcoming land transactions involving BLM are summarized in Table 1-4. The Federal Land Transaction Facilitation Act of 2000 is also expected to increase the amount of federal agency disposals and acquisitions in Nevada. The Act will create a new funding source and allow federal agencies to recover land transaction costs.

Land Management Status

All levels of government – federal, state, local, and tribal – are involved in the management of natural resources in Nevada. Each agency has statutory authorities that specify jurisdictions, and a range of responsibilities and duties. Intergovernmental coordination and cooperation is essential because watersheds, wildlife habitat, and many other natural features overlap political boundaries. State of Nevada policy promotes collaborative resource management planning and coordination with federal and local agencies.

Land Administered by Federal Agencies

The BLM and the USFS are the most prominent federal land management agencies in Nevada, managing about 68 percent and 8 percent of the state, respectively. Each agency prepares comprehensive resource management plans, and conducts environmental studies related to issuance of permits for mining, grazing, utility corridors, and other land use activities. The Humboldt-Toiyabe National Forest (HTNF) is the largest national forest in the country, outside of Alaska. About 92 percent of the HTNF land base is in Nevada. The remaining portion, which lies in California, consists of high elevation watersheds in the Sierra Nevada that are a major source of western Nevada water supplies.

The majority of BLM and USFS land in Nevada is managed under multiple use and sustained yield policies mandated by federal statutes. Multiple use 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, including recreation, rangeland, timber, minerals, watershed, and wildlife,

along with scenic, scientific, and cultural values. However, neither the courts nor government have interpreted implementation of the "multiple use" policy to require that all federal public land must simultaneously allow and be managed for all possible uses. Sustained yield means maintaining the continuous and productive output of the various renewable resources on the public lands consistent with the multiple use policy. In Nevada, the BLM and USFS manage multiple use lands for grazing, mining, timber harvesting, outdoor recreation, scientific study and ecological function. Resources that are receiving considerable attention in USFS forest plans and BLM resource management plans include wetland and riparian resources, wild horses, biodiversity, forage production, forest health, watershed conditions, wildlife habitat, motorized recreation, wildlife habitat, and noxious and invasive weeds.

A number of wilderness areas, national recreation areas, and other special management units have been established on BLM and USFS managed public lands (Table 1-5.). The special area designations are granted through Congressional or federal administrative actions. Specially designated areas are established to protect and preserve the ecological, natural, and cultural resources of specified areas. Grazing, mining, and other permitted activities existing at the time of the official designation often are allowed to continue.

Table 1-5. Special Designations on Federally Managed Resource Land in Nevada

Management Designation	Agency	Number of Management Units	Total Acres in Nevada	Created By
Wilderness Area	BLM	11	761,835	Act of Congress
	USFS	13	782,992	
Wilderness Study Area	BLM	102	4,344,600	Administrative Designation
	USFS	6	189,372	
Roadless Area	USFS	364	3,142,000	Administrative Designation
National Conservation Area	BLM	Black Rock Red Rock	795,200 196,000	Act of Congress
Areas of Critical Environmental Concern	BLM	30	1,139,267	Administrative Designation
National Trail	NPS BLM	California Trail Pony Express	475 miles 463 miles	Act of Congress
National Recreation Area	NPS	Lake Mead	709,129	Act of Congress
	USFS	Spring Mountain	316,000	
Research Natural Area	USFS	14	34,921	Administrative Designation
Lahontan Cutthroat Trout Natural Area	BLM	1	12,316	Administrative Designation
National Wildlife Refuges and Ranges	USFWS	9	2,200,000	Administrative Designation
National Parks*	NPS	3	110,168	Act of Congress
National Management Emphasis Area	USFS	Lake Tahoe Basin Management Unit	35,000	Act of Congress

Source: BLM, USFS, and National Park Service, 1999 and 2001.

The most recent wilderness area designation occurred in 2000, the result of a Congressional act creating the Black Rock Desert-High Rock Canyon Emigrant Trails National Conservation Area (NCA). The Act specifies protection and preservation for "historical, cultural, paleontological, scenic, scientific, biological, educational, wildlife, riparian, wilderness, endangered species and recreational values and resources associated with the Applegate-Lassen and Nobles Trails corridors and surrounding areas." The Act recognizes permitted livestock grazing as a use that is expected to continue in accordance with the management plan for the conservation area and other applicable laws and regulations. The BLM is preparing a new management plan for the NCA and ten wilderness areas that will review permitted grazing, mining, off-highway vehicle use, and other activities. The Act set aside approximately 815,000 acres as national conservation area and about 752,000 acres as wilderness area, of which approximately 380,000 acres are included in the NCA acreage (Bureau of Land Management, 2002).

Wilderness study areas (WSA's) cover 4.5 million acres. WSA's make up the largest category of specially designated public land in Nevada (Table 1-4). The newest category of management designation is the USFS Roadless Areas, potentially applicable to 3.1 million acres. Roadless area unit boundaries and management plans have yet to be established at the local forest district level. Inventoried roadless areas contain important environmental values that warrant protection, including drinking water sources, threatened and endangered species, biodiversity, dispersed outdoor recreation, barriers to the spread of noxious and invasive species, and scientific research. Until a forest-scale roads analysis is completed and incorporated into a forest plan, inventoried roadless areas shall, as a general rule, be managed to preserve roadless characteristics. However, the policy provides guidance on exceptions, in which case the decision to approve a road management activity or timber harvest is reserved to the Chief or the Regional Forester as provided (U.S. Forest Service, 2001).

The U.S. Fish and Wildlife Service (FWS) administers about 2.2 million acres of land that includes nine refuges and ranges and one fish hatchery. These public lands are set aside primarily for conservation of wildlife and habitat values and protection of threatened and endangered plant and animal species. Popular sites include the Sheldon National Wildlife Refuge (Antelope Range) and the Stillwater National Wildlife Complex in northwestern Nevada; Ruby Lake National Wildlife Refuge in eastern Nevada; Sheep Range Proposed Wilderness; and, the Ash Meadows Wildlife Refuge in southern Nevada, world renowned for its unique biological diversity (e.g., 24 plants and animals unique to the spring site).

Most national wildlife refuges and ranges are open for limited camping, fishing, hunting, boating, or other outdoor recreation uses that are compatible with the natural resources. The USFWS is the lead agency for implementation of the Endangered Species Act; preparation of recovery plans for threatened and endangered species (e.g., Lahontan cutthroat trout); and development of habitat conservation plans or agreements for sensitive species (e.g., the Clark County Multi-species Habitat Conservation Plan).

Land Administered by State Agencies

The Divisions of Wildlife, State Parks, and State Lands are the state agencies with primary authority for management of natural, outdoor recreation, or cultural resources on state-owned land. Other state agencies, also within the Department of Conservation and Natural Resources (DCNR), have resource management responsibilities on public and private land, such as air and water quality (Division of Environmental Protection – NDEP); water use and rights (Division of Water Resources – NDWR); forests and other native plants (Division of Forestry – NDF); fish and wildlife (Division of Wildlife – NDOW); plants and animals threatened with extinction (NDF and NDOW); mined-land reclamation (NDEP); and, cultural resources (State Historic Preservation Office – SHPO, Department of Cultural Affairs).

State land management agencies are mandated to manage resources according to multiple use and sustained yield principles, as defined by state law (NRS 321.0005). The NDOW manages 11 Wildlife Management Areas, for the maintenance and enhancement of fish and wildlife populations, diverse wetland and upland habitat, and wildlife-related outdoor recreation uses and facilities. The Division of State Parks (NDSP) is responsible for 24 state parks, water recreation areas, and historic parks and sites. State Parks contain boating access, campsites, and cultural resources, such as ancient marine fossils, petroglyphs, and settlement era forts, mills, and ranches. NDSP and NDOW prepare and update recreation and resource management plans for the parks and wildlife areas. In addition, NDOW prepares statewide management plans for certain game animals and fishes.

The Division of State Lands (NDSL) manages 500 parcels totaling 224 acres in the Lake Tahoe Basin as open space, emphasizing water quality improvement, wildlife habitat preservation, and forest health. The NDSL also manages 40,646 acres of "sovereign" land. Sovereign land consists of the river channels, lake bottoms, and shoreline areas below the "ordinary" high water marks of Lake Tahoe, Walker Lake, and the Truckee, Carson, Colorado, and Virgin rivers.

Land Administered by Tribes

Nevada includes 18 federally recognized Indian Tribes located throughout the state (Table 1-6). Prior to statehood, the Washoe, Paiute and Shoshone peoples occupied Nevada. Today, a relatively small amount of Nevada is reserved for the 18 tribes and their members. The amount of tribal acreage in Nevada is estimated at 1,161,865 acres. This amount is equivalent to 1.6 percent of the state's land area (Table 1-5) (Nevada Indian Commission, 2001a). The borders of many reservations overlap state or county borders, adding unique complexities to land administration efforts.

Table 1-6. Land Base of Nevada Tribes

Tribe	County	Total Tribal Land	Land in Nevada	Land In Adj. State	Comment
		Acres			
Duck Valley Shoshone Tribe	Elko	289,819	144,274	145,545	Portion in Idaho
Duckwater Shoshone Tribe	Nye	3,815	3,815		
Ely Shoshone Tribe	White Pine	111	111		
Fallon Paiute-Shoshone Tribe	Churchill	3,549	3,549		
Ft. McDermitt	Humboldt	35,488	16,660	18,829	Portion in Oregon
Fort Mojave Indian Tribe	Clark	34,998	3,998	31,000	Portion in California and in Arizona
Confederated Tribes of the Goshute Reservation	White Pine	108,933	70,489	38,444	Portion in Utah
Las Vegas Paiute Tribe	Clark	3,850	3,850		
Lovelock Paiute Tribe	Pershing	20	20		
Moapa Paiute Band	Clark	71,954	71,954		
Pyramid Lake Paiute Tribe	Washoe, Lyon, and Storey	475,000	475,000		Includes 112,000 acres of Pyramid Lake
Reno/Sparks Indian Colony	Washoe	1,978	1,978		
Summit Lake Paiute Tribe	Humboldt	10,098	10,098		Includes 560 acres of Summit Lake
Te-Moak Tribe of Western Shoshone Battle Mountain Band Elko Band South Fork Band Wells Band	 Lander Elko Elko Elko	16,636	16,636		Four Bands make up the Te-Moak Tribe: Battle Mountain, Elko, South Fork, and Wells
Timbisha Shoshone Tribe	Nye	7,454	5,500	1,954	Portion in California
Walker River Paiute Tribe	Churchill, Lyon	323,386	323,386		
Washoe Tribe of Nevada and California Carson Colony Dresslerville Colony Stewart Colony Woodsfords Colony	 Carson City Douglas Carson Alpine, CA	4,234	3,834	320 80	Four Colonies make up the Washoe Tribe: Carson, Dresslerville, and Stewart in Nevada; and, Woodsfords in California
Winnemucca Colony Council	Humboldt	340	340		
Yerington Paiute Tribe	Lyon	1,653	1,653		
Yomba Shoshone Tribe	Nye	4,718	4,718		
Total		1,398,036	1,161,865	236,171	

Source: modified from Nevada Directory of Native American Resources 2000/2001. Nevada Indian Commission.

Tribal lands are diverse and have been reduced from their original base located throughout Nevada. Tribal lands include: colonies, reservations, allotments, ranches, tribal fee land, federal land, government owned land, and trust lease lands. Tribal sovereignty encompasses lands within the exterior bounds of Tribal land held in trust by the federal government for Tribes and members. Tribal lands, colonies, and reservations are held in trust for the beneficial use of tribal members.

Native American culture with respect to land use management and protection often differs from the general populace. Indian people view their relationship to the land as one of stewardship. Their strong sense of protection over the land and its resources is inherent in the people and culture. Each generation is taught that their responsibility as a people is to guard over and protect "Mother Earth". Reservation community life is tied directly to the land tribal members occupy (Nevada Indian Commission, 2001b).

Mainly the tribes with a large land base engage in land use management plan development (i.e., the Pyramid Lake Paiute Tribe, Walker River Paiute Tribe, Duck Valley Shoshone Tribe, and the Washoe Tribe of Nevada and California). Many tribal master plans address natural resources and land use planning for residential and economic development on reservations. Historically, tribal and state agencies have had little interaction on resource plans. The primary reason is that tribal governments are sovereign and manage their own affairs. Tribal interactions on land use planning and resource management mostly involve the federal agencies having federal trust responsibilities (i.e., the Bureau of Indian Affairs, BLM, and USFS). In recent years awareness has grown that local, state, and federal land use and resource management decisions can impact tribal communities and tribal decisions can affect nearby communities.

Land Administered by Local Governments

Local governments play a major role in the conservation and development of natural resources on privately owned land and county and municipal controlled land. About 8.4 million acres of land in the state (12 percent) is owned privately or by local governments (Table 1-3). Local governments have the authority to establish master plans and regulate private land use activities through zoning. Master plans and zoning are land management tools that can be used to plan for the sustainable development of land, water, and other natural resources as communities develop. All of Nevada's 17 counties except Esmeralda, and all 18 incorporated cities, have adopted master plans that provide general guidance to land development and use activities.

Only the counties of Clark and Washoe are required by state law to prepare a master plan element that specifically addresses conservation of natural resources. In addition, Clark and Washoe counties each have created a state-mandated regional planning authority that considers the effects of growth and land development on environmental quality, water and energy use, outdoor recreation, wildlife habitat, and public land access. Other counties have the option of preparing resource conservation elements that establish environmental standards for land development and resource use. Several counties have prepared and adopted conservation plans for water conservation, open space preservation, stream corridor protection, as well as threatened, endangered and sensitive species conservation.

Counties also may directly participate in and influence land and resource planning and development on federal public land. Elko, Eureka, Lander, Lincoln, Lyon, Mineral, and White Pine counties have established Public Land Use Advisory Commissions for the purpose of participating in and influencing land and resource management plans and activities of federal agencies. Some counties have adopted a public land element as part of their master plan. Typically, public land policy plans articulate resource conservation and development policies supported by local citizens and county officials. Federal agencies preparing or updating resource management plans are required to be consistent with local government adopted policies. All of Nevada's counties have adopted Public Land Policy Plans or public land elements to the county master plan. Clark, White Pine, Humboldt, Lander, Esmeralda and Lincoln counties have updated their plans within the last five years.

Special districts that are political subdivisions of the State also may have substantial influence over land and resource management at the local level. Special districts include conservation districts, irrigation districts, water conservancy districts, and weed control districts. Special districts managed by elected

boards are empowered to levy fees for and implement environmental improvement projects. Districts may also conduct local resource planning and manage all or specified renewable natural resources within district boundaries in concert with private landowners.

Non-Governmental Organizations

A number of non-governmental organizations in Nevada prepare conservation plans, conduct resource inventories, construct environmental improvements, or acquire interest in conservation easements and environmentally sensitive land. Some of these organizations are The Nature Conservancy (TNC), Nevada Land Conservancy, Nevada Cattlemen's Association, Nevada Mining Association, Sierra Club, Nevada Association of Counties, Nevada League of Cities, Friends of Nevada Wilderness, and League to Save Lake Tahoe, Nevada Wilderness Project, American Land Conservancy, and the Audubon Society.

For example, TNC of Nevada recently completed "conservation blueprints" for the Great Basin and Mojave Desert ecoregions. Encompassing almost 80 percent of the Nevada land base, the resource plans identify 358 and 367 "portfolio sites," respectively. The goal is to enhance resource protection on the portfolio sites for the long-term survival of the diverse species and communities that characterize the ecoregions (The Nature Conservancy, 2000a and 2000b). TNC has also established about 7,700 acres of conservation easements on ranches in the Ruby and Carson valleys. In these cases, the landowners are compensated as an incentive to enhance conservation practices and forego new development while continuing agricultural operations. Some land trust organizations also acquire land and then convey it to another nonprofit organization or a government agency for permanent protection and stewardship.

Community and Citizen Stewardship

Throughout Nevada, citizens, conservation and industry organizations, government agencies, and public officials are working together to sustain and reclaim healthy environments. While a regulatory approach is appropriate to accomplish some environmental goals, more often we are relying on community cooperation and individual stewardship. Conservation districts and watershed planning groups are two examples of Nevadans taking strides toward sustainable development of renewable resources.

Natural resource planning activity has increased in recent years at each level of government. Most notable are the many collaborative planning processes established to seek solutions to contentious issues. Collaboration starts with willing participation by a full complement of government and citizen stakeholders that commit to cooperative work on finding equitable solutions for controversial resource issues. Collaboration produces solutions more likely to be implemented, rather than protested or litigated.

Over 60 natural resource planning and management projects are ongoing or will begin soon. In the past two years, the Governor's office initiated statewide collaborative planning projects for sage grouse conservation, noxious weed control, and wildfire management. One objective is to empower and support the role of county government or local organizations to take charge of site specific plan preparation and implementation. Examples of collaborative resource planning processes include the Nevada Sage Grouse Conservation Plan; Nevada's Coordinated Invasive Weed Strategy; Northeastern Nevada Stewardship Group; Great Basin Restoration Initiative; integrated natural resource planning at both the Nellis Air Force Range and Fallon Naval Air Station; Elk Management Plans; and, open space planning between the BLM, USFS, and western Nevada counties (Carson City, Douglas, and Washoe).

Conservation Districts

Statewide, there are 28 Conservation Districts (CDs) – locally led groups in rural and urban areas committed to proper management of renewable natural resources. Each CD prepares an annual and long-range work plan that identifies local resource management goals for the district. The CDs work closely with local offices of the federal Natural Resource Conservation Service (NRCS), which provide technical advice and professional services. Local watershed plans to improve water quality, enhance riparian areas, and control noxious weeds are developed and projects to improve wildlife, riparian, and

rangeland habitat implemented. Most CDs have implemented a noxious weed program. Cooperating with federal agencies, district members locate, map and control noxious weeds on private and public land. After the devastating wildfires of 1999 and 2000, the Paradise-Sonoma CD and the Nevada Division of Forestry (NDF) seeded several thousand acres of burned private rangeland. Each contributed equipment, labor and/or funds to successfully complete the seeding. Education, public outreach, and coordination among landowners and agencies are keys to the success of CD work plans.

A few CD's have taken on voluntary watershed planning initiatives. With grant funding through the State's Nonpoint Source Management Program and assistance by the federal Environmental Protection Agency, several CDs have developed Coordinated Resource Management Plans (CRMPs) that focus on improving water quality, stream bank rehabilitation, weed control, and channel clearance. The Carson Valley, Dayton Valley and Lahontan CDs are currently implementing CRMPs to address water quality and bank stability concerns in the upper, middle and lower sections of the Carson River. The Mason and Smith Valley CDs are doing similar work within the Walker River Basin.

Watershed Planning

Development of watershed management plans is another community-based activity that is increasing. Voluntary watershed planning is occurring at the municipal, watershed, and river basin levels. Though results are difficult to measure because each approach is different, watershed groups throughout the state make important contributions to stewardship of water and related resources. Well organized, collaborative watershed planning efforts are occurring throughout Nevada, with the most comprehensive efforts taking place in the Truckee, Carson, and Walker river basins, Las Vegas Valley, and Elko County.

Riparian area improvement project planning and implementation, an important element of watershed management, is more likely to be successful with collaboration. Crowley Creek is a perennial stream, tributary to the Quinn River, which flows in the Montana Mountain Range of Northwest Nevada. The area was in poor condition. The Lahontan cutthroat trout inhabits the stream. In 1992 (left photo) the Winnemucca BLM Field Office began an interdisciplinary resource and habitat evaluation process for the grazing allotment. The allotment permittee, Nevada Division of Wildlife, users groups, and resource specialists were involved in the evaluation and decision-making. The evaluation lead to a modified grazing cycle, reducing late summer use until conditions improved sufficiently to support additional use. Treatment began in 1993. Stream banks were next to non-existent, the water column was wide and shallow, and stream temperatures were lethal to fish in most locations. An unusually intense warm rain on snow flood event in February 1986 contributed to the degraded conditions. Between 1987 and 1991, little riparian habitat recovery occurred and the channel widened. By 1997 (right photo) significant improvements in habitat area were occurring. The water column narrowed and an active floodplain formed, retaining more of the limited spring runoff and resisting erosion. Water quality conditions have improved and streamflow is sustained throughout the year. Fisheries conditions have also improved in several reaches. 1992 and 1997 photos courtesy of Nevada BLM.

In 1998, a unique river basin planning coalition was formed for the Carson River. Following a conference and subsequent workshops, government officials and citizens recommended creation of a broad coalition to develop an integrated watershed planning process for the basin. The Carson River Coalition was formed and four years later continues to work on improving coordination. The Carson Water Subconservancy District and the University of Nevada Cooperative Extension facilitate the process. Guiding principles, statements of common interests and understanding, were developed and adopted by each county in the watershed, including Alpine County in California). Subgroups meet periodically to

devise and take action on specific planning issues, i.e., water quality protection and improvement, education and public information, regional water supply arrangements, land use planning, natural resource management, and government interaction. An intangible benefit is the cooperative support for individual programs, such as channel repair projects, community river clean-up events, water resource studies, conservation easement and land acquisition projects, and outdoor learning experiences for school children.

Urban area watershed plans are under development also. The Clark County Wetlands Park (CCWP) Master Plan will control erosion of and water quality impacts to the Las Vegas Wash related to greater discharges from wastewater treatment facilities and urban runoff. Cooperators include the Southern Nevada Water Authority, Clark County, the Conservation District of Southern Nevada and other members of the Las Vegas Wash Coordination Committee (Las Vegas Wash Project Coordination Team, 2001).

In the Truckee Meadows urban area, the Washoe-Storey CD, Washoe County, the University of Nevada Cooperative Extension, and other cooperators are implementing a restoration plan for Steamboat Creek. The Washoe-Storey Conservation District initiated the Steamboat Creek Restoration Plan because Steamboat Creek is considered the largest tributary source of non-point source pollution to the Truckee River. High levels of sediment, nitrogen, phosphorus and trace metals resulted in the tributary being listed as an impaired water body. The Nevada Division of Environmental Protection (NDEP) awarded a Clean Water Act 319(h) grant and the Regional Water Planning Commission also awarded a grant to promote plan implementation. The plan, which relies on voluntary participation, contains reach-by-reach recommendations for on-stream and off-stream restoration actions designed to improve water quality (Washoe Storey Conservation District, 1998).

References

Las Vegas Wash Project Coordination Team. 2001. Watch Our Wetlands Grow Project Overview. Internet site: http://www.lvwash.org/wetlands/project.html

Nevada Bureau of Mines and Geology. 2001. The Nevada Mineral Industry, Special Publication MI-2000.

Nevada Department of Taxation. 2001. Statistical Analysis of the Roll, Fiscal Year 2000-01.

Nevada Division of Environmental Protection. 2002. Table of Las Vegas Valley Total Natural Gas Gallons by User (by Clark County Regional Transportation Commission).

Nevada Indian Commission. 2001a. *Nevada Directory of Native American Resources, 2001 – 2002.*

Nevada Indian Commission. 2001b. Personal communication with Executive Director.

Nevada State Demographer's Office, Bureau of Business and Economic Research. 2000. *Nevada County Population Projections 2000 to 2010. June 2000.*

Nevada State Energy Office, Department of Business and Industry. 2000. Energy for Nevada, Report to the Legislature on the Status of Energy in Nevada for the Year 1999.

Public Utility Commission of Nevada. 2001. Report to the Governor of the State of Nevada from the Nevada Electric Energy Policy Committee. 91 pp.

The Nature Conservancy. 2001a. *Great Basin, An Ecoregion-based Conservation Blueprint.* v. 2001a. Reno, NV.

The Nature Conservancy. 2001b. *Ecoregion-based Conservation in the Mojave Desert.* Las Vegas, NV.

U.S. Bureau of Economic Analysis. 2000. Regional Accounts, Gross State Products Data. Internet address: http://www.bea.doc.gov/bea/regional/gsp/action.cfm

U.S. Bureau of Land Management. 2002. Black Rock Desert – High Rock Canyon Emigrant Trails National Conservation Area Fact Sheet. http://www.blackrockhighrock.org/NCAFacts.asp

U.S. Census Bureau. 2000a. Census 2000. Internet address: http://www.census.gov/main/www/cen2000.html

U.S. Census Bureau. 2000b. Population Paper Listing #47. Population Projections for States, by Age, Sex, Race, and Hispanic Origin: 1995 to 2025. Internet address: http://www.census.gov/population/projections/state/stpjpop.txt

U.S. Census Bureau. 2000c. Census 2000 Redistricting Data (P.L. 94-171) Summary File, Table PL1, and 1990 Census.

U.S. Energy Information Agency. 1999a. State Energy Data Report. Internet address: http://www.eia.doe.gov/pub/state.data/pdf/nv.pdf

U.S. Energy Information Agency. 1999b. Alternatives to Traditional Transportation Fuels. Internet address: http://www.eia.doe.gov/cneaf/alternate/page/datatables/atf1-13_00.html

U.S. Energy Information Agency. 2000. State Electricity Profiles. Internet address: http://www.eia.doe.gov/cneaf/electricity/st_profiles/toc.html

U.S. Forest Service. 2001. Chapter 1920, Land and Resource Management Planning, Forest Service Manual, National Headquarters. Internet address: http://www.fs.fed.us/im/directives/fsm/1900/id_1920-2001-1.doc

Washoe-Storey Conservation District. 1998. *Steamboat Creek Restoration Plan* (revised November 11, 1998). Prepared by Jeff Codega Planning/Design Inc. Reno, Nevada.

Quality of the Environment

The quality of life mirrors the quality of the environment. As a technology and knowledge-based society, we are more capable and vigilant than ever about managing and monitoring pollutants released into the air, water, and soil. Nevada state agencies are responsible for the implementation of many laws intended to lessen impacts of activities that diminish environmental quality and impair the health and well being of people and other life forms. Agency programs deal with discharges of pollutants from large and small sources into the air, water, and soil; the prudent allocation and conservative use of limited water supplies; and, the safe use, transportation, and storage of solid and hazardous waste and toxic substances. Some programs are mandatory and prescribe protective standards and practices. Many others are voluntary, and require individual, industry, and community involvement to be successful. State agencies most extensively involved are the Divisions of Environmental Protection (NDEP) and Water Resources (NDWR), and the Department of Agriculture.

The information presented in Part 2 provides an overview of Nevada's environmental quality status and some of the programs implemented to sustain favorable air, water, and soil conditions. Information from state and local agencies indicates environmental values are being maintained in many areas of the state. However, deteriorated environmental quality is evident where land and water resources are intensively developed for urban, agricultural, mining, and military land uses. In the past couple of decades, regulations have resulted in improved pollution controls at large, easily identified pollution sources. Today, major threats to environmental quality come from numerous, dispersed, and smaller scale activities in both urban and rural areas. The expanding population and economy combined with the consumption habits of individuals, industries, and institutions make achievement of environmental standards dependent upon changes in the daily behaviors and choices of everyone. Education is an important strategy for gaining the broad support needed to make environmental progress. Resource agencies can contribute to public education by sharing the results of environmental monitoring data and assessments of program effectiveness. Ultimately, high environmental quality depends upon each citizen, industry, and community learning how to modify our lifestyles, work practices, and recreational activities that negatively impact the air, water, and soil resources.

Air Quality

The quality of air throughout almost all of Nevada is better than government standards set to protect the health and welfare of humans and the environment. The clearest air in the nation is found in rural eastern Nevada, based on monitoring of airborne particulates at Great Basin National Park. However, most of the state's population resides in two urbanized areas that are designated as having moderate to serious air quality impairment, relative to air quality standards. Air quality is determined by measuring concentrations of common pollutants near ground level, where people live and work. If concentrations for a pollutant rise above air quality standards for a specified period of time and number of days, then the airshed can be classified as "nonattainment." In nonattainment areas, State Implementation Plans (SIP) must be prepared by the air quality management agency. The SIPs demonstrate how proposed strategies, technologies, practices, and regulations will reduce pollution, improve air quality sufficiently to achieve standards, and maintain improved conditions.

The State of Nevada has set air quality standards for criteria pollutants that are generally based on the federal standards for air quality. Air quality standards specify the maximum pollutant concentrations over specific averaging periods. The six criteria pollutants for which standards have been set are sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone, particulate matter, and lead. These pollutants are relatively common and capable of causing mild discomfort or seriously affecting the health of people when elevated concentrations persist. Perhaps the greatest success of the Clean Air Act was the nationwide reduction in the level of atmospheric lead brought about by mandatory removal of lead from

gasoline. The Nevada State Environmental Commission also has established an air quality standard for hydrogen sulfide (H_2S), a toxic gas with a disagreeable odor.

Management of air quality in Nevada is handled by both state and county agencies. The Bureaus of Air Quality Planning (BAQP) and Air Pollution Control, within the NDEP, implement air quality programs for the state, with the exception of Clark and Washoe counties. The Washoe County District Health Department and the Clark County Department of Air Quality Management are responsible for the air pollution control programs and air quality monitoring in those jurisdictions.

Air Quality Status

Throughout the 1990s, the BAQ periodically monitored air quality in Carson City, Minden, Gardnerville, Stateline, Zephyr Cove, Fernley, Fallon, Lovelock, Battle Mountain, Elko and McGill. Results indicate that generally good air quality occurs throughout Nevada. The BAQ reports that monitoring data show no deterioration in the air quality of these areas between 1989 and 1999 (Bureau of Air Quality, 2000).

Table 2-1. Annual Number of Days that Air Quality Standards Were Exceeded In Non-Attainment Areas

Year	Carbon Monoxide		Particulate Matter		Ozone	
	Truckee Meadows	Las Vegas Valley	Truckee Meadows	Las Vegas Valley	Truckee Meadows	Las Vegas Valley
1990	6	13	6	3	4	1
1991	3	6	0	1	0	0
1992	0	2	0	0	0	0
1993	0	3	1	0	0	0
1994	0	4	0	0	0	0
1995	0	1	0	16	0	0
1996	0	3	0	17	0	0
1997	0	1	0	13	0	0
1998	0	2	0	6	0	0
1999	0	0	1	6	0	0

Sources: Clark County Department of Air Quality Management, personal communication. State of Nevada, Bureau of Air Quality 1989 – 1999 Trend Report.

Air quality standards have been exceeded in the two most populated air basins – the Truckee Meadows and Las Vegas Valley (Table 2-1). Within the Truckee Meadows non-attainment area are the cities of Reno, Sparks, and the Nevada side of the Lake Tahoe Basin. The Las Vegas Valley nonattainment area includes the cities of Las Vegas, North Las Vegas, Henderson, and Boulder City. Overall, the annual number of days when air quality standards were exceeded declined during the 1990's.

Las Vegas Valley is designated a serious nonattainment area for carbon monoxide and particulate matter. The Truckee Meadows basin is designated as a moderate nonattainment area for carbon monoxide and a serious nonattainment area for particulate matter. Both areas experience elevated ozone concentrations during the summer months. Anticipated standard changes may result in the classification of both areas as nonattainment for ozone. Because Nevada is a highly urbanized state, about 80 percent of the state's population lives within the particulate matter and carbon monoxide nonattainment areas.

Primary human-derived sources of particulate pollution include windblown dust from construction sites, unpaved roads and trails, sand and gravel operations, and off-road recreational vehicles. Secondary sources include motor vehicle emissions, residential wood burning stoves and fireplaces, wildfire and brush/waste burning, tilled and fallowed agricultural fields, toxic chemicals, and industrial sources. Particulate matter also can form when gases emitted from motor vehicles and industry undergoes chemical reactions in the atmosphere.

Carbon monoxide typically is higher during calm periods. A large amount of carbon monoxide comes from motor vehicles and wood burning for home heating. Other sources include lawn mowers, off-road vehicles and construction equipment. Federal rules have required placement of pollution controls on automobiles, thereby lowering emission rates from a portion of the vehicle mix. However, onboard emission controls have not been required on trucks and buses yet.

Air quality improvements from lower auto emissions may not be maintained due to demographic trends. Between 1991 and 1999, the amount of vehicle miles traveled (VMT) in Nevada increased 6.8 billion miles to 17.4 billion miles, a 65 percent increase (Nevada Department of Transportation, 2001). Population increased about 30 percent during the same period. A portion of the increased VMT may be attributable to tourism and suburban sprawl. More residential developments built distant from core urban areas translate into more workers and shoppers driving longer distances. Sprawl works against the local economy of scale to fund mass transit services, a pollution reduction strategy used in other metropolitan areas. An inspection and maintenance program for vehicles in the Reno and Las Vegas area helps to reduce vehicle tailpipe emissions. The use of oxygenated fuels, cleaner alternative fueled vehicles, vapor recovery at gas service stations, and improved on-board emission controls also lower pollutant emissions.

Air Quality Management

State and county air quality management agencies administer permitting programs to control and track emissions of the six criteria pollutants from a wide variety of sources. Emissions of volatile organic compounds (VOCs) are also regulated and tracked because this group of chemicals (e.g., petroleum based solvents) contributes to formation of ozone and some pose serious human and environmental health threats. Major stationary sources and hazardous pollutant emission sources are subject to stringent permits that specify the amount of emissions allowed, minimum pollution control measures, and monitoring and reporting requirements. Source emissions data is collected or estimated periodically and analyzed to check on permit compliance.

The state's BAPC issues permits for Nevada electric generating stations that burn fossil fuels. Although coal remains the primary fuel for electricity generation in Nevada (56 percent), natural gas fueled generation has increased to 20% over the past decade. More geothermal power plants have also been added to the state's generation mix, helping hold down pollutant emission increases. From 1988 to 1998, power plants in Nevada produced fewer tons of sulfur dioxide, declining from 61,000 to 54,000 tons (Table 2-2). However, nitrogen dioxide emissions rose from 69,000 to 76,000 tons. Carbon dioxide, a greenhouse gas associated with accelerated climate change and global warming concerns, also increased modestly.

Table 2-2. Electric Power Industry Emissions Estimates from 1988, 1993, and 1998

Emission Type	1988	1993	1998	Annual Growth Rate 1988-1998 (Percent)
	(Thousand Short Tons)			
Sulfur Dioxide	61	53	54	-1.2
Nitrogen Oxides	69	65	76	1.0
Carbon Dioxide	21,125	20,074	24,167	1.4

Source: U. S. Energy Information Administration. Website: http://www.eia.doe.gov/cneaf/electricity/st_profiles/nevada/nv.html

Air toxics, or hazardous air pollutants (HAPs) are compounds known or suspected to cause serious health effects or environmental effects. Common HAP's include benzene and toluene from gasoline, perchloroethylene from dry cleaning facilities, and methylene chloride from paint stripping compounds. Others are dioxin, asbestos, and metallic compounds (e.g., those with cadmium, mercury, chromium, and lead). HAP's that are persistent, such as mercury, may accumulate in the food chain, reaching higher levels than in the surrounding environment. Most HAP's originate from mobile sources. Forest fires may release large quantities. Stationary sources of air toxics are divided into major and area source categories. Few major sources, which include chemical plants, steel mills, oil refineries, hazardous waste incinerators, and power plants, are located in Nevada. Area sources, such as dry cleaners and gas stations, release smaller amounts, which though small, can be of concern where concentrated. The 1996 National Toxics Inventory data from the EPA show that mobile sources contribute 50 percent of our country's HAP's emissions, major stationary sources 26 percent, and area and other sources 24 percent.

Greenhouse Gases and Climate Change

The atmosphere contains gases that trap re-radiated energy from the sun, warming the earth, similar to a greenhouse trapping heat. "Greenhouse gases" – primarily carbon dioxide, methane, and nitrous oxide –

make up a fraction of one percent of all atmospheric gases. Without them, the earth's surface would be 34° F cooler. Because a small amount of gases exerts such a strong global effect, the continuing rise in greenhouse gas concentrations during the past century has generated intense scientific interest.

Measurements taken directly from the atmosphere since the 1930's confirm that carbon dioxide (CO2), the most plentiful greenhouse gas, has been increasing. Carbon dioxide levels for earlier times are inferred from measurements of CO2 trapped in air bubbles in glacial or polar ice. Concentrations have varied naturally throughout Earth's history, however, the 30% increase observed since pre-industrial times cannot be explained by natural causes. Carbon dioxide concentrations are higher now than in the past 450,000 years (U.S. Environmental Protection Agency, 2002). Table 2-3 shows calculated changes in greenhouse gas emissions in Nevada from 1990 to 1995. Total emissions increased 16.5 percent, corresponding with population and economic growth (Nevada Energy Office, 1998).

Table 2-3. Human Caused Greenhouse Gas Emission Estimates for Nevada, 1990 and 1995

Source	Gas	Carbon Dioxide Equivalent Emissions (tons)		Percent Change 1990 – 1995
		1990	1995	
Fossil Fuel Combustion	CO_2	33,340,968	38,239,348	14.7
Coal	CO_2	16,854,070	16,570,144	-1.7
Petroleum	CO_2	12,613,710	14,971,430	18.7
Natural Gas	CO_2	3,873,187	6,697,775	72.9
Biomass Fuel Combustion	CO_2	167	206	23.2
Production Processes	All	1,203,830	2,055,220	70.7
	CO_2	1,203,830	1,865,531	55.0
	N_2O		189,689	
Natural Gas and Oil Systems	CH_4	144,976	245,563	69.4
Landfills	CH_4	561,351	684,285	21.9
Domesticated Animals	CH_4	819,204	757,460	-7.5
Manure Management	CH_4	82,635	86,940	5.2
Fertilizer Use	N_2O	20,460	38,750	89.4
Forest Management and Land Use Change	CO_2	-183,797	-183,758	0.0
Agricultural Burning	All	326	269	-17.3
	CH_4	202	176	-12.5
	N_2O	124	93	-25.2
Wastewater Treatment	CH_4	20,727	26,166	26.2
Total (less Biomass)	All	**36.010,680**	**41,950243**	**16.5**
Carbon Dioxide	CO_2	34,361,001	39,921,121	16.2
Methane	CH_4	1,629,095	1,800,590	10.5
Nitrous Oxide	N_2O	20,584	228,532	1,010.2

Source: Greenhouse Gas Emission Inventory for Nevada, Nevada Energy Office and Desert Research Institute, 1998.
Notes: Carbon Dioxide Equivalent relates the warming potential of a molecule of carbon dioxide to a molecule of another greenhouse gas. For CH_4 the multiplier is 21, and for N_2O it is 310.

Climate scientists predict that average temperatures for the U.S. will warm 7°F by 2090. This change appears small compared to short-term weather. For global climate, such a warming would be larger and faster than any changes in the past 10,000 years. The global average temperature this past century has warmed 1° F. Computer climate models that evaluate the potential effect of expected warming on western water resources give insight into potential effects in the Sierra Nevada and Great Basin ranges. Possible impacts include: less snowfall and more rain; a shorter snowfall season; and accelerated snow pack runoff. Flashier, earlier, and greater spring runoff would lower supply availability during the growing season. Higher evaporation would reduce water storage in reservoirs, aquifer recharge, and soil moisture. Longer dry seasons would present new challenges to managers of Nevada's water supplies and aquatic ecosystems (Frederick and Gleick, 1999).

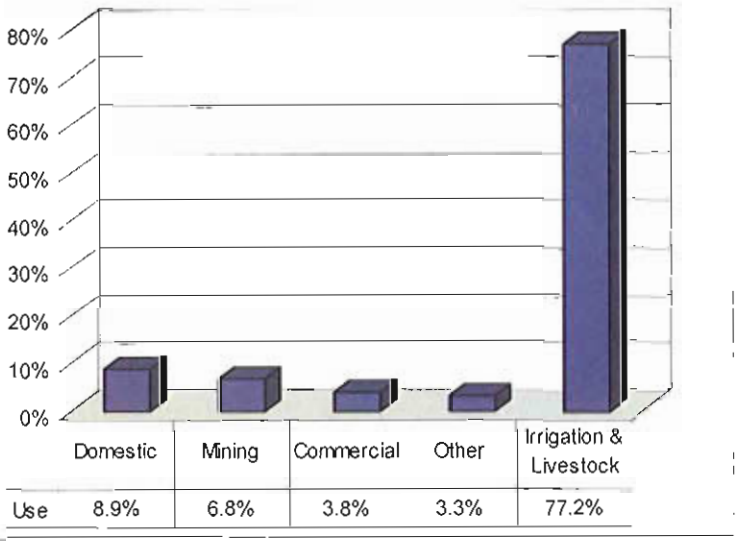
Water Resources and Supply

Water is Nevada's most precious resource and more than any other will determine Nevada's future. Wise management of water resources and protection of water quality is vital to the state's economic future and quality of life. Finding ways to stretch water supplies for new beneficial uses while maintaining existing beneficial uses is perhaps the biggest challenge confronting Nevada. The Nevada State Engineer, in the

Nevada Division of Water Resources (NDWR), administers state water law. The mission of NDWR is to conserve, protect, manage, and enhance Nevada's water resources through the appropriation and reallocation of the public waters. All surface and underground waters within the state belong to the public (Nevada Revised Statute 533.025).

Surface waters are limited and essentially fully committed. Ground water resources are approaching full commitment in the state's southern and western regions. In the fast growing counties, obtaining water to meet additional municipal or industrial uses requires the developer to purchase and obtain a permit to transfer water rights from agricultural uses. About three-fourths of the water withdrawn from surface and groundwater is used for agriculture (Figure 2-1). Negative consequences may result from agricultural water rights transfers. For example, browning of fallowed farmland and irrigated greenbelt areas (e.g., pasture, artificial meadows and riparian zones) can lead to nuisance weed cover, erosion of barren soil, and lost wildlife habitat.

Figure 2-1. Total State Water Withdrawals by Type of Use



Source: Nevada State Water Plan, 1999.

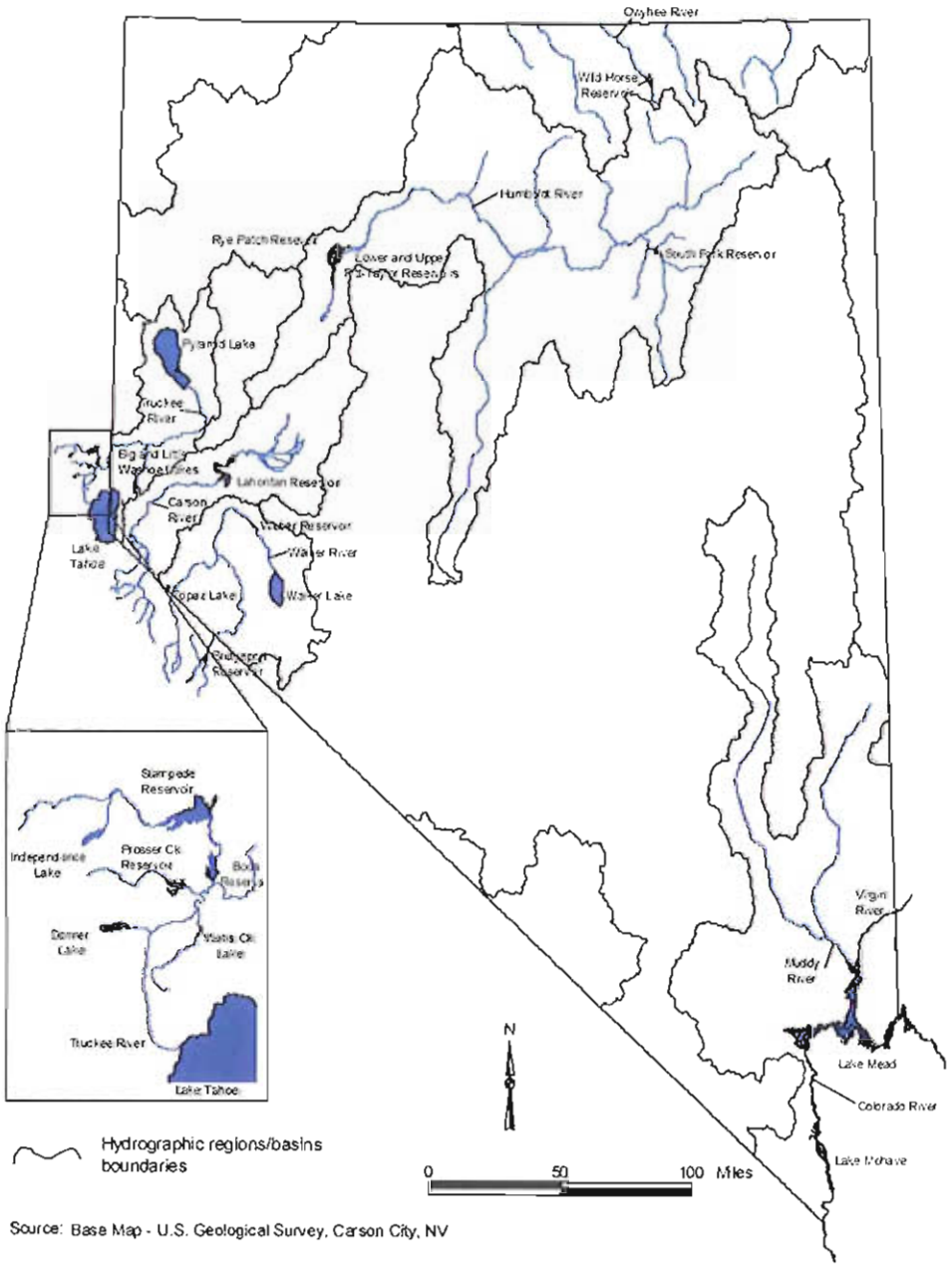
Awareness is growing that active management of water resources can improve supplies and quality, as indicated by an apparent increase in the number of stream channel, wetland, watershed, and groundwater recharge projects. Conservation also can extend limited water supplies, although a comprehensive state strategy has not been developed. However, municipal and industrial suppliers in Las Vegas Valley and Truckee Meadows are making progress, as are the Truckee-Carson and Pershing County irrigation districts. Only municipal suppliers are required to adopt a conservation plan. However, without periodic reporting, the status of conservation plans and achievements cannot be estimated.

Surface Water

Nevada's major rivers are shown in Figure 2-2. Surface water is the source of 60 percent of the total water supply used, and 72 percent of the residential, commercial, industrial and public use. The Truckee River and Colorado River provide drinking water for approximately 85 percent of all Nevada residents (i.e., Washoe and Clark county urban areas). Streamflow primarily comes from annual snowfall and melt, though groundwater flow may also augment flow in rivers and creeks where underground water bodies (aquifers) are connected to channels.

Annual and seasonal variation in surface water flow can be large. Maximum stream flow often occurs in May or June (peak snowmelt). With one exception, most of the flow in Nevada's major rivers originates in other states. Headwaters of the Carson, Truckee, and Walker rivers lie in California, and the Colorado River carries water from several Rocky Mountain States. The exception is the Humboldt River, which begins and ends in Nevada. Flow in the major rivers and streams follow a typical pattern. River channels gain most of the flow in the mountains, and then lose it as the channel traverses drier valleys. Stream flow losses come by evaporation, vegetative transpiration, percolation, and diversions for beneficial uses.

Figure 2-2. Major Streams in Nevada



Source: Base Map - U.S. Geological Survey, Carson City, NV

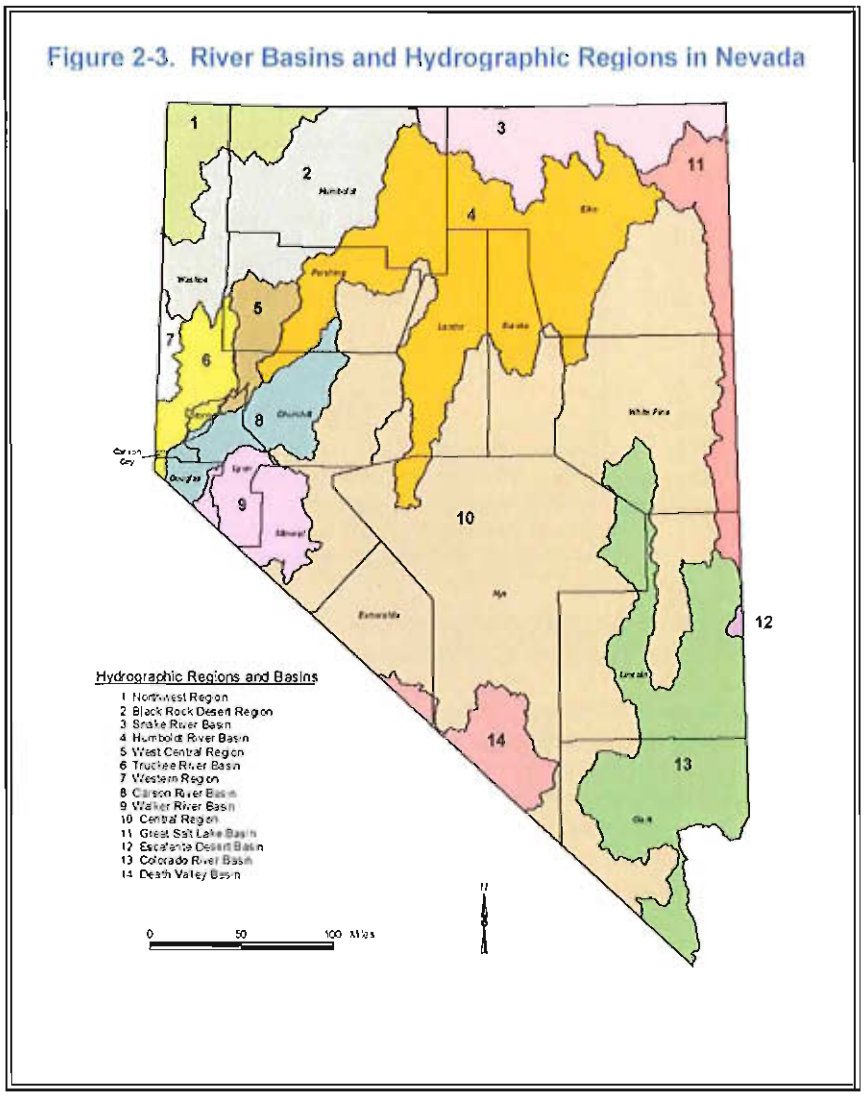
Water diverted for off-stream uses and not consumed by crops, people, or industry, and subsequently delivered back to the stream of origin is called return flow. Return flow is a vital component in the water use cycle, because the practice provides some assurance that water will be available for use in lower reaches.

The estimated average annual yield from rivers and streams in Nevada is approximately 3.2 million acre-feet per year. For 1995, the estimated surface water withdrawals totaled 2.4 million acre-feet (Nevada Division of Water Planning, 1999a). About 1.9 million acre-feet originate in Nevada watersheds, and about 1.3 million acre-feet flows in from and 0.7 million acre-feet flows out to adjoining states. Surface waters have been fully appropriated for many years, though in wet years surplus water may be available. Streamflow reaching terminal basins can replenish lakes and wetlands that support a variety of habitat types, fishes, and wildlife; recharge groundwater; improve water quality; and provide outdoor recreation opportunities. Most priority rights for surface water in Nevada were established in the 1800's. Rights to use water for irrigation date back to the 1850's in streams draining the Sierra Nevada Range and to the 1870's and 1880's in the Humboldt River Basin. Additional dams and reservoirs would be needed to impound the water to detain surplus flows for later use.

Major Rivers, Lakes, and Reservoirs

Nevada contains 14 river basins and hydrographic regions (Figure 2-3). Five contain major rivers. Except for the Colorado River, Nevada's perennial rivers are comparatively small. Only the streams in the Snake River Basin (e.g., Owyhee, Bruneau, Goose, and Jarbidge) and Colorado River Basin flow to the ocean. All other streams discharge into alluvial fans along the mountains or into terminal sinks, which may contain lakes, playas, or wetlands. The major river systems in Nevada are the Colorado, Walker, Carson, Truckee, and Humboldt. Major lakes and reservoirs are listed in Table 2-4.

Figure 2-3. River Basins and Hydrographic Regions in Nevada



The **Carson River** flows in two main forks from the eastern slopes of the Sierra Nevada Range in California, into Carson Valley where the forks join. The main stem flows through other populated valleys – Eagle (Carson City), Dayton, and

Lahontan before the 184-mile long river empties into the Carson Sink (California Department of Water Resources, 1991a). Several small, regulated lakes and storage reservoirs located high in the basin help prolong the irrigation season. Waters of the Carson River are used primarily for agriculture. Important fisheries, wildlife, and water based recreation uses occur also, most prominently in the upper river reaches. Municipal and industrial users are supplied by groundwater. Lahontan Reservoir, located in the lower river, stores water for use in the state's agricultural oasis and large wetland complexes in the Lahontan Valley. In lower river reaches, water sinks into the ground, leaving dry reaches, as happens in many streams in Nevada. These wetlands, which are part of the Western Hemispheric Shorebird Reserve Network, provide vital feeding, breeding, and resting habitat for hundreds of thousand of migratory and resident birds.

Table 2-4. Major Reservoirs and Lakes of Nevada and Eastern California

Hydrographic Region	Lake/Reservoir	Surface Area	Active Storage Capacity	Total Storage Capacity
		acres	acre-feet	
Carson River	Lahontan Reservoir	14,600	317,000	317,000
Colorado River	Lake Mead**	158,000	26,200,000	29,700,000
	Lake Mohave**	28,000	1,810,000	1,820,000
Humboldt River	Pitt-Taylor Reservoir, Lower	2,570	22,200	22,200
	Pitt-Taylor Reservoir, Upper	2,070	24,200	24,200
	Rye Patch Reservoir	11,400	171,000	171,000
	South Fork Reservoir	1,650	40,000	40,000
Snake River	Wild Horse Reservoir	2,830	73,500	73,500
Truckee River	Big and Little Washoe Lakes	5,800	14,000	38,000
	Boca Reservoir**	980	40,870	41,110
	Donner Lake**	800	9,500	no report
	Independence Lake**	700	17,500	no report
	Lake Tahoe**	124,000	744,600	125,000,000
	Martis Creek Lake**	770	20,400	21,200
	Prosser Creek Reservoir**	750	28,640	29,840
	Pyramid Lake*	111,400	NA	21,760,000
	Stampede Reservoir**	3,440	221,860	226,000
Walker River	Bridgeport Reservoir**	2,914	40,500	40,500
	Topaz Lake**	2,410	61,000	126,000
	Walker Lake*	33,500	NA	2,153,000
	Weber Reservoir	950	13,000	13,000

Source: Nevada Division of Water Planning, 1999.
Note: *Pyramid and Walker Lakes are natural terminal lakes with no outlet. **Located entirely or partially in California. Active storage capacity means the amount of water that can be released from the lake or reservoir. Total storage capacity is the total amount of water held in the lake or reservoir. All data as of 9/30/96.

The **Colorado River** is the largest river in Nevada, receiving water from many western states, including Wyoming, Colorado, Utah, New Mexico, Arizona, California, as well as Nevada. Along its 1,400-mile course to the Gulf of California, the Colorado River Basin drains an area of about 240,000 square miles – about one-twelfth the area of the contiguous United States. The Colorado River and tributaries in Nevada (i.e., Muddy, Virgin, and White rivers) provide a majority of the drinking water supply to the Las Vegas area, hydroelectric power and recreation opportunities at Lake Mead and Lake Mohave, and water for agriculture. Nevada receives a 300,000 acre-feet annual allotment of the river's water under the Colorado River Compact, the smallest portion among the seven states and Mexico. Fortunately, Las Vegas is located close to Lake Mead so southern Nevada water utilities can economically pump from the Colorado River system to meet municipal and industrial needs. Nevada is allowed a "return-flow" credit for all water returned to Lake Mead. Water treated and returned to Lake Mead is accounted for and Nevada has "earned" as much as an additional 151,000 acre-feet annually in return-flow credits.

The **Humboldt River** is the longest river entirely within Nevada. The Humboldt River originates in the Ruby, East Humboldt, Independence, and Jarbidge Mountains and flows 310 miles westward to terminate in the Humboldt Sink. Higher elevation watersheds north and south of the main stem feed seven tributaries that help sustain flow. A majority of the Humboldt River system water is used for agriculture. There are only a few flow-regulating reservoirs in the basin, the largest (Rye Patch Reservoir) being near the end of the system. Extensive reaches of the lower half of the river lose water to the ground and also evaporation. As a result, late season irrigation water shortages are commonplace throughout much of the area above Rye Patch Reservoir.

The **Truckee River** begins at a modestly sized dam located at the northern end of Lake Tahoe, in California. It flows down a narrow, winding canyon until the channel enters the Truckee Meadows where the cities of Reno and Sparks are located. The 145 mile long river terminates at Pyramid Lake (California Department of Water Resources, 1991(b)). Pyramid is one of only two sizable lakes surviving the desiccation of ancient Lake Lahontan. With numerous upstream reservoirs, mostly in California, the Truckee River is the most regulated river system in Nevada (Figure 7). Along its course, water is diverted to meet the needs of municipal and industrial, agricultural, and hydropower users. In response to greater use and dependency on Truckee River water, a new river operating agreement is being prepared. The Truckee River Operating Agreement is intended to provide modified operational criteria of reservoirs to conserve the endangered and threatened fishes of Pyramid Lake (i.e., cui-ui and Lahontan cutthroat trout) and to provide for future municipal and industrial water demands during droughts (U.S. Bureau of Reclamation, 1998). A portion of the Truckee River flow is diverted at Derby Dam and then conveyed via canal to Lahontan Reservoir in the Carson River Basin. Reservoir water is distributed to irrigate 50,000 to 60,000 acres in the Newlands Reclamation Project and large wetlands in Lahontan Valley.

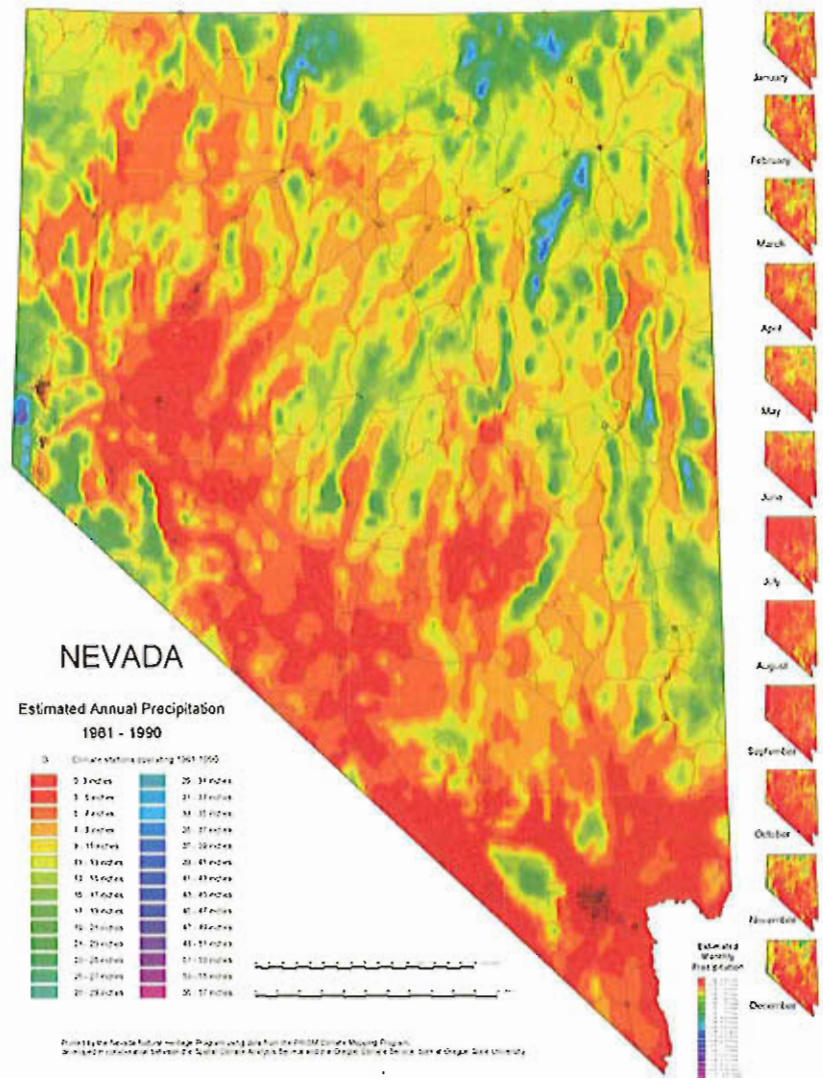
Like the Carson and Truckee, the **Walker River** rises in California. The river flows into Nevada through large irrigated valleys, the most prominent being Bridgeport and Antelope in California, and Smith and Mason in Nevada. The terminus is Walker Lake. Walker Lake is the only other surviving descendant of ancient Lake Lahontan, which covered 8,000 square miles in northern Nevada when mountain glaciers were melting and the climate was wetter several thousand years ago (California Department of Water Resources, 1992). Most of the Walker River streamflow originates in California and is used almost exclusively for a variety of agricultural uses in Nevada and California. The two largest reservoirs on the system are Topaz Lake, straddling the Nevada/California border, and Bridgeport Reservoir in California. Both are owned and operated by the Walker River Irrigation District to supply irrigation water to district members. Small lakes and reservoirs in the Sierra Nevada Range and nearby valleys help sustain stream flow into the autumn months during all but the driest years.

Climate

Climate factors that influence water resources the most are annual precipitation and evaporation. Statewide, total precipitation averages approximately nine inches per year, making Nevada the most arid state. Although the climate is generally characterized as semi-arid to arid, actually precipitation, evaporation, and other climate factors vary greatly. Figure 2-4 shows the large regional variation in average annual precipitation. Annual average precipitation ranges from three inches in the Mojave Desert region of southern Nevada to more than 40 inches (over 300 inches of snowfall) on Mount Rose in the Carson Range, near Lake Tahoe. Both elevation and latitudinal differences are causes for these extremes. Year to year and month to month, the amount of precipitation can fluctuate greatly. This variability creates uncertainty for irrigators, water suppliers, fish and wildlife managers, and stream flow forecasters. Factors contributing to unpredictable snow and rainfall patterns are seasonal variability in the approach of moisture-bearing storm fronts from the Pacific Ocean, and the rain shadow effect created by the Sierra Nevada Range along the state's western border as well as dozens of other high elevation mountain ranges.

Of the total annual precipitation falling in Nevada, on average less than 10 percent produces stream runoff or percolates downward to recharge aquifers. Nevada is desert-like, because on average, 90 percent of the moisture is returned to the atmosphere by evaporation and plant transpiration. Similar to the state's precipitation pattern, the rate of evaporation varies tremendously in time and space. Key

Figure 2-4. Average Annual Precipitation Patterns in Nevada



Source: This poster was compiled from estimated annual precipitation values calculated by the PRISM Climate Mapping Program at Oregon State University. The small side maps show estimated precipitation in each month. Also shown are the locations of climate stations that were likely used in the estimation calculations. Precipitation values are interpolated from estimates made on a 1 km grid.

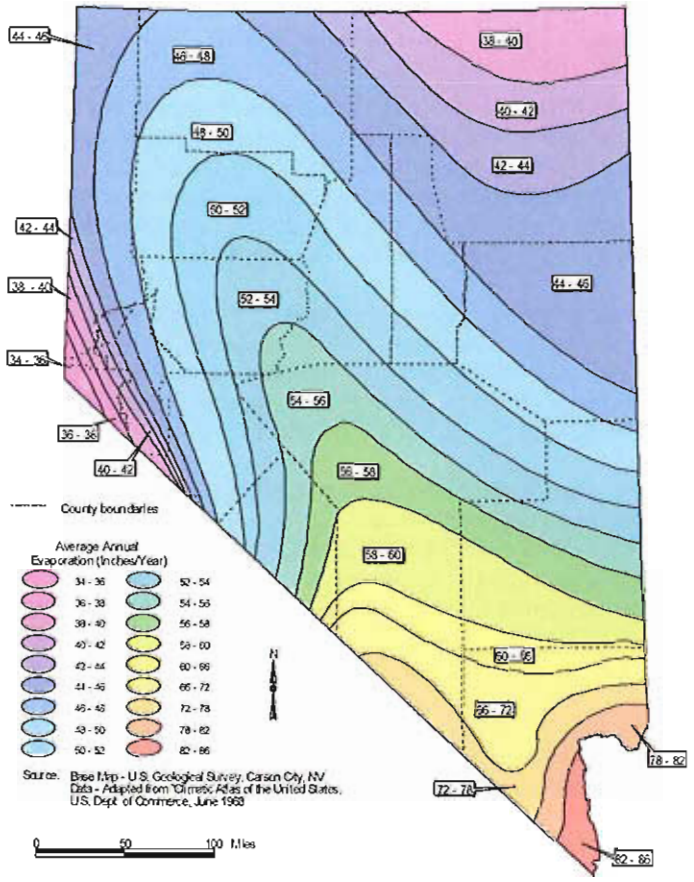
factors are elevation, latitude, and the type and density of vegetative cover. Average lake surface evaporation rates range from less than 36 inches per year in the west to over 80 inches per year in the south (Figure 2-5). Droughts and floods are relatively common in our highly variable climate. Years of average stream flow occur rarely. Alternating periods of high and low flows are the norm in Nevada. Many water users cope with low stream flow in summer and autumn with supplemental sources, such as reservoirs and groundwater.

For most water users that rely principally upon surface water, problems can begin when below average flows are experienced for two or more consecutive years. Dry soil and hot weather conditions during a drought lead to higher watering requirements, especially on farmland, parks and golf courses, and urban landscaping. Increasing withdrawals from reservoirs and wells can result in depletion of the supplemental water sources. In water basins where surface and groundwater resources are fully committed, extended recovery periods for depleted supplemental sources may raise uncertainty in the short and long term water supply picture for some (junior) water rights holders as well as aquatic ecosystems.

Periods of drought (i.e., consecutive years with stream flow less than 80 percent of the annual average) are frequent in Nevada. In many cases, Nevada's river systems experience more "below average water years" than "above average water years". Five serious drought periods occurred during the Twentieth Century. The periods were 1928-37, 1953-55, 1959-62, 1976-77 and 1987-94. The 1928-37 period possibly was the most severe and longest in northern Nevada. The most recent drought was severe

enough to effectively remind public water suppliers and agricultural operators of the limited nature of Nevada's water, as well as the environmental impacts of dry lakebeds and streams to fisheries, wildlife habitat, and air quality. Droughts can also create or aggravate water quality problems for both surface water and groundwater sources. Over time, lower flow and less groundwater recharge tends to diminish quality of the remaining water.

Figure 2-5. Average Annual Evaporation Patterns in Nevada



Source: Base Map by U.S. Geological Survey, Carson City, Nevada. Data from "Climate Atlas of the United States, U.S. Department of Commerce, June 1968.

Even though the average annual precipitation is only nine inches, floods are common and have occurred in all parts of the state. The intensity and damaging effects of floods in urban communities have increased steadily with population and development since the mid-1900s. Land development has encroached onto riverine and alluvial fan floodplains, decreasing floodwater storage capacity and increasing flood damage risk.

The most severe floods occur on the Truckee, Carson, Humboldt, and Walker rivers when warm winter rain falls on snow in the higher mountain ranges. Flash flooding from intense rainfall over relatively small areas is common in the larger, more sparsely vegetated watersheds of southern Nevada and on alluvial fans of smaller drainages throughout the state. Flooding from summer storms is typically sudden, and often life threatening. Rain-on-snow flooding along the major rivers usually takes many hours or days to develop, so time to prepare for flooding is available. However, peak flows and inundation extends over a longer period of time. In the Clark and Washoe county metropolitan areas where recent floods have seriously damaged lives and property, local government have developed regional flood control plans and programs and are actively working on controls to additional runoff generated by new development.

Interest is growing in retention and restoration of natural floodplain features and functions. An example is the development of the Truckee River Flood Management Plan, which started shortly after the devastating 1997 New Year's Day flood. In 1999, the Washoe County Board of Commissioners, with support of the cities of Reno and Sparks, the State Legislature, and local organizations, approved a 1/8-cent sales tax to be used for public safety and flood management in the Truckee Meadows region. The

Community Coalition for Truckee River Flood Management was formed to coordinates with the U.S. Army Corps of Engineers. The Coalition includes about 25 local stakeholder organizations, 15 agencies, and interested individuals. In addition to flood protection, this plan addresses restoration and preservation of the River's natural habitat, scenic beauty, recreational amenities, and other environmental resources. Flood management concepts will be based on the natural processes and characteristics of the river.

Groundwater

Careful management of groundwater, the state's long term water supply source, is vital to economic and ecological sustainability. Hydrologists estimate that three to seven percent of the average annual precipitation recharges groundwater systems. Surface water resources are essentially fully appropriated, so new development projects often tap into groundwater sources or seek to transfer existing surface or groundwater rights. Groundwater provides about 40 percent of the total water supply used in Nevada. Groundwater is the sole supply source in some regions.

Twenty-eight percent of the state's municipal and industrial water needs are met with groundwater (Nevada Division of Water Planning, 1999). However, the amount of groundwater used can vary considerably each year. More new groundwater wells are being constructed to supplement surface water sources. During periods of low streamflow, groundwater use increases, and conversely, decreases during high flow periods.

Proper planning and management of groundwater resources grows in importance as more communities and industries come to depend on this finite resource. Because the state's population and economy is projected to continue to rapidly grow, greater scientific understanding of groundwater conditions will be essential. Particularly, greater knowledge is needed in aquifer location, refined perennial yield, recharge, storage volume, committed resources (water righted amounts), actual water use, water levels, water quality, and projected trends.

Forty years ago, the Nevada Division of Water Resources (NDWR) and the U.S. Geological Survey (USGS) recognized the need for a systematic identification of the states "hydrographic areas". A cooperative groundwater program was initiated to study, research, develop, manage, and administer groundwater and surface water systems. A product is the 1968 hydrographic unit map, the first systematic delineation of all hydrographic regions and areas. With minor revisions, the 1968 map continues as the basis for water planning, management, and administration. The current map delineates 14 hydrographic regions subdivided into 256 hydrographic areas (HA's) (Figure 2-6). Another result of the cooperative program was reconnaissance level estimations of perennial yield for each HA.

Perennial yield is the estimated volume (acre feet) of usable water in a groundwater basin or aquifer that can be economically withdrawn and consumed each year for an indefinite period without depleting (mining) the source. The State Engineer uses perennial yield estimates as the baseline to compare total committed groundwater allocations to water available in the system, or uncommitted resources (Figure 2-6). Technically, the calculation method subtracts the amount of water evaporated and transpired (i.e., water vapor from plants) from the amount that may be appropriated. Basins include one or more aquifers, or water-filled cracks, joints, and pores in consolidated volcanic, granitic, or sedimentary rock formations or thick, unconsolidated valley sediment deposits formed by upland erosion. Some aquifers in Nevada contain water recharged thousands of years ago under much wetter climate conditions. Recharge rates under current conditions are much lower. If over-pumped, groundwater levels may be irreparably lowered.

According to the cooperative studies performed by the State Engineer and the USGS, the statewide perennial yield totals about 2.1 million acre-feet per year (Nevada Division of Water Planning, 2001a). "Committed resource" refers to the total volume of groundwater rights that the State Engineer officially recognizes and that usually can be withdrawn from a basin each year (Figure 2-7). In 1995, groundwater withdrawals total approximately 1.6 million acre-feet statewide. Of the quantity of groundwater pumped, about 0.7 million acre-feet used consumptively.

Figure 2-6. Estimated Uncommitted Groundwater Resources for Hydrographic Units (acre feet per year)

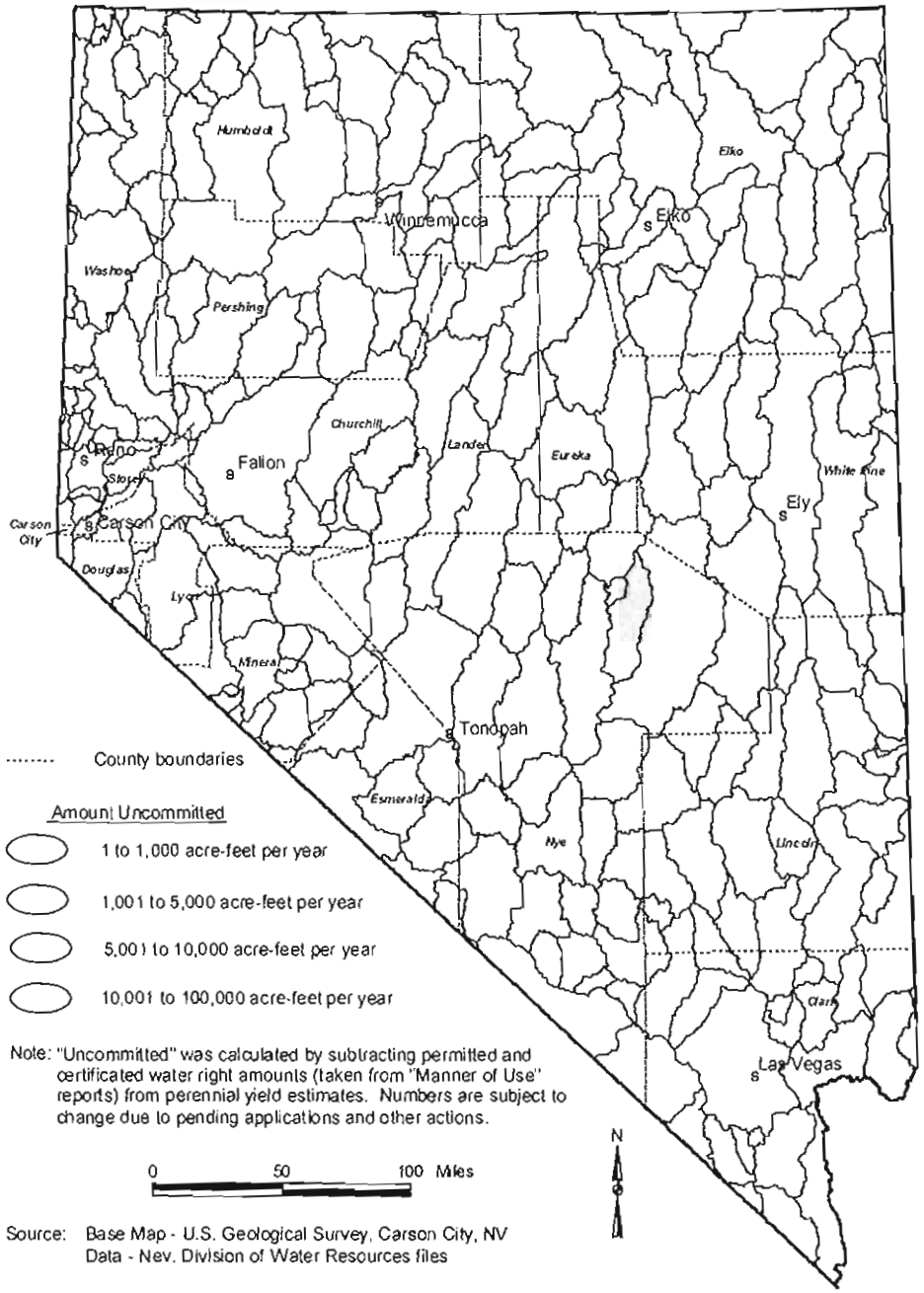


Figure 2-7. Estimated Committed Water Resources for River Basins and Hydrographic Regions (acre feet per year)

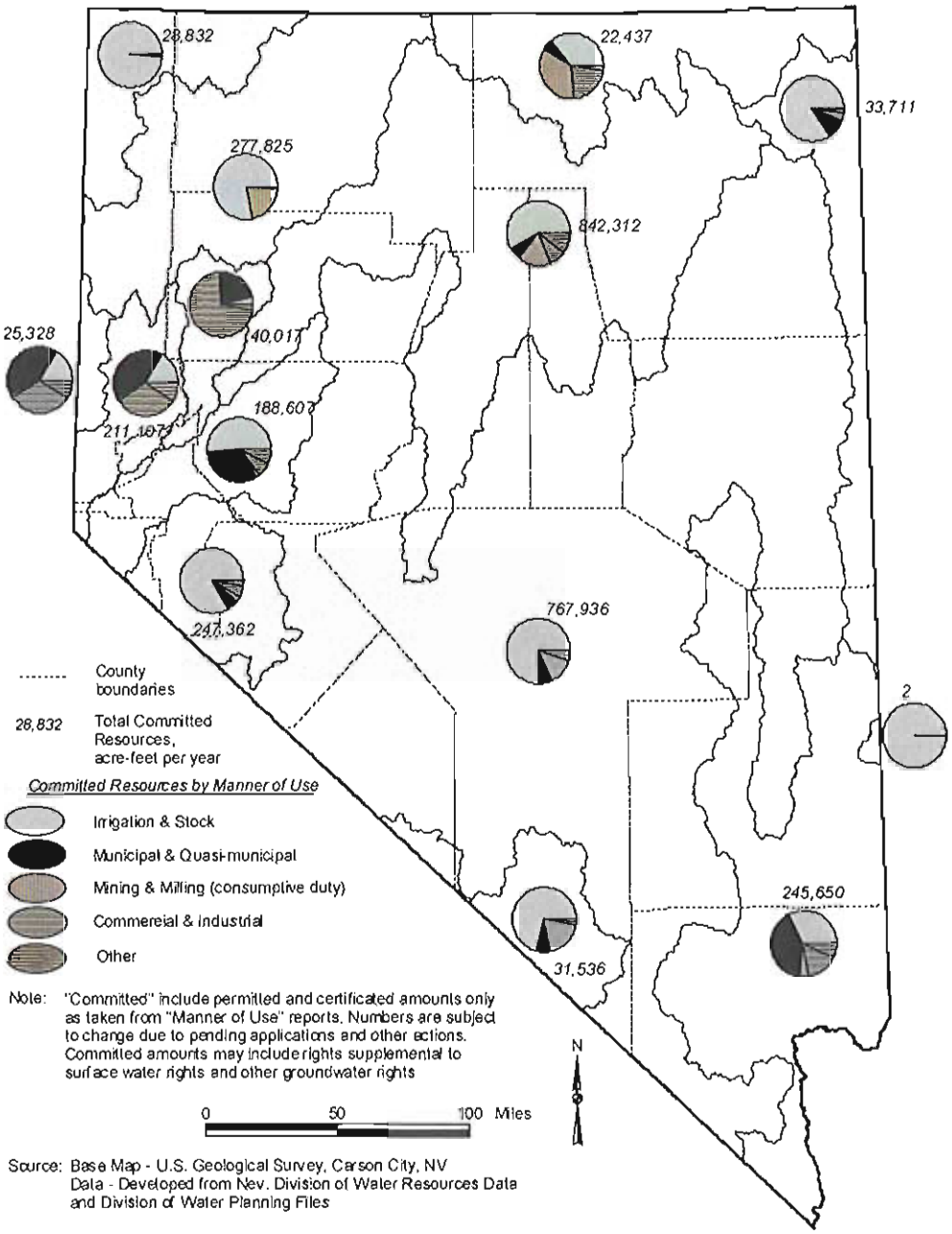
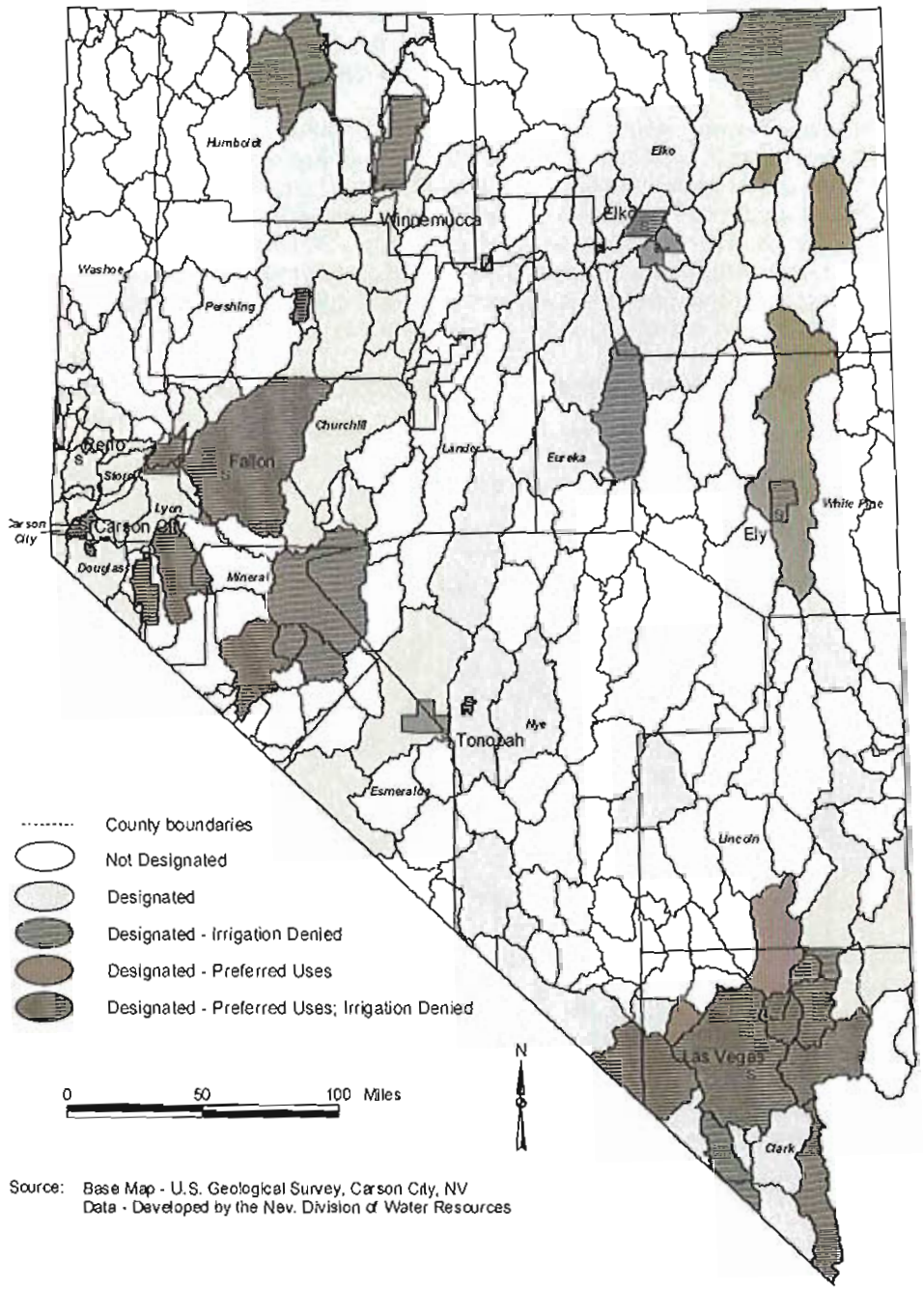


Figure 2-8. Non-Designated and Status of Designated Hydrographic Units in Nevada



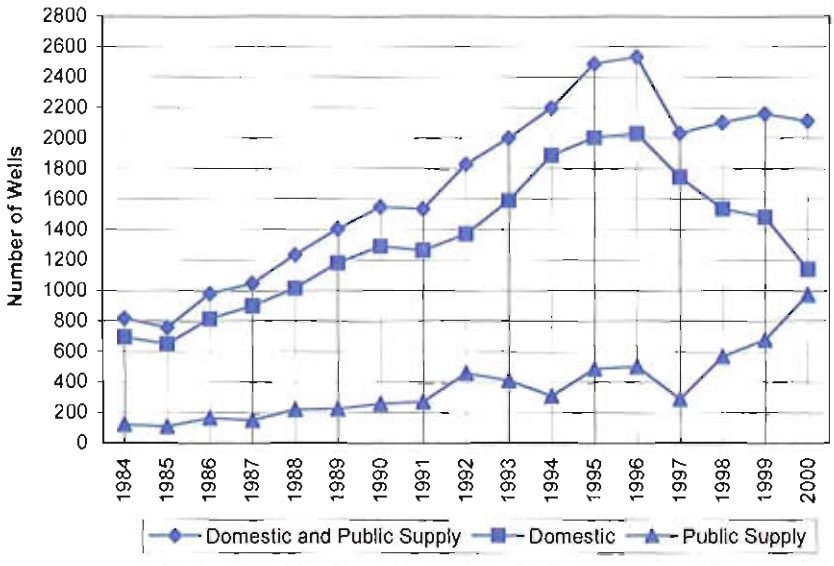
Source: Base Map - U.S. Geological Survey, Carson City, NV
Data - Developed by the Nev. Division of Water Resources

When making determinations on groundwater right applications, the State Engineer considers the individual and regional perennial yield estimates, system yield estimates, and committed resources, among other factors. Committed volumes of water remain lower than perennial yield in about 60 percent of the 256 basins. The state's un-appropriated groundwater supplies are located in these basins. The State Engineer has increased administrative efforts in many of the groundwater basins where demand for groundwater supplies has grown. The State Engineer has authority to "designate" a groundwater basin that is being depleted or requires additional administration to make sure important local uses of the aquifer(s) can be sustained. By issuing an order of designation, the State Engineer is granted additional authority to make special administrative decisions regarding groundwater resources.

For example, the State Engineer may issue orders that define preferred uses, deny certain water uses, or curtail pumpage. Preferred uses may include domestic, municipal, quasi-municipal, industrial, irrigation, mining and stock-watering uses or any other beneficial use. Each basin is managed as a separate unit. The State Engineer issues orders and rulings, as needed for the management of the groundwater resources. Figure 2-8 displays the "designated basin" status for the 256 hydrographic units. This map is a useful tool to generally determine where the greatest impediments to groundwater development may exist. However, the associated State Engineer's orders and rulings need to be examined for a complete understanding of the management issues and water availability within a basin.

The number of new well logs filed each year gives some indication of the intensity of groundwater development. Figure 2-9 shows the trend in the number of new domestic and supply wells drilled each year since 1984. In 1984, 817 wells were drilled. Since the peak year (1996) when 2,527 wells were drilled, activity has leveled off, ranging between 2,028 and 2,155 each year. Wells drilled for other purposes, such as geothermal production, monitoring, and mineral or future water supply exploration, are not included. The increased well construction activity for domestic and public supply is greatest in areas experiencing rapid growth (i.e., northcentral, northwestern, and the southern regions).

Figure 2-9. Number of Domestic and Public Supply Wells Drilled in Nevada, 1984 to 2000

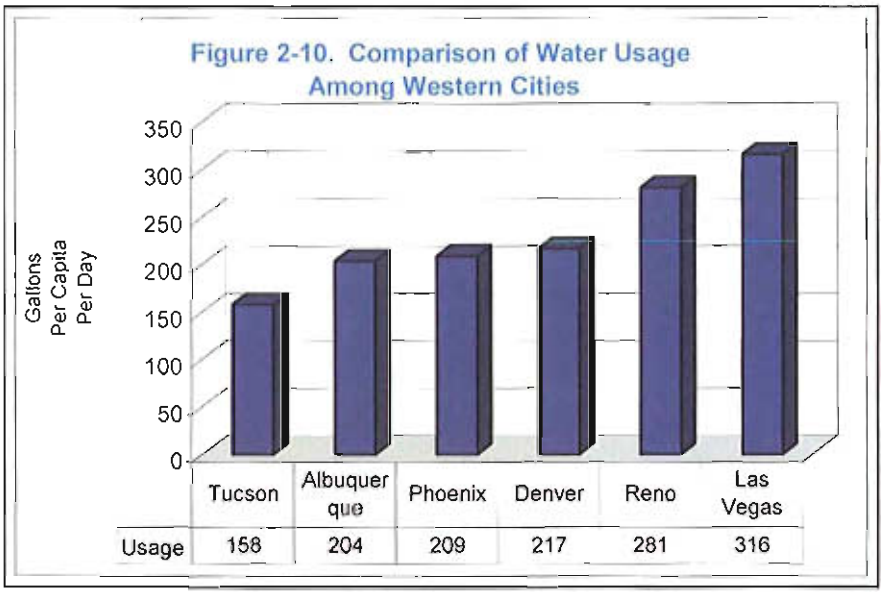


Source: Nevada Division of Water Resources, Well Log Database, 2001.

Water Supply for Future Needs

Meeting our future water needs will require implementation of a combination of strategies. Two basic strategic approaches are demand management and supply development. Through demand management, water purveyors make wiser use of the available water thereby lessening the need for new source development. Supply development strategies include a variety of methods for increasing supplies and improving supply reliability. Increasing demands and competition for our limited resources oblige water managers and suppliers to implement both demand management and supply development

strategies. However, each option needs to be evaluated on a case-by-case basis for suitability, cost effectiveness, and public acceptance.



The time is past when water supply needs can be met simply by developing more water withdrawal, storage, and delivery systems. Demand management must also be part of any long-range water supply plan. By reducing demand, new supply developments can be delayed with potential savings to the users. Demand can be managed through conservation measures and alternate strategies such as effluent reuse, grey water use and dual water systems. Figure 2-10 compares the average amount of water used per person per day in cities in Nevada and other western states. Though urban water utilities and local governments encourage conservation through tiered pricing, limited landscape watering days, and low-volume appliances, the data suggest that there is room to improve upon conservation and other demand management strategies. However, a direct comparison of average water use between cities must consider different climate and water supply circumstances. For example, other cities receive summer rains or use other water sources for lawn watering, thereby reducing public supply system water use.

Even as more effective demand-side strategies evolve, water supply development strategies also need to include methods for increasing supplies and improving reliability. The supply-side strategies described below may not be appropriate in all situations and must be examined on a case-by-case basis.

- Use of existing committed and uncommitted supplies refers to water suppliers that further utilize supplies under their existing water rights and/or obtain new appropriations for unallocated water.
- Water transfers involving a water rights purchase or lease from one user for use by another.
- Groundwater recharge and recovery or artificial aquifer recharge, is a water resource management option available to some areas as a means of securing more reliable water supplies during periods of low surface water flows. This strategy involves ponding or injecting surface water when abundant, to enhance aquifer recharge for later use. State water law provides criteria for establishing groundwater recharge/recovery programs. Currently, the State Engineer's office has sixteen (16) recharge applications and permits on file, with a total potential recharge of 93,709 acre-feet per year.
- Conjunctive use, in which different supply sources (e.g., surface and groundwater) are used in combination or in alternating periods, depending upon the relative abundance of each. When surface water supplies are abundant, excess is stored in aquifers, and groundwater use curtailed, optimizing natural recharge. Conversely, when surface supplies are low, stored surface water and recharged groundwater can be used to make up for limited surface water supplies.
- Desalination requires the use of a processing plant to remove dissolved minerals (including but not limited to salt) from seawater, saline water, or treated wastewater.
- Cloud seeding is a weather modification technique involving the injection of silver iodide or other compound into clouds to increase precipitation. The estimated additional amount of water obtained each year has varied from 35,000 to 60,000 acre-feet during the 1990's.
- Reclamation or restoration of deteriorated watershed conditions to reduce surface runoff and enhance groundwater recharge conditions, and by land use planning considerate of the relationship between water resources and development patterns.

Efforts to raise Pyramid Lake water level exemplify the types of water management strategies that are essential in our desert region. Since 1981, the lake level has risen about 30 feet, recovering a portion of the 80-foot decline that occurred in the first half of the 1900's. Though most of the recent increase came during wet winters in the Truckee River watershed, modified supply strategies and use practices have helped to deliver more water to the lake and stop further lake declines during drought years. Measures include: conjunctive use of the Carson and Truckee River to meet agricultural water supply requirements in Lahontan Valley; identification and curtailment of non-essential uses; conservation measures implemented by farmers in the Truckee Carson Irrigation District and residents and businesses in Reno and Sparks; and, the transfer of water rights to maintain higher river water quality during droughts.

In southern Nevada, innovative management strategies are being used to secure water from the Colorado River for the growing population and economy in Clark County. Water suppliers and government agencies have worked out agreements that permit Nevada to store a portion of the state's share of Colorado River water in Arizona aquifers. Southern Nevada water suppliers will be able to draw a proportionate amount of water from the river and Arizona will have access to the groundwater for future use. Growing water demand and diversification of water uses is occurring in numerous other water basins (e.g., Carson Valley and Walker Lake). Each presents unique opportunities to develop creative supply and demand strategies that add value to the water resources for all Nevadans.

Small mountain reservoirs, such as Hobart Reservoir in the Carson Range of western Nevada, can provide important benefits. For example, Hobart is located at a higher elevation and situated in a sheltered valley, a situation that reduces evaporative losses during the summer. By detaining a portion of the year's snowmelt, the reservoir yields drinking water supply, sustains late summer stream flow, adds to the diversity of plant and animal communities, provides fishing opportunity, and enhances scenic value.

Water for Instream Use

Balancing "off stream" uses of water with "instream" uses always will present challenges in this arid region. When the state legislature officially adopted the prior appropriation doctrine, a diversion was a key to claiming a water right. Since then Nevada Supreme Court has determined that state water law gives the State Engineer discretion to grant a water right for instream flow or to maintain a minimum pool in lakes and reservoirs. Though a portion of the water diverted gets returned, water conditions gradually become less hospitable to native plants and animal species further downstream due to annual and seasonal depletion of surface waters and deterioration of water quality. Many native fish species no longer inhabit state waters, and more are classified threatened or endangered. Relatively few water rights, however, have been acquired for instream uses. Ironically, urban population growth and economic growth appears to correspond with heightened public interest in improving instream water supplies. Improvements in water quality, water-based recreation, aquatic habitats, and scenic quality are some of the benefits various interests seek to gain or protect on behalf of the public.

In recent years, agencies, conservation organizations, and some local governments have shown interest in acquiring water rights from willing sellers to retain more water in streams, reservoirs, and wetlands for environmental, biological, and recreational purposes. Often, the opportunity to acquire water rights and transfer the beneficial use for instream uses arises as property owners convert private agricultural land to another land use, such as urban, commercial, or industrial development. The sustainability of farming and ranching in downstream rural communities is an important consideration. Most of the water planning

and acquisition activity has occurred in the Truckee and Carson River basins to improve water quality, stream flow conditions, fisheries at Pyramid Lake, and wetlands in Lahontan Valley. Water rights have been acquired for some state Wildlife Management Areas and other locations (e.g., Meadow Valley Wash, Upper Blue Lake, and the Bruneau River) (Division of Water Planning, 1999b). State agencies involved with instream water rights include the Divisions of State Lands, Wildlife, and Water Resources.

Surface and Groundwater Quality

Surface Water Quality

Water quality standards define water quality goals of rivers and lakes in Nevada. Standards are set and revised through a regulatory process that starts with detailed analysis and a proposal by NDEP, which must be adopted by the State Environmental Commission. Two types of standards are in use. One type is the general "narrative" standard, assigned to all water bodies in the state to set a minimum level of protection. In addition, detailed "numeric" standards have been set for major rivers, streams, lakes, and reservoirs. The latter take into account specific chemical and physical conditions necessary to maintain designated beneficial uses (e.g., drinking, swimming, fishing, and industrial processes). Stream reach specific numeric standards have been developed for water bodies in the Carson, Colorado, Humboldt, Snake, Truckee, and Walker River Basins and many smaller streams.

To ensure standards are being maintained, the NDEP periodically monitors water quality in 80 river reaches and 10 lakes and reservoirs. Water bodies identified in the agency's Water Quality Monitoring Plan are sampled 3 to 12 times each year. The state's surface water monitoring network was established in 1967. Modifications are periodically made based on review of the database, resource constraints, and opportunities to coordinate and utilize other government agencies monitoring activities. The monitoring network is used to assess compliance with water quality standards, conduct trend analysis, validate water quality models and set total maximum daily loads (TMDL's). The data also is used for nonpoint source assessments, the 303 (d) List, 208 Plan Amendments, and the 305(b) report.

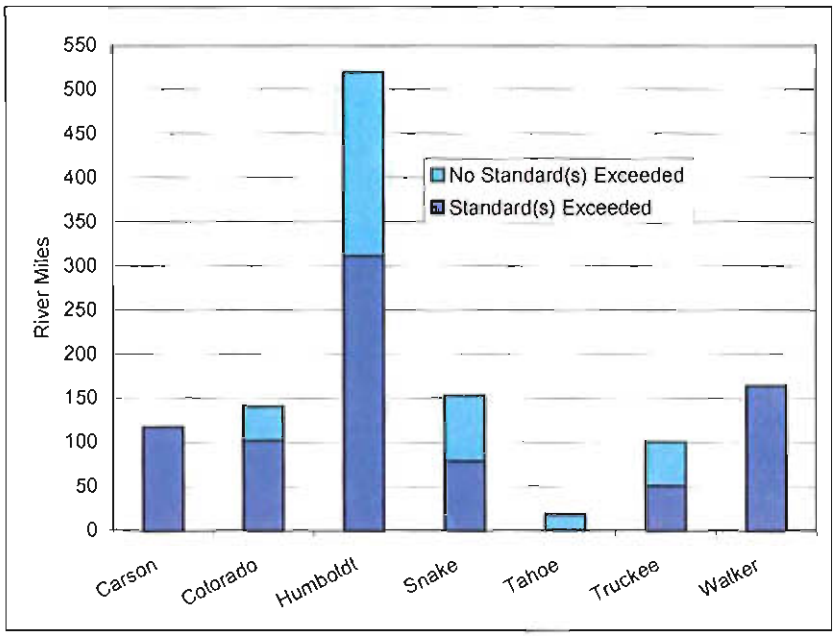
Selection of the more than 100 sampling sites in the monitoring network is based on land use intensity, water quality, hydro-modifications, and topography. Samples are analyzed for nutrients, sediment, metals, temperature, dissolved oxygen, pH, and other chemical and physical parameters. In general, if twenty-five percent of the samples for a pollutant exceed the water quality standard, then the water body may be classified as impaired. Impaired water bodies placed on the Clean Water Act 303(d) List. The 303(d) List is intended to draw more attention to water bodies in need of water quality improvement. A new listing will be published by NDEP in 2002, incorporating new methods of determining impairment.

Beginning in Summer 2000, the NDEP began a preliminary bio-assessment monitoring program to supplement physical and chemical quality assessments. The bio-assessment monitoring involves investigation of the presence of macro-invertebrates (i.e., insects, such as stone, caddis, and mayfly larvae), channel shape and dimensions, flow conditions, and riparian plant cover. Fifty initial sampling sites were established on the Truckee, Carson, and Walker rivers. In 2001, additional bio-assessment sampling sites will be established on the Muddy and Virgin rivers, and tributaries of the Humboldt.

River Water Quality Status

A summary of the water quality status of major rivers in Nevada and streams tributary to Lake Tahoe is shown in Figure 2-11. All rivers, except streams flowing from the Nevada side of Lake Tahoe, show slight to serious signs of impaired water quality in a number of reaches. Each receives runoff from land developed for urban, industrial, mining, and/or agricultural uses. Of 1,213 river miles periodically assessed, water quality standards were not met for one or more pollutants on 825 miles (Nevada Division of Environmental Protection, 2001a). Nutrients, sediment, and metals are the most widespread pollutants contributing to exceeded standards (Table 2-5).

Figure 2-11. Water Quality Status of Major Rivers in Nevada Measured in River Miles, 1996 and 1997.



Source: *Nevada's Revised 1998 Section 303(d) List.* Nevada Division of Environmental Protection. January 2001.
Note: "Tahoe" refers to streams monitored on the Nevada side of Lake Tahoe Basin.

Phosphorus is the most widespread nutrient found at elevated levels. Human sources are probably fertilizer use and animal feedlots. However, many soil types and rock formations are naturally phosphorus rich. Historic mining and milling activities, as well as natural sources, such as metal-bearing rock formations and geothermal springs, are associated with high metal levels in monitored water bodies in addition to various others located throughout the state. Abandoned mine land (AML) sites that are or have the potential to degrade water quality are numbered in the thousands according to a report produced by the U.S. Bureau of Land Management (BLM) and the Nevada Division of Mines (NDOM) as part of a federal-state task force. The Task Force identified and prioritized AML sites where contamination is present or possible. Thirty-three priority reclamation sites are identified in the *Nevada Abandoned Mine Lands Report* (Interagency Abandoned Mine Land Environmental Task Force, 1999).

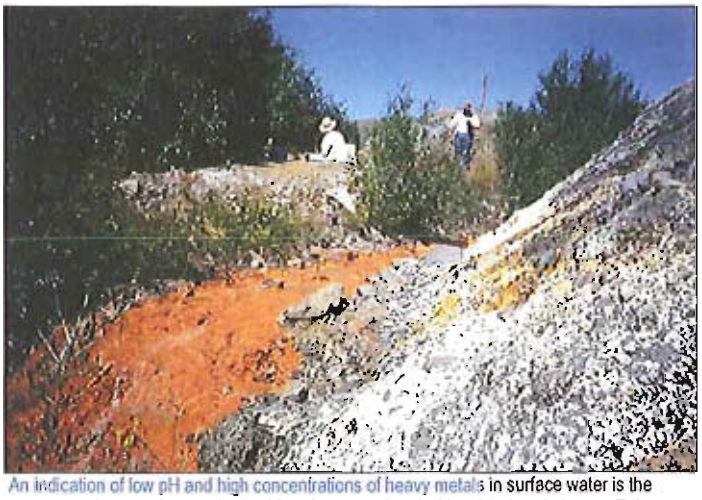
Water quality standards exceeded on other water bodies also include boron in reaches of the Humboldt and Colorado rivers; suspended solids, or sediment, in the lower Walker and lower Truckee rivers; and, mercury in the Carson River, below Carson City. The elevated nutrient level in the Truckee River occurred below the outfall from the Truckee Meadows Water Reclamation Facility. Operational improvements and more stringent permit limits have lowered the amount of nitrogen in the discharge. More recent water quality data show the total nitrogen

Table 2-5. Common Pollutants Causing Sub-standard Water Quality by River Miles, 1996 and 1997

River	Nutrients	Sediment	Metals	Total Miles Assessed
Carson	114	80	53	118
Colorado	42	0	12	141
Humboldt	290	290	311	519
Snake	30	30	17	153
Tahoe	0	0	0	18
Truckee	51	46	0	100
Walker	88	96	30	164
River Miles	615	542	424	1,213

Source. *Nevada's Revised 1998 Section 303(d) List.* Nevada Division of Environmental Protection. January 2001.

standard is being met. Where mercury or other toxic metals reach levels in fish that could pose a threat to human health, the state Heath Division issues advisories. The only fish consumption advisory in the state is the result of mercury in the lower Carson River, below the historic Comstock-era mill sites.



An indication of low pH and high concentrations of heavy metals in surface water is the presence of orange iron oxyhydroxide, often associated with acid mine drainage. This water quality condition also occurs naturally by weathering of altered rock in association with subsurface water. The photo shows a streambed next to a tailing pile at the Rio Tinto Mine in Elko County. A remediation plan has been developed for the mine site. 1995. Courtesy of Jon Price, Nevada Bureau of Mines and Geology.

The process to identify water quality improvement measures for the purpose of attaining the standard(s) begins with establishment of the Total Maximum Daily Load (TMDL). A TMDL is equivalent to calculating a budget for pollution. In the TMDL process, scientists estimate the total amount of a pollutant that could be released by all point and nonpoint sources to a specific water body without exceeding the beneficial use standards. After pollution sources are identified, the NDEP works with local government and interested parties to allocate pollution reduction responsibility.

The TMDL process has been implemented on several water bodies. Included are: 1) total phosphorous in seven segments of the Carson River; 2) total suspended solids in two segments of the Walker River; 3) total nitrogen, total phosphorous, and total dissolved solids in a segment of the Truckee River; 4) total phosphorous and total suspended solids in three segments of the Humboldt River, and total dissolved solids in two segments; and, 5) total phosphorous and total ammonia in Las Vegas Wash and Bay. Priorities for TMDL review and revision include the Las Vegas Wash and Bay, Humboldt River, and Walker River.

Because discharges from wastewater treatment plants, industrial facilities, mines, and other large point sources are regulated and monitored, much is known about the types and amount of pollution released. For most rivers in Nevada, all point source discharges have been removed. Nonpoint sources are the major causes for substandard quality in Nevada's impaired water bodies. Pollutant discharges from nonpoint sources are much more difficult to assess and control.

Nonpoint pollution is associated with serious impacts to native and endangered fishes, accelerated ageing of lakes (eutrophication), increased drinking water treatment requirements and costs, and general unsightliness that lowers scenic value, especially important to recreation-based tourism. In urban areas, runoff from streets and parking lots, construction sites, lawns and golf courses, and eroding channels contribute to elevated nutrients, heavy metals or sediment loads. In rural areas, nonpoint sources include intensive agricultural activities, irrigation, abandoned mine sites, and unpaved roads, eroding channels and barren stream embankments. Artificially low streamflow or lake levels and loss of wetlands and riparian plant communities can amplify the affects of nonpoint source pollution.

Lake and Reservoir Water Quality Status

Nevada contains 131 publicly owned lakes and reservoirs. Of these, 21 are of a significant size and account for 94 percent of the total lake surface area in the state. According to Nevada's 1998 Water Quality Assessment 305(b) Report, sixteen (16) of the larger lakes have high enough quality to be categorized as fully supporting all current beneficial uses. Some water quality parameters for Lake Tahoe, Topaz Lake, Lahontan Reservoir, and Las Vegas Bay (Lake Mead) indicate water quality is impaired, but still supports most beneficial uses (Nevada Division of Environmental Protection, 1998a).

Because Walker Lake, a desert lake at the terminus of the Walker River, contains high levels of dissolved salts and seasonally low oxygen levels, it has been classified in the state's 305(b) Report as not supporting beneficial uses. Primarily, the lake provides habitat for Lahontan cutthroat trout (LCT) fisheries and a variety of migratory and resident birds, as well as various water-dependent and wildlife related recreation activities. Upstream consumptive uses have reduced the amount of water reaching the lake. A long term lowering of the lake level is the major factor for episodes of degraded water quality that imperils aquatic life, including fishes. Concern over the Walker Lake ecosystem remains high.

Monitoring for Toxic Substances

The NDEP and the state Department of Agriculture, as well as federal agencies periodically sample water bodies to test for the presence and levels of toxic contaminants. The 1998 U.S. Geological Survey (USGS) report, *Water Quality in the Las Vegas Area and the Carson and Truckee River Basins*, describes the occurrence of toxic contaminants (e.g., metals, pesticides, uranium) in surface water bodies in the most populated areas of the state. Between 1992 and 1996, water samples were collected above and below areas with intensive agricultural, mining, and urban land uses in the Truckee and Carson River basins and Las Vegas Valley (Colorado River system). Samples also were collected in areas of known natural sources of contaminants.

In general, contaminants were present below areas of intensive land use, but usually at low levels. High arsenic concentrations were found in samples taken from Steamboat Creek, a Truckee River tributary, and agricultural drain water in the Carson Desert. Also, according to the USGS report, high uranium concentrations were found in samples taken from Las Vegas Wash and agricultural drains in the Carson Desert.

Geothermal systems in the Reno-Sparks and the Carson Desert were found to contribute arsenic, boron and mercury by way of springs and shallow water-table aquifers connected to surface waters. Elevated mercury in the Truckee River sediments occurs below Steamboat Creek. Steamboat Creek transports mercury and other metals from both naturally occurring and man-made sources associated with geothermal and mineral resources. The sediments of the Carson River below Carson City contain high levels of mercury, most originating from the processing of Comstock-era ore along the river between Dayton and Carson City.

Pesticides occurred in surface water samples taken downstream of all urban and agricultural areas, but at levels below the safe drinking water standards. Many samples contained detectable levels of more than one type of pesticide. Samples collected above urban and agricultural areas produced only one sample with one type of pesticide detected.

Groundwater Quality

Ground water resources in Nevada are precious. Cleaning up groundwater once contaminated is extremely costly and can take years. Before beginning activities that could contaminate groundwater, a permit must be obtained from the Bureau of Water Pollution Control. Strict regulations require implementation of preventative measures and monitoring. Preventative measures include holding tanks, impermeable liners, wastewater pretreatment, and using products or processes that do contain fewer or no potential contaminants. Monitoring helps identify undesirable water quality changes and prevent larger problems.

Because the purposes for monitoring groundwater quality vary, responsibilities are divided among different agencies. The Bureau of Health Protection Services, part of the Nevada Health Division, monitors aquifers tapped to supply public water systems. The Nevada Department of Agriculture (NDOA) shares responsibility for pesticides monitoring with NDEP. In addition, NDEP monitors groundwater quality through a permit program for facilities and activities that discharge, or may discharge, pollutants to groundwater. An important federal partner is the U.S. Geological Survey (USGS). The USGS conducts special studies and long term monitoring programs, often in conjunction with state agencies.

Monitoring is critical because early warning of changes in quality can avoid decades of treatment or abandonment of aquifers. Declining quality can result from natural, man-caused, or a combination of natural and human sources. Natural pollutants of concern include arsenic, radon, total dissolved solids, and metals. Certain land disturbing activities may disturb geologic or soil formations and mobilize natural contaminants, such as mining sulfide rich metal deposits, or concentrate them in specific areas, such as irrigation drain water. Problematic groundwater contaminants are released from residential, agricultural and industrial sources. Contaminants of greatest concern include pesticide/herbicide contamination, solvents and petroleum products, radioactive materials, metals, dissolved salts, and nitrogen.

Like surface water, the biggest groundwater quality protection challenges derive from less obvious, widespread pollution sources. Numerous diffuse sources of petroleum chemicals, solvents, metals, nutrients, dissolved salts, pesticides and pathogenic bacteria occur in urban, suburban, farming, mining, and industrial areas. In general, higher groundwater quality occurs in rural areas and lower quality in urban and suburban areas. The most frequently encountered mineral contaminant is nitrates, typically associated with high septic tank density, concentration of livestock in feedlots or low-density subdivisions, and fertilizer application for turf and certain crops. Solvents, such as perchloroethylene (PCE), and gasoline byproducts are the most common chemical constituents in degraded groundwater. Federal and state underground storage tank replacement and monitoring programs have greatly reduced the likelihood of leaks, thereby reducing accidental spills.

Groundwater Quality Status

In general, all groundwater bodies are considered to be a potential source of drinking water. The federal Safe Drinking Water Act standards, called Maximum Contaminant Levels, are applied when evaluating potential impacts of different pollutant sources and setting remediation or clean-up levels (Nevada Division of Environmental Protection, 1998b).

Though substantial groundwater quality monitoring is conducted by various agencies, these data are not managed in a statewide database. The U.S. Geological Survey National Water-Quality Assessment Program (NAWQA) recently published a comprehensive groundwater quality assessment report. The NAWQA study area in Nevada includes the Las Vegas Valley area, the Carson River Basin, and the Truckee River Basin. These basins were selected for an intensive sampling and assessment project because they contain more than 90 percent of Nevada's population; rapid population growth has increased competition for limited water supplies; and, natural and human-caused water-quality problems are evident (U.S. Geological Survey, 1998).

A number of important groundwater quality findings were reported in the study. Many of the shallow monitoring wells and deeper water supply wells sampled in urban areas contained low levels of pesticides and volatile organic compounds. However, pesticide occurrences in shallow wells located in agricultural areas were lower than in the urban areas. Similarly, sampling of shallow wells in agricultural and urban areas showed that the latter contained higher levels of nitrates. Some urban shallow wells contained nitrate levels exceeding the safe drinking water standard. Deeper supply wells tested contained elevated nitrate concentrations, but all were below the standard of 10 milligrams per liter. The significance of these findings is that shallow water-table aquifers can be linked to deeper drinking water aquifers.

The incidence of elevated nitrate levels in aquifers underlying suburban and rural subdivisions has increased. New homes and businesses built outside urban areas often use individual septic systems, which at the time of construction appear to be a cost effective alternative to community wastewater treatment systems. In some valleys, septic systems have become concentrated, especially where piecemeal (parcel map) subdivision development is allowed. Of special concern are subdivisions on septic systems that use local groundwater sources for domestic or community drinking water supply. A study of groundwater beneath un-sewered subdivisions in valleys north of Reno found that contaminant plumes expand rapidly when the combined domestic well pumpage exceeds annual groundwater recharge. The study suggested that septic system seepage was a major source of recharge and was contributing to elevated nitrates. In the studied valleys, 20 percent of the 250 sampled domestic wells

contained water near or above the nitrate drinking water standard (Washoe County Department of Public Works and Desert Research Institute, circa 1995).

Elevated nitrate levels have been found in shallow groundwater bodies underlying twenty-three residential subdivisions (Nevada Division of Environmental Protection, 2001b). Currently only six communities are known to have public supply wells with elevated nitrates, and only two of these have had to take actions that reduce nitrate levels because the drinking water supply standards were exceeded (Nevada Division of Environmental Protection, 2001b). Domestic well quality data is not compiled by state agencies, but homeowners are advised to have domestic well water analyzed periodically at a certified lab. Alternative solutions to the problem of high nitrate levels in groundwater include closure of individual septic systems with connection to community wastewater treatment systems; switching from a domestic well supply source to a public water supply system; or, pumping groundwater for irrigation uses to contain the zone of high nitrates. Cooperation between state, local, and property owners is necessary to improve impaired groundwater supplies in suburban and rural communities.

Well Head Protection

As more homes and businesses rely on groundwater, pollution prevention has become increasingly important. In 1994, the Division of Environmental Protection set up the Wellhead Protection Program (WHPP) that gives local communities technical guidance for long-term drinking water source protection. Though not required, many communities already have prepared local WHPP's. The wellhead protection framework involves identifying the land surface area that should be managed to protect the groundwater being pumped; inventorying and mapping existing and potential contaminant sources located within that area; and, selecting appropriate management strategies.

Common potential contaminant sources include underground storage tanks, improperly abandoned wells, improperly applied fertilizers and pesticides, and high concentrations of septic systems. Management options might include regulations such as zoning ordinances, or non-regulatory options such as public education. A WHPP also can include plans for dealing with emergencies or accidental contaminant releases. Because pollutants come from many smaller sources (e.g., residential lawns, commercial parking lots, and individual septic systems) that are difficult to oversee, public education and participation is a critical element of WHPP.

Since 1994, 27 water systems or communities have prepared wellhead protection plans. This number is projected to increase to 32 during 2001 (Bureau of Water Quality Planning, 2001). The program is voluntary, so data is not available on the number of communities that have progressed with plan implementation. Implementation challenges include limited local government funds, additional public and private costs, and concern that limitation might be placed on land uses within a wellhead protection zone.

Underground Injection Control

The Underground Injection Control (UIC) Program is another federal program for which the State of Nevada has accepted responsibility. The goal of the program is to protect Nevada's groundwater resource from potential degradation by the injection of fluids into a well. Injection of fluids is allowed for various purposes. One is injecting water to boost groundwater supplies, known as Aquifer Storage and Recharge (ASR). Nevada's UIC program regulates the injection of fresh, potable water into drinking water aquifers where it is stored for use at a later date.

Fluids also are injected for groundwater remediation. Contaminated water can be pumped, treated, and then returned to the aquifer. Another type of injection activity introduces nutrient enriched fluid into a polluted aquifer to stimulate bacterial decomposition of the contaminants. Biodegradation is a prominent means of re-establishing the beneficial use of groundwater where oil, gas and petroleum byproducts have leaked or spilled.

Geothermal energy is used at Empire Farms to process garlic and onions, in addition to generating electricity. The photo shows the pond and drying facility in the background. Photo courtesy of Larry Garside, Empire Farms. 2001

Nevada's geothermal resources, used for electricity generation, space heating, and industrial processes, are regulated under the UIC program. After use, the spent geothermal fluid is re-injected into the aquifer of origin, where feasible. Care must be taken to avoid both contamination of adjoining aquifers with higher quality water and accelerated cooling of the natural reservoir of hot or warm water. Open pit mines that dewater and then return groundwater to the aquifer are also covered under the UIC Program.

Leaking Underground Storage Tanks, Spills, and Brownfields

Contaminated properties most often involve industrial or commercial activities that have released chemicals. Nevada law requires owners to report contamination events to the state Division of Environmental Protection (NDEP) and to take necessary remedial action at the site. The most serious long-term clean up projects occur where contamination moves through the soil and contaminates groundwater. Leaking underground petroleum storage tanks are responsible for most of the cleanup sites in Nevada. To comply with state administered regulations established under the federal Resource Conservation and Recovery Act, older tanks were to have been removed or upgraded by December 1998. Each year, fewer contaminated sites are being found, and more sites are being cleaned up. Consequently, the number of open sites with ongoing corrective action is declining.

The Petroleum Fund and the Underground Storage Tank/Leaking Underground Storage Tank (UST) Programs provide incentives and regulatory oversight for cleanup activities. The programs are implemented by the Bureau of Corrective Actions, which operates under regulations requiring cost benefit evaluations prior to clean up actions. In fiscal year 1999, the Bureau opened 88 new Petroleum fund cases, closed 191 cases, and disbursed approximately $ 4.98 million in Petroleum fund monies. In fiscal year 2000, 60 new cases were opened, 3 were closed, and $ 6.04 million dollars were disbursed (Nevada Division of Environmental Protection, 2000).

Since the 1992 inception of a formalized remedial action program, approximately 1,097 non-UST sites have been investigated and cleaned up to State requirements. These cases involved petroleum products, heavy metals, organic compounds, pesticides and PCB's. Approximately 125 cases are open and active at any given time. Remediation efforts continue in Washoe County to investigate the extent of ground water contamination by cleaning solvents in Downtown Reno. Monitoring activities indicate the need for additional remediation efforts, which are underway. Sampling was conducted near the Yerington Anaconda mine project to determine if the mine has impacted any down gradient municipal or private wells. Sampling results indicated that there were no impacts on these wells. Cleanup activities at the Rio Tinto mine in northern Elko County are continuing. Major cleanup efforts at the BMI industrial complex in Henderson have begun to remediate contamination and turn the site into a master planned community.

About 500 spills are reported annually. More than half occur in the heavily populated southern and western part of the state. Prompt cleanup of hazardous substance spills reduces danger to public safety and prevents spill sites from becoming contaminated properties. Most spills are small. While quantity

can be important, the properties of the substance spilled and the location of the spill are generally more critical factors. The most common substances spilled are petroleum products. Nearly 75 percent of all spills impact the soil. Excavating the contaminated soil and refilling with clean soil usually cleans up these spills. When a spill impacts surface water or groundwater, it presents a greater risk and requires a more intensive response.

State and federal environmental protection agencies are teaming up to accelerate the clean up of contaminated lands. The Brownfields Program applies to contaminated property that has been abandoned or under-used. Putting these brownfield properties back into productive use returns them to the tax base, brings jobs to populated areas, and helps conserve other land for farming, recreational areas, and green space. The NDEP-operated program advises property buyers and sellers, local governments, lenders, and developers about legal and technical options that will get the cleanup done and help ensure that land development does not hopscotch around the brownfield sites. Advanced monitoring and contaminant transport modeling technologies will be used by NDEP that raise the certainty that remediation of a contaminated site has been successful. The Nevada State Legislature in 1999 passed the Program for Voluntary Cleanup of Hazardous Substances and Relief From Liability. The purpose is to encourage voluntary cleanup of contaminant releases and remove the stigma of potential liability for future landowners and lenders. The Voluntary Cleanup Program will result in clearing the pathway for returning these properties to beneficial use in a timely and efficient manner.

Drinking Water Supply

Chances are great that the tap water you use for drinking and domestic purposes comes from a public water system. In 1999, 97 percent of Nevada's citizens were served by one of 670 public water systems. Public water systems can be small, with as few as 15 connections or 25 people, or large, serving hundreds of thousands of people. Cities, towns, casinos, campgrounds, restaurants, schools, mines, and factories are served by public water systems. Ensuring that water delivered by public systems meets drinking water standards is vital to the public health, welfare, and economy. Reducing outbreaks of waterborne disease and chemical poisoning, and increasing the proportion of people who receive a supply of drinking water that meet Safe Drinking Water Act standards established by the U.S. Environmental Protection Agency (EPA), are two of the Department of Health and Human Services' objectives.

EPA has set drinking water maximum contaminant levels (MCL) for 90 substances, establishing safe limits for public water supplies. However, many contaminants in drinking water have no MCL's. Furthermore, combinations of chemicals in drinking water can have health impacts that are not well understood yet. As a result, preventing contamination of sources of drinking water supply is a critical concern. Public water system operators must monitor drinking water for microbiological and chemical contaminants regulated under the Safe Drinking Water Act (SDWA) to ensure drinking water standards are not exceeded. Monitored chemicals include nitrogen compounds, metals, pesticides, solvents, petroleum byproducts, and radon. As a precautionary measure, drinking water in Nevada is monitored for about 50 additional organic chemicals for which standards have not been set.

When a public water system violates a drinking water standard, it must notify the public, identify the source of the problem, take necessary corrective action and resample. Public water systems in Nevada have done well in providing clean water. In 1999, seven public water systems generated seven chemical violations (arsenic, antimony and nitrate) and 71 systems generated 89 microbial violations, only three of which were acute. Of the 670 public water systems in the state, 89 percent reported no contaminant levels that exceeded the standards (Nevada Health Division, 1999).

Wastewater Treatment and Reuse

The ground water and surface water discharge program administered by the NDEP plays a leading role in protecting the quality of Nevada's natural water supplies. The Bureau of Water Pollution Control issues permits for the discharge of treated wastewater (sewage) under the state groundwater protection program

and National Pollution Discharge Elimination System (NPDES) program. The U.S. Environmental Protection Agency (EPA) delegated responsibility for the NPDES program to Nevada. The discharge of treated wastewater to surface waters is regulated through pollutant limits in discharged water, best available treatment technology guidance, monitoring, and reporting.

Similar to the NPDES program, the state groundwater protection program protects the quality of underground aquifers through a permitting and inspection system for treated wastewater discharged into rapid infiltration basins and evaporation ponds. The reuse of highly treated wastewater (reclaimed water) for irrigation is another type of discharge to groundwater that has become more common. Properly treated and applied, reclaimed water is a safe and economical irrigation alternative to using limited groundwater and surface water supplies. An environmental benefit of using reclaimed water for irrigation is the reduction in pollutant discharges into Nevada's rivers and lakes. The number of permits in effect for reclaimed water uses reached sixty-five in 2000. An applicant proposing to use reclaimed water must submit an effluent management plan (EMP) which details how the reclaimed water will be applied to the site. The EMP lists health safeguards for irrigation and application rates. Health safeguards include aerosol drift controls, public notification, and protection of water supplies.

Reclaimed water is applied throughout the state for irrigation of parks, golf courses, and agricultural lands. Other uses of reclaimed water include dust control on unpaved roads and construction sites, soil compaction, and power plants. In Carson Valley, treated wastewater piped from communities in the Lake Tahoe Basin supplies water for wetlands and agricultural uses. In some circumstances, a new use of reclaimed water for irrigation results in less water returned to a surface water body. Any beneficial use of reclaimed water requires two permits from the State Engineer: a primary permit on the source (i.e., waste water treatment facility) and a secondary permit for the beneficial use.

Wastes and Environmental Contaminants

Solid and Hazardous Waste

During the past decade, Nevada has implemented federal laws that regulate municipal landfills. The Bureau of Waste Management (BWM) in the NDEP administers the federal regulations. More than 60 open dumps have been closed, replaced with a network of transfer stations and 22 regional landfills. The transfer stations and regional landfills are designed and operated to safely contain waste and prevent contaminants from reaching groundwater.

The amount of municipal solid waste (MSW) disposed of in landfills continues to grow each year, roughly proportional to the growth in population. However, generation of MSW per capita in Nevada at nine pounds per person per day is twice the national average of 4.5. The amount of solid waste delivered to solid waste disposal sites increased almost five percent annually from 1998 to 2000 (Table 2-6). Not included in the total is MSW imported from California. Of the 4.8 million tons of the MSW disposed of in 2000, about 11 percent originated in another state. Almost all imported waste was accepted at the privately owned Lockwood Regional landfill, near Sparks. A small amount is accepted at landfills by Mesquite and West Wendover (Bureau of Waste Management, 2001a).

Table 2-6. Tons of Solid Waste Delivered to Solid Waste Disposal Sites, 1998 – 2000

Category of Waste	1998	1999	2000*
	Tons per year		
Municipal Solid Waste from In-State Sources	3,003,261	3,152,658	3,308,512
Municipal Solid Waste from Out-of-State Sources	231,257	449,617	544,307
Industrial and Special Waste	941,749	1,013,946	914,572
State Total	4,176,267	4,616,221	4,767,391

Source: modified from Nevada Recycling Status and Market Development Report, Bureau of Waste Management, 2001.
Notes: *Year 2000 data is estimated, since five percent of the fourth quarter reports had not been received. The Industrial and Special Waste category includes several types that require special management at permitted landfills. Ninety percent of this waste type is construction and demolition debris.

The BWM calculates the recycling rate in Nevada each year. State laws require municipalities to operate recycling programs at varying levels, depending upon population. Recycling must be offered to residential premises and public buildings where solid waste collection is provided. However, participation in the programs is voluntary. The statutory goal for municipal recycling is 25 percent. Statewide, the MSW recycling rate has trended downward, falling from 14.5 to 11.3 percent between 1996 and 1999. The 50-state average is 28 percent.

Washoe and Carson City county recycling rates approximated 21 percent in 1999, but Clark County's rate was 8.3 percent. Nevada's tourist-based economy, coupled with low waste disposal costs at most landfills contributes to high waste generation and a low recovery rate for recyclables. Slumping prices for recyclable commodities is another reason for falling recycling rates. The NDEP participates with the Nevada Commission on Economic Development and its contractors to promote recycling market development. A number of significant obstacles have blocked progress in developing recycling markets, including few industries that might use recycled materials, a tourism economy, and large distance between urban centers (Bureau of Waste Management, 2001b).

Almost 80 facilities in Nevada generate enough hazardous waste per month (more than 1,000 kilograms) to be designated as a large quantity generator. Approximately 350 facilities are designated as small quantity generators of hazardous waste. Three commercial facilities are permitted to treat, store or dispose of hazardous waste, located at Beatty, Fernley, and North Las Vegas. Certain federal facilities, including the Nevada Test Site and Hawthorne Army Depot, have permits to manage hazardous waste on-site. The only land disposal site for hazardous waste is the state-owned Beatty facility operated under lease agreement by US Ecology, Inc. This 80-acre facility located south of Beatty, has received both low-level radioactive waste and chemical waste since the 1960's. The radioactive waste portion of the site closed in 1992. Currently, the facility receives limited types and quantities of hazardous waste. The remaining capacity is limited (Bureau of Waste Management, 2001a).

Legacy Wastes

Collectively, the federal facilities in Nevada have caused significant degradation to the environment. A large portion of the Nevada Test Site will remain restricted, requiring "in perpetuity" institutional control. The NTS was the site of 100 above ground "atmospheric" nuclear tests followed by 800 underground tests. Underground testing has contaminated groundwater over vast areas. Nearly 30 percent of the underground tests were conducted near or below the groundwater. State officials now estimate that an area more than 300 square miles is contaminated beneath the site. Surface soils at NTS are also contaminated with various radionuclides. At least 30,000 acres will remain permanently restricted for all uses at the site.

Contamination at the various military bases is generally limited to site-specific industrial contamination, such as solvents and aviation fuels in shallow aquifers. Included are Hawthorne Army Depot, Nellis Air Force Base, and Fallon Naval Air Station. Surface and sub-surface contamination at the various bombing and testing ranges is considered significant, including the Nellis Test and Training Range and the Fallon Range Training Complex. However, because of high costs or limited cleanup technologies, or both, many of the bombing ranges likely will never be remediated. Most of the range contamination is in the form of un-exploded ordnance and represents a significant safety hazard and potential long-term environmental risk.

Federal officials, with state government oversight, are expending considerable funds to characterize and remediate groundwater and surface soil contamination, where feasible at the respective federal facilities. At military bases, federal funds are allocated each year to address site-specific cleanup and closure activities (e.g., industrial site cleanups). About 160 contaminated sites on the military bases are under various degrees of investigation and remediation. Since most of the military bombing ranges in Nevada are active, remediation at air-to-ground bombing and testing ranges is limited to annual surface cleanup of un-exploded ordnance, scrap metals, and target debris.

The NDEP oversees site remediation activities at the national defense sites. In the early 1990's, NDEP established the Bureau of Federal Facilities to oversee remediation and focus clean-up activities at DOD and DOE facilities in Nevada. NDEP officials evaluate remediation plans, conduct site visits, and provide regulatory oversight. State concurrence is required to close sites where contamination is left in place. At the present time, the respective DOD entities are expending about $2 million annually on legacy waste site cleanup and remediation activities.

At the Nevada Test Site, federal and state officials are evaluating groundwater contamination caused by underground nuclear testing. Some of the contaminants are mobile in water, such as tritium. Because radionuclides have decay periods measured in thousands of years, monitoring groundwater flows beneath the site is of particular concern. The DOE is spending about $30 million annually to characterize, model, and define compliance boundaries of contaminated units beneath the site. The State, under a consent order administered by NDEP, provides regulatory oversight of the DOE groundwater and surface soil investigation programs. Site monitoring activities are anticipated to extend beyond 2030.

References

Bureau of Air Quality (NDEP). 2000. Bureau of Air Quality 1989 – 1999 Trend Report.

Bureau of Waste Management (NDEP). 2001. Nevada Recycling Status and Market Development Report.

California Department of Water Resources (a). 1991. Carson River Atlas.

California Department of Water Resources (b). 1991. Truckee River Atlas.

California Department of Water Resources (c). 1992. Walker River Atlas.

Frederick, Kenneth D. and Peter H. Gleick. 1999. *Water and Global Climate Change, Potential Impacts on U.S. Water Resources*. Prepared for the Pew Center on Global Climate Change.

Interagency Abandoned Mine Land Environmental Task Force, 1999. *Nevada Abandoned Mine Lands Report*. Prepared by the U.S. Bureau of Land Management and Nevada Division of Minerals.

Nevada Department of Transportation. 2001. Personal communication. Estimated Annual Vehicle Miles Traveled Data Tables.

Nevada Division of Environmental Protection, 1998a. *Nevada Water Quality Assessment 305(b) Report*.

Nevada Division of Environmental Protection. 1998b. Comprehensive State Groundwater Protection Program, Profile, Updated March 1998.

Nevada Division of Environmental Protection. 2000. *Nevada Division Environmental Protection 2000 Biennial Report*. Internet address: http://ndep.state.nv.us/admin/report98.htm

Nevada Division of Environmental Protection. 2001a. Personal communication with Bureau of Water Quality Planning. Tabulated Summary of Impaired River Miles – 1998 303(d) List.

Nevada Division of Environmental Protection. 2001b. Personal communication with the Bureau of Water Quality Planning. Survey of groundwater quality data on elevated nitrate levels.

Nevada Division of Water Planning. 1999a. Nevada State Water Plan, Summary.

Nevada Division of Water Planning, 1999b. Nevada State Water Plan, Part 3 – Water Planning and Management Issues.

Nevada Energy Office and Desert Research Institute (DRI). 1998. Greenhouse Gas Emissions Inventory for Nevada, Phase I Report Estimates for 1990 and 1995. DRI Document No. 98-8380.DF.2.

Nevada Health Division. 2001. Personal communication with the Bureau of Health Protection Services.

Nevada Health Division. 1999. Annual Compliance Report for the State of Nevada Public Water Systems.

U.S. Bureau of Reclamation. 1998. Working Draft of the Truckee River Operating Agreement EIS/EIR.

U.S. Environmental Protection Agency. 2002. Global Warming Website. Internet address http://www.epa.gov/globalwarming/index.html

U.S. Geological Survey. 1998. Water Quality in the Las Vegas Valley Area and the Carson and Truckee River Basins, Nevada and California, 1992 – 1996. Circular 1170.

Washoe County Department of Public Works, Utility Division, and Desert Research Institute, Water Resource Center. Circa 1995. Groundwater Contamination from Septic Tank Effluent in a Closed Basin, Washoe County, Nevada.

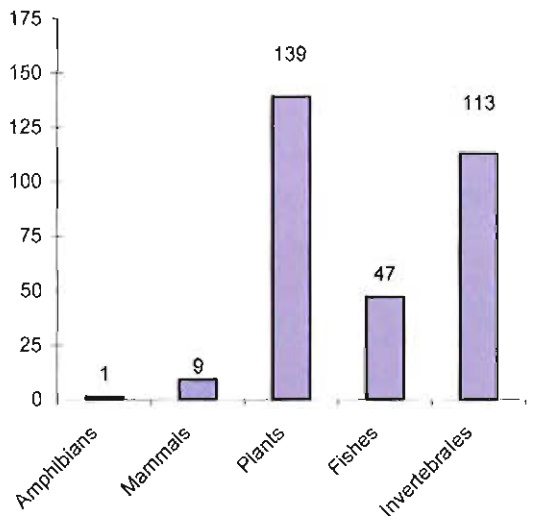
Biological Resources

Flying over Nevada's numerous mountain ranges or speeding across shrub-covered basins on the Loneliest Road in America (Highway 50), travelers will undoubtedly miss one of the state's most notable features - the enormous variety of wildlife and habitats that grace the state. The corrugated topography and dramatic elevation changes gives rise to many distinctive climate and vegetation zones, from salt desert scrub surrounding dry lakebeds (playas) to alpine tundra with persistent snowfields. In between, lies a rich diversity of shrub, woodland, forest, grassland, and riparian zones. Botanists have found over 2800 different native plants in Nevada, 139 of which occur nowhere else. Though predominantly arid to semi-arid, the moister, higher elevation climate zones capture sufficient amounts of snow and rain to feed numerous rivers, creeks, lakes, wetlands, and springs. Many unique native fishes, freshwater snails, birds, amphibians, and insects inhabit these widely distributed aquatic resources. Overall, Nevada hosts well over 3800 plant and animal species and some of the most biologically diverse ecoregions in North America.

Biodiversity and Ecoregions

Nevada is inhabited by a large number species and subspecies (i.e., taxa) that are unique to Nevada (i.e., endemic). With 309 kinds of plants and animals found in the state and nowhere else, Nevada ranks sixth in the nation for the number of endemic animal and plant species (Figure 3-1). As scientists continue to study the state's biological resources, the number of taxa will change. In particular, the number of endemic aquatic and terrestrial invertebrates is certain to increase.

Figure 3-1. Endemic Taxa of Nevada



Source: Nevada Natural Heritage Program, 2001.

Why does a predominantly arid state harbor so much biodiversity? Basically, the complex history of regional climate swings that occurred over recent millennia propelled a series of changes in the distribution and abundance of water and vegetation, as well as landform features. As new and diverse habitat conditions formed, animals and plants were migrating, adapting, and evolving in order to survive. An important condition for species evolution is isolation. The basin and range topography, fluctuations in large ancient lakes, and vegetation zones shifting with climate changes resulted in populations of terrestrial and aquatic species becoming separated and isolated.

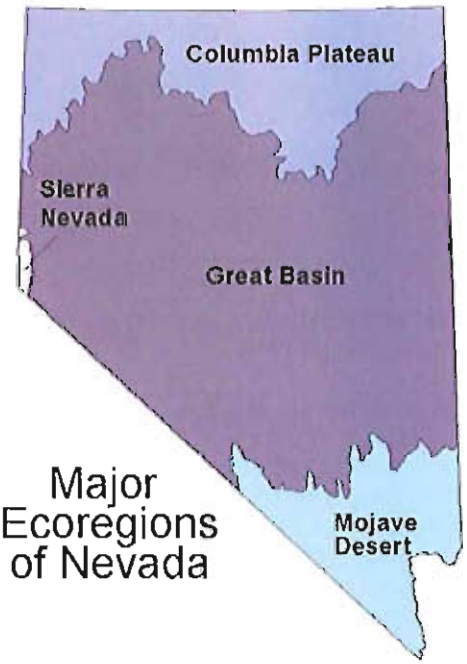
With 314 named mountain ranges and 232 (hydrographic) basins, the basin and range topography is the state's most prominent feature. Mountain ranges are mostly tilted fault-bounded blocks, five to 15 miles wide, with many extending more than 50 miles. Peaks and ridges typically rise 1,000 to 5,000 feet above the floors of the intervening basins, and occupy roughly 40 to 50 percent of the total land area. The basins are filled with rock and soil eroded over millions of years. Very coarse to fine grained sedimentary layers make up the valley fill deposits, which range in thickness from several hundred feet to more than 2 miles (Fiero, 1986). Elevations of larger valley bottoms vary from 500 feet above mean sea level to 6,800 feet. Twenty-five mountain ranges have at least one peak over 10,000 feet (Grayson, 1993). Nevada climbing enthusiasts report summiting 42 peaks higher than 11,000 feet (Strickland, 2002).

Periodically during the past 10,000 years, many northern Nevada basins were filled with freshwater lakes. The inundated valleys separated populations of the same species and created new habitat conditions. The largest prehistoric lake within the state was Lake Lahontan, which at its peak inundated about 8,600 square miles in the Humboldt, Truckee, Black Rock, Carson, and Walker basins. Remnant features of the wetter, cooler periods, the last of which ended 4,000 years ago, are found in desert "sinks" distributed throughout northern Nevada (Grayson, 1993). Relict landform features include terminal lakes, playas, and wetland complexes ringed by ancient wave cut terraces. Pyramid and Walker lakes are the lone survivors of ancient Lake Lahontan. These rare relict lakes are fed by snowmelt from the Sierra Nevada Range, which ironically captures so much moisture from Pacific storms that an enormous rain shadow is cast across the state.

The relatively recent and rapid climate transition from wetter and cooler conditions to drier and warmer brought about region-wide changes in the distribution and abundance of plant species and community types. Conifer forests withdrew into the mountains, replaced by pinyon and juniper woodlands and expanding shrubs and grasses. As water bodies receded and groundwater recharge declined, wetlands and riparian zones contracted. Ultimately, the climate changes and the highly segmented landscape provided new, unique, and isolated habitats in which aquatic and terrestrial species adapted and evolved. Thus, the ecosystems in which we live are the recent product of a dynamic period in the state's natural history. Nevada consists of four major ecosystem units, or ecoregions - the Great Basin, Mojave Desert, Columbia Plateau, and Sierra Nevada (Figure 3-2). Most of the state's population resides in the Great Basin and Mojave Desert ecoregions.

The Great Basin covers about 48 million acres (68% of the state). Roughly two-thirds of the ecoregion falls within Nevada's borders, with the remainder in Utah and California. Of 110 ecoregions in North America, the Great Basin ranks fifth in total species richness and second in diversity of imperiled species (The Nature Conservancy, 2000). Valley bottoms in the Great Basin sit at higher elevations and more northerly latitudes than the Mojave Desert; thus, the climate is cooler, moister, and vegetation grows thicker. Salt tolerant shrubs and playas prevail in the lower valleys. Expanses of sagebrush and other shrub communities cover most of the higher valleys and slopes, occasionally mixed with grasses, especially at higher elevations. Pinyon and juniper, or pygmy conifer, woodlands occupy large portions of lower elevation mountain slopes and ranges. Conifer and hardwood forest occur in widely dispersed patches. Major rivers are limited to the northern and western extremities. Numerous perennial and ephemeral creeks drain higher elevation ranges. Thousands of springs dot valleys throughout the Great Basin. Almost all precipitation falls during winter, with temperatures cold enough to bring more snow than rain. Warm springs and hot summers hasten snowmelt from the mountains and quickly evaporate the moisture in upland soils. Gradually, stream flow dwindles to a low flow or dry state by late summer.

Figure 3-2. Major Ecoregions of Nevada



Source: Nevada Natural Heritage Program, 2001.

The Mojave Desert covers the state's southern tip, and extends into California, Utah, and Arizona. Compared to the Great Basin, Mojavean valleys are broader and mountain ranges fewer. Vegetation is widely spaced on the hot, dry valley floors and slopes. Cacti and

Mojave yucca are abundant at lower elevations, cohabitating with white bursage. Higher desert vegetation zones are identified by blackbrush, creosote bush, and shadscale. Joshua trees and perennial grasses occur in higher shrub-dominated valleys. Mid-level mountain elevations support pinyon and juniper in several ranges. Forested mountain areas of pine and fir have a limited, high elevation distribution (Utah State University, 1996). On average, less than five inches of rain falls in the winter and during the summer monsoon season, but higher elevations often receive several feet of snow. Extensive water bearing carbonate rock formations contribute flow to some perennial stream reaches and numerous springs, a number of which are inhabited by rare fishes and snails. The Colorado River flows through the eastern portion of the ecoregion. Other important streams are the Amargosa, Muddy, Virgin, Meadow Valley, and White rivers. Desert tortoise, Amargosa toad, Mojave yucca, and Joshua trees are distinctive life forms in this ecoregion. Over 1.4 million people inhabit Las Vegas Valley, which lies centrally in the Nevada portion of the Mojave Ecoregion. Urban development, outdoor recreation, military uses, and large reservoirs are major land uses.

The southern portion of the Columbia Plateau ecoregion stretches across northern Nevada, and extends into Idaho, Oregon, Washington. In Nevada, landforms are a mix of basin and range and volcanic plateau features, with inclusions of low lying alkaline lakebeds in the westernmost portion. A variety of sagebrush and perennial grass, or sagebrush steppe, communities prevail as the dominant vegetation type. Salt desert scrub and pinyon woodlands are scarce in the cooler climate, which favors juniper woodlands and mountain mahogany. Rocky Mountain type subalpine conifer and aspen forest patches occur at higher elevations of the volcanic highlands and mountain ranges. Higher average annual precipitation sustains many small perennial streams that flow northward to tributaries of the Snake River in Idaho. The valleys are semi-arid, although irrigated pastures makes up a greater portion of the vegetative cover than elsewhere in Nevada. Livestock grazing, irrigated pasture, big game habitat management, and hunting and fishing are major land uses. Towns are small and remote, sustained by the agricultural- and outdoor recreation-based economy.

In contrast, fast growing cities and towns are clustered along the margin of the Sierra Nevada ecoregion. Moderately well forested, the steep granite slopes along the eastern edge of the Sierra Nevada Range is the source of numerous mountain streams. The Eastern Sierra and Carson Range watersheds feed Lake Tahoe and three major rivers that yield a substantial amount of water for farming, urban and industrial development, water-based recreation, and desert lakes and wetlands. Eastern Sierran mixed conifer forest and mountain shrub communities are accustomed to a milder climate pattern and thus have a limited presence eastward. Only small patches of Sierran plant communities occupy the most favorable locations in adjacent mountains of the Great Basin ecoregion. Commercial logging, ranching, and forest/range wildlife habitats are being replaced by urban and suburban development, outdoor recreation facilities and trails, and tourism along the eastern Sierra Front.

A few important generalizations can be made about the ecoregions in Nevada. Compared to the Columbia Plateau and Sierra Nevada ecoregions, natural plant communities of the Great Basin and Mojave Desert ecoregions appear to be less resilient and slower to recover from intensive land use and natural disturbance. Dispersal of noxious weeds and cheatgrass appears to be a more significant problem in the Great Basin and Columbia Plateau ecoregions than the others, although red brome continues to invade Mojavean shrub communities. A majority of the more than 2.3 million acres that burned during 1999 and 2000 were from wildfires located in the Great Basin ecoregion. The environmental and habitat impacts of urbanization are most evident in biologically diverse areas of the Sierra Nevada, western Great Basin, and Mojave Desert ecoregions. However, in all ecoregions, intensive agricultural, mining, past logging, and outdoor recreation land uses as well as uniform suppression of fires have, to varying degrees, contributed to widespread, significant ecological changes in rangeland, forest, aquatic, and riparian zones.

Wildlife and Habitat

Nevada is home to West-wide common species of wildlife and plants, such as mule deer and sagebrush, as well as endemic and rare species that have adapted to unique habitats, such as the Railroad Valley

springfish (*Crenichthys nevadae*) and Las Vegas bear poppy (*Arctomecon californica*). The Nevada Division of Wildlife (NDOW) and U.S. Fish and Wildlife Service (FWS) have primary responsibilities for protecting and managing wildlife according to various state and federal regulations and special management designations. Most of the wildlife habitat is managed by the BLM, USFS, and FWS, which combined control the use of land on about 80 percent of the state. The Nevada Division of Forestry also has certain vegetation protection and management responsibilities on state and private land for designated plant species.

Before state and federal agencies regulated hunting and fishing, populations of many native species plummeted due to lack of awareness and carelessness. Now that state and federal agencies oversee hunting and manage wildlife and habitats, better data are available on the numbers and distribution of game species. NDOW routinely gathers information from hunters and fishers, and with fees paid by hunters, conducts surveys and models population dynamics of game species. In addition, scientists have gained more knowledge about imperiled animal and plant species. However, these species constitute a small fraction of Nevada's total biodiversity. A frequently stated theme regarding our biological resources is the dearth of information on the vast majority of plants and animals that populate our ecosystems.

One way to report on the overall status of Nevada's wildlife and plants is to group species according to designations that indicate their management or conservation status (Table 3-1). For example, native and endemic species are classified and tracked to account for the state's overall and unique biodiversity. Game species are wildlife that are hunted, fished, or trapped by sportsmen. Federally threatened and endangered species are those whose numbers have dwindled and are believed to need special protection and recovery actions in accordance with the Endangered Species Act of 1973, as amended. Rare and sensitive species are identified during periodic review of the state's inventory of native species that takes into consideration the population size and distribution, level of threats and corresponding management attention, and the biology of the species.

Table 3-1. Number of Wildlife and Plant Taxa by Management Designation

Major Groups	Native	Endemic	Game	Extinct & Extirpated	Federal Threatened & Endangered	Rare and Sensitive
Mammals	128	9	16	6	0	53
Birds	283	0	50	2	6	47
Fishes	91	53	30	11	23	63
Reptiles	54	0	0	0	1	7
Invertebrates	unknown	113	0	6	2	171
Plants	2800	139	0	0	9	297
Amphibians	16	2	1	1	0	6
Nevada Total	>4600	309	97	26	40	644

Source: Nevada Natural Heritage Program, 2002. Internet site: http://www.state.nv.us/nvnhp/
Note. Only taxa that regularly occur within Nevada are included in the category counts. Data on native invertebrate species are too limited to estimate. Information on species is constantly updated as more data becomes available. The counts will certainly change as more is learned.

Each species that has become extinct or extirpated (i.e., no longer exists in part of its native range, i.e., Nevada) represents an unfortunate loss and a reminder that careful resource management and development is essential for maintaining Nevada's biological diversity. The number of mapped rare species per thousand square miles is greatest by far in the Sierra Nevada ecoregion (81), followed by the Mojave (16), Great Basin (6), and Columbia Plateau (5) (Nevada Natural Heritage Program, 2001a).

Adequate habitat availability and quality largely determine the abundance and distribution of all wildlife species. Over the short term, wildlife populations and distribution fluctuates with winter precipitation patterns that in turn dictate seasonal plant growth and habitat conditions. Successive drought years can

be particularly stressful. Generally, the larger and more mobile animal species have adapted to extremely variable conditions by moving among suitable habitats, thereby maintaining healthy, widely distributed populations. Wildlife species restricted to small, unique habitat patches or with limited mobility are more sensitive and vulnerable to human alteration of the environment. Some of the most immediate wildlife diversity concerns occur where loss of unique, specialized native habitats is imminent. Yet, even mobile species are vulnerable to the cumulative fragmentation and deterioration of natural habitats. The range-wide decline of sagebrush ecosystems and sage grouse population is an example. Another example is found in the Mojave Ecoregion, where unique pool-, spring-, and pupfish populations that occupy widely distributed springs have been federally listed as threatened and endangered.

The vast openness of our state can give the impression that much remains wild and untrammeled. The practical reality is that the cumulative effects of land use and resource management activities, historically and today, have altered the structure, function, integrity, and biodiversity of wide-ranging and small, unique ecosystems. Progress in managing and improving remnants of native aquatic and terrestrial habitats, must keep pace with rapid population and economic growth. Otherwise, the likelihood grows that more species will be designated for mandatory protection under federal and state laws. By the time listing of a species as threatened or endangered has occurred, substantial ecological and economic losses and regulatory costs already are incurred, which are likely to extend far into the future.

Interest in balancing the land and water needs of human activities with those of native ecosystems has grown with Nevada's population. State, federal, and local government, industry, and citizens are working on joint conservation plans intended to ensure that viable populations of vulnerable species will be sustained. Relatively new tools include multi-species habitat conservation plans, conservation agreements, and the acquisition of conservation easements, land, or water rights. Also, resource managers are re-examining approaches to the control of floods, fires, and other natural disturbances for the purpose of determining how ecological benefits of such phenomenon can be safely and economically obtained. Species benefiting from specific collaborative initiatives include the Desert tortoise and other sensitive Mojave Desert species, the Amargosa toad, Columbia spotted frog, Lahontan cutthroat trout, Virgin River spine dace, and Greater Sage Grouse. However, 644 animal and plant species currently are considered to be rare or sensitive. Keeping these populations at safe levels while demand for land and water development expands will depend upon greater investment in coordination and advance planning to sustain existing high quality habitats and restore suitable sites.

Plants

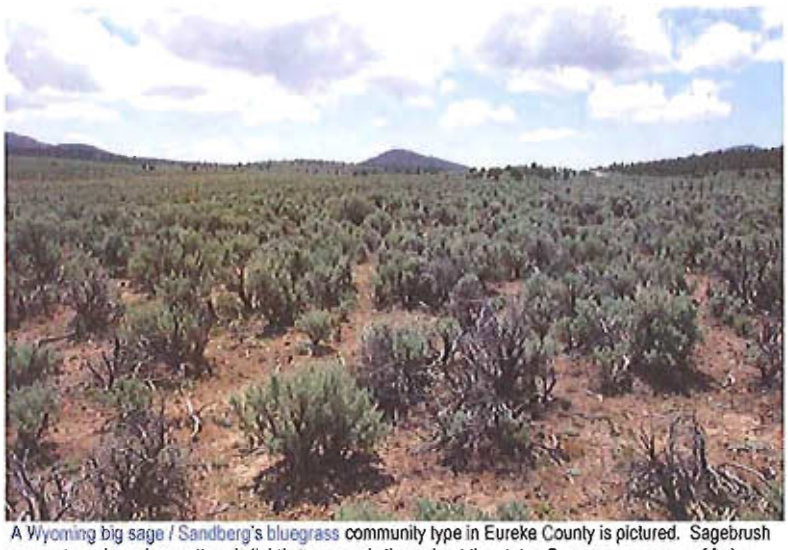
The foundation of healthy wildlife populations and habitats is a diverse mix of native plant communities. Nevada's floral diversity is enormous. Botanists estimate roughly that 2,800 native species live in the state, of which 139 are endemic. The great variability in vegetation provides many different habitat niches and promotes diversity of associated animal life found here. Many plants are annuals, only living above ground for a short period of time – a necessity where daytime temperatures can exceed one hundred degrees and annual evaporation exceeds four feet to eight feet north to south. Trees and shrubs have many physical adaptations to access and conserve water, such as enormous root structures, waxy leaves, and the ability to drop leaves and become dormant during extreme dry periods.

Vegetation occurs in broad patterns, or zones, that reflect physical and biological factors, including climate zone, geology, landform, soil type, and inter-relationships with other plants and animals. Vegetation zones consist of commonly associated species and are often classified by dominant plant species or position in the landscape. Since precipitation and temperature strongly influence the distribution and species composition of vegetation, the zones transition from south to north and from warm, dry valleys upslope to cooler, moister mountain canyons and ridges. In Nevada, vegetation zones are identified as alpine, montane, pygmy conifer, sagebrush, blackbrush, saltbush or shadscale, Lower Mojavean, and absolute desert. Sand dunes, riparian, and lakes and ponds are "azonal" features that occupy a relatively small area of each vegetation zone, but occur frequently. Within a zone, distinctive plant communities can be found, which are generally characterized as forest, woodland, meadows or grasslands, and shrublands (Charlet, 1998).

Because vegetation zones describe broad, landscape scale patterns of floral diversity, relatively rapid or distinctive changes in species composition, boundaries, continuity, or ecology of a vegetation zone should be seen as signals that significant natural or human stresses are at work and special management attention may be needed. The vegetation zones showing signs of extensive changes are the sagebrush, pinyon/juniper woodland, saltbush, and riparian zones. Contributing factors variously include excessive grazing by livestock, wild horses, and wildlife; expansions of non-native grass and weed species; suppression of wildfire in fire-maintained ecosystems; bigger and more frequent wildfires; a warming in certain climate zones; fertilization effect from higher atmospheric carbon levels; deteriorated watershed conditions; and, conversion of land for urban, agriculture, mining, and transportation developments. Two zones of special statewide concern are the riparian and sagebrush zones.

Historical loss and deterioration of riparian zones and wetlands is extensive. Occupying a small fraction of the landscape, riparian and wetlands contribute greatly to biodiversity, as well as the production of clean water. These areas produce large amounts of biomass that provide food and habitat for many forms of wildlife. Riparian zones are found in moist soil zones between open water and drier upland sites, and traverse all vegetation zones. Since water supplies are limited, the much wetter riparian areas have a greater concentration of birds, fishes, bats, insects, and plants. Riparian corridors are critical habitat for breeding, feeding, and migration, yet are also the most impacted by water diversions, grazing, and various other uses. According to one reconnaissance level study, more than half of the state's riparian and wetlands have been converted to other land cover types (Dahl, 1990).

The sagebrush is the state flower, but that is not why declining land coverage and quality of sagebrush habitats is of general concern. The sagebrush zone contains many subtly different plant communities covering an enormous portion of Nevada, about 30 million acres. Prior to settlement, native sagebrush communities commonly contained a mix of shrubs, grasses, and forbs. Since settlement, use of the Great Basin sagebrush zone for ranching, wild horses, and big game species has been emphasized. More recently, cheatgrass has invaded millions of acres, forming monocultures where fire recurred and occupying voids in the shrub understory where native grasses and forbs have been removed. In other parts of the sagebrush zone, the shrubs are overcrowded, which, coupled with flammable cheatgrass, creates extensive beds of fuel for wildfires. Wildfires of catastrophic proportions have become more frequent in altered sagebrush ecosystems. The decline in the state's sage grouse population is one of several landscape scale biological indicators that the functions and values of sagebrush ecosystems are serious and widespread. Comprehensive statewide assessments detailing the magnitude of loss and degradation of riparian and sagebrush zones in Nevada are generally lacking. Public discussion and decision-making about changes in the sagebrush zone would be better informed if more comprehensive scientific documentation concerning Nevada-specific circumstances was available. Detailed mapping and data analyses of the composition, ecological status, and threats to sagebrush and riparian plant communities is necessary to provide a modern



A Wyoming big sage / Sandberg's bluegrass community type in Eureka County is pictured. Sagebrush ecosystems have been altered slightly to severely throughout the state. Sparse occurrence of forbs and grasses between shrubs is indicative of the reduced plant diversity and cover found in intensively used sagebrush. Ecological changes can be subtle but substantial over time. Removal of understory cover reduces exposes soil to sun and erosion, invites nonnative weeds to invade, oversimplifies the food web, and alters the availability of usable forms of nutrients and energy. Photo by Eric Peterson, NNHP. 2002.

information base as part of the planning process to improve land use practices, management strategies, and rehabilitation and restoration techniques.

Fungi

For many people, the mention of "fungi" brings to mind mold in forgotten parts of the refrigerator, or mushrooms at the grocery. In fact, there are nearly 70,000 species of fungi known worldwide, and many thousands more as of yet unclassified. Fungi are very diverse and many are important. Consider the yeasts used to make bread or beer, *Penicillium chrysogenum* (the source of penicillin), the beautiful but deadly Amanita mushrooms, delicious wild morels that pop up in recently burned areas, and the ubiquitous lichens on trees, rocks, or even soil. While most people think of fungi as plants, they actually form their own kingdom separate from plants and animals. Surprisingly, fungi are more closely related to animals than to plants. However, fungi are far less studied than plants and animals, and this is especially true in Nevada.

No checklist of species exists yet for fungi in Nevada. However, the collection at the USDA's Systematic Botany and Mycology Laboratory in Maryland has nearly 1000 species of non-lichen fungi from Nevada, and there is a preliminary checklist of about 300 species of lichens. The total number of lichens extant in Nevada will likely double to about 600 before surveys are complete. Lichens are unusual fungi that host colonies of algae growing in close association. In this symbiotic relationship, the fungus receives energy stored by the algae through photosynthesis, and the algae reside in a more hospitable environment. While some lichens reveal the green color of the algae growing within them, most have strongly colored pigments, which shield the lichen from harmful UV radiation, much like a sun-screen lotion. Common colors include brown, white, yellow, and orange.

The slow growth of lichens on rocks in arid regions makes them useful to anthropologist for dating cultural events (e.g., the age of a petroglyph). Lichens perform many functions in ecosystems, including forage, nesting materials, and nutrient supply. Beard-like lichens in some of Nevada's conifer forests likely provide foods for squirrels and other mammals. Greater Sage Grouse have been observed eating lichens on rocks during Nevada's cold winters, probably to get liquid water when everything else is frozen. Perhaps the most important function of lichens in Nevada is the formation of biotic soil crusts. These crusts, which also include mosses and free-living algae, form a deeply textured cover over soil in the spaces between plants, primarily in non-forested arid lands. Many crust forming lichens convert atmospheric nitrogen to a nutrient form usable by plants, increasing the nutritional value of forage. Biotic soil crusts also reduce soil erosion and surface runoff by absorbing raindrop impact. Although more research is needed, preliminary data suggest that crusts can inhibit cheatgrass germination.

Crusts are very sensitive to ground disturbances. Intensive livestock grazing nearly eliminated biotic soil crusts from much of the western landscape. Where crusts remain, decades old off road vehicles tracks can be seen. Native grazers undoubtedly impact the continuity of crusts, but their numbers and population densities are much smaller. Crusts are also killed by severe wildfires, though apparently they can survive light fires. In the driest areas of the Mojave Desert, biotic soil crusts may require several centuries to re-occupy disturbed sites. Fortunately, in moister sagebrush habitats, crusts should begin to recover within a couple decades and form reasonably well developed communities after a few more decades.

Mammals

There are 128 native mammal species and subspecies recorded in the state. Sixteen are game mammals, and therefore subject to hunting regulations set by the State Board of Wildlife Commissioners and enforced by the NDOW. Nine mammal taxa are endemic to Nevada. Fifty-three are considered rare or sensitive. Nevada mammals are very diverse. Among them are tiny shrews and jumping mice, large elk, secretive nocturnal bats, not so reclusive black bears, snowshoe hare, and the fastest land animal in North America, the pronghorn antelope.

Large native mammal species compete with introduced mammals (e.g., livestock and wild horses). Estimated numbers of large native mammals, livestock, and wild horses populating Nevada's wildlands are presented in Table 3-2.

Table 3-2. Estimated Number of Large Native Mammals, Wild Horses and Burros, and Livestock in Nevada, 1999 and 1990.

Animal Group	1999	1990
Large Native Mammals	173,350	204,900
Mule deer	145,000	180,000
Pronghorn Antelope	16,000	18,500
Bighorn sheep	6,650	4,000
Elk	5,700	2,400
Wild Horses and Burros	25,100	29,455
Livestock	595,000	631,000
Cattle and Calves	510,000	530,000
Sheep and Lambs	85,000	101,000
Total	793,450	865,355

Sources: Nevada Division of Wildlife, Nevada Department of Agriculture, and Nevada Bureau of Land Management

Large mammals greatly add to the wild appeal of open space, perform important ecological functions, and provide recreation for wildlife enthusiasts. The desert bighorn sheep is Nevada's state animal and exemplifies historic population trends of many wildlife species. Desert bighorn were formerly found in most mountain ranges south of the Humboldt River. As the frontier population and ranching industry expanded, bighorn numbers were reduced because of over-hunting and competition with domestic livestock. Desert bighorn disappeared over most of their range. Only small isolated groups were found in the southernmost mountain ranges. There, conditions were too severe for domestic livestock or large settlements. Wildlife interest groups, federal agencies, and the NDOW have reintroduced desert bighorn into most of their former range. The population has grown to approximately 5,000 animals.

Similar efforts for California bighorn sheep and Rocky Mountain bighorn sheep have resulted in stable populations of these animals in suitable habitats throughout the state (Table 3-3). Mountain goats and Rocky Mountain elk have also been successfully introduced into Nevada. Exotic mountain goats are found in the East Humboldt and Ruby mountain ranges in Elko County. The special habitat requirements for goats limit their range substantially. Exotic mountain goat populations are estimated at 260 animals. Elk, which do not have such special habitat requirements, are currently found in several locations in northeastern and central Nevada. Elk populations continue to expand due to immigration from adjoining states, growth of established herds, and transplanting by the NDOW. About 5,700 elk currently inhabit the state.

Table 3-3. Large Mammal Population Estimates for Select Years

Year	Mule Deer	Pronghorn Antelope	Elk	Desert Bighorn	California Bighorn	Rocky Mtn. Bighorn
1990-91	180,000	18,500	2,400	3,996	-	-
1995-96	132,900	14,800	4,000	4,945	1,085	329
1999-00	145,000	16,000	5,700	5,000	1,400	250

Source: Nevada Division of Wildlife, 2000.

Mule deer is the most common wild ungulate found in Nevada today. However, mule deer numbers were much lower prior to settlement. Wildlife biologists relate the "explosion" of mule deer during the first half of the 1900's to removal of woodlands, forests, and native grasses and replacement by shrub-dominated communities. The vegetation changes came about primarily by excessive livestock grazing and clear-cutting of trees for mines, mills, and towns. Also, deer predation by mountain lions was sharply curtailed while aggressive hunting, trapping and poisoning occurred. In 1988, the statewide deer population hit a record peak of 251,000 animals. Subsequently, a seven-year drought followed by a severe winter reduced the population by half. In 2000, wildlife biologists estimated 145,000 mule deer inhabited the state. Herd sizes naturally fluctuate with extreme weather and corresponding changes in habitat conditions (Nevada Division of Wildlife, 2001). Longer-term changes that affect the suitability of rangeland for large deer herds include nonnative plant invasions (especially cheatgrass), and large wildfires, and overcrowded forest and woodlands.

American pronghorn antelope inhabit expansive open rangelands throughout Nevada. Forbs and browse, including sagebrush, bitterbrush, and rabbitbrush, make up most of their diet. Pronghorn generally eat different plants than cattle. Sometimes they migrate between summer and winter ranges. Due to limited jumping capability, improperly designed fences can block their movement. During settlement of the West, pronghorn numbers declined from an estimated 35 million to 13,000. Populations are gradually rebounding after decades of complete protection and special management programs. Photo by Pete Rissler.

Pronghorn antelope are native mammals, unique in their ability to run fast and survive under harsh conditions. Reaching speeds of 60 to 70 miles per hour, the pronghorn is North America's fastest land mammal. Not a true antelope, the pronghorn is the only living representative of a group of ungulates that evolved in North America. The West-wide pronghorn population declined to critically low levels by the early twentieth century. Factors in their near demise were over-hunting, habitat conversion, and competition with livestock for food. During the 1990's, the state's population of pronghorn fluctuated, roughly in proportion to mule deer population changes (Table 3-3). Live trapping and transplanting along with habitat improvement projects, primarily guzzlers (i.e., small, artificial water development designed to trap and store runoff), help maintain pronghorn population and distribution. Their preferred shrub/grassland habitat consists of lower growing (less than 24 inches), well-spaced shrubs with plentiful forbs on rolling to flat slopes at low to moderate elevations. Fawns predation is likely to be higher where shrubs are overgrown. Improvements in grazing practices and management of livestock distribution can also improve the suitability of rangeland for pronghorns (U.S. Department of Agriculture, 2002).

Mountain lions and black bears are the largest predators in Nevada. Both are classified as game animals, though bear hunting is not allowed. Mountain lions are widely distributed and are found in most mountain ranges. Region-specific annual quotas are set to control mountain lion sport harvest. Lions can also be hunted to protect livestock under the authority of depredation permits issued to the U.S. Dept. of Agriculture. The highest harvest on record occurred during the 1997-98 period, when 230 lions were taken by both sport and depredation hunters. In 1999-2000, 144 animals were taken. Mountain lion populations peaked in the mid 90's as the result of high mule deer populations and since have declined with deer numbers. Mountain lion are secretive, so the population is difficult to estimate. Overall, lions are believed to be secure and in balance with the prey base.

Black bears occupy a limited area of Nevada, mainly along the east side of the Sierra Nevada Range and in the Carson Range. In the Sierra Nevada and Carson Ranges, bear populations are at high densities. The number of confrontations between bears and humans is rising as western Nevada urban areas expand. Subdivisions built in the mountains and foothills encroach into bear habitat and displace food supplies. Residential, commercial, and campground developments often attract bears where garbage is not properly managed. Bears have adapted to the more reliable supply of garbage, and young bears are developing the same foraging habits. In addition, the intensity of backcountry travel and mountain oriented recreation has increased. The Nevada Division of Wildlife (NDOW) and the University of Nevada, Reno are currently studying the status and habits of black bears in the urban interface along the Sierra front and Tahoe Basin. The black bear population is estimated to exceed 200 animals.

A variety of mid to small sized mammals inhabit the state. In addition to fur bearers listed in Table 3-4, other mid to small sized mammals include river otter, pine marten, ringtail, weasel, and ermine are other mid to small sized mammals. In some situations these mammals are seen to be a nuisance, but overall they are critical to healthy ecosystems. For example, beaver and muskrat are removed from irrigation and domestic water systems to alleviate disease concerns and to prevent damage to water distribution structures. However, ponds created by beaver dams create special aquatic and riparian habitats and

enhance water resources. The carnivorous furbearers keep populations of rodents and rabbits in check, and some eat carrion, which may otherwise be a source of disease.

Table 3-4. Fur Sales in Nevada 1999-2000

Species	Number Sold
Bobcat	691
Coyote	243
Grey Fox	147
Kit Fox	39
Beaver	112
Muskrat	979
Mink	2
Badger	13
Raccoon	18

Source: Nevada Trappers' Association.

Ten mammals are classified by NDOW as furbearers. Historically, furbearers were important commercial species. In recent years, market demand for fur has decreased significantly, lowering commercial trapping activity (Table 3-4). Relatively little biological information is available on these important mammals.

Many small mammal species inhabit a great variety of niches, from (sub)alpine mountaintops, along riparian zones, to sand dunes. Of the nine mammal species and subspecies endemic to Nevada, the only full species is the Palmer's chipmunk (*Tamias palmeri*). It lives in the Spring Mountains, near Las Vegas. Palmer's chipmunk is one of 16 North American mammal species that became isolated in "mountain islands" as the climate and vegetation shifted to drier conditions. Rodents, which include desert dwelling kangaroo rats and a variety of mice, rats, squirrels and ground squirrels, gophers, and voles, perform important ecological functions, such as seed dispersal and soil aeration. The range of a different type of beaver, the mountain beaver (*Aplodontia rufa*), extends into riparian areas of the Sierra Nevada's in western Nevada. Pygmy rabbits and five other species of rabbits and hares are widespread. The pika, a relation of the rabbit, occupies alpine talus slopes. Several species of shrews and one mole species also live in Nevada.

Twenty-three species of bats are found throughout the state. Bats are well known for their nocturnal feeding habits, consuming large quantities of insects. One species, the Mexican long-tongued bat (*Choeronycteris mexicana*) feeds on the nectar and pollen of Mojave Desert plants. All bat species are considered rare or sensitive (Nevada Natural Heritage Program, personal communication, 2002). However, only the spotted bat is designated as a threatened species and protected by state law. Bats inhabit or utilize many niches. These include abandoned mines, urban structures, caves, cliffs, springs, riparian, aspen, pinyon-juniper, and desert shrub habitats. Though bats benefit the environment and mankind in many ways, bats are misunderstood and feared. Unfounded fear coupled with habitat loss among other factors has caused many bat populations to decline. A bat conservation plan has been developed by the Nevada Bat Working Group, which includes the NDOW and NNHP (Bradley et al., 2002). The purpose of this Plan is to reduce the threats to bat populations and their habitats, and also to reduce the risk that any bat species in Nevada will require protection under the Endangered Species Act. Because bats are part of a much larger ecosystem, the goal of the Plan is to promote healthy bat habitats and stable and/or increasing bat populations throughout western North America.

Five mammal species are classified as protected and another as threatened. With the exception of the pika (*Ochontona princeps*), all mammals classified as protected inhabit the eastern Sierra Nevada ecoregion. The mammals are mountain beaver (*Aplodontia rufa*), Douglas squirrel (*Tamiasciurus douglasi*), northern flying squirrel (*Glaucomys sabrinus*), and western gray squirrel (*Sciurus griseus*). The spotted bat (*Euderma maculatum*) is the only mammal species designated as threatened in Nevada. Many wildlife species that inhabit the mountains around Lake Tahoe and the east Sierra Front are at the eastern edge of their range. The number of protected mammals highlights the unique biology of the mountain range, and the encroachment of urban development into wildlands.

Birds

Nevada is home to a large and diverse group of resident and migratory bird species. However, birds are mobile, so none of the 283 native species are considered endemic. The popularity of bird watching has grown steadily. Premier bird viewing areas can be found throughout the state, including urban areas

such as Oxbow Nature Center in the heart of Reno and the Henderson Bird Preserve in the Las Vegas metropolitan area. Large wetland complexes in northwestern and northeastern Nevada attract large populations of many migratory shorebird, waterfowl, and wading bird species. The Bird Conservation Plan (1999), prepared by Nevada Partners in Flight, provides comprehensive information about nongame birds that are of special conservation concern (Table 3-5).

Table 3-5. List of Species of Concern in the Nevada Partners in Flight Bird Conservation Plan (1999)

Greater Sandhill Crane	White-faced Ibis	Snowy Plover
American Avocet	Black Tern	American White Pelican
Clark's Grebe	Long-billed Curlew	Northern Goshawk
Prairie Falcon	Ferruginous Hawk	Cooper's Hawk
Swainson's Hawk	Short-eared Owl	Burrowing Owl
Flammulated Owl	Orange-crowned Warbler	Black-throated Gray Warbler
MacGillivray's Warbler	Virginia's Warbler	Lucy's Warbler
Grace's Warbler	Wilson's Warbler	Black Rosy Finch
White-headed Woodpecker	Western Bluebird	Cooper's Hawk
Southwestern Willow Flycatcher	Olive-sided Flycatcher	Ash-throated Flycatcher
Gray Flycatcher	Willow Flycatcher	Lewis's Woodpecker
Red-naped Sapsucker	Western Yellow-billed Cuckoo	Bobolink
Bank Swallow	Blue Grosbeak	Yellow-breasted Chat
Phainopepla	Loggerhead Shrike	LeConte's Thrasher
Scott's Oriole	Calliope Hummingbird	Vesper Sparrow
Black Rosy Finch	Juniper Titmouse	Pinyon Jay
Gray Vireo	Sage Sparrow	Sage Thrasher

Source: Nevada Working Group, Partners in Flight, 1999.

State wildlife regulations classify birds as upland game, migratory game, protected, or unprotected. Continental and local declines in numerous bird populations have led to concern for the future of migratory and resident bird species, regardless of game of nongame designation. The reasons for declines are complex, largely the result of habitat elimination, conversion, and fragmentation, including critical wintering and migratory habitat. With data on nongame birds sorely lacking, scientists, government agencies and the concerned public have become engaged in conservation initiative focusing on nongame landbirds, waterfowl, and shorebirds. Collaborative conservation and data collection efforts include the Nevada Working Group of Partners in Flight, the Great Basin Bird Observatory, and the Intermountain West Joint Venture component of the North American Waterfowl Management Plan (Nevada Partners in Flight, 1999).

Fifty game bird species may be found in the state, many of which are introduced. Sixteen birds are classified as upland birds, of which eight are native to Nevada and eight are introduced. The native game birds are Sage Grouse, Blue Grouse, Sharptail grouse, Mountain Quail, and Gamble's Quail. Greater Sage Grouse numbers and distribution have declined throughout Nevada and the western U.S. As with other species in decline, a major factor is habitat loss or alteration - the cumulative effects of land and water development that, in this case, converted and fragmented the Great Basin sagebrush and sagebrush steppe ecosystems. Historic grazing, cheat grass, and wildfires are among the negative impacts. Nevada Sage Grouse have a stronger reliance on wetlands and riparian areas for their survival, due to the short precipitation season. Since 1970, Greater Sage Grouse numbers have decreased between 49 and 60 percent. Meanwhile hunting harvest declined by 72 percent. A statewide strategy was adopted in 2001 to establish regional cooperative working groups that will design and implement scientifically sound management plans to ensure that the Greater Sage Grouse and healthy habitat areas does not continue to decline (Nevada Division of Wildlife, 2001).

The Sage Thrasher requires dense stands of tall sagebrush. Breeding adults conceal nests in or underneath a shrub. An important characteristic for nest placement is consistent foliage density, which protects the young from temperature extremes and predators. Sage Grouse prefer low sagebrush expanses during portions of their life cycle. Sage Grouse and Sage Thrashers are examples of "sagebrush obligate" species with differing sagebrush habitat requirements. These differences exemplify one of the challenges in managing diversity within sagebrush ecosystems. Photo by Paul Slichter.

Several species have been introduced in natural and altered habitats (e.g., farmland) to provide more hunting opportunities. Chukar, originally from India and Pakistan, have adapted to the drier, rockier terrain of northern Nevada and are the most common upland game bird found in the state today. Hungarian partridge have been introduced into areas with similar habitats. The efforts of sportsmen's groups and the NDOW to build water collection devices in dry habitat have substantially increased the range and population levels of Chukar. A similar effort in southern Nevada has greatly expanded the range of Gamble's quail. Over 1,000 guzzlers have been constructed to provide water for wildlife in areas where natural supplies are limited or nonexistent. Himalayan Snowcock occupy a narrow habitat range above tree line in the Ruby and East Humboldt mountain ranges of Elko County. Ring-necked and White-winged Pheasants are imports from Asia and small numbers now inhabit agricultural valleys in northern Nevada. Wild Turkeys from Texas and California also have become established in several agricultural areas. California and Scaled Quail are also successful transplants to Nevada. Upland game bird population levels are highly influenced by climatic conditions. The NDOW uses annual hunting data to monitor population trends (Table 3-6). Biologists typically require more information than quotas and harvest data to evaluate the robustness or vulnerability of populations. Biological factors to consider include the quality and distribution of habitat conditions and the population size and trend of the species and its predators. Hunting factors could include weather and climate, hunting pressure, skill, and chance.

Table 3-6. Upland Game Bird Harvest for Selected Species

Year	Sage Grouse	Blue Grouse	Chukar	Quail	Pheasant
1969	23,270	767	124,353	107,287	2,938
1979	28,228	3,123	151,270	171,972	6,072
1989	9,445	2,303	82,464	30,632	1,246
1999	6,070	1,702	105,655	54,996	990

Source: Nevada Division of Wildlife, 2000.

Migratory game birds include species found in the Families Anatidae (wild ducks, geese, brants, and swans), Columbidae (wild doves and pigeons), Gruidae (little brown cranes), Rallidae (rails, coots, and gallinules), and Scolopacidae (woodcocks and snipes). These species depend on aquatic habitats and/or wetlands. Large numbers of each are found in the state during certain seasons as exemplified by estimated peak waterfowl populations shown in Table 3-7. Each year is different. Seasonal site-specific environmental conditions influence the abundance and distribution of different birds. Winter precipitation is an important short-term key to wetland habitat availability and maintenance. Significant wetland losses in the state have had an affect on water dependent bird populations, as well as other resident and migratory birds. For example, Mourning Dove and White-winged Dove populations fluctuate in response

to moisture dependent habitat conditions. Dove populations have shown a long-term downward trend, possibly due to changes in agricultural practices and drought years.

Table 3-7. Estimated Peak Waterfowl Population on Select State and Federal Wildlife Areas, 1988 – 1997

Species	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Ducks	180,858	243,028	151,936	95,563	71,357	174,580	108,064	360,631	334,273	450,148
Geese	10,361	15,959	28,658	7,663	8,462	38,561	11,252	34,557	15,249	14,768
Swan	2,785	2,042	2,227	383	813	2.390	1,971	2,324	5,543	8,225
*Res. Storage	348,800	244,600	225,400	92,200	101,900	163,300	189,200	239,200	357,100	426,000

Source: Nevada Division of Wildlife
Note: * March 1 Reservoir Storage for Lahontan and Rye Patch Reservoirs

Approximately 235 non-game bird species occur in Nevada for all or part of their life cycle. This does not include the "accidental" occurrence of migrants that find their way here due to weather events or other misguidance. (In 2001, a Sabine's Gull, an arctic open-ocean bird, was observed in northwestern Nevada.) Historical information on the populations and trends of most nongame birds is quite limited. Birds occur in all habitats and life zones with the largest number of species utilizing water-associated habitats.

Twenty-five species of raptors are represented in Nevada, and a major raptor migratory corridor passes through the state. Favorable wind patterns tend to funnel major migrations of raptors through concentrated areas, making Nevada one of the premier spots to watch and monitor migrating raptors. Spring and fall migrating raptors are regularly monitored at Goshute Peak in eastern Nevada. Raptor populations are useful to wildlife researchers because they provide clues about the health of the environment. Raptors are also popular with wildlife watching and photography enthusiasts.

Passerines (i.e., perching songbirds) such as warblers, sparrows, finches, and flycatchers comprise 60 percent of the non-game species. Water and shorebirds, cranes, woodpeckers, hummingbirds, swifts, and kingfishers are among the other groups represented in our state. All wild birds, with the exception of the starling and house sparrow, are covered by the Federal Migratory Bird Treaty Act, and are further protected from shooting or capture by State wildlife regulations.

Amphibians and Reptiles

Sixteen native amphibians occur in the state. Amphibians generally require access to water and/or moist habitat conditions throughout their life cycle, and therefore are limited in number and distribution in Nevada. The Vegas Valley leopard frog (*Rana fisheri*), one of six native frogs, has gone extinct. The bullfrog (*Rana catesbeiana*) is one of two introduced amphibian species. It has become a dominant species in marsh and pond habitats, and preys on the young of native amphibian, fish, and reptiles. The bullfrog is the only amphibian game species. Two other native frog species, the relict leopard frog (*Rana onca)*, and the Columbia spotted frog (*Rana luteinventris)* are classified as protected by state law.

The Amargosa toad (*Bufo nelsoni*) is one of nine native toad species. It is the only one classified as state protected. The toad is endemic to a small area in the Oasis Valley in the midst of the Amargosa Desert (southern Nye County). While springs and ponds are essential habitat for young toads, adults can tolerate drier habitat patches. Adults find shelter under bushes, woody structures, rocks, and rodent burrows. In the past, the limited habitat for this species was subjected to a variety of land disturbances that threatened its existence. A cooperative planning process involving federal and state agencies, Nye County, The Nature Conservancy (TNC), ranch owners and others produced a species conservation agreement. The Agreement sets specific conservation actions for the long-term survival of the toad. TNC also acquired a Wetland Reserve Program easement from a ranch owner, in concert with the Nevada NRCS. Other native toads occupy a variety of habitats, some relatively common and widely distributed, and others rare with narrow ranges.

The state's desert habitats are well suited to the 54 native reptile species. Thirty-six species are allowed to be collected commercially with a permit from NDOW. Commercial collectors provide reports on the number of reptiles collected. In the period 1992-1997, 138,871 individuals were collected; an amount 10 times greater than the quantity taken between 1986-1991 (10,679 individuals). Ninety percent of the collected reptiles consisted of four species that occur in northwestern Nevada. Baseline population and distribution data are lacking for most reptile species, so the long term effects of commercial collecting and unlimited reptile harvesting are unclear.

The relict leopard frog, similar to the Amargosa toad, inhabits wetland patches in the Mojave Desert that contracted as the climate warmed and dried during recent millennia. More currently, water diversions and dams have impaired remaining habitat patches. Early records indicated the relict leopard frog lived in 64 locations. The species was thought to be extinct for 40 years until the 1990's, when eight populations were found. Two have been lost since then. Surviving populations are located at springs on the Lake Mead National Recreation Area. Agencies, such as NNHP, provide current information on the status, biology, and threats to sensitive species populations, an important step in conserving the state's biodiversity and avoiding strict regulations. Photo by Ross Hayley, NPS.

Two fully protected reptiles are the desert tortoise (*Gopherus agassizii*) and the banded Gila monster (*Heloderma suspectum cinctum*). The desert tortoise is the state reptile. It is federally listed as a threatened species. Special adaptations have enabled the tortoise to live in the extreme heat and dryness of the Mojave Desert ecoregion, such as being diurnal (i.e., an early bird and night owl), a thick shell to conserve water, and the ability to excavate their own burrow in order to beat the heat of the day. The Clark County Multi-species Habitat Conservation Plan is intended to protect desert tortoise and other special status species of the Mojave Desert at risk from rapid development, off-highway vehicle use, and other urban related threats.

Fishes

Ninety-one native fishes occur in a variety of aquatic habitats. Of that total, 53 are endemic species and subspecies. The number of fishes unique to Nevada is large because thousands of year ago, large postglacial lakes and streams receded. Remnant water bodies became more isolated as the climate became increasingly arid. Over time, separated populations of fish species adapted to changes in stream flow quantity and patterns as well as changing water quality conditions. During centuries of isolation and adaptive change, surviving fish species became genetically unique. Some very rare fishes live in a single spring or stream.

One of many examples is the Devils Hole pupfish, which lives in one deep-water pool at Ash Meadows National Wildlife Refuge. The pupfish was nearly extirpated in the 1970's when the level of the pool was drawn down by pumping from groundwater wells near Ash Meadows. Native fishes living in small water bodies are all the more vulnerable to the combined threats of drought and human activities that change the amount of water in the system, modify the habitat, or introduce more competitive foreign species. The Devils Hole pupfish is one of thirty-two fish species classified as protected, threatened, or endangered by state law. In addition, 11 fishes are designated sensitive by state law (Nevada Administrative Code 503.065). Sixty-three taxa are considered rare or sensitive by the NNHP.

More than 200 reservoirs and lakes and 500 streams are distributed throughout the mountains and valleys. A variety of cold and warm water fisheries are maintained for angling. Many species of non-native game fish have been introduced into these waters. Notable game fish are rainbow, brook, and brown trout, largemouth bass, several species of catfish, perch, walleye, and striped bass. Another introduced species, the carp, was originally hailed as a fabulous food and game fish. Now ubiquitous, carp have proved to be a scourge and virtually impossible to eradicate. Most sport anglers concentrate on non-native species, populations of which are either self-sustaining or supplemented by hatchery stock.

The Lahontan cutthroat trout (LCT) is the state fish. Native to the Great Basin, the LCT was once widely distributed throughout northern Nevada. A close relative is the Bonneville cutthroat, which populates mountain streams and lakes within the Lake Bonneville Basin in easternmost Nevada. The LCT has a lacustrine (lake dwelling) and a fluvial (stream dwelling) form. The lacustrine strain lives in Pyramid, Walker, and Summit lakes. The fluvial (stream dwelling) fish occurs in the Humboldt River system, isolated streams in northwestern and central Nevada, and tributaries of the Truckee, Carson and Walker River tributaries.

Lahontan cutthroat trout, a native of desert and montane streams and lakes, occupies only about 10 percent of its historic habitat. In many places, stream and lake ecosystems are impaired by changes in water quantity and quality, channel structure and stability, riparian plant cover, and nonnative fishes. Other sensitive native trout species, such as Bonneville cutthroat trout, inland Columbia Basin redband trout, and bull trout, exist in similar limiting conditions. Cooperative restoration projects on Marys River, Eightmile Creek, Maggie Creek, East Fork Quinn River, and others show streams can be mended to benefit fishes, songbirds, waterfowl, wading birds, upland birds, and mammals. Conditions for outdoor recreation and grazing also improve. Photo by Pete Rissler.

The FWS designated LCT as a threatened species because populations throughout much of its native range have been eliminated. Reasons for this decline include alteration of stream channel and riparian habitats; water diversions that reduce stream flow and lake levels; impaired water quality in lower river reaches and terminal lakes (e.g., Walker and Pyramid lakes); dams and other obstructions to migration; and, the introduction of non-native game fishes and other competitive animals. Substantial efforts to improve the fisheries and increase the number of water bodies maintaining reproducing LCT populations have been undertaken by the FWS, NDOW, Pyramid Lake and Summit Lake Paiute Tribes, and others. Gains have not been sufficient to remove LCT from the Endangered Species List. An implementation plan for the improvement of the Truckee River system is being developed to assist in the recovery of the LCT and endangered cui-ui. Maintenance of recreational fishing opportunities is a goal of the planning process. A planning process has also been initiated by the FWS for LCT in the Walker and Humboldt River systems and in northwestern Nevada (U.S. Fish and Wildlife Service, 2001).

To sustain popular lake and reservoir fisheries, resource agencies in Nevada operate seven fish hatcheries and rearing stations. Three are run by NDOW (Mason Valley, Lake Mead, and Gallagher near Elko), three by the Pyramid Lake Paiute Tribe (Dave Koch and David Dunn at Sutcliffe, and Numana near Wadsworth), and one by the FWS (Lahontan, near Gardnerville). Native fishes on the Endangered Species List and introduced species are produced at the hatcheries. The April 2001 NDOW fish stocking update reported over 51,500 rainbow and brown trout, and almost 82,800 hatchery-reared Lahontan cutthroat trout were planted in Nevada waters. Almost all the cutthroat trout were placed in Walker Lake, with a small fraction going into Topaz Lake. About 99 percent of the other trout species were planted in 15 lakes and reservoirs located in both rural and urban areas. The Carson and Truckee rivers received the remaining one percent. In a May 2001 update, NDOW reported planting another 200,000 rainbow, brown, and rainbow-cutthroat hybrid trout were planted in many rivers, creeks, and reservoirs. The NDOW data do not include fish plantings by the Pyramid Lake Paiute Tribe nor the FWS.

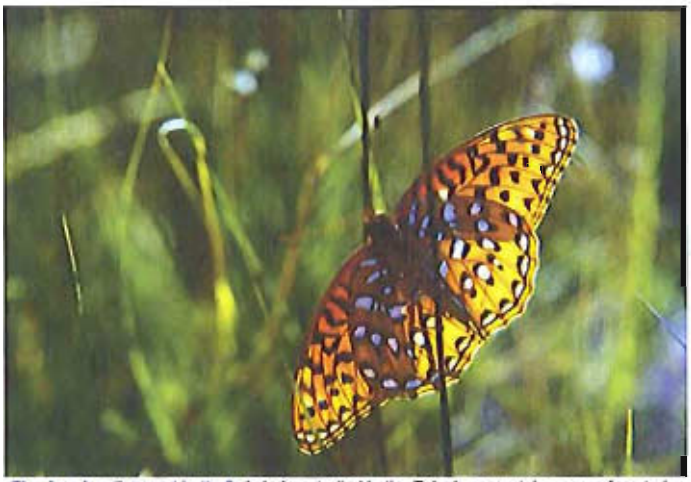
Other groups of native fish species include various minnows, (e.g., dace, chubs, shiners) (*Cyprinidae* Family), suckers (*Catostomidae* Family), pupfishes (*Cyprinodontidae* Family), and several springfishes and poolfishes (*Goodeidae* Family). Like many other fishes, these have evolved into numerous distinct forms in isolated water bodies. For example, the nearest relative of poolfishes in Nevada occurs in central Mexico, and nowhere else in the U.S. An important lakesucker species is the cui-ui, unique to Pyramid Lake and important to the Pyramid Lake Paiute Indian Tribe. The cui-ui population declined early in the 1900's when dams, diversion, channel erosion, and delta formation blocked access to

essential fresh water spawning habitat in the lower Truckee River. Cui-ui are hatched and reared at the Dave Koch hatchery as part of the effort to recover this endangered species.

Invertebrates

An overlooked group of organisms is our invertebrate population. Although there is much to still be learned, worldwide diversity among this group is probably higher than all other wildlife combined. Invertebrates occupy virtually all habitat types even lightless caves, alpine tundra, and searing sand dunes. Invertebrates play a critical role in pollination and are an essential food source of insectivorous predators higher on the food chain.

Butterflies are a relatively well-known group of invertebrates. Nevada ranks ninth among all states in the diversity of resident or regularly occurring colonies of butterflies. Butterflies are found in almost every habitat type. Some butterflies, such as the painted lady (*Vanessa cardui*), are migratory, while others are specialized residents of narrow habitat types. Incredibly, the Sand Mountain blue (*Euphilotes pallescens arenamontana*) inhabits only one sand dune in Churchill County. In addition to the showy characteristics and bright colors that provide us with an immeasurable aesthetic resource, butterflies also perform the critical ecological function of pollinating many types of plants. There are approximately 200 species and 170 additional subspecies of butterflies known to exist in Nevada. Thirty-one taxa are endemic. In most cases, butterflies rely on only one or a few closely related plant species to feed and lay their eggs. In central Nevada mountain riparian zones, the Apache silverspot butterfly (*Speyeria nokomis apacheana*) requires a single violet species during its larval stage, and four thistle species for nourishment as an adult. The high degree of habitat specificity makes such butterfly species all the more vulnerable.



The Apache silverspot butterfly is being studied in the Toiyabe mountain range of central Nevada. Biologists are learning about factors affecting the absence or presence of breeding populations of animal species requiring specific habitat types. Field research shows the Apache silverspot is very particular about plants used during life cycle stages. Suitable breeding habitat patches contain a singular violet species and select thistle species that co-occur in riparian areas. The study found that the presence of breeding populations was more related to plant composition and vegetation structure than the size or proximity of suitable habitat. Such research provides valuable information to land use managers responsible for sustaining sensitive species, among other conservation goals. Photo courtesy of Erica Fleischman, Stanford University, Center for Conservation Biology.

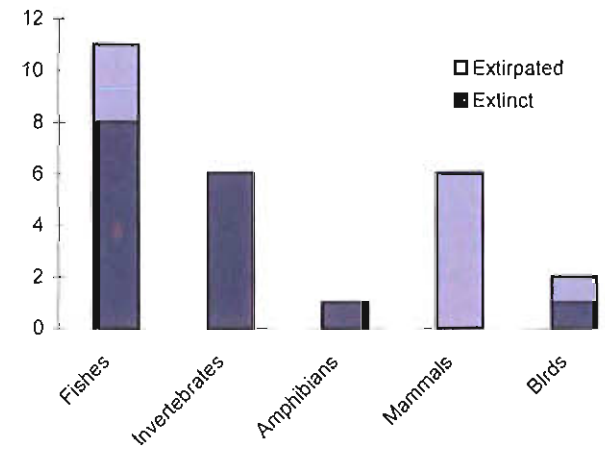
Springsnails are an interesting group of invertebrates. These freshwater, gill-breathing mollusks occur throughout North America, primarily in springs. In Nevada, many species specialize in extreme habitats including springs with temperatures ranging from 37° F (3° C) to 111° F (44° C). More species of *Pyrgulopsis*, the largest genus of springsnails, occur in the Great Basin than anywhere else in the U.S. Most springsnail 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 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 invertebrate populations, their distribution, conservation status, and special ecological functions. Currently, no invertebrates are afforded state protection. As scientists continue to monitor and survey populations, undoubtedly new species will be described and more will be learned about Nevada's exceptional diversity.

Endangered, Threatened, and Sensitive Fauna and Flora

The loss of plants and animals changes ecosystem functions in ways difficult to predict or observe, until serious impacts arise. Once species have been eliminated from the state or even a portion of the state, restoring the lost species and ecological functions may be difficult, if not impossible. An example is the removal of perennial grasses and forbs from large portions of Nevada's sagebrush and sagebrush steppe vegetation zones. As shrubs and cheatgrass filled the voids, the stage was set for large, intense wildfires and the accelerated invasion of non-native annual weeds and grasses. Actions that subtract species from the total mix of native plant and animal communities are not small matters.

Figure 3-3. Nevada Wildlife Losses



Source: Nevada Natural Heritage Program, 2001.

The use and development of Nevada's natural resources unfortunately has resulted in losses of native fishes, mammals, and birds. Many animal species have become extinct or have been extirpated (i.e., no longer inhabit Nevada, but still occur elsewhere) (Figure 3-3). A total of 26 taxa no longer exist in Nevada. Sixteen are extinct and ten are extirpated. A majority of the extinct species lived in aquatic environments, including springsnails, fishes, and one amphibian. These losses highlight the sensitivity of these ecosystems to dewatering, as well as the alteration of stream channels and riparian vegetation. As the growing population and economy increases demands placed on Nevada's limited water resources, there is a corresponding need for innovative water management solutions to sustain aquatic habitats and species from additional losses. Currently, records do not indicate that any plant species has been completely extinguished from the state. However, many plant species are declining and no longer occupy much of their former range.

Threatened and Endangered Species

Forty plant and animal species or subspecies are on the federal List of Endangered and Threatened Wildlife and Plant Species. Overall, 644 taxa are considered rare or sensitive in Nevada (Table 3-8). The loss and fragmentation of native habitats and competition by nonnative species are the biggest threats to biodiversity. Activities associated with habitat loss and deterioration include urban sprawl; surface water diversions; overgrazing by domestic and wild animals; mineral development and exploration; and concentrated outdoor recreation, especially involving careless off high vehicle use. Wildfires and non-native plant invasions have destroyed millions of native habitat acres in recent years. Proactive habitat conservation has become vitally important.

The regulatory approach to conserving Nevada's most imperiled plants and animals is based on federal or state programs that designate, study, and plan for the protection and recovery of threatened and endangered species and their habitats. The U.S. Fish and Wildlife Service (FWS) administers the federal Endangered Species Act of 1973 (ESA), as amended. As the lead agency for ESA implementation, the FWS has responsibility for ensuring that threatened and endangered species will be sufficiently protected and can survive in their natural habitat. Public or private land use activities that may jeopardize listed species must be permitted and a plan approved to avoid, minimize, or mitigate the taking of individuals of endangered or threatened species. Endangered means a species of plant or animal is in danger of being eliminated throughout all or a portion of its range. Threatened means a species is likely to become endangered in the foreseeable future. The FWS has designated, or "listed", 24 distinct Nevada taxa as

endangered and 16 as threatened (Table 3-8). In addition, the BLM and the USFS manages 234 sensitive and rare taxa.

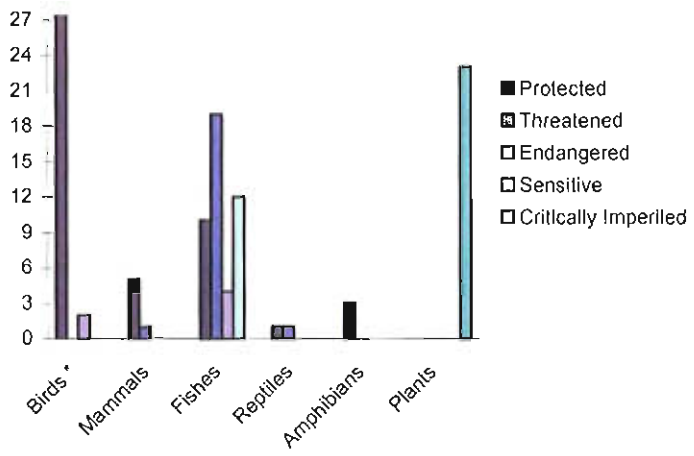
Table 3-8. Number of Rare and Sensitive Taxa in Special Protection Designations by Federal and State Agencies In Nevada

	FWS Threatened or Endangered	BLM Sensitive and Rare	USFS Sensitive and Rare	NDOW & NDF State Protected	NNHP Sensitive and Rare
Amphibians	0	3	3	3	6
Birds	6	35	17	30*	48
Fishes	23	48	13	45	61
Mammals	0	19	13	6	40
Reptiles	1	3	2	2	6
Invertebrates	1	38	3	0	169
Plants	9	129	103	25	297
Total	40	275	154	111	627

Sources: Nevada Natural Heritage Program website: www.state.nv.us/nvnhp.
Note: *Nevada Administrative Code 503.015 through 503.080 protects all nongame birds that are protected under Federal laws, in addition to the 30 species listed.

Of the 40 species federally listed as endangered or threatened, 37 are protected under state statutes and regulations administered by NDOW and NDF. Under state law, a species may be designated as protected, threatened, endangered, or sensitive. Capturing, removing or destroying plants and animals on the state's fully protected list is prohibited unless a special permit has been obtained from the state Divisions of Forestry and Wildlife. Of the 86 wildlife species protected under Nevada Administrative Code 503.050, most are fishes (45) and birds (30) (Figure 3-4, Table 3-7).

Figure 3-4. State Protection Designations for Flora and Fauna



Source: Nevada Natural Heritage Program, 2001.
Note: *NAC 503.050 protects all nongame birds that are protected by Federal laws in addition to the 30 species included

The NDF administers a regulatory program (NRS 527.270, NAC 527.010) that requires a permit to be obtained prior to removal or destruction of any of the 23 "critically listed" native flora species or its habitat. Adoption of new regulations during 2000 for the native flora program provides for establishment of special management areas for critically endangered plants. Specific management area plans are required so that native flora can be protected while land and resource uses can continue.

An example is the Steamboat buckwheat (*Eriogonum ovalifolium* var. *williamsiae*), which occupies a single site in the Steamboat Springs geothermal area of Washoe County. An established management area and plan provides for the coexistence of an operating geothermal power plant and the habitat conditions necessary for plant population survival. Plants may be removed from the state protected list. In 2001, the NDF and NNHP de-listed two plants, Beatley milkvetch (*Astragalus beatleyae*) and Ruby Mountain primrose (*Primula capillaries*). These endemic species are no longer considered at high risk because land use and management changes have alleviated threats.

Table 3-9. Cactus and Yucca Harvest Permit Activity Level in Recent Years

Year	Harvest Permits	Tags	Shipping Permits
1990	14	2,924	60
1995	18	3,848	104
2000	14	4,715	84

Source: Nevada Division of Forestry, 2000.

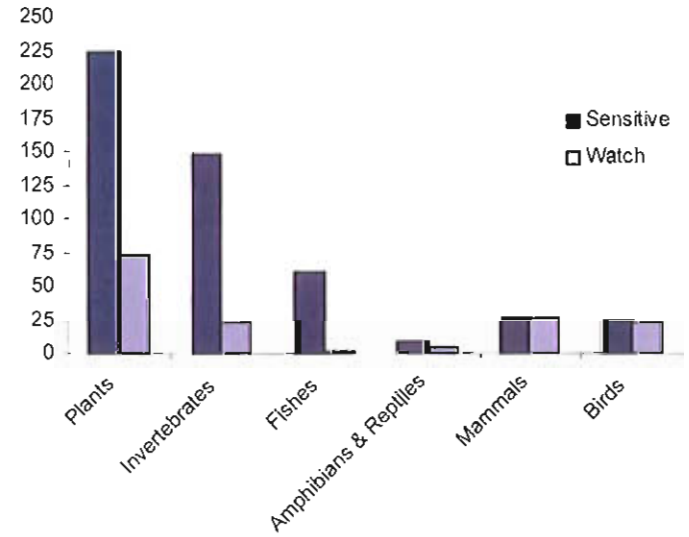
Cactus and yucca species found in the Mojave Desert ecoregion are in high demand for landscaping. To ensure that the number of cactus and yucca plants removed does not put the species at risk, permits must be obtained from NDF to harvest cactus and yucca species, such as Joshua trees, on private lands destined for development. Though the number of harvest permits issued remains relatively constant, the quantity of tags given for individual plants has increased over 60 percent since 1990 (Table 3-9.). Surveys have not yet been conducted to determine the appropriate population level of these species.

Thousands of cactus plants are taken illegally from public lands. On BLM managed land, all collectors are required to obtain a permit prior to harvesting cactus or yucca. The BLM only permits harvesting on land that will be permanently disturbed. Owners of projects on BLM land must salvage the plants, which are used by the BLM for site restoration, often in desert tortoise habitat. The cactus theft problem is serious enough for the National Park Service to implant computer-tracking chips into larger barrel cactus where poaching is high on the Lake Mead National Recreation Area. The BLM also has identified poaching hot spots. One is near Searchlight where hundreds of exposed 'cactus butts' have been found. BLM intends to install and maintain education signs in these areas.

Rare and Sensitive Species

As part of the state's early warning system for the conservation of biodiversity, the Nevada Natural Heritage Program (NNHP) tracks more than 600 rare and sensitive taxa (i.e., species and subspecies). This is accomplished through well-established biological inventory methods and data sharing with the member agencies of the Nevada Biodiversity Initiative and other collaborators. Nationally, the state Natural Heritage Program network is recognized as the leading source for detailed information on rare and sensitive plants and animals, and on identification of biodiversity "hotspots." The Heritage method, which is used nationwide, is followed to evaluate the relative risk of extinction using data on the number and condition of populations and individuals; the area or range occupied by the species; population trends; known threats; and protection or management status. Biologists evaluate each species against these risk factors based on the best available scientific information and assign the appropriate "rank". Ranks are classified globally and within individual states as secure, apparently secure, vulnerable, imperiled, critically imperiled, possibly extinct, and presumed extinct. Extensive files are maintained on the biology and mapped locations for each sensitive species.

Figure 3-5. Nevada Natural Heritage Program Sensitive and Watch Taxa



Source: Nevada Natural Heritage Program, 2001.

Using the Heritage method of assessing biodiversity significance, the NNHP identifies 493 sensitive species (Figure 3-5). Taxa classified as sensitive include those with federal or other Nevada agency status, and those ranked as vulnerable or of greater risk, or experiencing downward trends indicating some level of range-wide imperilment. In general, a sensitive species is any taxon whose long-term viability has been identified as a concern. Sensitive species are

widely distributed throughout the state (Figure 3-6). A separate Watch List includes taxa that could qualify for the sensitive list in the future, or that recently have been removed from the sensitive list. NNHP passively accumulates data for watch list taxa. The watch list consists of 151 taxa (Figure 3-5).

A state-by-state assessment recently published by NatureServe, the parent organization of the Natural Heritage Network, provides a relative ranking of states using measures of biological conditions – diversity, risk, endemism, and extinctions (NatureServe, 2002). Of the 50 states, Nevada ranked 11th in species diversity; 3rd in rarity and risk level; 6th in endemism (taxa unique to Nevada); and, 11th in extinctions. The 3rd rank in the rarity and risk measure can be attributed to the relatively large percentage of native fishes, amphibians, plants, and birds that are considered to be vulnerable, imperiled, or critically imperiled.

The NNHP, working with biologists and resource managers from many organizations, identifies landscape units that contain assemblages of sensitive species. The Natural Heritage Scorecard reports on particular conservation sites defined by occurrences of sensitive species that are appropriately managed as a unit based on common biological, land-ownership, and conservation-planning criteria. Sites with high diversity, protection urgency, and adaptive management requirements become the highest priority conservation sites. Scorecard 2000 brings attention to a total of 66 sites (Figure 3-7). Many of the Scorecard sites are associated with unique water and spring systems and sand dunes in rural areas. Others are near rapidly growing urban areas (Nevada Natural Heritage Program, 2000). The Scorecard, sensitive and rare species rankings and reports, and other biological resource assessments are performed by NNHP and made readily available. This information, when used in community master planning, land development project design, or public resource management can avert habitat loss or population declines in vulnerable species that trigger stringent federal or state regulations.

Coordinated planning and cooperative management to conserve special status species is growing. In southern Nevada, state, local and federal partners have prepared and are implementing the Clark County Multi-Species Habitat Conservation Plan. This far-reaching plan covers 78 different taxa and identifies the needed management and monitoring actions for a variety of habitats including low elevation uplands, desert riparian habitats, low elevation springs, and low elevation plant species.

To avoid further declines in Greater Sage Grouse populations in the northern half of the state, the Governor established a special task force office to prepare a state strategy. Sage Grouse populations have declined in different portions of its western U.S. wide range by 40 to 80 percent since the 1950's. The strategy emphasizes local collaborative conservation planning. The intention of enabling development of area-specific plans is to harmonize customary resource uses and locally meaningful incentives with actions to maintain good habitat conditions, improve degraded habitat, and stabilize, then increase, the bird's population.

Another instance of model collaborative conservation planning is development of the Nevada Bird Conservation Plan by the Nevada Partners in Flight (NPIF). Seeing indications of continent-wide and local declines in the population, distribution, and habitat of migratory and resident songbird and other species, the National Fish and Wildlife Foundation brought together federal, state, and local government agencies, foundations, conservation groups, industry and the academic community to form a program to address the problem. By 1993, interested parties coalesced into the Nevada Working Group of Partners in Flight.

During the next several years, ornithologists, wildlife experts, and bird watchers networked in the joint goal of developing a comprehensive bird conservation plan intended "to keep common birds common." A priority list of 46 species was developed for 15 major habitat types. Although long-term population data specific to Nevada were lacking for most of the priority species, population objectives were set for all species and then nested within one or more major habitat types. Strategies outlined how the objective could be achieved. The strategies usually address habitat management activities, but monitoring strategies and public awareness strategies also were deemed necessary. In all, 63 bird conservation objectives were set. The plan creates a modern day baseline for species monitoring and specific long-term goals

Figure 3-6. Mapped Distribution of Rare and Sensitive Species In Nevada

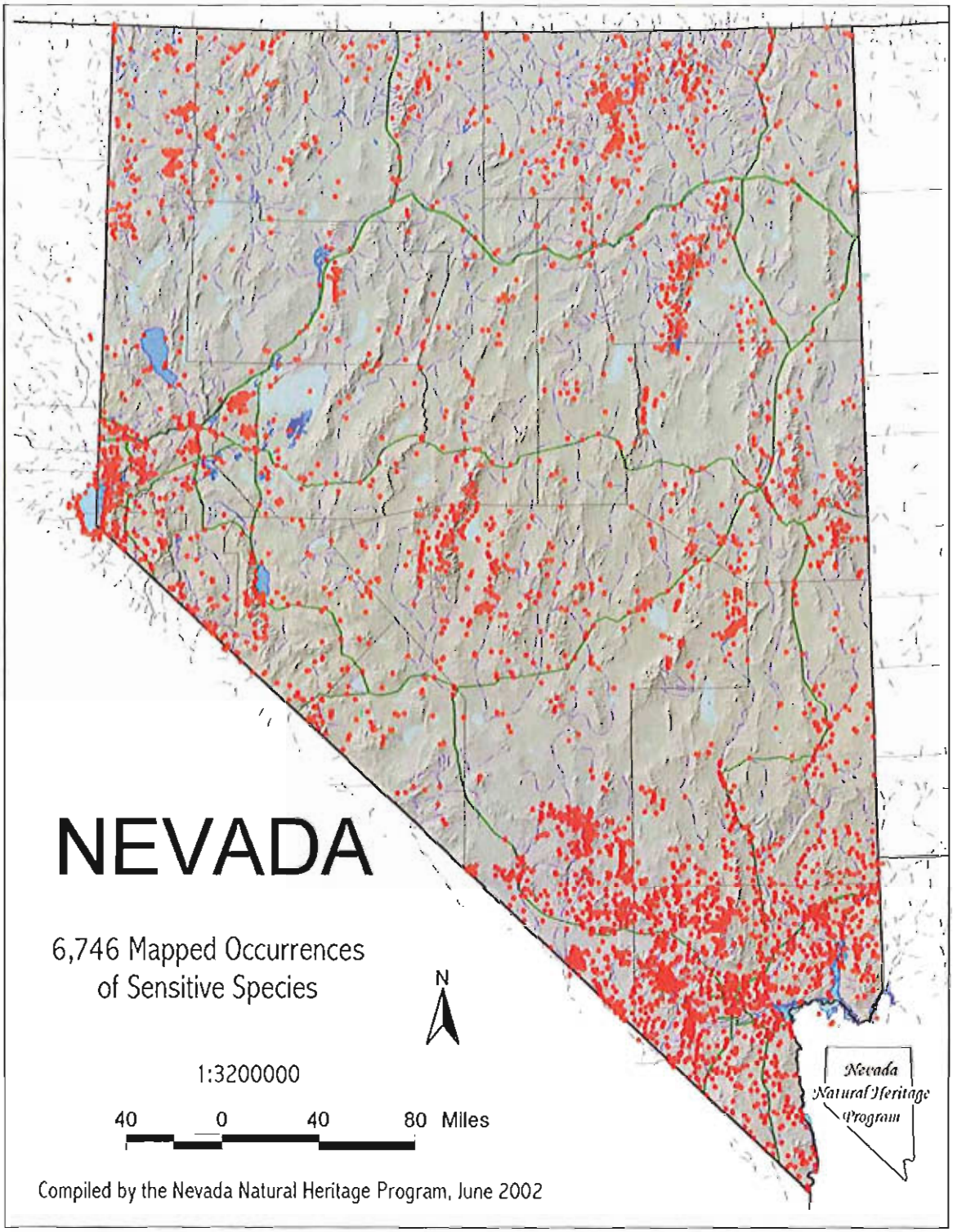
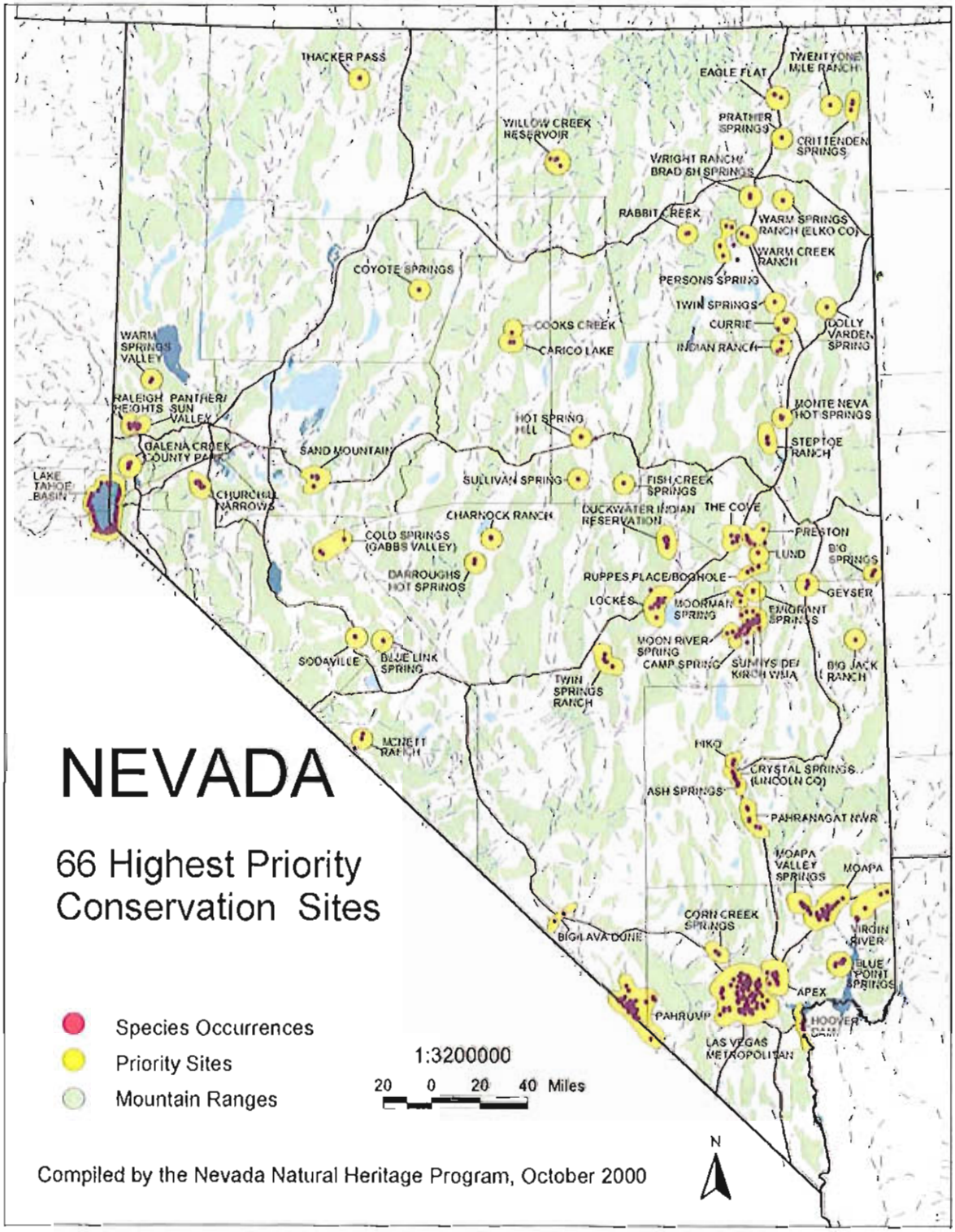


Figure 3-7. Highest Priority Conservation Sites in Nevada, 2000 Scorecard



For example, the Northern Goshawk and White-faced Ibis objectives are to maintain at least 300 and 4000 nesting pairs, respectively, in Nevada during the next three years. The White-faced Ibis is a priority species that occupies wetlands and lake habitats, nesting in colonies on sites with prolonged flooding to discourage predators and to prevent damage to their nests. Drought, water diversions, and thin eggshells from pesticides contributed to this bird becoming a species of concern. The Northern Goshawk inhabits aspen groves and coniferous forest, habitat types that are decreasing. Ultimately, the Nevada Bird Conservation Plan sets the stage for better stewardship and greater public awareness of the extraordinary bird life found in the state. Currently, NPIF is implementing a statewide all-bird monitoring program, which is being coordinated by the Great Basin Bird Observatory (GBBO).

In addition to the work being done by NPIF and the GBBO, Nevada has initiated an Important Bird Areas (IBA) Program. Through this program, locations with significant diversity of birds or large concentrations of single species are designated as an Important Bird Area. The Nevada IBA program is part of an international program. The over-arching goal of the Nevada IBA Program is to raise awareness of and promote enhanced management of IBA sites. The program will contribute to the preservation, maintenance, and recovery of bird populations in Nevada in collaboration with private landowners, federal and state agencies, and NGO's responsible for the well being of birds, wildlife and their habitats. The program started in Spring 2001, already has received recommended nominations for more than 50 sites.

Many people with different interests are striving to be better stewards of Nevada's living resources. The key to effective ecosystem management and sustaining biodiversity in concert with population and economic growth is collecting, sharing, and distributing information on the status of flora and fauna. Each year more is learned about the plants and animals that live here and about the ecology of native plant and animal communities. However, rapid population growth and changes in land use often outpace the ability of agencies to collect and analyze detailed data needed on the distribution and abundance of sensitive, as well as a wide range of other plants and animals.

More base-line data on common species would help ensure that management efforts are properly directed to truly vulnerable species. Also, coordination among environmental scientists and managers in different disciplines is needed to integrate data on the physical and biological components of ecosystems, to better understand the conditions which contribute to declining populations. More scientific information on causes for species imperilment will lead to greater certainty in conservation strategies. Increasing collaborative projects among government, industry, and conservationists is already bringing Nevadans closer to the goal of sustaining biodiversity while meeting the resource needs of urban and rural communities.

Wetlands, Riparian Zones, and Springs

Wetlands

Of the total wetlands that probably existed in Nevada prior to settlement, 52 percent have been lost (i.e., converted to another type of land cover or use) (Dahl, 1990). The largest regional wetland losses have occurred in the terminal basins of the Truckee, Carson and Humboldt rivers, where an estimated 82% of the wetlands have been altered (Thompson and Merritt, 1987). The distribution and size of wetlands naturally vary between wet and dry periods. Losses are primarily attributed to the diversion of streamflow for agricultural, municipal, and industrial uses; filling and draining wetlands for development; and, stream channel erosion and modification. Information on the ecological and water quality status is limited for most wetlands. Additional factors affecting wetland quality include: non-native plant invasions (e.g., tamarisk, perennial pepperweed, and hoary cress); discharges from irrigated farmland, abandoned mines, and urban stormwater containing high levels of salts and metallic compounds; and livestock and wild horse grazing that has not been properly managed.

Wetlands and riparian areas cover a relatively small amount of land in Nevada, but the benefits far exceed the area occupied. Wetlands are protected under the Clean Water Act and receive substantial attention from natural resource managers for several reasons.

- The diversity and abundance of vegetation and wildlife is higher in wetlands than any other ecosystem in Nevada.
- Water quality is better because lake and stream banks are more stable, vegetation provides cooling shade, and pollutants from surface runoff are filtered.
- Water is stored and released more slowly from channel banks and floodplains to adjacent waterways.
- Wetlands create habitat conditions required for the reproduction and survival of many fishes and other aquatic species.
- Recreation opportunities are high – hunting, fishing, wildlife watching, and scenery.
- Highly productive plant communities provide abundant forage and cover for the large number of wetland dependent wildlife

Different criteria are used by agencies to classify wetlands to reflect variation in statutory protection and management objectives. The US Army Corps of Engineers (USACE) has primary authority under Section 404 of the Clean Water Act for protection of "jurisdictional" wetlands – those that meet strict regulatory criteria for soil type, water dependent plant species, and period of saturated soils or inundation. The federal wetland policy of "no net loss" is not necessarily a one-for-one replacement objective. More acres may be required to be restored for mitigation than the amount drained or filled. The determination is based on an evaluation of the socioeconomic values and ecological functions of impacted wetlands. The federal policy and permit requirements may substantially deter unnecessary wetland losses.

Federal regulations provide for two permit types. A nationwide permit covers many routine land use activities that typically cause minimal impacts. An individual permit must be obtained for projects that could impact wetlands significantly. The process is involved, requiring application, public review and comment, scientific studies, and assessment of project alternatives to avoid, minimize, and mitigate impacts. The NDEP is involved in wetland protection through section 401 of the Clean Water Act. The provisions give the state's water quality standard setting agency the authority to deny projects in wetlands that could degrade water quality. During the period 1989 to 2000, the USACE permitted 700 acres of wetlands for conversion to another land use and required mitigation totaling 998 acres (U.S. Army Corps of Engineers, 2001). Mitigation data is not sufficient to determine whether there is a net gain or loss of wetlands. The USACE is working on improved enforcement and tracking of wetland mitigation projects.

The U.S. Fish and Wildlife Service (FWS) uses a broader definition of wetlands than the USACE for mapping wetlands. Riparian zones are more likely to be included in the wetland classification used by the FWS. State-by-state mapping was performed in the 1980's for the National Wetlands Inventory (NWI) project using aerial photographs shot in the summer from 1980 through 1986 and limited field verification. A statewide series of reconnaissance level (1:250,000 scale) wetland site maps was prepared. Five major categories of wetlands were identified:

- Wetlands less than 10 acres – a range of small and diverse wetlands such as vegetated springs and seeps, seasonally flooded vegetated wetlands, temporarily flooded unvegetated flats, and permanently flooded ponds. The size of individual wetlands could not be determined.
- Wetlands between 10 and 40 acres – the same types as the smaller size category of wetlands.
- Wetlands greater than 40 acres – classified based on vegetation or, if unvegetated, based on substrate. The total number of acres for these types was determined.
- Wetland/upland complexes – comprises several small wetlands too close to map individually.
- Linear wetlands (miles) – unvegetated, intermittent streambeds or woody or emergent wetlands in stream course or drainages.

The NWI mapping provides the only statewide statistics on wetlands available. About 1.7 million acres of wetlands were delineated. The total only includes wetland areas greater than 40 acres, wetland/upland complexes, and playas. Table 3-10 shows the areas covered by different types of wetlands greater than 40 acres separated by type. The amount of vegetated wetlands by type is shown in Table 3-11.

Table 3-10. Wetlands Greater than 40 Acres by Wetland Type	Acres
Playas	935,500
Vegetated wetlands, ponds, misc. types	665,400
Wetland/upland complexes	100,800
Total	**1,701,700**
Source: U.S. Fish and Wildlife Service, Nevada Office	

Table 3-11. Wetlands Greater than 40 Acres by Vegetation Type	Acres
Emergent wetlands	501,700
Scrub/shrub wetlands	160,800
Unvegetated wetlands and ponds	3,500
Total	**666,000**
Source: U.S. Fish and Wildlife Service, Nevada Office	

In addition, the mapping identified 30,547 wetlands less than 10 acres in size; 1,370 wetlands between 10 and 40 acres in size; and 29,810 miles of linear wetlands. Acreages are not estimated for these. The surface area of lakes and reservoirs was estimated to be 364,800 acres of lakes and reservoirs, in addition to the 1.7 million acres of wetlands (U.S. Fish and Wildlife, 2001b). Open water and wetlands cover about 0.5 percent and 2.3 percent of the state, illustrating how limited are aquatic habitats. Wetland size data separated by county is shown in Table 3-12.

Protection and rehabilitation of wetlands is challenging because of the competition for land and water resources required for increasing urban, agricultural, and transportation system developments. Projects by NDOW, NDSL, and federal agencies to purchase water rights for premier wetland areas provide for long-term stabilization of core wetland habitats. In some cases, however, sufficient water may not be available during drought conditions. Most significant wetland areas in Nevada are located within state wildlife management areas, federal wildlife refuges, tribal lands, and other specially designated management units. The NDOW has acquired or leased large tracts of land to establish 12 wildlife management areas (WMA's), 10 of which contain 59,250 acres of wetlands and open waters. A wetland conservation plan will be developed for each by the Division with public input.

A variety of wetland conservation and improvement projects are underway throughout the state. For example, in Oasis Valley, The Nature Conservancy has purchased a perpetual easement for riparian wetlands through the Wetlands Reserve Program, which is administered by the U.S. Natural Resources Conservation Service. The site is on a ranch near Beatty. Riparian habitat will be restored or enhanced on 190 acres to benefit two special status species, the Amargosa toad and the Oasis Valley speckled dace, and other wildlife and wetland species.

Another project is centered on the Las Vegas Wash. The site of 2,000 wetland acres in the 1970's, the wash became seriously eroded when runoff from urban development and discharges from wastewater treatment plants increased. The wetland area was reduced to 400 acres. Citizen organizations, local utilities, and government agencies are cooperating in the implementation of a comprehensive plan that concentrates on erosion control, environmental monitoring, and wetland construction. Primary benefits include improvement of water quality entering Lake Mead, outdoor recreation opportunities for Las Vegas Valley residents and visitors, and more diverse, healthier habitats for Mojave Desert wildlife.

The FWS is leading a multi-party effort to recover a portion of the wetlands in the Lahontan Valley wetlands complex in western Nevada. This area is a critical stopover for migrating shorebirds and one of 14 Western Hemispheric Shorebird Reserve Network sites. When sufficient water is available, up to 70 percent of Nevada's migratory waterfowl population use the wetlands. More than 175,000 waterfowl regularly stop in the valley during migration, and peak counts of up to 475,000 birds have been recorded. Historically, the Carson River sustained an average of about 150,000 acres of wetlands in the Lahontan Valley.

Table 3-12. NWI Reconnaissance Level Mapping Units By County

County	Number of Wetlands <10 Acres	Number of Wetlands 10-40 Acres	Acres of Wetlands > 40 acres[1]	Acres of Wetland/ Upland Complexes[1]	Miles of Linear Wetlands[2]	Acres of Playas[1]	Acres of Lakes and Reservoirs[1]
Carson City	38	----	350	----	50	----	6,950
Churchill	1,310	64	27,150	34,900	750	181,050	23,400
Clark	353	16	11,500	----	2,170	23,700	97,800
Douglas	305	23	27,950	900	350	----	17,250
Elko	11,189	367	181,900	1,050	8,790	25,900	9,550
Esmeralda	326	15	5,700	1,800	180	38,300	1,450
Eureka	1,610	65	37,700	6,000	1,560	48,250	----
Humboldt	3,406	116	134,350	950	3,380	28,900	4,050
Lander	1,392	68	79,400	3,550	1,490	35,900	50
Lincoln	644	35	11,650	2,800	1,240	71,700	1,150
Lyon	764	115	16,950	11,300	840	7,150	8,800
Mineral	668	25	9,750	150	1,160	23,500	36,600
Nye	2,625	145	30,800	15,900	2,750	114,350	1,700
Pershing	912	53	19,450	1,750	1,650	146,650	16,300
Storey	35	1	100	----	40	----	----
Washoe	2,678	162	22,200	800	1,800	152,450	139,150
White Pine	2,292	100	49,200	18,950	1,600	37,700	650
State Total	30,547	1,370	666,100	100,800	29,800	935,500	364,850

Source: U.S Fish and Wildlife Service, Nevada Office.
Notes: [1] To the nearest 50 acres. [2] To the nearest 10 miles.

Competing demands for water reduced the wetland acreage more than 90 percent, to less than 10,000 acres. By 1992, several years of drought caused the wetland acreage to drop below 2,000 acres. Meanwhile, Congress in 1990 passed the Truckee-Carson-Pyramid Lake Water Rights Settlement Act. The legislation established a program to acquire from willing sellers water and water rights sufficient to maintain a long-term average of about 25,000 acres of wetland habitat on the Stillwater National Wildlife Refuge, Stillwater Wildlife Management Area, Carson Lake, and the Fallon Paiute-Shoshone Indian Reservation.

Riparian Zones

Riparian zones hold particular importance for many Nevadans. The diversity of fish and wildlife, the quality and quantity of water resources, and a wide variety of outdoor recreation resources are strongly connected to presence and quality of riparian ecosystems. Riparian ecosystems occur in the full range of climate zones and landforms. Consequently, there are many varieties of riparian communities. Some are dominated by short or tall grass and grass-like species, by willows and other shrubs, by cottonwood, aspen and other trees, or by varying mixtures of trees, shrubs, grasses, and forbs. Healthy riparian zones play a vital role in commercial uses of rangeland ecosystems, for example, by providing abundant forage and shade for livestock. Recognizing the downward trend in conditions due to over-utilization of streamside vegetation and embankment erosion, the BLM and USFS launched a major initiative in the early 1990's to improve riparian management and protection.

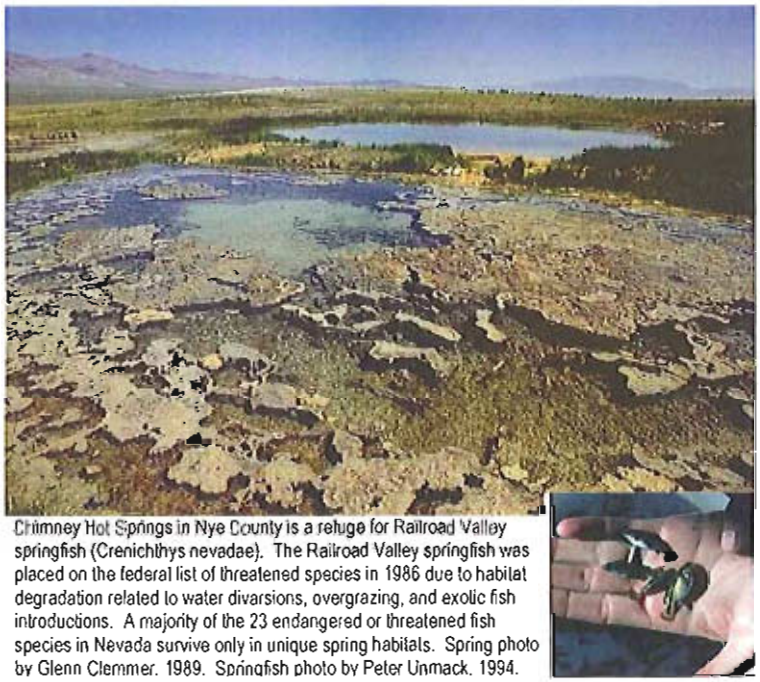
The BLM and the USFS monitor riparian areas on lands under their management. Using an assessment method called "proper functioning condition," (PFC) the BLM has performed site evaluations on 99 percent of the riparian areas and 33 percent of wetland meadow areas. In the PFC method, the hydrology, vegetation, channel erosion, sediment deposition, and land use features are evaluated to determine the overall physical condition in terms of the potential natural plant community and important resource values. Of 2,537 miles of riparian habitat mapped on BLM land, 753 were classified as "proper functioning condition" and 489 as "non-functional." Of the remainder, 495 miles were trending toward the desired condition, 321 miles trended downward, and the trend was not apparent in 475 miles. Wetland acres were also assessed. Of 34,327 acres, 8,962 were considered to be properly functioning, 476 acres trending up, 382 trending down, and on 1,400 the trend was not apparent. About 170 acres were classified as non-functional.

The USFS has conducted extensive monitoring in the western and central mountains of Nevada as part of the preparation of ecological "scorecards" for riparian condition assessments. Though the data has not been centrally organized, general conclusions can be drawn based on scorecard development at almost 1000 sites. Steeper and higher elevation stream reaches tend to be more stable and well vegetated. Streams and meadows at lower elevations tend to be in unacceptable condition. However, trend in condition on USFS land is generally upward for a majority of all stream reaches. These generalizations include riparian sites in both forest and rangeland areas.

Restoration of degraded riparian habitat is a primary objective in the Recovery Plan for the Lahontan Cutthroat Trout, prepared by the FWS in 1995. Because Lahontan cutthroat trout formerly inhabited northern Nevada lakes, rivers and headwater streams, restoration of degraded riparian habitat will be a regional effort involving many agencies, conservation organizations, ranch owners, and more. Extensive riparian zone restoration efforts on the Marys River and Trout Creek in northern Nevada have already occurred.

Springs

The wetland habitats identified in Table 3-12 as being less than 10 acres and between 10 and 40 acres (second and third columns) include a distinctive subset of riparian and aquatic habitats commonly called a spring. A spring occurs where deep or shallow groundwater flows naturally from bedrock or natural fill onto the land surface and forms a body of water. The source and subterranean pathway of water may be local or regional. Thousands of springs occur in a variety of landform settings throughout the state. Springs were important to emigrants crossing Nevada. Many have been developed to provide water for livestock, mining, wildlife, and public and domestic water supply. Gains in scientific knowledge about the relevance of spring habitats to biodiversity and the longevity of "ancient" water supply sources has drawn attention to spring conservation and management. Because springs are isolated and have unique environmental characteristics, aquatic and riparian plant, fish, and invertebrate (e.g., springsnail) diversity and endemism are high.



Chimney Hot Springs in Nye County is a refuge for Railroad Valley springfish (Crenichthys nevadae). The Railroad Valley springfish was placed on the federal list of threatened species in 1986 due to habitat degradation related to water diversions, overgrazing, and exotic fish introductions. A majority of the 23 endangered or threatened fish species in Nevada survive only in unique spring habitats. Spring photo by Glenn Clemmer, 1989. Springfish photo by Peter Unmack, 1994.

Like other water-associated habitats, dewatering, diversion works,

channelization, and invasion of nonnative plants and animals have altered springs (U.S. Bureau of Land Management, 2001). Groundwater pumping has been found in some basins to depress spring flow. Field studies have found degraded habitat conditions, declines in sensitive plants and animal populations, and species extinctions. Similar to other wetlands, springs are intensively used. Livestock, including wild horses, and diversions, many for livestock watering, were the predominant disturbances found in one study of 511 northern Nevada springs (Sada, 1991). Concern exists that current protection and management attention is not sufficient to sustain the ecological site integrity and long-term water production of springs.

Non-Native Flora and Fauna

Whether introduced for a specific purpose or accidentally, an increasing number of non-native species are devastating native habitats and croplands. The spread of noxious and invasive weeds and insects adds significant costs to the use and management of natural resources throughout the state. Non-native plants and animals, if not kept in check, have the ability to spread rapidly, resist controls, exclude native species, interfere with crop and forage production, degrade wildlife habitats, promote wildfire, leave soils vulnerable to erosion, and alter entire ecosystems.

Non-Native Flora

With increased globalization and human mobility Nevada's ecosystems are at greater risk of exposure to undesirable plants. The growing number of state-designated noxious weed species illustrates the threat posed by invasive plant species or weeds in Nevada. In 1992, there were 29 weed species officially designated by the Nevada Department of Agriculture (NDOA) as noxious (Table 3-11). By 2001, 13 additional non-native species were classified as noxious. In 2002, two more plants will be added to the noxious weed list – Fountain grass (Pennisetum setaceum) and Giant salvinia (Salvinia molesta) – raising the total to 46 noxious weeds in the state (Nevada Department of Agriculture, 2002).

Nevada, like most states, has a law for designating certain weeds as "noxious." Nonnative plant species designated as noxious are characterized as prolific, and are difficult to control or eradicate. They displace desirable plants on agricultural lands and natural sites, and causes significant environmental and/or economic damage. "Invasive weed" is a separate, unofficial, category of damaging alien plants. The key distinction is that noxious weeds are considered to be manageable and may be eliminated. An invasive weed species has become so widespread that eradication is infeasible. State law requires landowners to control noxious weeds that occur on their property (NRS 555.130). Unfortunately, resources to prevent or limit the spread of nonnative plants are limited, so public and private land managers must decide whether to control the plants that already are dominating plant diversity, or those that may become dominant in the future if not immediately controlled.

Noxious weeds have impacted several land cover types. Floodplains and riparian zones have been smothered with perennial pepperweed and whitetop. Tamarisk obstructs stream channels. Croplands are infested by Russian knapweed and yellow star thistle. Musk thistle and diffuse knapweed choke out native plants from pastures and other ranchlands. Shrublands, pasture, cropland, and riparian zones appear to be the most heavily impacted cover types.

The serious economic and ecological damage caused by noxious and invasive weeds makes preventing new introductions a top priority for state and federal agencies. To coordinate early control efforts, Conservation Districts (CDs), federal and state land use management agencies, scientists, ranchers, and farmers and others are assisting with mapping the occurrence of noxious weeds. Preliminary mapping and reporting of the extent of noxious weed infestations has produced a rough estimate of 276,000 acres (Table 3-13). However, this number underestimates (perhaps grossly) the statewide impact. Field mapping is incomplete, and some landowners have not inventoried or reported data on infestations yet.

Cheatgrass (*Bromus tectorum*) is the most widespread "invasive" plant in Nevada. Cheatgrass and its southern cousin, red brome, exemplify the vulnerability of the state's rangelands. Cheatgrass has invaded sagebrush zones in numerous basins. Scientists have observed the plant invading mountain shrub zones, indicating it may be adapting to other climate zones. Following repeated wildfires, cheat grass forms a monoculture. During the growing season, livestock, wild horses, and other grazers can eat and gain nutritional value from cheat grass. However, after cheatgrass cures in early to late spring, the nutritional value and edibility of the plants declines. Domestic and wild grazing animals, upland birds, and other wildlife must go elsewhere to meet their nutritional and other habitat needs. According to the report *Nevada's Coordinated Invasive Weed Strategy* prepared by the Nevada Weed Action Committee, approximately nine million acres in northern Nevada (about 13 percent of the total state) has succumbed to the cheatgrass invasion.

Table 3-13. Reported Acres Infested by Noxious Weeds for Various Government Jurisdictions

Organization	Area within Jurisdiction	*Reported Area of Infestation
	Acres	
Douglas Weed Dist.	144,769	15,000
Churchill Weed Dist.	640,000	6,400
Division of Wildlife	142,959	17,955
Division of State Parks	132,878	1,000
Department of Transportation	133,000	12,000
University Lands	25,000	unknown
Tribal Lands	1,218,651	12,000
Conservation Districts	11,000,000	unknown
Bureau of Land Management	46,500,000	195,750
US Forest Service	6,500,000	16,000
US Fish & Wildlife	2,218,000	unknown
Total		276,105

Source: Nevada Department of Agriculture,2001.
Note: *The area of Weed Districts may overlap Conservation Districts, resulting in double counting.

Much is being done to combat the introduction and spread of noxious weeds. Nevada's 28 Conservation Districts, which cover the entire state, have traditionally focused much of their resources on the control of invasive weeds located within the district. In addition, with the increased awareness of the threats posed by invasive species, the formation of weed control districts in Nevada has increased from six in 1992 to 10 in 2000. Conservation Districts and weed control districts typically consult and work closely with experts at their local University of Nevada Cooperative Extension and the Natural Resources Conservation Service offices.

Increased awareness in large part is due to efforts of the NDOA. In 1995, the NDOA created an interagency working group whose mission was to coordinate and facilitate local, county, state and federal agency programs and projects for the control and management of noxious and invasive weeds in Nevada. The group was named the Nevada Weed Action Committee (NWAC). A result of the formation of this group is the creation of the state weed plan, *The Nevada Coordinated Invasive WeedStrategy*. The strategic plan emphasizes five key objectives: weed control; prevention of new infestations; education and awareness; cooperative and coordination of control efforts; and, research.

The NWAC has taken on the challenge of effectively coordinating public and private resources and efforts toward proactive prevention, control, and management of invasive weed species in Nevada to benefit all land users in the state. The NWAC emphasizes prevention of additional invasions and quick action to eradicate new introductions, primarily because these are the most cost effective approaches. An example is the program to inspect for and certify hay and forage as "weed free." Another priority is mapping the occurrences of noxious and invasive weed species on a real-time basis to ascertain the level of threat, update management priorities, and assist with coordinated weed management plans. Other NWAC priorities include improved communication and education, and finding project funding (Nevada Weed Action Committee, 2002).

Non-Native Fauna

Invasive invertebrate species continue to be introduced into Nevada at an alarming rate. In recent years both the Turkestan cockroach and the Africanized honeybee have expanded to fill niches in southern Nevada. In 1999 and 2000, nine sites infested with red imported fire ants were eradicated in Clark County. Surveys for gypsy moth and Japanese beetle have both been negative in recent years. Surveys and inspection efforts for these and other threatening species have been increased (Nevada Department of Agriculture, personal communication, 2001). All survey, detection, monitoring and control activities relating to invasive invertebrate species are closely coordinated between the Nevada Department of Agriculture and the USDA Animal and Plant Health Inspection Service.

Control of Plant and Animal Infestations

In general, the choices for methods to control or eliminate noxious weeds are mechanical, biological, and chemical. Each has its advantages and disadvantages, depending upon the species, site conditions, and type of land use. The use of herbicides, insecticides, and fungicides (i.e., pesticides) to control noxious weeds and other pests requires special care and oversight because contamination of soil and water can pose serious health threats to people and other life forms. Even with proper use, some chemicals that are mobile, persistent, or degrade into other toxic chemical compounds may accumulate in surface and groundwater bodies. Using pesticides at higher rates or in a place or manner of use different from label specifications is against the law.

State laws give the NDOA authority to manage pesticide use and coordinate with other organizations in monitoring use and effects. The agency trains and certifies pesticide applicators, investigates complaints concerning pesticide use, and monitors the use of pesticides. The Nevada Agricultural Statistics Service compiles data contained in mandatory monthly reports submitted by custom applicator licensees to NDOA. Licensed applicators in 2000 reported that approximately 133,140 acres of farm and ranch land were treated with one or more types of pesticide. This is not a complete summary in that it does not include chemical applications by individual farmers and ranchers who may apply chemicals on their own operations (Nevada Agricultural Statistics Service, 2002).

The NDOA, USGS, and NDEP periodically monitor groundwater quality in areas where pesticides are used. The presence of pesticides has been detected in the groundwater around urban and agricultural areas, but at levels below drinking water maximum contaminant levels. Local University of Nevada Cooperative Extension offices have experts in the area of noxious weed and insect pest controls and can provide state of the art information on the responsible use of pesticides.

Wild Horses and Burros

Wild Horse and Burro Populations

The federal Wild and Free-Roaming Horse and Burro Act of 1971 requires the BLM and USFS to protect, manage, and control wild free-roaming horses and burros on public lands at population levels that assure a "thriving natural ecological balance" under the multiple use concept. The Act defines ecological balance as the balance on a long-term sustained yield basis between populations of wild horses, burros and wildlife, livestock, and rangeland vegetation. The federal agencies manage wild horses and burros at the minimum feasible level to treat the animals as wildland species and not as livestock. Management focuses on monitoring, removal of excess animals, preparing them for adoption, the adoption process, and compliance after adoption for one year when title is given.

Wild horses and burros are found throughout the western states, but nowhere do their populations come close to those in Nevada. The first aerial count, conducted in 1974, found approximately 20,000 animals. In 2000, the BLM estimated a total of 48,624 wild horses and burros roamed BLM land in the 10 western states, of which 25,096 (52 percent) inhabited Nevada (Table 3-14). In 1996, the USFS estimated that

746 wild horses occupied Humboldt-Toiyabe National Forest land within Nevada. Most of the wild horses and burros in Nevada live on open rangeland managed by the BLM. Though the large number of animals has brought national and even international attention from wild horse enthusiasts, the vegetation and water resources in areas overpopulated by wild horses have been seriously impacted.

Federal agencies initially identified wild horse Herd Areas based on animal distributions at the time federal legislation was passed. Within Herd Areas, the BLM has delineated 103 Herd Management Areas (HMA's) and the USFS delineated 13 Horse Territories. These wild horse areas are distributed throughout the state. The HMA's managed for wild horses are located primarily in the Great Basin ecoregion. In the Mojave region, the habitat is better suited to burros. The HMA's vary in size from as small as 5,000 acres to almost 700,000 acres, with most exceeding 100,000 acres. Land designated as HMA's also contains livestock grazing allotments and populations of wildlife species.

Table 3-14. Wild Horse and Burro Populations and Amounts Removed, 1980 - 2000

Year	Population*	Removals*
1980	32,199	---
1981	---	---
1982	27,380	---
1983	---	---
1984	31,386	1,410
1985	30,569	10,440
1986	28,872	5,444
1987	28,533	6,825
1988	28,401	4,294
1989	32,067	1,332
1990	29,455	3,023
1991	33,434	4,168
1992	34,677	3,632
1993	26,664	5,103
1994	23,107	5,328
1995	24,067	6,701
1996	23,483	5,884
1997	22,865	6,295
1998	22,463	4,581
1999	23,905	2,500
2000	25,096	4,131
2001	22,100	---
Total Removals		81,406

Source: Nevada BLM, 2001.
Note: *Includes only lands managed by Nevada BLM, not those managed by California BLM in northwestern Nevada.

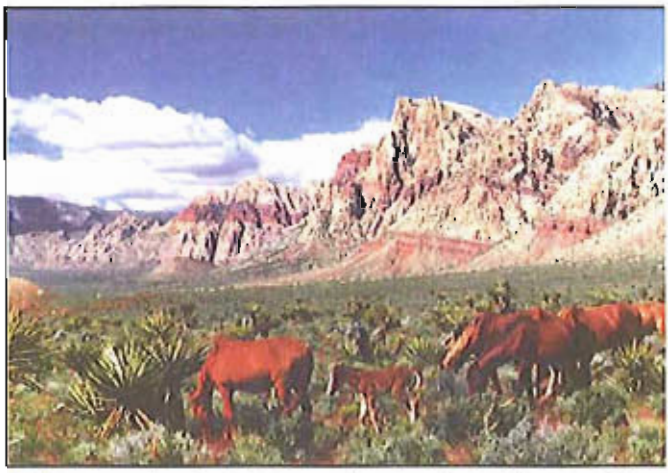
Wild Horse and Burro Management

Because forage production on Nevada rangelands is limited and must be shared among wildlife, livestock, and wild horses, public rangeland managers are required to set the Appropriate Management Level (AML) for wild horses and burros on each HMA. The number of wild horses, or AML, is set through a rangeland assessment and public review process known as the Allotment Evaluation/Multiple Use Decision. The AML is the number of wild horses that can inhabit a herd management area while maintaining a thriving natural ecological balance and avoiding deterioration of the rangeland and riparian resources.

As of September 2000, the AML had been achieved on thirty-eight (38) of the BLM managed HMA's. During the winter, additional gathers increased the number of HMA's achieving the AML by five. Four more HMA's are scheduled for gathers in the summer of 2001. As with many wild animal populations, the number of wild horses increases each year at a rate that is determined by the amount of seasonal precipitation and vegetative growth. Achieving and maintaining AML within herd management areas requires periodic removal of horses. From 1980 to 2000, the BLM removed over 81,400 wild horses (Table 3-13). The status of wild horse management on HTNF herd territories in Nevada is not available.

Recent fires and drought in the Great Basin have impacted wild horse habitat conditions. During the summer of 1999, wild fires burned approximately 1.6 million acres of land administered by the BLM. Twelve HMA's were burned, with the losses extreme enough in seven HMA's to require removals of all or a portion of the herds. In total, 2,070 animals were removed as a result of habitat losses from the fires. About 340 wild horses were being held for reintroduction into the burned HMA's from where they were gathered. The following winter of 1999/2000 was extremely dry and a number of HMA's were impacted by inadequate water supplies, forage or both. As a result, 1,980 wild horses and burros were removed in the summer of 2000 from 14 HMA's. The removals were targeted toward those herds severely impacted by the drought conditions. Only a few HMA's were reduced to the AML. With the emphasis on

emergency gathers due to habitat damaged by fires and drought, most of the planned gathers scheduled for FY 2000 were postponed. Less than 100 animals were removed from scheduled gathers.



Wild horses roam throughout the open range in southern Nevada. Careful population management is necessary in some areas where reproduction is high and resources are sensitive to excessive grazing and trampling, such as riparian zones. Protection of wild horse herds attracts national, even international attention. Photo courtesy of the Nevada Commission for the Preservation of Wild Horses.

BLM is charged with managing the public land for multiple uses. With the passage of the Wild and Free Roaming Horse and Burro Act in 1971, which came about because of nationwide concerns, BLM was mandated to manage those resources along with the multitude of other legitimate land uses. The competition for forage, of course, creates the greatest conflict. The act states that horses and burros must be managed within a "thriving ecological balance." BLM has interpreted that to mean that the forage use by all grazing animals must be within the carrying capacity of the land.

BLM rangeland grazing standards and guidelines have been established for four regions in the state by Resource Advisory Councils in each region. The standards describe regional soil, vegetation, water, wildlife habitat conditions, with the resource use and management guidelines, that are necessary to sustain the carrying capacity and ecological functions of rangeland resources consistent with community needs in the region. Maintaining wild horse populations at AML is important if the Rangeland Standards are to be met and the land managed at a "thriving ecological balance." Continued overstocking of the public lands by any one or a combination of grazing animals, domestic or wild, can create long-term degradation of rangeland resources and ultimately destroy the productivity of the land.

The adoption program is the only available option to care for animals removed from the range. The adoption market is very fragile and numerous forces affect that market, including publicity on the Wild Horse and Burro program. The adoption market also affects range management because if adoption targets are not met, BLM preparation and holding facilities quickly reach capacity. When the facilities become full, gathers must be slowed or ceased. Altering the gather schedule has a domino effect on achieving AML on HMAs scheduled for gathering that year, gathers in subsequent years. Several ranchers in the Midwest are under contract to hold wild horses, especially older, unadoptable animals, on a long-term basis to relieve the lack of holding space in BLM facilities.

A promising approach to improving the adoptability of wild horses is being implemented by the Nevada Department of Agriculture and Prisons. Recently, a wild horse inventory and habitat evaluation showed that 1000 wild horses were living in the Virginia Range of western Nevada where the habitat was suitable for only 500 individuals. In the Virginia Range Estray Program, wild horses are taken to the Western Nevada Correctional Center and gentled for six weeks before nonprofit "placement" agencies sell them to qualifying private owners.

Wildland Fire

Nevada, like many western states, is facing the escalation of wildland fire impacts in both rural and urban areas. From 1999 to 2001, almost 3,800 fires burned approximately 3.25 million acres, most in the northern half of the state (Table 3-15). The tremendous damage to biological resources and environmental quality caused by the extraordinary wildfire behavior cannot be adequately quantified or described. The distribution of Nevada wildfires from 1981 through 2000 (aggregated in five year

increments) is displayed in Figure 3-8. (Note that a number of areas have re-burned, although the overlapping patterns may be difficult to discern on the map.)

Table 3-15. Wildland Fire Season Statistics on Federal and Non-Federal Land, 1999-2001

Year	Number of Fires		Number of Acres Burned		Number of Fires by Cause			
	Federal Land	Non-Federal Land	Federal Land	Non-Federal Land	Federal Land		Non-Federal Land	
					Lightning	Human	Lightning	Human
1999	1,079	73	1,708,563	161,722	684	395	19	54
2000	1,067	104	692,553	6,657	820	247	63	41
2001	1,277	182	654,253	22,069	960	317	30	152
Total	3,423	359	3,055,369	190,448	1,504	642	112	247

Sources: Western Great Basin Coordination Center (WGBCC) website: www.nv.blm.gov/wgbcc. Western State Fire Managers reports, 2000 and 2001. Nevada Division of Forestry, 2002.
Notes: Values do not include prescribed fires or wildland fire use (controlled burn). The WGBCC reports for the three year period that 75 prescribed fires burned 42,300 acres. Wildland fire use data for 2001 is 45 fires and 9,211 acres burned. Prescribed fires are defined as those, which have been ignited by fire management personnel to meet specific resource management objectives. A written, approved prescribed fire plan must exist, and NEPA requirements must be met, prior to ignition. Wildland fire use describes the management of naturally ignited (lightning) wildland fires to accomplish specific pre-stated resource management objectives in predefined geographic areas outlined in Fire Management Plans.

The NDF cooperates with federal and local entities to mitigate threat of wildland fire statewide. Volunteer Fire Departments (VFD's) are a key player in wildfire suppression activities. VFD's typically are first on the scene of emergency incidents and provide critical information to arriving out-of-area state and federal fire suppression resources. The NDF provides training, equipment and vehicle maintenance support to VFD's within eight fire districts. The agency engages in initial attack, fire investigation, and direct protection capabilities to portions of the Humboldt-Toiyabe National Forest. NDF also partners with federal agencies, local government, and private property owners to locate funding for and implement rehabilitation projects on private land.

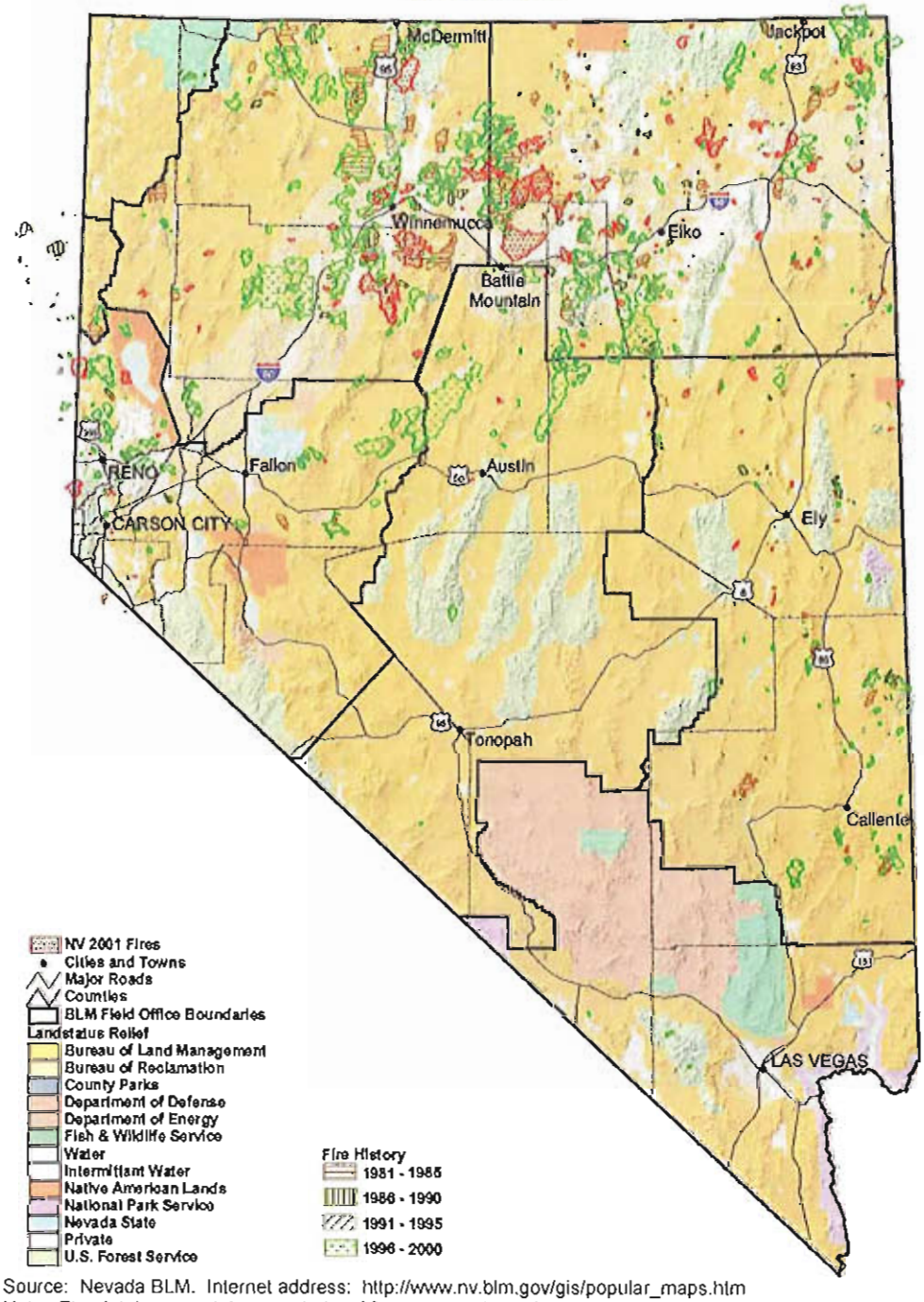
NDF and federal fire management agencies are increasing efforts to advise property owners on defensible space practices for the increasing number of homes built in the urban/wildland interface. The BLM and USFS fire suppression and prevention programs also are instrumental in protecting the state's natural and cultural resources. Recognizing the critical need to share information, expertise, and resources, intergovernmental entities have been formed. These are the Western Great Basin Coordination Center and the Sierra Front Interagency Dispatch Center.

Especially troubling is the cumulative, long-term natural resource losses caused by the greater intensity and number of large wildland fires in recent years. At the end of August 1999 fire storms, the NDOW estimated habitat losses for some game species: 340,000 acres of deer winter range, 305,000 acres of deer summer range, 668,100 acres of pronghorn antelope range, and 45,500 acres of bighorn sheep range were seriously impacted. In addition, about 144,560 acres and 185,667 acres of winter/spring and summer sage grouse habitat burned (Nevada Division of Wildlife, 1999). In addition, the fires killed livestock and destroyed structures, such as homes, fences, water developments, bridges, ranch buildings, and power lines.

Fire, like flooding and drought, is a natural disturbance that periodically returns to play an influential role in ecological cycles of a variety of vegetation types, especially in the semi-arid climate zones, as illustrated in Figure 3-8. Historically, people have used fire to alter vegetation and grow certain plants for food, fiber and to attract game animals. Since the 1950's, wildland fires were uniformly excluded to prevent destruction of the commercial value and natural functions of forests and rangeland. Ironically, aggressive firefighting in the past 50 years is one reason that recent fire seasons are notable for excessively large and destructive burns. Aggressively suppressing fires allowed overcrowding of shrub

species less adapted to fire and accumulation of dead plant matter. However, the present day wildfire problems are more complicated than recent fire suppression policies. The current wildfire pattern is both a response to and cause of "impaired" ecological conditions in fire prone shrub, woodland, and forest types.

Figure 3-8. Distribution of Wildfires In Nevada, 1981 to 2000, Mapped by Nevada BLM



Source: Nevada BLM. Internet address: http://www.nv.blm.gov/gis/popular_maps.htm
Note: The database contains a majority of fires greater than 10 acres that occurred in Nevada.

Though fire exclusion efforts increase fuels, land use practices precondition rangelands and forests for extreme wildland fire. Forage and timber harvest practices that extensively modified the composition, structure, and diversity of fire-adapted plant communities contributed to the conditions that are conducive to extreme wildland fire behavior. Widespread over-grazing and clear-cutting helped set the stage. Little attention was paid to changes in the regeneration of sagebrush-steppe, sagebrush, woodland and forest communities. The density of plants in regenerating shrublands and forests increased as perennial grasses and forbs were persistently removed and lighter-fueled fires limited. Cheatgrass, a flammable nonnative annual grass, invaded the understory of shrub and pinyon/juniper communities, eventually forming monocultures as fires returned to infested areas. Riparian zones that were eroded, dewatered, and denuded no longer provided cooler and moisture conditions that provides a natural brake on the spread of wildfire.

Of special concern is the construction of more buildings in the urban-wildland interface where coincident with hazardous levels of woody fuels. With more subdivisions built in fire-prone and fuel-rich wildland areas, the risk of catastrophic natural resource and private property damage escalates. State, federal and local fire suppression agencies are committed to protecting life and private property. Fires burning at the urban/wildland interface require that more fire fighting resources be directed to save people and homes as a priority over natural vegetation. The result can be unnecessarily extensive damage to critical wildlife habitat, watersheds and water supplies, cultural resources, and outdoor recreation resources.

Expanding development in wildland areas also limit fuels management options, in some cases precluding tree harvesting or prescribed fires. Because most property owners have been reluctant to prepare defensible, fire safe, space around buildings, the NDF, BLM and other land management agencies are implementing technical assistance programs to promote defensible space practices. However, casual attitudes toward fire risk and inadequate local regulations for defensible space in new and existing subdivisions continues to hamper state and federal agency efforts to advance reasonable strategies for the protection of lives and property at the wildlife/urban interface.

The extreme fire events of recent seasons have focus attention on reduction of hazardous fuel conditions, restoration, and fire ecology in shrub, woodlands, and forests. Scientists are studying the pre-settlement role of fire in Nevada vegetation types and learning about the effects different land uses and management practices have had on vegetation patterns and wildfire behavior. Past fire rehabilitation efforts have not been extensively monitored, so practical knowledge is limited on revegetation prescriptions for the subtly different rangeland ecosystems. Gaps in knowledge, different interpretations of the meaning of restoration, and variation in visions of the future uses of fire-damaged lands raise important issues. Ongoing debates involve the use of native versus introduced species; on the use of prescribed burns versus mechanical removal of fuels; and the distribution of funding between suppression and prevention activities. Unfortunately, disagreements over wildfire science can delay development and implementation of much-needed, landscape-scale restoration, vegetation management, and fire prevention strategies.

Progress is being made in state and national efforts to improve fire management and restore burned areas. One example is the Great Basin Restoration Initiative (GBRI), proposed by the Nevada BLM during the catastrophic 1999 fire season. The active component of the GBRI, the Eastern Nevada Landscape Restoration Project, entails a 10 million acre area with diverse shrub, woodland, forest, and riparian habitats. A coalition of all interests has formed under the mission of improving the dynamic and diverse landscapes of the Great Basin for present and future generations through collaborative efforts. Restoration, defined as a long-term, landscape-based approach to changing ecological health, is emphasized rather than reclamation. Urban interface fuel reduction, cheatgrass/weed control, prescribed fire and natural wildfire use, and learning about the ecosystems are short-term tasks (Nevada Bureau of Land Management, 2002).

The 2001 National Fire Plan promotes and supports federal, state, and local fire fighting agencies on five fronts to interrupt the fire cycle. Priorities are: 1) reduction of fuels in dense shrub and pygmy conifer zones; 2) restoration of burned areas; 3) protection of healthy native communities and restoration of degraded communities to reduce extreme wildfire risk; 4) enhanced fire suppression; and, 5) advance fire management planning that take into consideration local public safety, ecological site conditions,

biodiversity concerns, and cultural resources (National Interagency Fire Center, 2002). The Nevada Division of Forestry has the lead in developing a complementary State Fire Plan that will build on priorities set by the Governor's Wildfire Management Committee in 2000. Priorities include interagency risk/hazard assessment mapping; education and training of local volunteers, miners, and ranchers; fuels management emphasizing livestock grazing and green stripping; fire-safe community legislation; and, expansion of the state native seed bank.

References

Bradley, P.V., J.A. Williams, J.S. Altenbach, P.E. Brown, K. Dewberry, D.B. Hall, J. Jeffers, B. Lund, J.E. Newmark, M.J. O'Farrell, M. Rahn, and C.R. Tomlinson. 2002. Nevada Bat Conservation Plan. Nevada Bat Working Group. Austin, Nevada.

Charlet, David A., 1998. *Atlas of Nevada Mountain Ranges; Vegetation Zones of Nevada*. Biological Resources Research Center, University of Nevada, Reno and Department of Science, Community College of Southern Nevada, North Las Vegas.

Dahl, T.E. 1990. *Wetlands Losses in the United States, 1780's to 1980's.* U.S. Department of the Interior, Fish and Wildlife Service. Washington D.C.

Fiero, B. 1986. *Geology of the Great Basin*. Max C. Fleischmann series in Great Basin Natural History. University of Nevada Press, Reno, Nevada.

Grayson, D. K. 1993. *The Desert's Past: A Natural Prehistory of the Great Basin.* Smithsonian Institution Press, Washington, D.C.

Hutchins, Mary. 1999. Prairie Racer: the Pronghorn Antelope. North American Pronghorn Foundation Web Page. Internet Address: http://www.antelope.org/pronghorn1.htm

National Interagency Fire Center. 2002. National Fire Plan, Managing the Impact of Fires on the Communities and the Environment. Internet address: http://www.fireplan.gov/president.cfm

NatureServe. 2002. *States of the Union: Ranking America's Biodiversity*. Prepared for The Nature Conservancy. Arlington, Virginia.

Nevada Agricultural Statistical Service. 2002. Pesticide And Herbicide Application Summary, 2000. Internet address: http://www.nass.usda.gov/nv/Pesticide01.pdf

Nevada Bureau of Land Management. 2002. Eastern Nevada Landscape Restoration Project. Internet address: http://www.nv.blm.gov/ely/enlrp.htm

Nevada Department of Agriculture. 2002. Personal communication.

Nevada Division of Wildlife. 1999. Wildfire, An Assessment of Wildlife Losses Resulting from the 1999 Firestorm.

Nevada Division of Wildlife. 2001. *Nevada Sage Grouse Conservation Plan, Final Draft*. Prepared by Governor's Sage Grouse Conservation Team.

Nevada Natural Heritage Program. 2000. *Scorecard 2000, Highest Priority Conservation Sites.*

Nevada Natural Heritage Program. 2001a. Personal communication.

Nevada Natural Heritage Program. 2002. Internet address: http://www.state.nv.us/nvnhp/datasens.htm

Nevada Partners in Flight. 1999. Bird Conservation Plan. Larry Neel, ed.

Nevada Weed Action Committee. 2002. Internet address: http://agri.state.nv.us/nwac/

Sada, D.W., G.L. Vinyard, and R. Herschler. 1991. *Environmental Characteristics of SmallSprings in Northern Nevada.* In Proceedings of the Desert Fishes Council. Volume XXIII.

Strickland, Rose. 2002. Personal communication. Comments on the Public Review Draft, Nevada Natural Resources Plan.

The Nature Conservancy. 2000. *Precious Heritage: The Status of Biodiversity in the United States.* Edited By Bruce A. Stein, Lynn S. Kutner, and Jonathan S. Adams. Oxford University Press.

Thompson, S.P., and K.L. Merritt. 1988. *Western Nevada Wetlands – History and Current Status*, in Blesse, R.E. and P Goin, eds., Nevada Public Affairs Review No. 1. Reno, University of Nevada.

U.S. Army Corps of Engineers. 2001. Personal communication. Table of Impacted Wetland Acreage (Non-Tidal).

U.S. Bureau of Land Management. 2001. *A Guide to Managing, Restoring, and Conserving Springs in the Western United States.* Technical Reference 1737-17. National Science and Technology Center, Denver, Colorado.

U.S. Department of Agriculture. 2002. Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. Fire Effects Information System. Internet address: http://www.fs.fed.us/database/feis/index.html

U.S. Fish and Wildlife Service, Nevada Office. 2001a. Review comments submitted to DCNR pertaining to the Draft Nevada Natural Resources Report.

U.S. Fish and Wildlife Service, Nevada Office. 2001b. Personal communication. National Wetlands Inventory Mapping in Nevada, excerpted from draft report on the 1980's National Wetlands Inventory reconnaissance level mapping data.

Utah State University. 1997. Nevada Vegetation Cover-Type Codes and Descriptions (accompanies the Nevada Gap Land Use/Land Cover Map). Department of Geography and Earth Resources. Logan, Utah.

Land Resources and Uses

Nevadans past and present have overcome the hardships that arid valley and steep mountain environments can impose on human enterprise. To the casual observer, a vast majority of the state may appear vacant, wide-open, and wild. A closer look reveals that the land and all it bears has long been put to productive and recreational uses. Land here is grazed by livestock; irrigated and farmed; logged for wood products and fuel; mined for gold, silver, copper, and other metals; drilled for oil and geothermal energy; developed for rural and urban communities, industry, and transportation; and, enjoyed by a wide variety of outdoor recreationists. However, the dry climate and rugged landscape leave little margin for excessive use or neglectful management of the soil, water, vegetation, and wildlife. Decisions about resource utilization, especially water, greatly impact ecosystem health and the socioeconomic well being of communities. Sustaining resources harvested and extracted for food, fiber, energy, and minerals depends upon careful and vigilant stewardship of the environment by all individuals and institutions.

People often think of the landscapes around them in terms of the dominant land use or vegetation cover. Common terms include rangeland, forestland, farm and ranch land, mineral resource (mining) land, military land, urban and suburban developed land, and wilderness. Part 4 uses these terms to organize information about the land and resource use in Nevada. Land cover and land use types were mapped by Utah State University in collaboration with the BLM and USFS using circa 1990 satellite images (Gap Analysis Program, circa. 1995). Not surprisingly, the analysis shows that about 81 percent, or 57.5 million acres, of Nevada's landscapes can be described as rangeland (Table 4-1). Forestland, including pygmy conifer (pinyon and juniper) woodlands, covers about 8.5 million acres, or 12 percent of the state. Wetlands and riparian zones cover about 0.7 percent of the state's land area. The estimate of 0.5 million acres for this land cover type probably underreports the actual amount. Similarly, agricultural land estimated at 1.4 million acres, may be understated, since irrigated fields are rotated and only a portion of farmland receives water each year.

Table 4-1. Estimated Area of General Land Cover Types In Nevada

Vegetation Group	Area (Acres)	Gap Land Use/Cover Types
Rangeland	57,506,465	All listed below
Herbs and grass	1,873,843	Grassland, Dry Meadow
Sagebrush	30,531,351	Sagebrush, Sagebrush/Perennial Grass
Lowland Shrubs	20,366,039	Salt Desert Scrub, Greasewood, Blackbrush, Hopsage, Mojave Mixed Scrub
Creosote	3,563,553	Creosote/Bursage
Mountain Shrubs	1,171,679	Bitterbrush, Mountain Sagebrush, Sierra Mountain Shrub
Forest	8,505,556	All listed below
Hardwoods/deciduous	283,865	Ash, Aspen
Conifers	575,850	Englemann Spruce, Great Basin Subalpine Pine, Mojave Bristlecone, Pondersoa Pine, Sierra Lodgepole, Sierra Red Fir, Sierra Whitebark Pine, Sierra White Fir, Sierra Yellow Pine, Subalpine Fir, White Fir
Mountain mahogany	535,498	Mountain mahogany
Pinyon/Juniper Woodland	7,110,343	Juniper, Pinyon, Pinyon/Juniper
Riparian and Wetland	476,744	Wet Meadow, Lowland Riparian, Mountain Riparian, Wetland, Open Water
Agriculture	1,429,990	Row Crops, Irrigated Pasture and Hay Fields, Dry Farm Crops

Source: Original land use/cover types data from Gap Analysis Program by Utah State University.
Notes: Gap Land use and land cover types are named for the dominant plant species. Typically, other vegetation types are intermixed, but constitute less than 30 percent of the land cover. Cover types not included are alpine, barren, playa, sand dunes, snow, and urban.

Rangeland

Rangeland covers an immense portion of the state and provides a variety of ecological and economic benefits. Benefits of healthy rangeland include watersheds for rural and urban uses, livestock products, wildlife habitat, and land for urban development. These lands also provide aesthetic value, open space, and outdoor recreation. Rangeland is often used to refer to a group of vegetation zones composed primarily of shrubs, grasses, and forbs that are suitable for grazing and browsing animals, most notably domestic livestock, large herbivores (e.g., mule deer, elk), and wild horses.

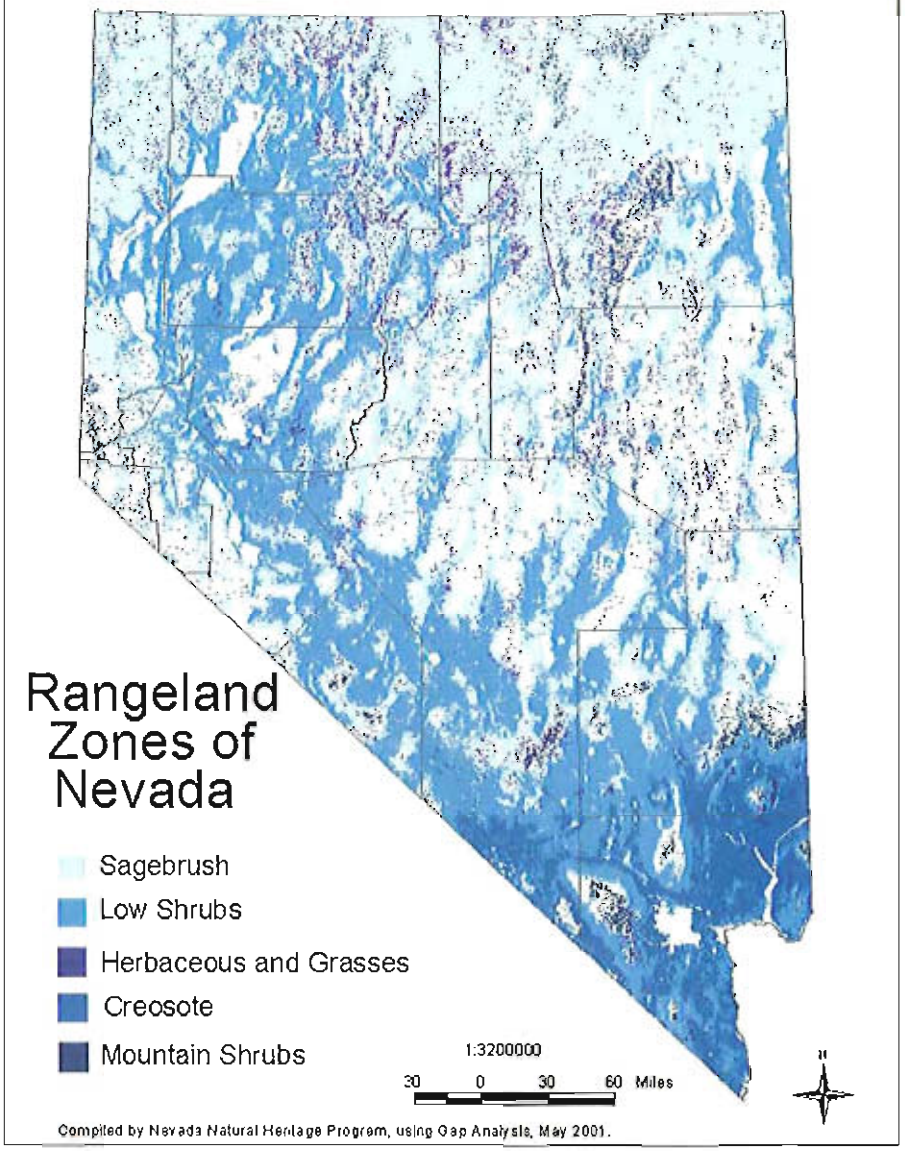
About 57 million acres (81 percent of the state) may be classified as rangeland. The vegetation zones include: sagebrush, mountain sagebrush, and sagebrush/perennial grass (sagebrush zone); salt desert scrub, greasewood, blackbrush, and Mojave mixed scrub (lowland shrub zone); dry meadows and perennial and annual grasslands (herbaceous and grasses zone); creosote/bursage (creosote zone); and, bitterbrush, mountain shrub, and Sierra mountain shrub (mountain shrubs) (Figure 4-1). Streams, springs, and patches of wetlands and riparian zones, woodlands, and forested areas are interspersed throughout rangelands, adding to the diversity of wildlife and variety of human uses. Rangeland uses include livestock grazing, ranching and farming, outdoor recreation, wildlife and fish habitat, wild horse and burro habitat, mining, and urban and rural community development.

Herbaceous and grass type covers about 1.9 million acres dispersed throughout the state. The dry meadow type is most prevalent in the foothills and mountains of northern Great Basin, Columbia Plateau, and the Sierra Nevada ecoregions. The grassland type is a northern Nevada feature, consisting of cheatgrass monocultures or grasslands, introduced perennial grasslands, or patches of native grasslands. Well-represented native grass species include wheatgrasses, bluegrasses, needlegrasses, basin wildrye, blue gramma, squirreltail, and Indian ricegrass.

The lowland shrub zone includes salt desert scrub, greasewood, blackbrush, and Mojave mixed scrub. Lowland shrubs cover 20.4 million acres on valleys and slopes below 5,000 feet. The largest expanses occur in the southern, central and northwestern part of the state, including the Mojave and Amargosa deserts northward to the Black Rock and Smoke Creek desert basins. This zone receives the least precipitation and experiences the warmest temperatures. Moist, saline soil conditions exist in some valley bottoms, generally identifiable by the presence of greasewood and salt grass, often up to the edge of a playa. In the salt desert scrub zone, dominant shrubs include shadscale, greasewood, winterfat, budsage, horsebrush, fourwing saltbush, and mormon tea. Saltgrass, Indian rice grass and cheatgrass area associated species. The salt desert scrub zone provides winter forage and cover for many forms of wildlife and livestock. Mojave desert mixed scrubland occupies lower slopes, washes or upland areas. The zone is characterized by creosote with bursage, desert thorn, hopsage, blackbrush, yucca, and cacti. The creosote-bursage zone is widely distributed in the Mojave Desert below 4,000 feet on valley floors and mildly sloping lowlands. Blackbrush, Mormon tea, indigo bush, honey mesquite, and brittlebush are associated shrubs. Yucca, prickly pear, and Joshua tree are also present (Cronquist, 1972).

A much smaller, but more productive rangeland component is the mountain shrubs zone. Mountain shrubs occupy almost 1.2 million acres, generally at elevations above 6,500 feet. Unlike the lower sagebrush and salt desert scrub zones, this vegetation zone has eluded major vegetation conversions and remains in relatively good condition. Serviceberry, snowberry, currant, bitterbrush, are present throughout. Unique shrub species in the Sierra Nevada ecoregion include varieties of manzanita, tobaccobrush and other species in the *Ceanothus* genera, and chinquapin. Patches of mountain mahogany, aspen, and conifers are common. The moister and cooler conditions at upper elevations help to sustain the vigor of native plants, giving them an edge over aggressive annual grasses and weeds. More moderate environmental conditions also dampen the risk of large and severe wildfires. Pinyon pine and juniper stands are expanding in central and eastern Nevada and in some locations crowding out the shrub and grass understory. Overcrowded woodlands reduce forage, creating competition among big game population and livestock herds. Mechanical thinning and prescribed fire are among the alternative measures being used to manage pygmy conifers.

Figure 4-1. Approximate Distribution of Rangeland Vegetation In Nevada



Sagebrush dominates the state, with subtly different shrub communities spanning 30.5 million acres. One or more of the twelve species and subspecies of sagebrush dominates over half of the state's rangeland. The sagebrush/perennial grass (also known as sagebrush steppe) and Great Basin sagebrush ecosystems are the two dominant types. Mountain sagebrush is prevalent above 6,500 feet in central and northern Nevada. Sagebrush steppe is more common in the Columbia Plateau ecoregion and mid-elevations in the central mountains in semi-arid microclimates. Associated shrubs may include bitterbrush, rabbitbrush, currant, gooseberry or cliffrose. Grasses make up a significant portion of the steppe plant mix. The Great Basin sagebrush zone typically occurs above 4,500 feet and native grass species make a small percentage of the understory or do not occur at all. An exception is areas invaded

by cheatgrass. Stands of juniper, pinyon pine, and possibly Jeffrey or ponderosa pine are intermixed. This lower elevation sagebrush ecosystem is the most widespread and abundant cover type in Nevada.

Scientists uncovering the natural prehistory of Nevada's ecoregions have found that rangeland plant communities were adapted to light to moderate grazing by comparatively small populations of large and small herbivores (e.g., pronghorn antelope, mule deer, elk, bighorn sheep, jack and cottontail rabbits) (Grayson, 1993). Other major influences on vegetation include human harvesting practices and frequency of natural and human-set fires. Given the low population densities and seasonal movements, native populations food gathering and use of fire likely affected only a small fraction of the landscape (Griffen, 2002). Since settlement, domestic livestock grazing has been the primary use of rangelands. The BLM and USFS combined manage about 85 percent of the rangeland areas in the state. Cattle and sheep production on public rangeland is managed within grazing allotments by permittees and agency resource scientists. In 1999, the BLM held 700 permits for livestock grazing on 45 million acres of the 48 million acres administered by the agency (U.S. Bureau of Land Management, 2000). On Humboldt-Toiyabe National Forest (HTNF) land, the USFS administered 298 grazing allotments covering 4.7 million acres of the total 5.8 million acres in the national forest (Humboldt-Toiyabe National Forest, 2001). The allotment and acreage totals include HTNF land in Nevada and California, of which 92 percent lies in Nevada.

The arid climate, low annual forage production, and the small amount of private holdings with sufficient area to make livestock operations economically viable requires the use of forage resources available on surrounding public lands. Almost all of the cattle and sheep raised in Nevada are produced on ranches that make some use of public rangelands. The non-federal component of rangeland used for livestock grazing livestock is significant (Table 4-2). The total amount of nonfederal rangeland used for grazing has changed little since the early 1980's, but grazing on pasture and forestland has decreased (U.S. Natural Resources Conservation Service, 2000). Private ranch land contains valuable water resources and riparian habitat, and therefore is important to maintaining healthy watersheds. Livestock operations either own or lease private land and get a BLM and/or USFS permit for the federal public land. Compared with other states, Nevada ranches, supplemented with public grazing land, are large but capable of continuously supporting relatively small numbers of livestock.

Table 4-2. Changes in Nonfederal Grazing Land in Nevada, 1982 - 1997

Year	Pasture Land	Rangeland	Forest Land	Total Non-federal Grazing Land
1982	312,600	8,246,200	366,000	8,924,800
1987	313,000	8,280,600	374,400	8,968,000
1992	310,300	8,258,700	374,900	8,942,900
1997	279,000	8,372,400	305,000	8,956,400

Source: Modified from 1997 National Resources Inventory, Revised December 2000. Website: http://www.nrcs.usda.gov/technical/land/grazing.html

The BLM manages and monitors forage and ecological conditions. Forage production and utilization (i.e., proportion of plants removed) traditionally has been the focus of monitoring. In recent years, ecological site condition monitoring is being performed more often. Ecological site condition monitoring is based on a comparison of existing soil, vegetation, wildlife, and physical site conditions to more natural conditions. The data from monitoring are used to evaluate post- or pre-grazing carrying capacity, select grazing management practices, and set priorities for special range improvement activities on public lands. To be consistent with multiple use principles, the BLM allocates available forage to each class of grazing animal, including domestic cattle and sheep, mule deer, elk, bighorn sheep, pronghorn antelope, and wild horses and burros. The BLM in 1999 used the combined results from ecological site and forage condition monitoring to characterize rangeland conditions. Of the 45 million acres covered under grazing allotments, five percent was rated in excellent condition and 12 percent poor (Figure 4-2). About 21 million allotment acres were rated as fair to poor (47 percent) and 13.6 million acres as good to excellent (13.6 percent). Grazing, fires, and nonnative plants are factors in the proportionately large amount of grazed rangeland in fair to poor condition (U.S. Bureau of Land Management, 2000)

Historically, cattle and sheep repeatedly grazed sagebrush, salt desert shrub, mountain shrub, and riparian zones, exhausting the regenerative capacity of native grass and shrub species. Though improvements in grazing management practices have been made throughout the state, harsh environmental conditions have slowed recovery of the natural vegetation. Ultimately, the extensive removal of perennial grasses substantially changed the sagebrush zone. Thickening shrub canopies and cheat grass understory have filled the voids. The flammability of cheat grass and closure of the shrub canopy has created conditions favorable to wildfire (Young, 1985).

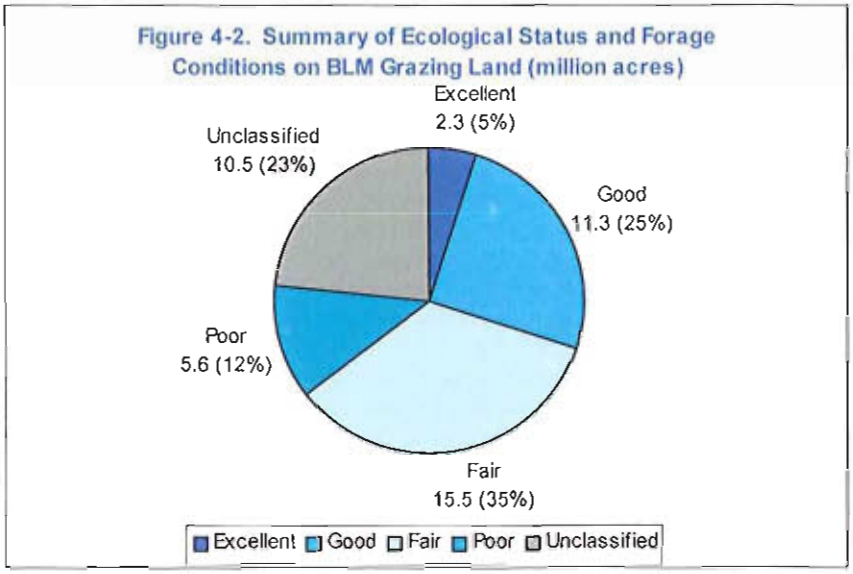


Figure 4-2. Summary of Ecological Status and Forage Conditions on BLM Grazing Land (million acres)

Source: Nevada Bureau of Land Management, 2000.

During the 1999 and 2000 fire seasons, wildfires consumed more than one million acres in the sagebrush zone. The intensity of some fires completely destroyed much of the vegetation within burned areas and seeds stored in the upper soil layer. Without native seed sources nearby, burned sagebrush habitats are not capable of natural regeneration, and therefore more susceptible to invasion by non-native plants. The spread of noxious weeds, some of which have been present in small numbers for decades, appears to have accelerated in recent years. In some areas, the numbers of livestock may still exceed the carrying capacity of rangeland plant communities. Less vegetative cover and fewer deep rooted plants increases runoff and accelerates erosion, contributing to the high sediment and nutrient loads in water quality impaired reaches of major rivers.

A related concern is the effects of wildfire on the distribution and abundance of vegetation consumed by game animals, livestock, and wild horses. Competition among the large grazing animals is likely to further degrade sagebrush ecosystems unless animal numbers are managed in proportion to acres of habitat burned. Wildfire and resulting overgrazing can impair living conditions for sensitive species as well. Special status wildlife species dependent on sagebrush habitats include the Sage Grouse, Burrowing Owl, Mountain Quail, Brewer's Sparrow, pygmy rabbit, sagebrush vole, and the sagebrush lizard.

The deterioration and conversion of millions of acres of sagebrush, riparian and other rangeland communities is a serious ecological event. The intensity of concern is evident in the number of agencies, scientists, and interest groups working on special collaborative studies and planning efforts involving restoration of sagebrush ecosystems. High profile cooperative efforts mentioned previously that focus on the sagebrush vegetation zone at-large include the Great Basin Restoration Initiative, sponsored by the BLM, and state sponsored initiatives for sage grouse conservation, fire management, and invasive weed control.

Rangeland areas are undergoing more permanent changes too. Rangeland made up 78 percent of the total land in Nevada developed for residential, commercial, industrial, utility, and transportation uses from 1992 to 1997. Though the amount of land converted is less than 0.5 percent of the total rangeland area, other associated activities extend the influence of development beyond building footprints. Solid waste

disposal; illegal dumping; hiking, biking, and motorized recreation trails; and, road and utility corridor construction are examples. Mining also constitutes a substantial and expanding use of Nevada's rangeland. However, information on the amount of rangeland converted for historic and contemporary mineral development was not available.

The use and management of public rangeland resources is becoming more challenging with the growing number and diversity of public land users. On today's federal public rangeland menu are livestock grazing, dozens of outdoor recreation pursuits, wildlife habitat, riparian management, endangered species management, mining, hunting, cultural resource protection, wilderness, wild horse and burro habitat, energy development, and various special uses. Administration of large land areas is especially challenging as national offices of federal agencies make frequent changes in policies and enforcement of regulations. Meeting the multiple use mandate has created divisiveness in Nevada where competition among incompatible land use activities is high. Public pressure from interests on all sides has required the agencies to open up their land use and resource planning processes, sometimes slowing down the decision making process. Because such a vast amount and diversity of Nevada's natural resources are found on the rangeland, special care is warranted in land management decisions. Investment in restoration of deteriorated conditions is vital to the future of agriculture, wildlife, and the quality of outdoor recreation experiences in Nevada.

Forestland

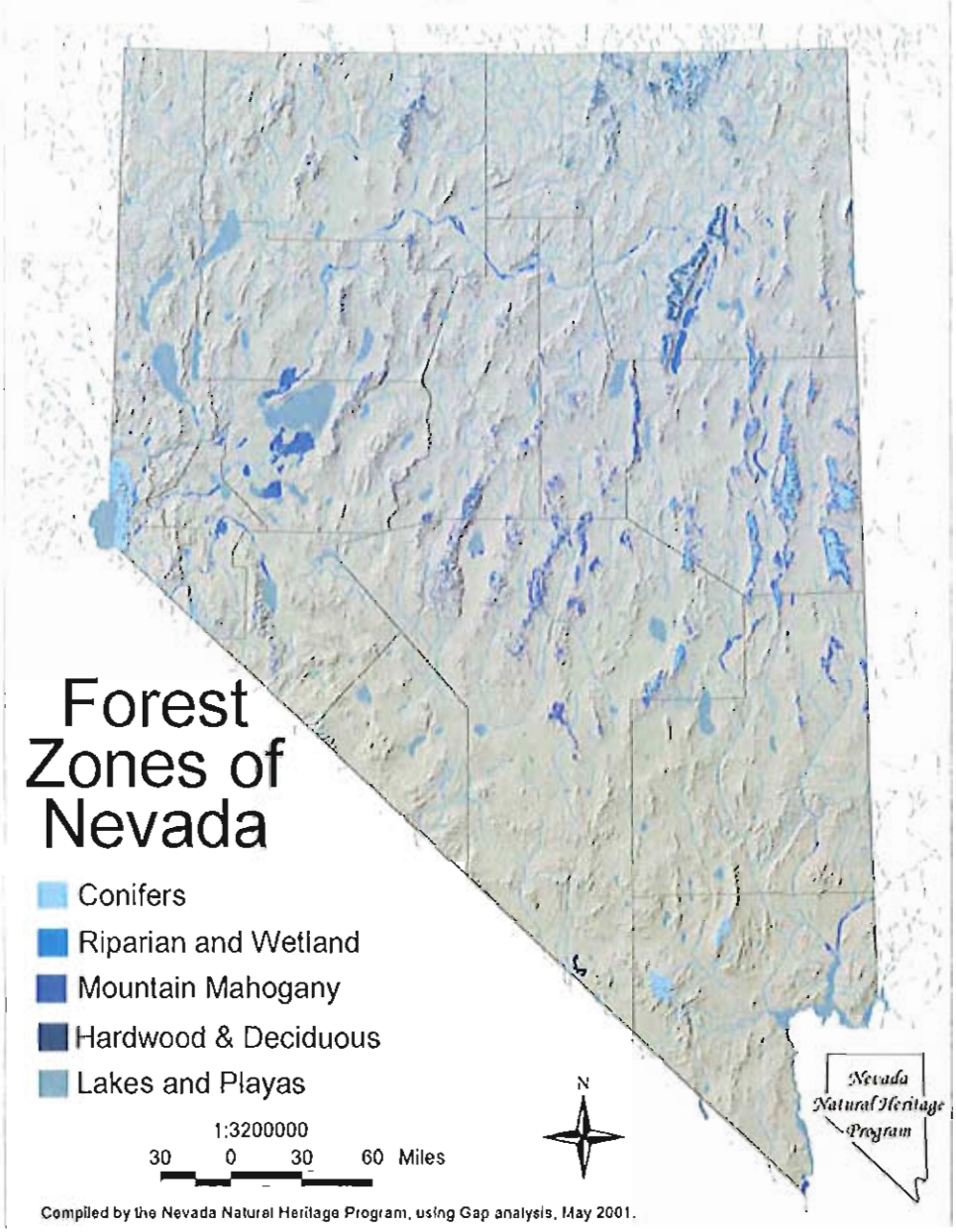
Forestland types cover approximately 8.5 million acres (12 precent) in Nevada. Forests can be divided into two major types, timberland and woodland. Timberland is comprised of conifer tree species (575,850 acres) formerly used for saw-log wood products such as ponderosa, Jeffrey, western white, sugar, and lodgepole pine, white and red fir, and incense cedar. Figure 4-3 shows the approximate distribution of timberland forests. Heavily logged in the past, conifer forests in many mountain ranges have rebounded and form fairly continuous forested areas, especially in the Sierra Nevada and Carson ranges and the Spring Mountains of western and southern Nevada. Large conifer forest patches also occupy higher mountains of central and eastern Nevada in varying mixtures of whitebark, bristlecone, ponderosa and limber pine as well as subalpine fir and Engelmann spruce. Aspen and cottonwood are the most common deciduous trees and are widespread along riparian areas, sometimes forming large groves around streams, springs and seeps.

Hardwoods and deciduous woodlands occupy about 283,865 acres. Mountain mahogany (535,500 acres) typically occurs above the Pinyon-Juniper woodlands, mostly in the mountains of northern, central, and eastern Nevada. Pinyon-Juniper woodlands are the most common forest type in the state.

More than 92 percent of the forestland occurs on Nevada's public lands and are managed primarily by the USFS and the BLM. Since 1969, the USFS has acquired 71,000 acres of forestland in the Carson Range of western Nevada. Conversion of private forestland to public land has decreased private commercial timber harvests and revenue. Approximately 750,000 acres of forestland is in private ownership with concentrations in the Carson Range of western Nevada, the Ruby Mountains, the Schell Creek Mountains of eastern Nevada, and portions of the Spring Mountains in southern Nevada (Nevada Division of Forestry, 2000). A large majority of non-industrial private forestlands are not adequately managed for their forest resource values.

Few forested areas are representative of the range, density, and mix of species that existed prior to settlement. Forests and their ecological conditions have been altered by commercial and domestic use, as well as to accommodate agricultural, urban, mining, and railroad development. As a result, a majority of the timberland resources during the 19th Century were depleted. Second growth stands found today occupy higher elevation and steep terrain that is difficult to log or treat for fuel loading. The margins of some conifer forestlands that were clear-cut have not regenerated, likely the result of erosion of barren soils and drier, warmer microclimates across exposed slopes. Overcrowded conditions are widespread on conifer and pygmy conifer forestlands, the result of aggressive fire suppression tactics and reduced harvests. Overstocked forests produce less streamflow, reduce groundwater recharge, and may

Figure 4-3. Approximate Distribution of Forestland in Nevada



Note: The distribution of Pinyon and juniper woodlands is shown separately in Figure 4-4.

contribute to higher flood frequency and peak flow. The Nevada Bird Conservation Plan prepared by the Nevada Working Group of Partners In Flight, prioritizes 21 bird species in conifer, pinyon and juniper, and aspen habitats for special conservation needs. The predominantly forested Carson Range on the edge of the Sierra Nevada ecoregion is designated a high priority conservation site by the Nevada Natural Heritage Program. Several sensitive plant and animal species inhabit the area.

The forests in the Sierra Nevada ecoregion of western Nevada generally receive substantially more attention than other forested areas because of the association with the large continuous Sierran forests, higher timber reproduction potential, and the proximity of rapidly growing urban areas. In the past 20

years, remaining foothill conifer forests along the eastern Sierra Front in western Nevada (including the Lake Tahoe Basin and the Carson Range) have become popular sites for residential development. Approximately 3,500 acres of timberland have been converted along the Sierra Front, resulting in the loss of commercial harvesting, recreational opportunities, and restricted public access to public lands (Nevada Division of Forestry, 2001). Developments in forested areas also threaten critical watershed values, diminish scenic beauty, and increase the risk that lives and personal property will be lost to wildfires. A majority of the timberland areas are overstocked, comprised of even-age class, and standing dead trees. Pine and fir beetles and mistletoe infestations are common in the Sierran forests. The potential for management of park-like, old growth forest appears to be limited to small, high elevation patches.

Timber harvests ten years ago were permitted primarily for private commercial timberlands. Timber harvest production has declined from about 2.3 million board feet per year to 150,000 (Nevada Division of Forestry, 2000). Most tree harvesting permits now are for fire fuels management (e.g., thinning dense areas) to meet subdivision development requirements or for forest ecosystem health. The last timber harvest permit issued in the Sierra Nevada on private commercial timberland was in 1998. In the Carson Range, fuelwood production has declined from 3,162 cords in 1990 to 550 cords in 2000. The mills closer to northwestern Nevada in Truckee, Loyalton, and Pioneer, California, have closed. Some potential commercial forest product uses have been identified, but markets have not emerged in the western Nevada region.

Forest Resources Status

Insects, disease, competing vegetation, climate, fire, and humans are the main factors that determine the health of forests. Overcrowded conditions are a widespread problem on some Nevada forestlands.

A majority of the forested lands in Nevada are administered by the USFS. Federal agency reports were relied upon to compile forest health information. Other sources of information include state agency reports, scientific publications, and personal communication with experts. Detailed information is lacking on the condition of much of Nevada's forested lands. However, during Summer 2000, the National Forest Health Monitoring (FHM) program was begun by the USFS in Nevada. The FHM will provide ongoing information on forest conditions in the state. The first report became available in Spring 2002 (U.S. Forest Service, 2002)

Subalpine Timberline Forests and Woodlands

This high elevation ecosystem occurs in remote locations in the island mountain ranges in Nevada. Five needle pines (whitebark, limber, and bristlecone pines) are common species. The typical forest structure is open with older aged trees. Fires are infrequent in this forest type due to its open nature, low fuel accumulation, and cooler conditions. Fire return intervals are likely over 100 years. Consequently fire suppression has likely had limited impact on this type. Aerial surveys in 1999 revealed a fair amount of mortality caused by mountain pine beetle in the Toquima, Toiyabe, Shoshone, Jarbidge, Ruby and East Humboldt Ranges. This is the first time these ranges have been surveyed in a number of years, so it is uncertain whether or not this beetle activity is unusual. Five needle pines are susceptible to the exotic disease white pine blister rust. This pathogen has not appeared yet in the interior of the state, but is located on the western border in all five-needle pine species.

Engelmann Spruce - Subalpine Fir

This forest type is found primarily in the Jarbidge range and Pilot, Snake and Schell Creek ranges. Subalpine fir mortality is occurring at high levels in the Jarbidge Mountains due to a complex of insects and disease pathogens. Extended drought in the late 80's and early 90's stressed the trees, leading to increased insect and disease activity. High levels of subalpine fir mortality can significantly change the structure and composition of the fir forests. Historically, fire regimes of mixed severity occurred on a 50 to 80 year cycle, with lethal fires every 100 to 300 years. Because of increased mortality in these older age

class forests the potential for stand replacing fires has increased. However, current conditions within the Region are within the historical range of variation for the type.

Potential major changes in stand structure and composition are high for this type. Changes will eventually occur as a result of large, stand-replacing fires, insect epidemics, or a combination of the two throughout much of the fir range.

Quaking Aspen

Quaking aspen is distributed throughout the State, occurring primarily along drainages, and at springs and seeps in mountainous terrain. The age of trees generally varies from 60 to 120 years. Most of the quaking aspen in Nevada is in a mid- to late seral stage of succession. Stands are not regenerating across much of the state for different reasons. In upper montane locations, conifers are beginning to dominate aspen stands. Without some form of disturbance to stimulate aspen suckering, and reduce shade intolerant conifers, these stands will continue to decline. In other areas wild and domestic grazing animals are preventing the stands from regenerating. Without management, these aspen clones will disappear and the probability is high that significant aspen acreage will continue on the path of succession to other vegetation types. The lack of successful regeneration over large areas increases this risk. Continued heavy browsing pressure on existing quaking aspen and other forage species will result in habitat degradation for all species found within this type.

Sierra Nevadan Forests

Sierran coniferous forests below the subalpine type can be classified as Red fir/Lodgepole pine, mixed conifer, and eastside pine. The red fir/lodgepole pine type occurs between 7000 and 8500 feet. Composition varies from almost pure fir to pure pine; with less frequent associates being white fir, Jeffrey pine at lower elevations and western white pine and mountain hemlock at the upper elevations. Fire frequencies are low in these high elevation forests and consequently, fire suppression policies have had less effect here than within the lower, drier forest types in Nevada.

The insects commonly associated with the species are fir engraver beetle, needle miners, and mountain pine beetle. Insect activity is at background levels currently. Earlier in the decade a prolonged drought combined with high stocking levels and annosus root disease led to high levels of mortality in the red fir. Lodgepole pine at high elevations was little impacted by the drought. Where associated with locally high soil moisture conditions at lower elevations, mountain pine beetle caused significant mortality. Overcrowding, the species' branch retention habit, and large numbers of beetle killed trees combine to create a significant wildfire hazard.

Mixed conifer forests are located below the red fir/ lodgepole pine type. Depending on aspect, soil moisture regime and disturbance history, the forest can range in species composition from almost pure white fir to a well balanced mix of white fir, Jeffrey and ponderosa pines with a smaller complement of sugar pine and incense cedar. The elevation range of this type is roughly 5800 to 7000. As in other forest types, fire suppression policies and the lack of active forest management has led to very high stocking levels, large fuel accumulations, and unsustainable species compositions over much of this type. Fire frequency within this type typically ranged from 5 to 30 years. Many of these areas have not experienced fire for over 100 years, putting much of the area far outside the natural range of variability for many characteristics. This situation places the forest at high risk of rapid change due to fire and insect activity.

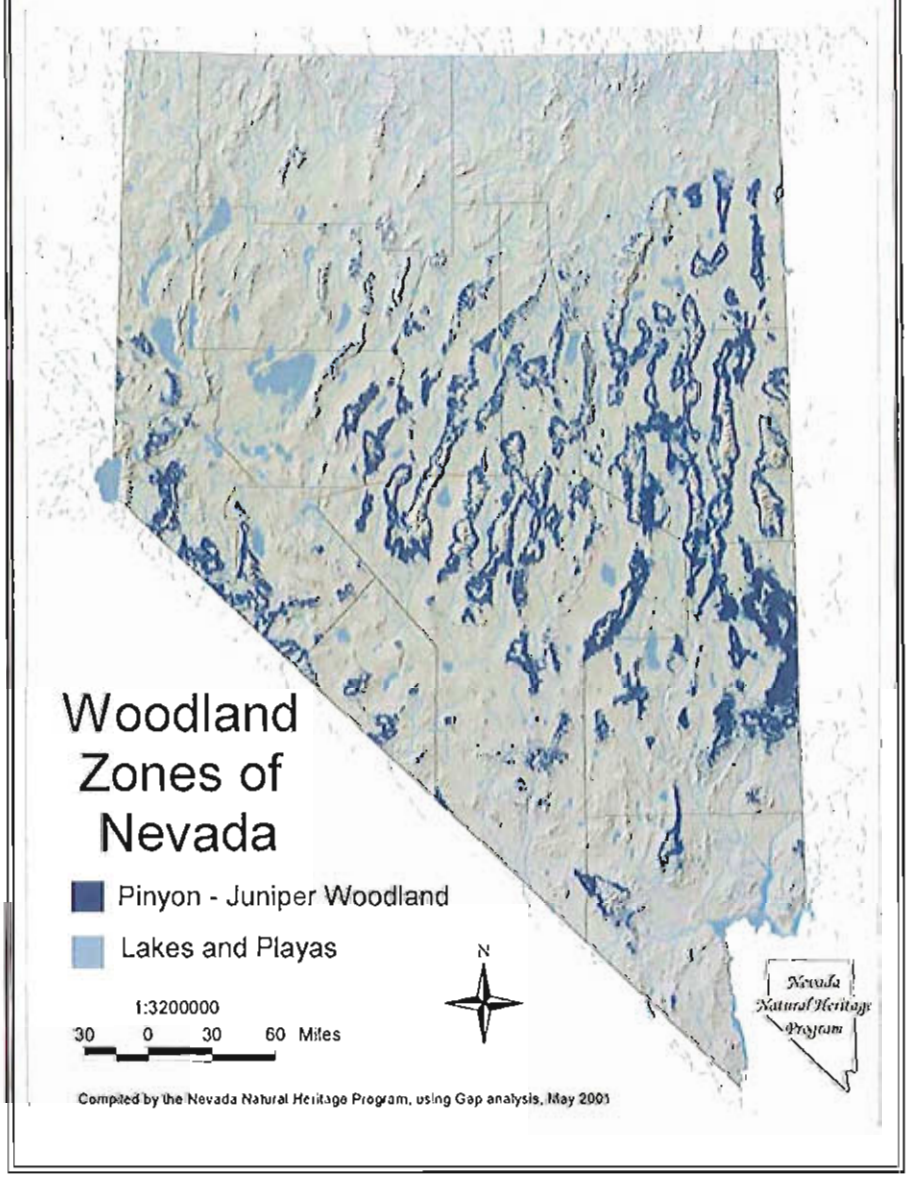
The drought of the late 1980's to the mid 1990's triggered a bark beetle epidemic in the mixed conifer type that led to the death of millions of forest trees range-wide. The standing dead trees constitute a large fuel load. Current bark beetle activity is at endemic levels. Dwarf mistletoe is the most significant pathogen in these forests. The parasitic plants exist on all conifers in the ecoregion, except for incense cedar. Where levels of infestation are high, natural regeneration of the affected individuals is not possible, leading to species composition changes in the future.

Below the mixed conifer type is the yellow pine type (e.g., Jeffrey and Ponderosa pine). Historically this type was characterized by open "park like" conditions with multiple age classes distributed as small even aged groupings. Wildfire burned on a 5 to 12 year cycle removing brush and tree regeneration, and stimulating herbaceous plant growth. Fuel accumulations were spotty and insignificant. In Nevada, the southernmost occurrence of the yellow pine forest type is in the Spring and Sheep ranges in Clark County. Past cutting practices and fire suppression have left large portions of the yellow pine forests in overstocked, even-aged conditions. Basal areas exceed 250 square feet per acre, distributed among smaller size classes. Fuel accumulations are exceedingly high for this type and wildfire hazard is high. Risk of attack by Jeffrey pine and western pine beetles, and flat-headed borers are very high under current conditions. Western dwarf mistletoe is widespread across the type and infections are intense.

Pinyon-Juniper Woodlands

The pinyon and juniper (PJ) type is the most widespread forest type in Nevada (Figure 4-4). The PJ woodland type is composed of pure stands or a mix of singleleaf pinyon pine and three species of juniper, western, Utah, and Rocky Mountain. Utah juniper is by far the most widespread of the three. PJ woodlands have been harvested for fuel wood, posts and Christmas Trees. Also called "pygmy conifers" due to their short stature at maturity, PJ woodlands are found throughout the state, occupying about 7.1 million acres (10 percent of the state). The most extensive woodland areas occur in eastern Nevada, though western and central Nevada woodland areas are also large.

Figure 4-4. Approximate Distribution of Pinyon and Juniper Woodlands



The range of the PJ woodland type has expanded and receded over the past 7,000 years, apparently the result of climate fluctuations. Over the past 500 years, the PJ populations have expanded further north, into the higher elevations, and down slope onto deep, well-

drained soils on alluvial fans. The "migration" is believed to be a response to climate change as well as human induced changes. Aggressive wildfire suppression and deteriorated rangeland habitats have presented pinyon and junipers opportunities to become established in shrub and grass communities. These factors may also be creating favorable conditions for PJ stand density to increase and create a closed pygmy conifer canopy. Figure 4-4 shows the distribution of PJ woodlands about 1990.

The rate of woodland expansion appears to have accelerated during this century. Wildfire in pre-settlement PJ woodlands is thought to have been comparatively frequent (10 to 30 year recurrence, compared to 30 to 50 year intervals for Great Basin sagebrush), burning small trees and lighter fuels and leaving more of this vegetation type open and thickets confined to rockier and more dissected terrain (Griffen, 2002). Risk of catastrophic wildfire is greater in the crowded conditions that are more commonplace in portions of eastern, central, and western Nevada. When conditions are right, stand-replacing fires can carry from the younger stands into the sparse, older stands, eliminating them as well.

Wildfire in pinyon thickets can readily crown. PJ woodland harvesting and management ideas, viewed retrospectively, were mistaken. Ecologists surmise that clear-cutting; over-grazing herbaceous plants; and, fire exclusion abetted overcrowding. Actions taken to protect woodland zone watersheds and biodiversity include controlled burns in open PJ stands, pre-treatment of fuel-dense green woodlands, and restoring those burned.

As woodland cover and density increase, other plant communities disappear. The replacement of native shrub and grass communities corresponds with a loss in diversity of land uses, native wildlife and habitat diversity, and favorable watershed conditions. For decades, ranchers, sportsmen, and agency land managers have attempted to remove and thin PJ forests using heavy equipment, herbicides, and fire in favor of shrub/grass vegetation. Likely there have been some locally important conversions; however, insufficient data exists to determine the amount of PJ forest converted and the resource advantages and disadvantages.

Insect and disease activity in the woodland type is at low levels. The most common destructive insects are pinyon ips bark beetle and borers. Population increases in these insects are usually local and are triggered by some sort of disturbance. Dwarf mistletoe is widespread in the pinyon pines and is the trees' most significant pathogen. Local pockets of Black Stain Root disease occur across the type. True mistletoe is common in the juniper species, but its harmful effects are minimal.

Currently, commercial and domestic use of woodland resources is limited to fuel wood, fence post, and Christmas tree harvesting. Opportunities exist to utilize PJ, but hauling distances and transportation costs to market are high. Promising economic ventures include combustion with other fuels at power plants to generate electricity, production of engineered chipboards, and the distillation of products from pinyon and juniper oils. As in other forest types of Nevada, the number of residential and commercial developments encroaching into woodland areas has increased. The risks and environmental impacts are the same. A major concern is the threat and management of wildfire. As an alternative to chaining, burning, or chemically treating woodlands, state and federal agencies are exploring and promoting productive uses.

Urban and Community Forests

For trees to grow in Nevada's communities, someone must plant them, then nurture and care for them for life. Nevada's earliest settlers planted the first urban forests with tree seeds and cuttings brought from their homelands and from cuttings taken from Nevada's native cottonwood trees. When the railroad was completed in the late 1860's and early 1870's, settlers began planting large, rooted trees delivered by train, alive and in good condition. Surviving trees continue to be the basis of the urban forests in older communities, providing shade, wind protection, and wildlife habitat. Unfortunately, many of these are in poor condition from improper care and pruning practices. Trees in Nevada are as important today as in

settler times. The protection and proper care of community trees is a major concern. For every tree planted in America, four die. The average life expectancy of an urban tree ranges from seven to 15 years.

The NDF administers the state's Urban and Community Forestry Program. All tree care programs in Nevada have been implemented through the U.S. Forest Service, State and Private Forestry Program, municipal, or volunteer efforts. Since 1991, almost one million dollars of Federal funding has been awarded to communities and groups in Nevada for tree planting and tree care education. The loss of federal funding for urban forestry programming would seriously impact tree planting and tree care education in Nevada and could have a long lasting detrimental affect on the health of the urban forests.

Receiving recognition from the National Arbor Day Foundation under the Tree City USA program is an indication of the ability of a community to sustain and manage its urban forests. In 1990, only three Nevada towns had received Tree City USA distinction – Boulder City, Las Vegas and Reno. The number increased to seven in 1995, but fell to six by 2000 when Las Vegas failed to re-certify in 1999. The six Tree City USA communities are Henderson, Boulder City, Reno, Sparks, Carson City, and Nellis Air Force Base. Each has a recognized person or group responsible for tree management, a street tree ordinance, an Arbor Day Proclamation and tree planting celebration, and spends $2 per capita on their tree program. Non-incorporated towns in Nevada may have good tree care programs, but are difficult to enroll in the Tree City USA program. One reason is that county and a community's budget is difficult to separate; and, the county's tree budget may not meet the minimum $2 per capita requirement consistently from year to year.

Farm and Ranch Land

Farming and ranching represents an important land use and economic activity in Nevada. Agriculture only makes up a small portion of the gross state product, but it is important to rural counties. Almost 90 percent, or approximately $315 million of the total annual market value of agricultural products sold is generated within 14 rural counties, (excluding Carson City, Clark, and Washoe counties) (Table 4-3). The economic activity generated from agricultural production represents a substantial revenue source for rural economies in Nevada. Nearly all the agricultural products in Nevada are sold for export, so the agricultural sales provide an important source of income to rural communities.

Compared to national average of about 450 acres per farm, agriculture in Nevada is characterized by a small number of large acreage, family-owned operations (Table 4-4). Of the total private farmland, 81 percent is classified as rangeland and 13 percent as cropland. Of the cropland area, 62 percent is harvested and 31 percent is pastureland. The average farm size in 1997 is about half of that in 1978. During that period, the annual output from the farming sector doubled, growing from 70 to 142 million dollars (Nevada Agricultural Statistics Service, 2000).

About 40 percent of the state's total agricultural output is from animal production (Figure 4-5) (Nevada Agricultural Statistics Service, 2000). It is the largest sector in Nevada agriculture. A recently released study

Table 4-3. Summary of Agricultural Production by County, 1999

County	Market Value of Products Sold ($ 1,000's)	% of State Total
Carson City	198	>1
Churchill	38,058	10.7
Clark	18,926	5.3
Douglas	8,796	2.5
Elko	49,228	13.9
Esmeralda	4,016	1.1
Eureka	13,133	3.7
Humboldt	57,315	16.1
Lander	12,794	3.6
Lincoln	7,317	2.1
Lyon	53,959	15.2
Mineral	1,809	0.1
Nye	27,792	7.8
Pershing	32,679	9.2
Storey	93	>1
Washoe	22,518	6.3
White Pine	8,236	2.3
State Total	356,565	100.0

Source: 1999-2000 Nevada Agricultural Statistics

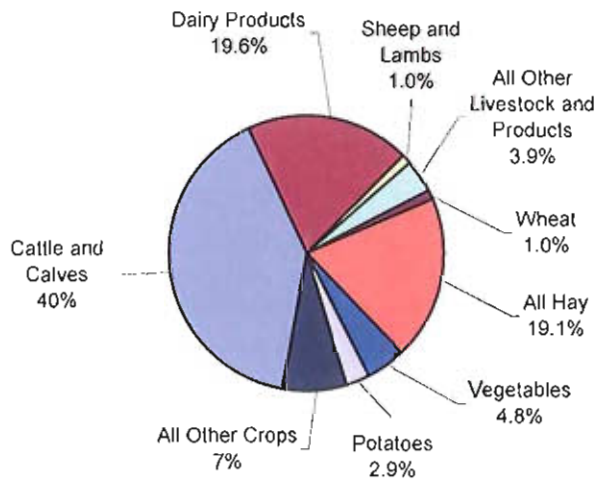
commissioned by the state Department of Agriculture documents a loss of over 475,000 animal unit months (i.e., the amount of forage consumed by a cow/calf pair or 5 ewe/lamb pairs in a 30 day period) of permitted public land grazing from 1980 through 1999. Over the 19-year period, the level of permitted grazing decreased 16 percent (Resource Concepts Inc., 2001). The reasons for reducing permitted grazing are related to resource issues and grazing permit violations. Between 1982 and 1987, the inventory of Nevada cattle decreased from about 600,000 to 500,000, but has held close to that number since. The inventory of Nevada sheep has fluctuated between 80,000 and 100,000 between 1987 and 1999. In 1999 the number of sheep was about 82,000, close to the 1987 number. Nearly 100 percent of the beef cows, sheep, and lamb raised in Nevada were produced on ranches with some dependency on federal public rangeland. Accordingly, federal policies and management have a direct economic effect on the animal production sector and rural county economies.

Table 4-4. Number and Area of Farms and Ranches in Nevada: 1974-1997

Year	Number of Farms	Total Farm Area (1,000 acres)	Average Farm Size (acres)
1974	2,076	10,814	5,209
1978	2,399	10,427	4,346
1982	2,719	9,980	3,671
1987	3,027	9,989	3,300
1992	2,890	9,264	3,205
1997	2,829	6,409	2,266

Source: 1997 Census of Agriculture Vol. 1 Geographical Area Series, Part 28, Nevada & County Data.

Figure 4-5. 1999 Cash Receipts from Nevada Farm Marketings



Of the land classified as cropland, 62 percent is cultivated for production of field and specialty crops (e.g., winter and spring wheat, barley, onions, garlic, and potatoes) and nearly 31 percent is pastureland. Approximately 75 percent of the farms in Nevada have access to irrigation, but in any given year only about 10 percent of the total farmland is irrigated (Table 4-5). Due to the arid climate and droughty soils, only a small portion of the land that is currently farmed in Nevada is considered prime crop or pastureland (Table 4-6) (Nevada Agricultural Statistics Service, 1999).

On-going trends in Nevada agriculture include increased output in horticultural products, high value row crops, and other less traditional enterprises. Traditional family farms and ranches have been facing increasing economic challenges and non-farm demand for their land and water resources. Nearly half (45 percent) of the farm operators in the state do not list farming or ranching as their principal occupation. The number of small, specialty, and equine operations is increasing. Many small part-time operators are in agriculture to preserve their way of life. They may not sell any agricultural products, or provide product solely for local or niche type markets. Almost half (48 percent) of the Nevada farms had annual sales of less than $10,000 according to the 1997 Census of Agriculture.

While certain components of the state's agricultural industry are expanding, other traditional sectors such as livestock production have stagnated or receded over the past decade. Agricultural water rights and arable land are being purchased and converted to non-farm uses to meet the demands of a growing, diversifying urban and rural population. The demand for agricultural water rights to meet additional municipal and industrial uses in urban areas will probably grow, since water resources are approaching full commitment, and approximately 77 percent of the water consumed in Nevada is for agricultural purposes. Once water rights are transferred from irrigated cropland or pastures, implementation of a site-specific revegetation plan is crucial to avoiding environmental problems, such as soil erosion, air pollution from wind-blown particulates, and nonnative plant invasions.

Table 4-5. Levels of Agricultural Irrigation in Nevada

Year	Irrigated Land (Acres)
1987	778,977
1992	556,172
1997	764,738

Source: 1997 Census of Agriculture: Nevada State & County Data. Nevada Agricultural Statistics Service, 1999

The NRCS estimates that 2,136 acres of cropland were converted to residential, commercial, industrial, or transportation uses from 1992 and 1997, an eight percent share of the total amount of land developed. From 1987 to 1997, about 16 percent of the prime crop and pasture land in Nevada was taken out of production (Table 4-6) (U.S. Natural Resources Conservation Service, 2000). Available data is not sufficiently detailed to determine in which areas of the state and for what uses prime farmland is being converted. From general observations, farmland is being converted in urban and rural areas for residential and commercial development and for wildlife habitat. In western Nevada, the loss of green space and cultural heritage associated with agriculture has heightened interest in the preservation of open space associated with farming and ranching. The purchase of development rights and conservation agreements through private and/or government sponsored agricultural trusts is a market-based approach to preserving the rural, agricultural character of Nevada that is generally viewed more favorably than regulatory alternatives, such as local zoning ordinances. Two conservation easements have been executed on ranches in Nevada for protection of sensitive species occupying wetland habitats in Ruby and Oasis valleys (eastern and southern Nevada, respectively). Availability of water has always been a controlling factor in agricultural developments, so farms lie adjacent to many of the state's limited number of rivers and streams.

Table 4-6. Changes in the Amount of Prime Farmland in Nevada, 1982 - 1997

Year	Cropland (Acres)	Pastureland (Acres)	Total Prime Farmland (Acres)	Change in Total Prime Farmland (%)
1982	286,800	22,800	309,600	---
1987	291,700	19,500	311,200	1.0
1992	264,900	15,000	279,900	-10.1
1997	246,300	15,300	261,600	-6.5

Source: 1997 National Resources Inventory, revised December 2000. Natural Resources Conservation Service.

The quality of surface water improved in past years with the removal and placement of more stringent standards on discharges of pollutants from municipal and industrial point sources. Today the focus is on nonpoint sources. Agriculture in general has the largest impact on water quality. Primary sources are runoff from irrigation, intensively grazed ranchland, and large livestock feeding operations. Nutrients, sediment, temperature, and pH are pollutants of concern (Nevada Division of Environmental Protection, 1998). Increased Clean Water Act regulations have increased agricultural production costs, and in some cases, reduced agricultural production or output. State and federal environmental protection agencies emphasize the voluntary control of nonpoint source pollution loads as a primary means for improving impaired water. All major rivers contain reaches that exceed water quality standards.

To help private property owners reduce pollution from agricultural practices, the Environmental Quality Incentive Program (EQIP) administered by the NRCS and the Clean Water Act Section 319 Grant Program provide matching funds for best management practices for water quality improvement. Nevadans continued to show interest in EQIP during 2000. Fifty-five landowners or operators applied for funding, which totaled $1,005,400, resulting in 43 contracts. The majority of the practices focus on

improving grazing land production and water quality and quantity. Practices include irrigation system improvements for conservation, fencing, stream bank protection, windbreaks, spring developments, prescribed grazing, wildlife habitat, and pest management. Eleven contracts were awarded to Native Americans or tribes amounting to $197,000, including $90,000 in Native American EQIP funds. In general, though, profitability of agricultural enterprises also is under pressure from increased production costs (e.g., energy, transportation, labor factors) without offsetting increases in product value (U.S. Natural Resources Conservation Service, 2001).

Mineral Resource Land

Nevada led the nation in production of gold and silver throughout the 1990's. Mining is especially important to rural community economies in northern Nevada where most of the large gold and silver mines are located. Production in 1999 was 8.3 million troy ounces of gold and 19.5 million troy ounces of silver, worth approximately $2.5 billion. In 2000, gold and silver production increased to 8.5 million and 23.0 million troy ounces, respectively, but the dollar value was about the same as 1999 due to lower prices for both metals. The industry employs about 11,000 people in Nevada, and pays a higher average wage than any other employment sector. Recent declines in precious metals prices have forced many companies to cut costs with layoffs or increased production. Exploration expenditures in 1999 were approximately half of the 1994 expenditures.

Other minerals are mined in Nevada. The recent increase in energy prices has increased demand for barite, which is primarily used for drilling mud. Industrial minerals such as silica sand (for making bottles and jars), diatomite (cat litter and filters), limestone/lime, lithium compounds, gypsum, magnesite, perlite and salt, and specialty clay continue to be mined at relatively stable rates. Enhancements in technologies and regulations have reduced the number and magnitude of negative environmental impacts from individual mines. State and federal agencies continue to work with industry and the interested public to ensure that mining operations from design through reclamation minimize and mitigate negative impacts and return disturbed land to a productive use. Mines are subject to extensive permitting and monitoring through their entire life cycle – during start-up, operations, reclamation, and closure.

The NDEP is the state permitting agency for all mining operations and exploration projects. For a mine or exploration project taking place on public land, a plan of operation approved by the responsible federal land management agency may be substituted for the permit application. Proposed exploration projects and mines located on public land are subject to an assessment of environmental impacts and implementation of an approved mitigation plan in accordance with the National Environmental Policy Act. The state Bureau of Mining Regulation and Reclamation within the

Reclamation of a waste pile at a modern-day mine on the Carlin trend in Eureka County. Regulations, university and industry research, and corporate stewardship have brought about improvements in reclamation planning and practices. A total of 2,375 acres (441 on private and 1,934 on public land) were reclaimed at large mines between 1996 and 2000 (Table 4-7). State law requires that large mine operators return mine sites to a productive use, such as wildlife habitat or grazing land. 1992 photo courtesy of Newmont Mining Company and NBMG.

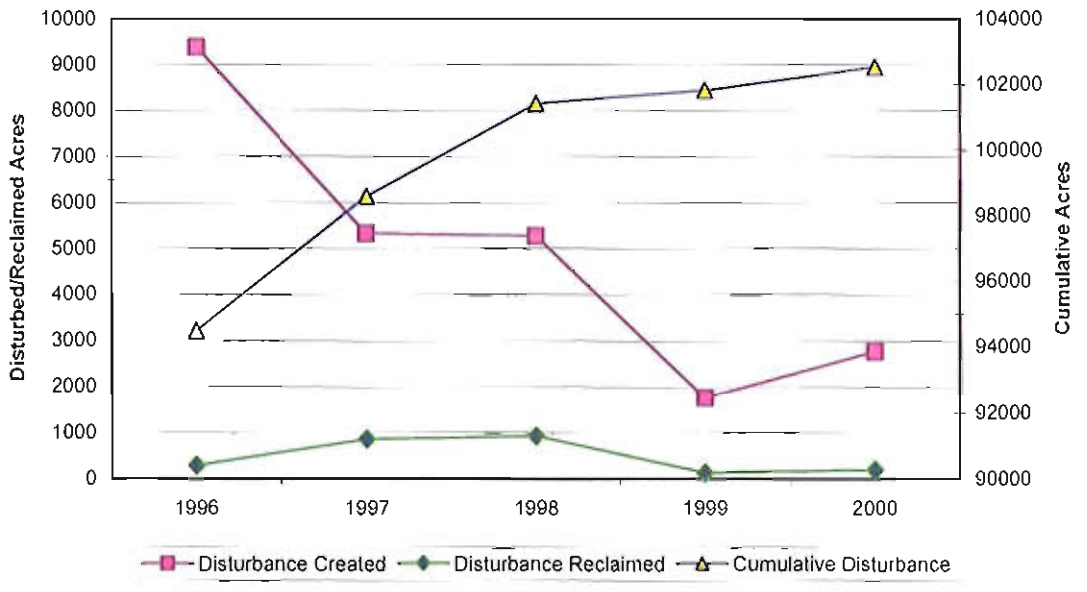
NDEP regulates 151 active mining operations through water pollution control permits to make sure the quality of water resources is not degraded. In 2000 and 2001, six percent of the regulated mining facilities were found by the Bureau to be in substantial noncompliance with permit conditions (i.e., an order or notice of violation has been issued, and enforcement activities are ongoing).

Land disturbed by mining and mineral exploration projects must be reclaimed according to federal and state law (NRS 519A). Reclamation means shaping, stabilizing, revegetating or otherwise treating the land, during or after mining and exploration activity, to return the site to a safe, stable condition that establishes a productive post-mining land use. Properly done, reclamation reduces risk of water quality problems, recreates wildlife habitat, controls slope erosion, and returns soil conditions capable of supporting native vegetative cover. Some reclamation requirements are retroactive for disturbances created after January 1, 1981.

A mining company must post a bond to ensure that funds will be available for reclamation in the event that the operator defaults. The Nevada Division of Minerals administers a bond pool that guarantees up to one million dollars of reclamation activities for small companies that have been refused help by commercial sources. Currently 253 mining reclamation operations have the required financial bonding. Ninety-eight percent of the mining reclamation operations have obtained required bonding.

Since 1989, operators of "large" mines and exploration projects (i.e., projects exceeding 5 acres of disturbance or 36,500 tons removed annually) annually report the amount of land disturbed and reclaimed to the NDEP. A project area is "reclaimed," and the bond released only after NDEP or federal agency officials have verified that the work conforms to an approved reclamation plan and guidelines. Guidelines address topsoil replacement, slope stabilization, and sustained reestablishment of plant communities representative of the project site. Between 1996 and 2000, the cumulative amount of public and private land disturbed for large mining and exploration projects increased by about 14,230 acres (Figure 4-6). Approximately 2,370 acres were reclaimed (Nevada Division of Environmental Protection, 2002).

Figure 4-6. Large Mine and Exploration Land Disturbance and Reclamation Activity, 1996 to 2000



Source: Nevada Division of Environmental Protection, 2002.

For the same period, mining companies reported a total of 18,880 additional acres were disturbed and 1,934 acres were reclaimed on public land (Table 4-7). On private land, 6,688 more acres were disturbed and 433 acres reclaimed. A majority of the additional land disturbed and reclaimed each year occurred on public land. The totals do not include incremental disturbance or reclamation occurring at mines or exploration projects that disturb 5 or less acres or that remove 36,500 tons or less each year. About 20 percent of the disturbance is reported as monitored reclamation, meaning earthwork and seeding has been completed, but the bond has not been released.

Table 4-7. Reported Large Mine and Exploration Land Disturbance and Reclamation Activity, 1996 to 2000.

Year	Private Land			Public Land			Cumulative Disturbed Public and Private Land Acres
	Additional Disturbed Acres	Additional Reclaimed Acres	Cumulative Disturbed Acres	Additional Disturbed Acres	Additional Reclaimed Acres	Cumulative Disturbed Acres	
1996	2,528	5	45,373	6,843	285	49,114	94,487
1997	1,803	124	47,844	3,520	728	50,734	98,577
1998	1,591	245	49,083	3,682	670	52,319	101,403
1999	613	28	49,588	1,137	102	52,210	101,798
2000	958	39	51,123	1,805	149	51,392	102,514
Total	7,494	441	---	16,987	1,934	---	---

Source: Nevada Division of Environmental Protection, Bureau of Mining Regulation and Reclamation, Annual Reclamation Report database.
Notes: Values only include disturbed or reclaimed acres at mines that annually disturb more than 5 acres, or remove more than 36,500 tons. Cumulative totals are based on reported data and do not precisely account for the annual net change in acres disturbed and reclaimed. Reclaimed area values reflect approved final reclamation and do not include areas that are partially reclaimed from completed earthwork and/or seeding.

Sometimes the nature of the ore deposit requires massive excavations called open pit mines. Open pit mines that extend below the groundwater table must be de-watered to keep from flooding the operating area. In many mines, the amount of water that must be pumped exceeds the mines' consumptive use needs. Excess water from open pit operations are used beneficially in a variety of ways. A majority of the excess water is discharged to surface water systems, re-injected into aquifers, or applied to crop land, or piped to power plants. After the mining and de-watering stops, the pits will eventually fill. Open pits may be exempt from reclamation, subject to NDEP approval.

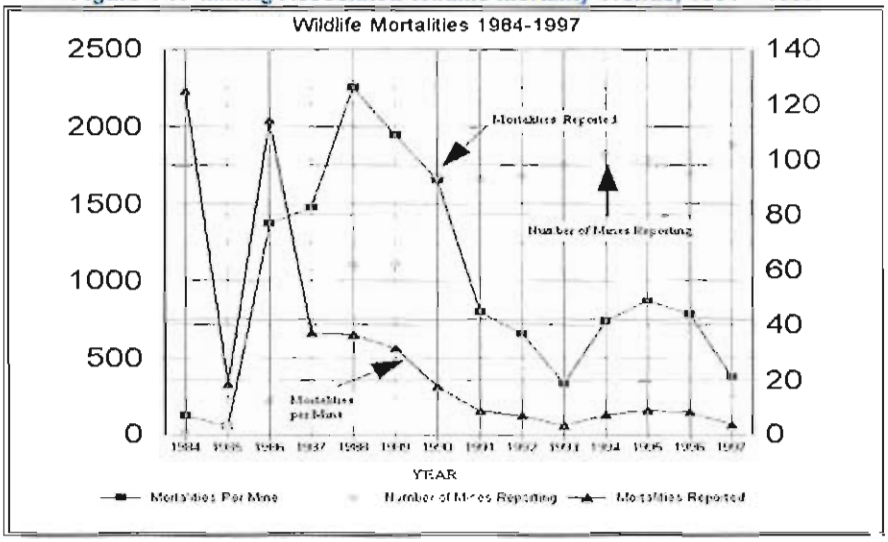
Over the long term, there is uncertainty over the potential cumulative and regional impacts dewatering of open pit mines will have on surface and groundwater resources. Other water users in the region and the public have expressed a deep concern, prompting government agencies and the industry to study the potential long-term impacts of de-watering on the hydrology of the region and water quality of the pit lakes. Most large open pit mining operations with dewatering discharges are located in the Humboldt River Basin. Mining water withdrawals initially were anticipated to remain relatively constant at about 275,000 acre-feet per year with a slight increase up to the year 2010. However, changes in mining operations are difficult to predict. More recent indications are that pumpage will decline at some major mines.

The trend of pit dewatering activities generating water volumes in excess of mine processing and consumptive needs is expected to continue. Actual mine dewatering may change if operators shift from open pit mining to underground mining, or if economics change. However, some degree of mine dewatering is expected to continue regardless of the type of production activity. Precious metal production from underground mines is slowly increasing. In 1999, about 24 percent of Nevada's gold production came from underground mines. In general, underground mines are easier to permit than surface mines because less land is disturbed.

Mining Operations and Wildlife

The mining industry and the NDOW have coordinated efforts to reduce direct mortality of wildlife at mine sites, particularly losses resulting from cyanide or other types of chemical poisoning. Since 1990, the NDOW and mine operators have worked together to implement a regulatory program to prevent wildlife mortality at heap leach ponds and mine tailings. Efforts to study and reduce wildlife mortality began in 1984, when use of the heap leach mine technology surged in Nevada.

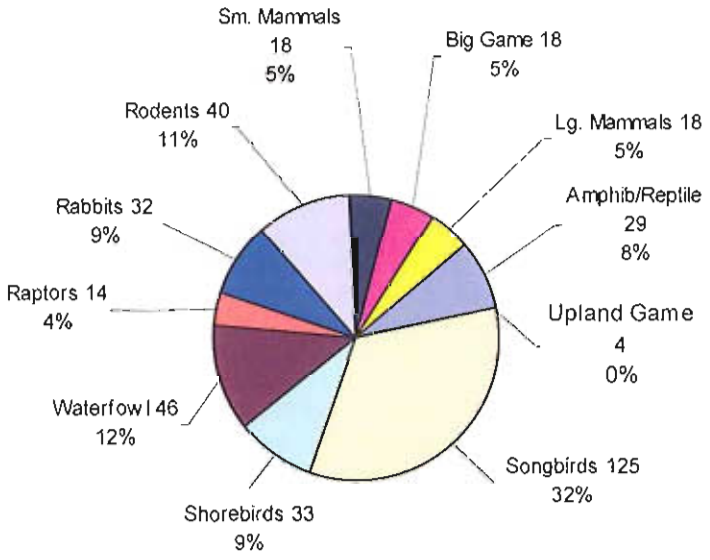
Figure 4-7. Mining Associated Wildlife Mortality Trends, 1984 – 1997



Source: NDOW, *Mining and Wildlife*, Vol. VII, No. 4. July 1998.

As a result of the joint efforts and the Industrial Artificial Pond permit program, overall wildlife mortalities at mine sites decreased from over 2,000 individuals in 1986 to just over 300 in 1997 (Figure 4-7). Less than 50 percent of the 1997 mortalities were the result of contact with permitted cyanide ponds or protective measures. These measures include fencing, pond covers (e.g., netting), HDPE floating "bird-balls", floating pond covers, dilution, and chemical neutralization. Figure 4-7 summarizes the overall decrease in mining related mortalities in Nevada since 1984. The average number of mortalities per mine decreased from over 100 individuals per mine to less than 10 individuals. A low of 3 individuals per mine occurred in both 1993 and 1997. During the 1990's, the number of permitted

Figure 4-8. Mining-Associated Wildlife Mortality by Animal Group, 1997



Source. *Mining and Wildlife*, Vol. VII, No. 4. July 1998. NDOW.

facilities at mines hovered around 100. About half of the increased number of mortalities from 1994 through 1996 was attributed to rodent (primarily mice) mortalities.

Waterfowl, shorebirds and big game animal deaths continued to decline during these years. The decrease in the total number of mortalities, from 1,645 in 1990 to 377 in 1997, includes a four-fold decrease in the numbers of bird mortalities during that period. Waterfowl mortalities reached an all time low of 16 individuals in 1995. Data on the distribution of mortalities by major animal groups in 1997 is presented in Figure 4-8. The program goal of zero mortality appears to be attainable. Twenty-nine active mines accomplished this goal in 1997. An additional 33 permit holders reported 5 or less wildlife mortalities over the entire year (Nevada Division of Wildlife, 1998).

Abandoned Mine Land Safety

The estimated number of potentially hazardous abandoned mine openings in Nevada is at least 50,000 (Nevada Division of Minerals, 2000). NDOM has identified 8,118. About 6,000 have been secured by NDOM, claimants, owners, or volunteers. Fencing is the most common security measure. About 1,000 have been backfilled. A priority is backfilling dangerous mines located near urban areas. The NDOM and the BLM have agreements in place to streamline the securing process. The number of new sites secured each year is expected to remain in the range of 300 to 400. Backfilling requires that properly trained scientists do biological and cultural surveys.

Backfilling may not be suitable in some instances. Mines can represent essential habitat for sensitive wildlife, especially bats. Today, the Nevada Bat Working Group is providing biological input to closure plans for the remaining mine openings. Three of Nevada's most significant bat roosts on record occupy historical mine workings. These unique resources include: the largest known big-eared bat (*Corynorhinus townsendii*) hibernation roost in Nevada (White Pine County); the largest known small-footed Myotis bat (*Myotis ciliolabrum*) hibernation roost in Nevada (Eureka County), and 3) Nevada's largest known pallid bat (*Antrozous pallidus*) maternity roost (Pershing County). There is considerable concern about bat roosts in mines that are, as yet, undiscovered (Bradley, 2002). Though some private and public entities continue to use total closure techniques, effective alternative mine closure methods have been designed, such as wildlife-friendly gates, to meet both safety and biological objectives.

Abandoned Mines and Water Quality

Today, mining operations are subject to water pollution control permits that ensure the mine site in the production, closure, and post-closure periods will not degrade water quality. Water quality impacts may arise if the natural metallic compounds exposed in the mine wall or removed and stockpiled rock changes chemically and leaches into groundwater or drains to a stream. Drainage of chemical solutions from ore wastes, such as cyanide solutions, may also become a water quality concern. Inadequate precautions were taken in the past, so some abandoned mines now pose minor to significant environmental risks. Such abandoned mine sites are scattered throughout the state. In the worst cases, drinking water supplies may become unusable, or fish and aquatic insects and plants may be unable to survive.

In 1999 the Interagency Abandoned Mine Land Environmental Task Force, composed of state and federal agencies, completed a statewide study to identify abandoned mine sites that pose significant environmental threats. The Nevada Abandoned Mine Lands Report identifies and prioritizes sites based on their potential to degrade water quality and jeopardize public health and aquatic ecosystems. As a result of the extensive mining history in Nevada, at least a couple thousand abandoned mine sites exist with the potential to impact ground or surface water. Because of the enormity of the effort that would be required to evaluate so many sites, the Task Force used institutional knowledge, available data and best professional judgment to identify 33 sites that may impact ground or surface water. Six of the sites have been prioritized for reclamation. Insufficient funding is anticipated to be an obstacle to achieving remediation objectives (Nevada Interagency Abandoned Mine Land Environmental Task Force, 1999).

Urban, Suburban, and Rural Developed Land

The first settlements in Nevada were established in the Carson River Basin (Genoa and Dayton) about 1855 (Rocha, 2002). Over the next few decades small, permanent towns took root, primarily wherever water supplies were sufficiently abundant and reliable to maintain ranching, farming, and mining enterprises. Rural communities dominated the state for the next century. The size of Nevada's towns remained small, in part because the high desert's limited renewable resource base (e.g., water, arable land, livestock forage, wildlife and habitat) proved to be variable and depletable. Almost 140 years passed after the first settlement was founded before the state's population surpassed the one million mark. In the 1960's, Truckee Meadows (Reno and Sparks) and Las Vegas Valley emerged as rapidly growing urban population centers. Only 25 years later, 80 percent of the population lived in a few cities located in extreme southern and western Nevada valleys. Only 15 years after Nevada reached the million-population mark, the state added another million. Today, 86 percent of the population lives in metro-areas of Clark and Washoe counties. The urbanization trend is projected to continue.

Table 4-8. Acreage and Percentage of Non-Federal Land Developed in Nevada

Year	Non-Federal Land Developed	% Non-Federal Land Developed
	Acres	%
1982	272,200	2.6
1987	320,300	3.0
1992	354,700	3.4
1997	381,400	3.6

Source: modified from 1997 National Resources Inventory, revised December 2000. Natural Resources Conservation Service. website http://www.nhq.nrcs.usda.gov/land/

Information on statewide land development status and trends is limited. The Natural Resources Conservation Service (NRCS) uses satellite images and aerial photos to periodically estimate land use changes on nonfederal land. The spatial analyses show that a total of 381,400 acres (3.6 percent) of the nonfederal land in the state (97 percent of nonfederal land is private) has been converted to developed land. Developed lands encompass urban, built-up rural areas, and rural transportation land, including residential, industrial, commercial, government, parks and schools, highways and roads. From 1987 through 1997, the NRCS mapping analysis showed 61,000 additional acres of land was developed (Table 4-8) (Natural Resources Conservation Service, 2000). During this period, the population increased by about 745,000. Compared to the population increase, the amount of additional land developed appears to be disproportionately small. This may reflect local government implementation of an "in-fill" strategy (i.e., efficient use of vacant land or redevelopment within an urban area), high-density zoning requirements, or a combination of these land use-planning strategies. Much more comprehensive information about local land development would be needed to more accurately track changes in statewide land use and the inventory of developable private land.

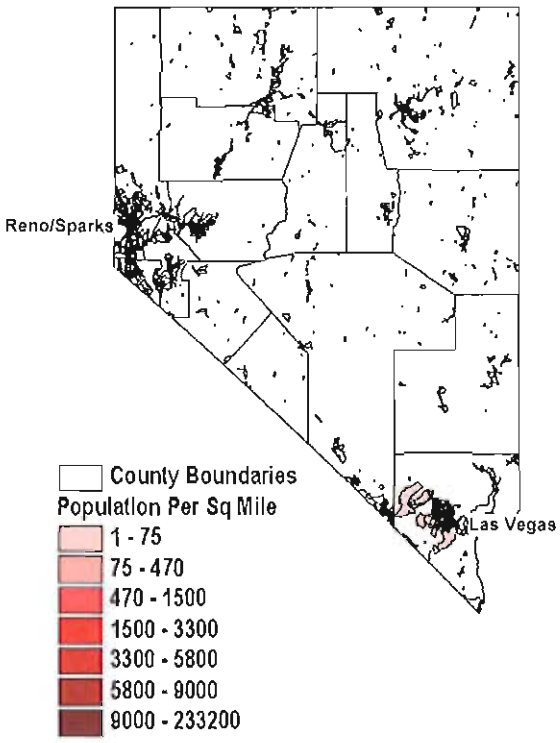
The NRCS data indicates that most of the nonfederal land developed for residential, commercial and industrial purposes replaced agricultural land uses. Of the 26,700 acres developed between 1992 and 1997, the NRCS estimates that 78 percent was rangeland, 15 percent pasture, and 8 percent cropland (Natural Resources Conservation Service, 2000). New development frequently involves agricultural lands, largely because farming or ranching homesteads and enterprises initially occupied private land in valleys with mild slopes, favorable climate conditions, and dependable, high quality water supplies. Though several mining towns have survived boom and bust cycles, generally these sites are not suitable for large urban and suburban development. Development on timberland is comparatively small. The NDF, which tracks timberland conversions, estimates about 3,500 acres have been converted in the past twenty years (Nevada Division of Forestry, 2001). However, urban development in forests has disproportionately large impacts to the resource due to the limited distribution of forests and to their importance in maintaining healthy urban watersheds.

In addition to being the fastest growing state, Nevada has the driest climate, the most mountains, and the largest percentage of federal public lands. These unique characteristics factor into Nevada becoming a very urbanized. Only 12 percent of the land in Nevada is privately owned, most centered along the limited perennial water bodies. Most private ownership was established early in the state's history, as a

result of late 19th century acts of Congress to encourage settlement of the West through federal public land grant programs. Not surprisingly, the lands brought into private ownership contained high resource value lands, which provided reliable, clean water supplies; flat, arable soils; abundant timber; and mineral resource. As a result, a large portion of the limited developable private land consists of valuable water, agricultural, and other natural resources; or possesses characteristics adverse to development, such as rugged terrain, steep slopes, floodplains, or wetlands. In areas of the state where developable private land is limited and rapid growth is occurring, local governments are required to make difficult tradeoff decisions between building on or adjacent to valuable resource lands or allowing dispersed development patterns. Some success in resolving the developable private land dilemma has been achieved through joint land use and resource planning involving local and federal government, developers, and a variety of community interests. The cooperative approach has produced federal laws, administrative mechanisms, and local public/private land plans that enable sales or transfers of environmentally sensitive private land into public ownership in combination with the acquisition or exchange of public lands that do not possess high resource values. Most of the land sales and exchanges are occurring in urbanizing valleys of southern and western Nevada.

Urban development is transforming Nevada in many positive ways, but some changes have proved be detrimental. Figure 4-9 illustrates how widely distributed urban and rural population centers remain despite a doubling of the state's population in 15 years. Notwithstanding the appearance of abundant open space between urban and rural population centers, the exuberant pace of urban development has raised region-wide resource issues that are relatively new to Nevada. One is the appearance of urban sprawl, which contributes to disproportionately large impacts on environmental quality. Table 4.9 presents calculated population densities for selected cities in Nevada and in neighboring states. Population density is sometimes cited as one measure of sprawl.

Figure 4-9. Nevada Population Distribution in 2000



Source: State of Nevada, Office of the Demographer. 2000.
Note: Population distributed by census block. Though color gradations are not distinguishable, the graphic clearly illustrates both the rural character and urban population centers of the state.

Sprawl is generally viewed as inefficient resource consumption and ineffective land management. A sprawling development pattern extends road and utility corridor construction and expands disturbance in native plant communities, thereby enlarging the area of soil disturbance and erosion, water quality impairment, and noxious weed invasions. Subdivisions built outside urban boundaries often resort to using individual septic systems. Groundwater quality deterioration occurring in several valleys throughout the state is associated with high densities of septic systems. Regional air quality deterioration in part is due to greater amounts of pollution emitted from the additional vehicle miles traveled and traffic congestion that accompanies sprawl. Mobile source emissions contribute to non-attainment of carbon monoxide and particulate air quality standards in Washoe and Clark County. In both urban and rural counties, subdivisions built in "wildland" areas have become an issue for wildfire management agencies. Homes built in flammable and fuel-rich areas are exposed to greater risk of wildfire damage. When

wildfires occur in such areas, fire-fighting resources intended for protection of natural resources must be diverted to protection of structures, resulting in greater resource damage.

Table 4-9. Population Density of Cities in Nevada and Selected Cities in Neighboring States

City	Population in 2000	Land Area (square mile)	Density (population per square mile)
Las Vegas	478,000	113.3	4,223
Reno	180,000	69.1	2,611
Henderson	175,000	79.7	2,201
North Las Vegas	115,000	78.5	1,471
Sparks	66,420	24.0	2.767
Boise	186,000	63.8	2,913
Tucson	487,000	194.7	2,500
Salt Lake City	182,000	109.1	1,666
Spokane	196,000	57.8	3,387
Portland	529,000	134.3	3,939
San Francisco	777,000	46.7	16,634
Los Angeles	3,695,000	469.1	7,877

Source: U.S. Census Bureau, Statistical Abstract of the United States: 2001.
Note: The land area of each city includes the area bounded by incorporated city limits as reported at the time of the 2000 census.

In response to rapid growth and sprawling development patterns, local interest in the conservation of open space emerged during the 1990's. Open space resources of concern do not only occur at the urban/wildland interface. In western and southern Nevada, communities are trying to protect natural stream courses, floodplains, wetlands, access to outdoor recreation resources, sensitive species habitats, agricultural greenbelts, cultural sites, scenic views, and wildfire prone forest and shrub lands. Spurred by community leaders, citizen groups, and conservation organizations, local government in Washoe and in Carson City County established an open space advisory board, hired an open space planner, and prepared open space conservation plans. In addition, the citizens of the two counties elected to employ bond and tax initiatives as a means for open space acquisitions.

Progress has been made in joint open space planning between local government and federal agencies in urbanizing regions. Notably, the BLM and USFS have coordinated with Washoe, Carson City, and Douglas County planning departments to update public land use plans at the urban/wildland interface. As a result, the BLM amended land use plans in Washoe and Carson City counties to meet mutually beneficial objectives. Various land use plan objectives are to: retain and manage certain areas for open space values; identify land for disposal (i.e. sale into private ownership or for nonfederal use under the Recreation and Public Purposes Act); withdraw designated areas from settlement or mineral entry where land use conflicts would arise; retain existing or acquire additional public recreation access to public lands; guide future utility corridor and facility siting; designate areas closed or open to off highway vehicle use; and, identify potential Areas of Critical Environmental Concern.

Another joint federal-local program was established with passage of the Southern Nevada Public Land Management Act. Among other things, the Act directs the BLM to collaborate with local government and others in a process for selling designated public lands in Las Vegas Valley consistent with an orderly urban growth pattern. A portion of the proceeds of public land auctions fund projects in southern Nevada that enhance outdoor recreation opportunities and contribute to development of a Multi-species Habitat Conservation Plan. Revenues also are used to acquire environmentally sensitive land throughout Nevada. As of May 2001, 116 parcels constituting 2,410 acres of BLM administered land was purchased at auction, generating $106.4 million. On the acquisition side of the program, 560 acres were purchased associated with the Desert National Wildlife Refuge (i.e., Moapa Valley National Wildlife Refuge, and Ash Meadows) (U.S. Bureau of Land Management, 2001).

Military Land

Nevada hosts several major military bases, air-to-ground bombing ranges, and weapons testing facilities. The U.S. Department of Defense administers activities on military lands that occupy more than 3.1 million acres in Nevada (4.7 percent of state land area). Use and management of natural resources on an area

this large has significance for the resources found on military lands themselves, as well as those of surrounding areas.

In southern Nevada, public land has been withdrawn from public entry and allocated to the United States Air Force to support the Nellis Air Force Base (NAFB) and Nellis Test and Training Range (NTTR). The Nellis Range is used for air-to-air and air-to-ground combat training by US composite strike forces and NATO forces. Every type of combat and combat support aircraft in the Air Force inventory is deployed over the Nellis range. Military special use airspace and ground targets are maintained to support air-to-air combat, air-to-ground bombing, and electronic warfare training. Overall, the NAFB and NTTR is considered the premiere air combat training center in the continental US.

Adjacent to the Nellis Range is the Nevada Test Site (NTS). Occupying just over 800,000 acres, the NTS is operated by the U.S. Department of Energy (DOE) as a nuclear weapons testing site. Although a moratorium on nuclear testing has been in place since September 1992, NTS is still maintained in "test readiness mode." Adjacent to the NTS is Yucca Mountain, which is the only site in the country being studied as a proposed High-Level Waste (HLW) repository for spent reactor fuel and defense HLW. The Nellis Range, the NTS and Yucca Mountain are located northwest of Las Vegas.

In north central Nevada, the U.S. Army operates the Hawthorne Army Depot (HWAD). It is the largest munitions depot in the western hemisphere. The depot was established in the early 1930s after the Lake Denmark, New Jersey explosion that injured hundreds in nearby towns. The HWAD occupies 147,000 acres of withdrawn public land, has over 170 support buildings along with 2,400 igloos (i.e., earthen storage magazines). The depot is located next to Walker Lake and the town of Hawthorne.

The U.S. Navy maintains an air station and training range complex in north central Nevada. The Fallon Naval Air Station (NAS Fallon) supports the famed "Top Gun" training school as well as integrated Carrier Air Wing strike training. Air-to-air combat and air-to-ground bombing is conducted in the Fallon Range Training Complex (FRTC), which occupies just over 200,000 acres of withdrawn public land. NAS Fallon is located adjacent to the city of Fallon, about 60 miles east of Reno/Sparks urban area.

Wilderness

Almost 1.7 million acres of Nevada's most ruggedly scenic areas have been designated wilderness (2.2 percent of the state). Except for the a portion of the Death Valley Wilderness Area, all of the state's wilderness areas are managed by BLM or the USFS. Designated wilderness areas are listed on Table 4-10, and their distribution is shown in Figure 4-10. Nevada's first wilderness, the Jarbidge Wilderness, was created under the Wilderness Act of 1964. The Nevada Wilderness Protection Act of 1989 greatly expanded the state's designated wilderness, adding approximately 733,400 acres. Designated wilderness in the state was almost doubled with the passage of the Black Rock Desert – High Rock Canyon Emigrant Trails National Conservation Area (NCA) Act of 2000. The NCA Act designated almost 757,000 acres within ten new wilderness area units. BLM plans to complete a management plan for the NCA and the associated wilderness areas (the Black Rock Desert, High Rock Canyon, East

Mount Moriah is a wilderness area designated within the Humboldt National Forest, located in eastern Nevada. Mount Moriah lies just north of Great Basin National Park. Wilderness areas contain many outstanding features, including in this case 12,050 feet high Mount Moriah, the Table, a plateau covered by subalpine Bristlecone and limber pine; four perennial streams with Bonneville cutthroat trout; Bighorn sheep; and numerous caves showing evidence of prehistoric habitation. Photo courtesy of National Wilderness Preservation System. Internet address: http://www.wilderness.net/nwps/

Fork High Rock Canyon, High Rock Lake and Little High Rock Canyon wilderness areas).

A large number of areas are being considered for future wilderness designation. Only Congress can designate the WSA's as wilderness or release them from the special designation. Many are designated as BLM or USFS "Wilderness Study Areas" (WSA's). BLM-managed WSA's total 4.4 million acres. A total of 1,590,000 acres that comprise of pieces or all of 46 WSA's were recommended as "suitable" for wilderness designation by the BLM. The remaining 2.8 million acres were recommended as "not suitable." The USFS manages 6 WSA's totaling 189,372 acres. Federal agencies are required by law to manage WSA's in a manner that protects their wilderness qualities.

The Wilderness Act of 1964 defines wilderness as "an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation." Other characteristics include: 1) natural in character...the imprint of man's work substantially unnoticeable; 2) outstanding opportunities for solitude or primitive and unconfined recreation; 3) at least 5,000 acres or sufficiently large to make preservation practicable; and, 4) contains other values important to society, such as ecological, geological, or other features of scientific, educational, scenic, or historical value.

Table 4-10. Nevada Designated Wilderness Areas

Wilderness Area Name	Agency	Area (Acres)
Alta Toquima	USFS	35,500
Arc Dome	USFS	120,597
Black Rock Desert	BLM	313,622
Boundary Peak	USFS	10,000
Calico Mountains	BLM	65,344
Currant Mountain	USFS	36,534
Death Valley	NPS	125,000
East Fork High Rock Canyon	BLM	52,754
East Humboldt	USFS	36,686
Grant Range	USFS	52,468
High Rock Canyon	BLM	46,560
High Rock Lake	BLM	59,250
Jarbidge	USFS	110,765
Little High Rock Canyon	BLM	48,688
Mount Charleston	USFS	43,918
Mount Moriah	USFS/BLM	71,370
Mount Rose	USFS	31,353
North Black Rock Range	BLM	30,764
North Jackson Mountains	BLM	23,915
Pahute Peak	BLM	57,350
Quinn Canyon	USFS	26,237
Ruby Mountains	USFS	93,112
Santa Rosa-Paradise Peak	USFS	32,053
South Jackson Mountains	BLM	56,753
Table Mountain	USFS	92,417
State Total		1,675,665

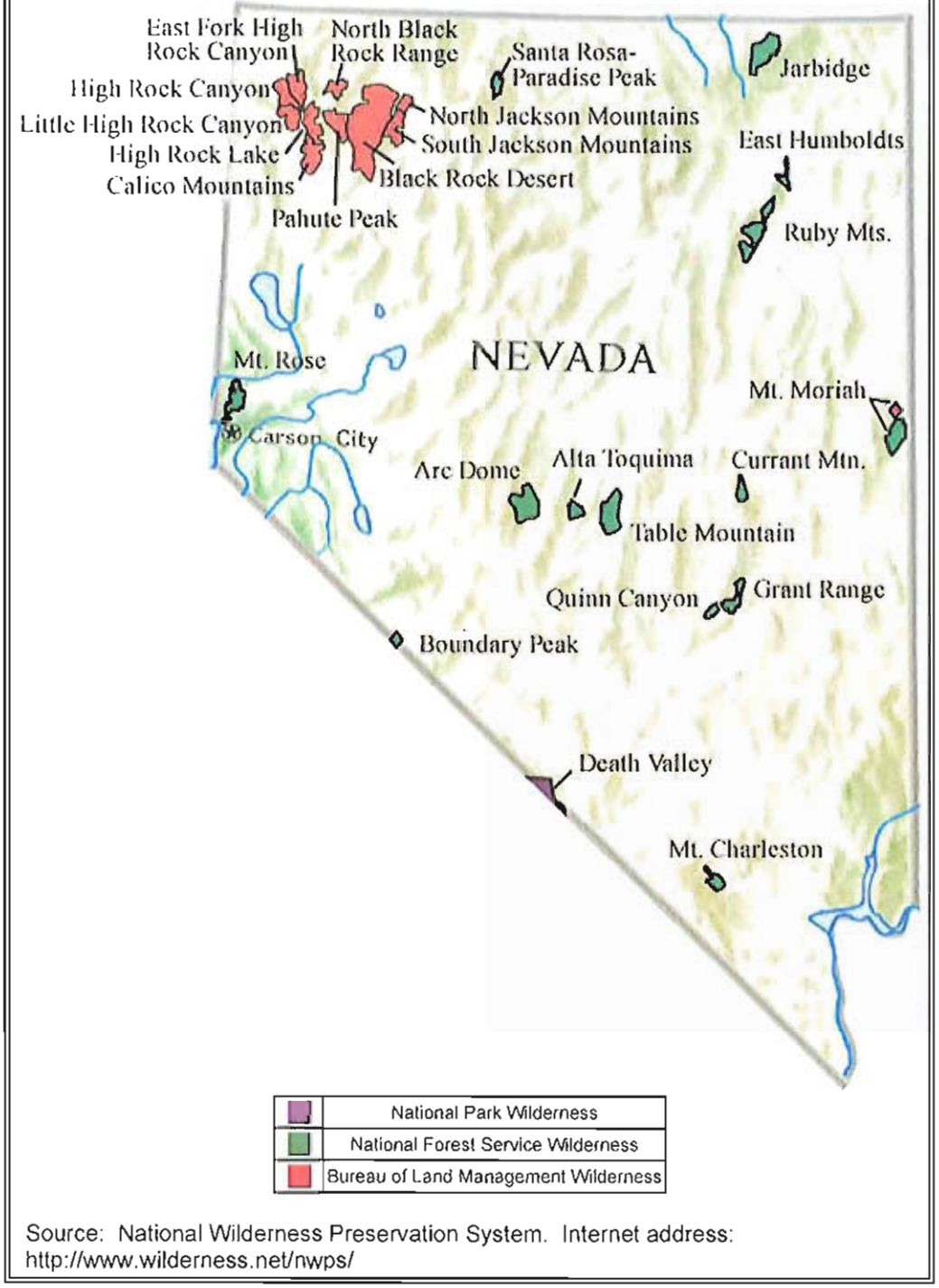
Source: Humboldt-Toiyabe National Forest and Nevada BLM, 2001.

With few exceptions, the lands that meet wilderness criteria in Nevada are predominantly steep, rugged, high altitude, or arid landscapes, and distant from towns and cities. A very limited range of Nevada's distinctive ecosystems and landscapes are encompassed within wilderness areas. Creation of a wilderness area does not eliminate existing uses, vested rights, or valid permits. Long standing grazing, mining, fishing, hunting, certain water supply developments, and recreational uses are generally allowed. However, revised rules or permit conditions may be imposed to make sure uses are conducted in ways that are more compatible with the purposes of the wilderness area specified in the Congressional act.

The Nevada Wilderness Project and affiliated organizations, including Friends of Nevada Wilderness and the Sierra Club, are expected to propose new wilderness areas for the state after they complete their ongoing statewide inventory of potential wilderness areas. Starting in 2003, the USFS will consider these proposals when they conduct a wilderness review as part of the process to update the Humboldt-Toiyabe National Forest Management Plan. This wilderness review also will consider converting some or all of the state's 3.1 million acres of designated roadless areas to wilderness. National forest wilderness areas in

Nevada are popular. In 1996, residents and visitors spent 331,800 visitor days at the 13 wilderness areas managed by the USFS (HTNF, 2000). Eleven of the wilderness areas are located in rural areas. However, data is not available on the economic benefits to rural communities that could be attributed to outdoor recreation tourism.

Figure 4-10. Distribution of the Twenty-five Wilderness Areas in Nevada



Source: National Wilderness Preservation System. Internet address: http://www.wilderness.net/nwps/

The process for designating wilderness can be contentious. In 1992, the BLM completed their studies and alternative evaluation process that led to their current recommendations regarding which WSA's are suitable for wilderness status. In 2001, the interest level in resolving the status of the WSA's grew, but a cohesive statewide planning effort remains elusive. Supporters of additional wilderness areas point out that wilderness helps protect watersheds, scenic viewsheds, rare plant and animal habitat, unique recreation experiences, and other natural resources and values.

The public demand for wilderness designations and experiences generally correspond with increasing urban populations. Rapid growth in Nevada and neighboring states is a motivating factor to wilderness proponents. Opponents feel that too many limitations on land and resource use come with wilderness designations. Potential restrictions may be placed on the future development of commodity resources (e.g., minerals, energy resources, livestock) and on use of motorized or mechanical equipment.

Some residents view designation of wilderness areas as an economically, socially, and ecologically beneficial. Wilderness areas can provide new opportunities to increase local taxes and income derived from increased tourism trade, more outdoor recreation visitors. Also, future costs associated with environmental impacts of potentially damaging land uses may be avoided. On the other hand, rural economies rely on supplementing the harvest or extraction of commodity resources from private land with resources on public land. Rural communities can experience negative impacts where wilderness area designations restrict access to economically viable mineral, energy, forage, or other commodity resources. To estimate economic tradeoffs, studies can be done that analyze the future benefits of increased recreation and tourism activity compared to resource development. However, the analysis is often complicated by disparate views in valuing environmental quality and ecological functions. Another complication arises with the quantification of assumptions used to evaluate the future costs and benefits of resource development as compared to those with tourism and recreation. Frequently the economic analysis is viewed as conjectural and controversial by one group or another, and may not contribute to objective decision-making.

Regardless, the delay in resolving the status of BLM WSA's and potential USFS wilderness areas postpones the realization of potential social and economic benefits the come with use of public land. Until Congress determines which WSA's will be designated as wilderness areas, the WSA's by law must be managed as designated wilderness. WSA's lack the broad public appeal and federal and state investment in enhanced local amenities that are given to designated wilderness areas. Perhaps soon, as citizens, government, and industry gains more experience in collaborative planning and achieving consensus on the conservation and management of natural resources, Nevadans will be better prepared to cooperatively resolve wilderness issues.

References

Bradley, P.V., J.A. Williams, J.S. Altenbach, P.E. Brown, K. Dewberry, D.B. Hall, J. Jeffers, B. Lund, J.E. Newmark, M.J. O'Farrell, M. Rahn, and C.R. Tomlinson. 2002. *Nevada Bat Conservation Plan*. Nevada Bat Working Group. Austin, Nevada.

Cronquist, A., A.H. Holmgren, N.H. Holmgren, and J.L. Reveal. 1972. *Intermountain Flora, Vascular Plants of the Intermountain West, U.S.A.* Hafner Publishing Company, Inc. New York and London.

Gap Analysis Program. Circa 1995. Nevada Land Use/Land Cover, a digital map of Nevada. Developed by Utah State University, U.S. Forest Service, and U.S. Bureau of Land Management.

Grayson, D.K. 1993. *The Desert's Past, A Natural Prehistory of the Great Basin*. Smithsonian Institution Press. Washington D.C.

Griffen, D. 2002. Prehistoric Human Impacts on Fire Regimes and Vegetation in the Northern Intermountain West. in *Fire, Native Peoples, and the Natural Landscape*, ed. By T.R. Vale. Island Press.

Humboldt-Toiyabe National Forest. 2000. Personal communication.

Humboldt-Toiyabe National Forest. 2001. Humboldt-Toiyabe National Forest at a Glance. Internet address: http://www.fs.fed.us/htnf/Forest-facts_at_a_glance.htm

Nevada Agricultural Statistics Service. 1999. 1997 Census of Agriculture: Nevada State and County Data.

Nevada Agricultural Statistics Service. 2000. Nevada Agricultural Statistics Publications. Internet address: http://www.nass.usda.gov/nv/rlsetoc.htm

Nevada Division of Environmental Protection. 1998. *Nevada Water Quality Assessment, 305(b) Report, Biennial Report for 1996 and 1997*.

Nevada Division of Environmental Protection. 2002. Personal communication. Annual reclamation report database, in the Bureau of Mining Regulation and Reclamation.

Nevada Division of Forestry. 2000. Personal communication

Nevada Division of Forestry. 2001. Personal communication. Estimated number of acres indicated on timberland conversions certificates filed with NDF.

Nevada Division of Wildlife. 1998. *Mining and Wildlife*, Vol. VII, No. 4. July 1998.

Nevada Interagency Abandoned Mine Land Environmental Task Force. 1999. *Nevada Abandoned Mine Lands Report*.

Resource Concepts Inc. 2001. *Nevada Grazing Statistics Report and Economic Analysis for Federal Lands in Nevada*. Prepared for Nevada Department of Agriculture and Nevada Association of Counties. Carson City, Nevada.

Rocha, G. 2002. *Myth # 22, Nevada's First Permanent Settlement*, in Nevada State Archives, Historical Myth a Month. Internet address: http://dmla.clan.lib.nv.us/docs/nsla/archives/myth/myth22.htm

U.S. Bureau of Land Management. 2000. 1999 BLM Rangeland Monitoring Report. Data tables prepared by Nevada BLM.

U.S. Bureau of Land Management. 2001. *Southern Nevada Public Land Management Act, Annual Report, 2001*.

U.S. Forest Service. 2002. Forest Health Protection. By USDA Forest Service, State and Private Forestry Program. Internet address: http://www.fs.fed.us/foresthealth/publications.html

U.S. Natural Resources Conservation Service. 2000. 1997 Natural Resources Inventory, Revised December 1999. Internet address: http://www.nrcs.usda.gov/technical/NRI/

U.S. Natural Resources Conservation Service. 2001. 2000 Report, Natural Resource Conservation Activities in Nevada. Internet address: http://www.nv.nrcs.usda.gov/

Young, J.A. and B.A. Sparks. 1985. *Cattle in the Cold Desert*. Utah State University Press. Logan, Utah.

Outdoor Recreation Resources

Outdoor Recreation Lands and Waters

Nevada is endowed with a larger per capita acreage of publicly owned lands available for recreation than nearly any other state. Public lands administered by the Bureau of Land Management (BLM), the vast majority of which is designated for multiple uses, dominate the state. The BLM claims that more than 99 percent of the 47,867,000 acres it manages are open to recreation (Table 5-1). With over 5 million acres, the Humboldt-Toiyabe National Forest is the largest in the lower 48 states. Nearly all of the U.S. Forest Service (USFS) lands are also open to multiple recreation uses. The National Park Service (NPS) manages another 775,000 acres, including Great Basin National Park, Lake Mead National Recreation Area, and a small portion of Death Valley National Monument. The U.S. Bureau of Reclamation (BOR) and U.S. Fish and Wildlife Service (FWS) also administer substantial holdings that offer certain recreation opportunities, such as Sheldon National Wildlife Refuge, Ruby Lake National Wildlife Refuge, Desert National Wildlife Refuge.

Recreation Lands

The State of Nevada owns about four tenths of one percent (0.4 percent) of the state or about 274,000 acres. Much of the state-owned land is comprised of state park units administered by the Nevada Division of State Parks (NDSP) and wildlife management areas administered by the Nevada Division of Wildlife (NDOW) (Table 5-2).

The Nevada State Park System is comprised of 24 separate units with approximately 132,878 total acres of land and water. However, only 77,343 of the total state park acres are actually owned by the state. The Bureau of Reclamation controls 49,495 acres, leasing lands surrounding both Lahontan and Rye Patch to the state. Another 5,280 acres are leased from the Bureau of Land Management under the Recreation and Public Purposes program, while

Table 5-1. State and Federal Public Outdoor Recreation Land Area by County (Acres)

County	Federal Public Land (Multiple Use)*	Nevada Division of Wildlife	Nevada Division of State Parks	Total
Carson City	43,347	0	3,140	46,487
Churchill	2,144,414	18,179	8,213	2,170,806
Clark	4,952,434	17,657	40,843	5,010,934
Douglas	254,451	0	1,329	255,780
Elko	7,852,284	8,000	4,044	7,864,328
Esmeralda	2,247,863	0	0	2,247,863
Eureka	2,162,840	0	0	2,162,840
Humboldt	4,963,872	0	0	4,963,872
Lander	3,336,706	0	0	3,336,706
Lincoln	6,426,556	1,337	6,933	6,434,816
Lyon	864,178	30,202	26,922	921,302
Mineral	1,943,946	0	280	1,944,226
Nye	8,528,805	14,814	1,155	8,544,774
Pershing	2,929,481	16,905	20,241	2,966,627
Storey	12,795	0	0	12,795
Washoe	2,892,806	2,382	17,856	2,913,044
White Pine	5,297,529	6,426	1,922	5,305,877
NEVADA	56,854,287	115,902	132,878	57,103,057

* "Multiple use" applies to the federal policy to manage land and resources for a combination of uses, including outdoor recreation, commodity, and ecological functions and values, that will best meet the needs of the people. Multiple use land in Nevada generally excludes land withdrawn by U.S. Departments of Defense and Energy, though a limited range of activities are permitted on specified military reservations.

240 more acres are administered by State Parks under a management agreement with BLM. Finally, 520 acres encompassing the Ichthyosaur fossil sites near Berlin are controlled by State Parks under an USFS special use permit.

Five of the state park units are designated state historic parks or sites. Each of these emphasizes cultural features; including Mormon Station, Belmont Courthouse, Fort Churchill, Ward Charcoal Ovens and the Old Las Vegas Mormon Fort each emphasize cultural features. However, most of Nevada's state parks have significant cultural features complementing natural and recreational features. Dayton State Park has the Rock Point Stamp Mill. Spring Mountain Ranch, Floyd Lamb and Spring Valley all have historic ranch features. Lake Tahoe has numerous, though mostly obscured, archeological and cultural sites. Berlin is arguably the best-preserved ghost town in the state. Cathedral Gorge, Kershaw-Ryan, Beaver Dam and Valley of Fire State Parks all have remnant Civilian Conservation Corps constructed cultural features. In addition, Valley of Fire is famous for its petroglyphs.

Trails offer the means for increasingly popular recreation pursuits, both motorized and non-motorized. Nevada's State Parks offer very limited opportunities for motorized trail use. However, the state parks' trail inventory includes 118 miles of single-track trails primarily devoted to hiking, equestrian and/or mountain bike usage. Another 159 miles of un-maintained dirt roads within the various state parks offer additional multi-use trail opportunities, including some motorized access for licensed vehicles. ATV's, dirt bikes and other unlicensed motorized vehicles are not permitted.

Table 5-2. Nevada State Park System Land and Waters

State Park Units	Acres		
	Land	Water	Total
Region 2	18,074	4,403	22,477
Dayton SP	152	0	152
Lake Tahoe NV SP[5]	13,805	465	14,270
Mormon Station SHP	2	0	2
Washoe Lake SP[1]	4,115	3,938	8,053
Region 3	33,069	23,590	56,659
Belmont Courthouse SHS	2	0	2
Berlin-Ichthyosaur SP	1,153	0	1,153
Fort Churchill SHP	4,461	0	4,461
Lahontan SRA[2]	18,422	12,100	30,522
Rye Patch SRA	8,751	11,490	20,241
Walker Lake SRA	280	0	280
Region 4	2,394	1,650	4,044
South Fork SRA[3]	2,274	1,650	3,924
Wild Horse SRA	120	0	120
Region 5	8,708	147	8,855
Beaver Dam SP	2,378	15	2,393
Cathedral Gorge SP	1,633	0	1,633
Cave Lake SP	1,208	32	1,240
Echo Canyon SP	1,045	35	1,080
Kershaw-Ryan SP	264	0	264
Spring Valley SP[6]	1,498	65	1,563
Ward Charcoal Ovens SHS	682	0	682
Region 6	40,832	11	40,843
Big Bend SRA	2,343	0	2,343
Floyd Lamb SP[5]	2,347	10	2,357
Old LV Mormon Fort SHP	3	0	3
Spring Mtn. Ranch SP[4]	839	1	840
Valley of Fire SP	35,300	0	35,300
State Total	103,077	29,801	132,878

[1] State-owned acreage includes Washoe Lake.
[2] Lahontan state-owned and BOR managed lands are estimates only.
[3] State-owned acreage includes South Fork Reservoir.
[4] 240 acres within Red Rock Canyon NCA are managed by NDSP under management agreement with BLM
[5] Acreage includes 28 acres contiguous to Van Sickle Unit not yet officially assigned to Division of State Parks.

The vast majority of trail mileage in Nevada occurs on federally owned lands, primarily BLM public lands and the national forests. The BLM estimates that 39,311,000 acres (85 percent of BLM land) are open to off-highway vehicle (OHV) use. The BLM's inventory includes 56 trails totaling 622 miles. Humboldt-Toiyabe National Forest land contain a total of 1,283 trial miles, including 718.5 in designated wilderness areas.

Recreation Waters

The major recreation lakes and reservoirs of the state are itemized in Table 5-3. Most significant in terms of total acreage and recreation opportunities are Lake Tahoe, Lake Mead and Lake Mohave. The latter two are both part of the Lake Mead National Recreation Area, which sustains one of the highest visitation rates of any national park unit in the nation, over 8 million per year. Pyramid Lake, the largest entirely within Nevada, is also significant.

Table 5-3. Important Recreation Lakes And Reservoirs In Nevada

Name	County	Surface Acres	Volume, Acre-Ft.
Wild Horse Reservoir	Elko	2,830	73,500
Wilson Sink Reservoir	Elko	828	10,469
South Fork Reservoir	Elko	1,650	40,000
Lower Pitt-Taylor Reservoir	Pershing	2,570	22,200
Upper Pitt-Taylor Reservoir	Pershing	2,070	24,200
Rye Patch Reservoir	Pershing	11,400	171,000
Lake Tahoe	Carson, Douglas, Washoe	36,812	125,000,000
Pyramid Lake	Washoe	108,000	25,000,000
Washoe Lake	Washoe	6,100	37,000
Lahontan Reservoir	Churchill, Lyon	14,800	322,000
Topaz Lake	Douglas	1,205	126,000
Walker Lake	Mineral	38,800	2,990,000
Weber Reservoir	Mineral	950	13,000
Ruby Marsh	Elko	9,000	13,000
Lake Mead	Clark	90,000	29,700,000
Lake Mohave	Clark	14,000	1,820,000

Total water acreage in the state parks approximates 29,801, of which 23,590 can be attributed to the two major Bureau of Reclamation reservoirs in the state, Lahontan and Rye Patch. Seven park units are situated adjacent to or encompass major water bodies. In addition to Lake Tahoe Nevada State Park, Lahontan State Recreation Area and Rye Patch SRA, there are Washoe Lake State Park and Walker Lake, South Fork and Wild Horse State Recreation Areas. Seven others incorporate smaller bodies of water, while several lay adjacent to perennial rivers or streams. Eleven have boat ramps with a total of 28 lanes. The acreages of surface water bodies within the State Park System are shown in Table 5-2.

Outdoor Recreation Use

Based on a statewide survey of citizens 16 years of age and older in Nevada conducted in early 2001, 84 percent of Nevadans participated in outdoor recreational activities in the year 2000, and most report engaging in several. The top ten most popular activities, based on the percentage of the population participating, were pleasure driving (55%), picnicking (48%), walking without a dog (41%), swimming in a pool (40%), wildlife viewing (39%), swimming in a lake or stream (39%), hiking (38%), walking with a dog (34%), lake fishing (34%), and motor-boating (33%). Least popular were water sailing, cross country skiing, roller/in-line hockey, snow shoeing, wind surfing, and hang gliding/parasailing, all with less than 5% participating (Nevada Division of State Parks, 2002).

When similar types of outdoor recreational activities are grouped, water related activities are the most popular (82%), followed by swimming (60%), walking (55%), fishing (42%), camping (39%), bicycling (31%), off-road motorized recreation (29%), winter related activities (28%), and hunting (13%). Water resources remain a major attraction for outdoor activities. Of the individual water related activities, 39 percent said swimming in a lake or stream was an activity in which they participated, demonstrating the importance of meeting water quality standards established for contact recreation uses.

Changes in the state's socio-demographic characteristics are reflected in the survey results. Comparing 2001 and 1986 data shows that the percentage of the population participating increased slightly in golfing and motor boating while decreasing significantly in every other comparable activity except downhill skiing,

which decreased only from 19% to 17%. While difficult to fully explain, an aging population and limited expansion of recreation opportunities with a simultaneous explosion in population are possible explanations.

Survey data specific to wildlife-associated recreation activity is collected and reported by the U.S. Fish and Wildlife Service every five years. The state-by-state survey presents data on participation in and expenditures for hunting, fishing, and wildlife-watching activities, such as observing, feeding, and photographing wildlife (U.S. Fish and Wildlife Service, 1998). According to the 1996 FWS survey data for Nevada, the number of residents and nonresidents anglers increased since 1991, but fewer were hunting and wildlife watching (Table 5-4). The 1996 estimates indicate that the number of Nevadans and visitors choosing to go wildlife watching approximates the combined total of those choosing fishing and hunting combined. More recent preliminary data shows that fishing and hunting participation in 2001 declined from 1996 levels, and wildlife watching increased. Among the Rocky Mountain and Pacific Coast states, Nevada has the lowest estimated number of residential and nonresidential hunter and anglers. Compared to Nevada, California is the only state with a smaller percentage of the resident population participating in any wildlife-associated outdoor recreation activity than Nevada (U.S. Fish and Wildlife Service, 2002).

Table 5-4. Wildlife-Associated Outdoor Recreation Activity Statistics for Nevada, 1996

Measure of Outdoor Recreation Activity	Fishing		Hunting		Wildlife Watching	
	1991	1996	1991	1996	1991	1996
	(Thousands)					
Total Participants In State	171	224	57	52	451	271
Total Days In State	1,218	1,976	565	650	2,940	1,394
Total In State Trip-Related Expenditures ($)	47,036	73,244	21,527	20,303	84,212	62,666

Source. *1996 National Survey of Fishing, Hunting, and Wildlife Associated Recreation, Nevada.* U.S. Fish and Wildlife Service. 1998.
Notes. Participants in state include resident and nonresidents. The wildlife-watching category includes only individuals that traveled at least one mile from home to observe, photograph, or feed wildlife.

Despite the arid climate and limited water, a large number of lakes and reservoirs are available for boating, fishing, swimming, wildlife watching, and other water recreation. In total, there are more than 200 ponds, lakes, and reservoirs that provide nearly 400,000 surface acres of sport fishing opportunity. In addition, more than 500 streams and rivers offer nearly 3,000 miles of fishable habitat (Nevada Division of Wildlife, 2001). The 1996 National Survey of Fishing, Hunting and Wildlife Associated Recreation Survey for Nevada, reports that in 1996 anglers spent an average of 9 days fishing and an average of $900 per year on fishing related expenses. In 2000, Nevada resident anglers purchased 97,912 fishing licenses and 34,029 combination licenses (for fishing and hunting). Nonresident anglers purchased 32,215 fishing licenses. Total fishing license sales increased between 1990 and 2000, from 136,385 to 164,153.

Anglers at Wild Horse Reservoir show off their catch. Fishing is one of the most popular outdoor recreation activities in Nevada, according to the NDSP Citizen's Survey. Fishers in Nevada spent over $73 million on trip-related expenses during 1996 (Table 5-4). Photo courtesy of NDSP.

Boating activity, including use of motorized and non-motorized craft, is growing in popularity. Nearly 62,000 vessels (i.e., any watercraft used for transportation on the water) were registered with NDOW in 2000. Personal watercraft, like the use of other motorized recreation vehicles (e.g., all terrain vehicles and snowmobiles) has grown substantially. In some locations, the use of personal watercraft (i.e., jet skis) has generated controversy. Because jet skis are operated near shore, concerns are related to the significance of negative effects on water quality, fish and wildlife, habitat, shoreline vegetation, noise, and safety of other water recreationists. The most popular boating water in the state is

Lake Mead, located in Clark County where over half the boats in the state are registered. Other popular boating waters include Lake Tahoe, Lahontan Reservoir, Pyramid Lake, Wildhorse Reservoir, and the Ruby Marshes.

With public "multiple use" land abundant, Nevada offers ample open space for hunting. Almost 30,000 big game tags were sold by NDOW in 2000 to hunt deer, pronghorn antelope, Desert and California big horn sheep, elk, and mountain goat. Deer hunters spent a total of nearly 112,000 days in the field and over 11,000 days were spent in pursuit of other big game animals in 2000. Upland game and waterfowl hunters numbered 143,000 in 1999 (NDOW, 2001). The 1996 National Survey reported that total in state hunting expenditures amounted to nearly $95 million in 1995. Of that total, $20 million were spent on trip related expenses, which provides vital income for rural Nevada businesses (U.S. Fish and Wildlife, 1998).

Boating on the Middle Carson River. The growing popularity of canoeing and kayaking is an exemple of changes in public recreation activities in Nevada. Access was made possible with the acquisition of riverfront ranch properties next to Fort Churchill State Historic Park. A portion of the state administered land is leased for agricultural uses.

State Parks and Wildlife Management Areas

The NDOW administers outdoor recreation activities on 11 state Wildlife Management Areas (WMA's). Primary activities are hunting, fishing and wildlife watching. Activities are subject to regulations established by the State Board of Wildlife Commissioners. Natural and artificial lakes, reservoirs, streams, springs, and wetlands are central to ten of the WMA's. Public use data is limited because most of the WMA's are unmanned. The average annual number of "use days" for Mason Valley WMA is 47,000; for Overton, 5,300; for Kirch, 22,000; and, for Key Pittman WMA, 1,800. Each is popular for fishing, waterfowl and upland game bird hunting, as well as substantial "nonconsumptive" uses. Nonconsumptive activities include wildlife watching, photography, hiking, education, and scientific study (Nevada Division of Wildlife, 2001).

Table 5-5. State Wildlife Management Areas Administered by NDOW

Wildlife Management Area	County	Land Area (Acres)
Overton	Clark	17,657
W. E. Kirch	Nye	14,814
Key Pittman	Lincoln	1,337
Mason Valley	Lyon	13,735
Humboldt	Pershing Churchill	37,140
Fernley	Lyon	13,019
Scripps	Washoe	2,382
Alkali Lake	Lyon	3,448
Bruneau WMA	Elko	4,771
Franklin Lake	Elko	3,229
Steptoe Valley	White Pine	6,426
Total		117,959

Source: Nevada Division of Wildlife, 2001.

For Nevada's state parks, visitation has grown with development of the park system, but has lagged behind the rate of population growth. The earliest record of visitation occurred in 1960 when 155,887 people reportedly used the parks. By 1971, the annual visitation had grown to 1 million. The largest and most steady increases occurred during the early to mid-1970's when development of new facilities and the acquisition of new park acreage were at their peak. By 1976, over 2 million visitors were recreating at the state parks annually. Visitation increased 100 percent in only 5 years. However, 19 years passed before visitation exceeded the 3-million threshold, despite rapid population growth.

The fact that state park visitation increases have not kept pace with population growth is probably attributable to the state's failure to increase capacity of park facilities commensurate with population increases. Severe capital improvements budget limitations since the early 1980's have constrained the NDSP's ability to

increase facility capacity within the state park system. Overnight camping, in particular, has seen virtually no growth since the early 1980's. Only two new campgrounds, South Fork State Recreation Area and Cave Lake State Park, with 41 campsites have been completed since that time. Another 14 campsite units at Ward Charcoal Ovens have been partially completed. The entire state park system currently has only 321 improved campsites (i.e., with modern restrooms but no hook-ups) and 805 primitive campsites for a total of 1,126. Of the nine state parks in close proximity to the western and southern Nevada urban population centers, only three provide camping facilities.

The additions of new state park sites or expansions of existing ones have been very limited in the past decade. Only two new park sites and one major addition took place during the 1990's. The three-acre Old Las Vegas Mormon Fort was incorporated into the Nevada State Park System in 1991. Fort Churchill was expanded by several thousand acres in 1994 with the acquisition of adjacent Carson River ranches using the Question 5 Park and Wildlife Bond of 1990. Finally, the 2,343-acre Big Bend of the Colorado State Recreation Area was acquired from the Colorado River Commission in 1994. Nevertheless, State Parks' visitation has steadily increased over the years, though at a much slower pace than the state's population growth. Without additional investment in the state's park system capital improvement program, the trend is likely to continue.

Table 5-6 presents visitation data for Nevada State Parks for the period 1996 to 2000. Though the overall visitation in 2000 shows an increase of six percent over 1996,

Table 5-6. State Park Visitation, 1996-2000

Park Name	1996	1997	1998	1999	2000
Region 2					
Dayton	91,116	77,965	77,382	76,327	73,845
Lake Tahoe	894,446	892,760	752,864	946,737	1,072,858
Mormon Station	74,067	95,659	40,211	83,077	108,883
Washoe Lake	230,699	179,891	148,606	175,000	187,122
Region 3					
Belmont Courthouse	1,944	2,270	1,996	2,122	2,736
Berlin-Ichthyosaur	17,499	19,245	15,638	14,605	10,704
Fort Churchill	76,547	74,180	83,267	86,742	90,010
Lahontan	430,573	412,433	384,253	383,493	481,148
Rye Patch	84,756	82,611	79,908	82,239	94,188
Walker Lake	39,780	36,459	30,670	32,310	33,652
Region 4					
South Fork	199,839	100,668	82,192	112,111	105,386
Wild Horse	22,765	21,696	20,530	21,023	28,724
Region 5					
Beaver Dam	6,702	7,357	5,849	7,650	8,072
Cathedral Gorge	41,346	59,433	57,914	66,025	57,167
Cave Lake	146,666	97,540	66,034	69,733	92,548
Echo Canyon	52,058	49,250	45,526	45,584	49,762
Kershaw-Ryan	NA	8,349	18,319	19,725	20,689
Spring Valley	124,107	118,673	106,197	111,914	119,959
Ward Charcoal	2,715	1,505	3,787	11,055	11,977
Region 6					
Big Bend	10,351	9,648	34,503	53,185	57,493
Floyd Lamb	178,199	190,489	155,876	204,032	140,942
Old LV Mormon Fort	4,214	6,821	4,509	3,545	9,581
Spring Mtn. Ranch	232,825	210,441	186,622	193,523	195,709
Valley of Fire	291,744	418,127	438,485	427,286	419,093
TOTAL	3,254,958	3,173,470	2,841,138	3,229,043	3,472,248

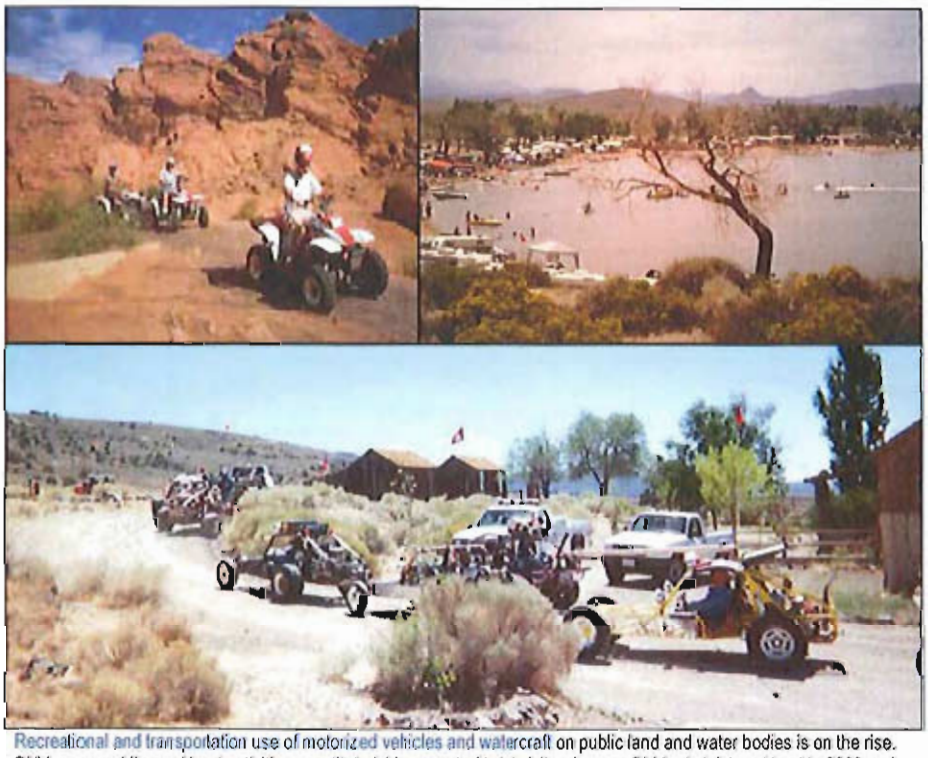
Source: Nevada Division of State Parks, 2001.

visitation at certain parks has actually declined (Nevada Division of State Parks, 2001). Dayton, Washoe Lake, South Fork, Floyd Lamb, and Spring Mountain Ranch State Parks are located close to urbanized areas. Local residents who tend to resist paying entrance or other user fees traditionally have dominated use of these parks. However, with enhanced enforcement of fee collections and with the collection of fees in locations where none were previously charged, local visitation during recent years has dropped. At the same time, fee revenues have substantially increased.

Other factors come into play for individual parks. The 1996 visitation figures for Cave Lake, for example, are suspect. The visitor counting procedures in 1996 are believed to be faulty. With the institution of revised procedures, the visitation level fell dramatically in 1997. Floyd Lamb State Park suffers from noticeably deteriorated facilities and this is believed to be the main reason for the dramatic decline in use during 2000. Spring Mountain Ranch, on the other hand, has been impacted by the introduction of fee collections by the BLM in the Red Rock Canyon National Conservation Area (NCA). Spring Mountain Ranch lies entirely within the NCA, but has been relegated to a secondary destination status. Many visitors first pay an entrance fee at the BLM Visitor Center. Those that do drive to Spring Ranch after touring the 13-mile scenic loop are reluctant to pay a second fee for entrance to the state park. Despite capacity and maintenance shortfalls, visitation at State Parks has steadily increased statewide over the long-term, though at a slower rate than the state's population growth. This difficult set of circumstances is not anticipated to change soon.

Federal Public Land

Recreationists on Nevada BLM and Humboldt-Toiyabe National Forest (HTNF) administered public lands are engaging in a wider variety of activities. Table 5-7 presents visitor day data grouped by type of activity. The HTNF recorded a total of 2,953,000 visitor days in 1996. The Forest contains 85 developed recreation sites within its 5.8 million acres (Humboldt-Toiyabe National Forest, 2001). HTNF developed sites have a total capacity of 7,460 persons at one time. Nevada BLM manages about 180 developed recreation sites statewide and 33 designated dispersed recreation use areas. The BLM areas had a total of over 5 million visits or an estimated 4.1 million visitor days in 2000 (Nevada BLM, 2001).



Recreational and transportation use of motorized vehicles and watercraft on public land and water bodies is on the rise. OHV, snowmobile, and boat activities constituted 11 percent of total visitor days on BLM administered land in 2000 and 3.5 percent on HTNF administered land in 1996 (excludes OHV transportation use with other activities) (Table 5-7). Relatively little is known about the nature and scale of environmental effects from additional OHV recreation and transportation. Agencies are trying to address related issues, including air and water quality, wildlife, habitat, noxious and invasive weeds, and recreational use conflicts (i.e., motorized vs. non-motorized use). Photos show ATV touring at Valley of Fire S.P.; a busy day at Lahontan S.R.A.; and dune buggies at Berlin-Ichyosaur S.P. Photos courtesy of NDSP.

The combined 7 million visitor days on HTNF and BLM recreation areas indicates that a Nevada's uniquely vast and stark lands present a range of attractions to a diverse set of

outdoorsman, as well as presenting an array of opportunities for outdoor recreation-related tourism enterprises. Public recreation lands are widely distributed in the state, and both urban and rural communities stand to gain by growth in outdoor recreation and by enhanced resource conditions. However, the large number of visitors and uses (Table 5-7) indicates that the act of balancing resource protection with growing demands of the recreating public can only become more challenging.

Table 5-7. USFS & BLM Visitor Day Counts By Recreation Activity Type In Nevada

Activity	USFS Visitor Days	BLM Visitor Days	Activity	USFS Visitor Days	BLM Visitor Days
Archery	NA	26,218	Pack Trips	NA	6,116
Backpacking	NA	34,805	Photography	NA	76,608
Bicycling	27,500	71,604	Picnicking	216,500	43,141
Boating	3,100	20,842	Racing-Auto Track	NA	25,541
Cabins	36,400	NA	Racing-Horse Endurance	NA	93
Camping	633,700	1,153,213	Racing-OHV Cars/ Trucks/ Buggies	NA	5,586
Camping-Organizational	65,800	NA	Rockhounding/ Mineral Collection	NA	31,654
Caving	NA	2,801	Row/ Float/ Raft	300	21,312
Climbing-Mountain/Rock	63,100	33,557	Skiing-Cross Country/ Snowshoeing	30,600	16,698
Dog Trails	NA	1,044	Skiing-Downhill	59,100	NA
Driving for Pleasure	421,500	288,874	Snow Play-General	77,100	4,786
Environmental Education	28,000	31,221	Snowmobiling	39,100	14,490
Fishing	89,400	171,171	Social Gathering/ Festival/ Concert	NA	221,263
Gather Non-Commercial Products	121,300	86,852	Specialized Sport/ Event (Non-Motor)	NA	36,023
Hang-Gliding/ Parasailing	NA	77	Spectator Sport	19,500	760
Hiking/ Walking/ Running	326,100	151,542	Sports/Games	17,100	NA
Horseback Riding	96,700	131,209	Staging/ Comfort Stop	NA	833
Hunting-Big Game	144,800	440,417	Swimming/ Water Play	1,400	48,358
Hunting-Small Game	16,900	60,302	Target Practice	NA	38,144
Hunting-Upland Bird	33,000	109,575	Touring	14,900	NA
Hunting-Waterfowl	2,200	22,179	Trapping	NA	10,591
Ice Skating	0	891	Viewing-Cultural Sites	18,100	83,800
Interpretive Programs	4,100	179	Viewing-Other	NA	92,541
Land/ Sand Sailing	NA	2,747	Viewing-Scenery	192,800	NA
Miscellaneous/Other	24,400	NA	Viewing-Wildlife	NA	57,982
Nature Study	75,700	14,675	Viewing-Interpretive Exhibit	49,300	8,541
OHV (Specialized Land Craft)	5,100	292,811	Water Skiing	0	163
OHV-Motorcycle	57,200	115,892	Wilderness Use	331,800	NA
Total Visitor Days				2,953,600	4,109,722

Sources: Nevada BLM and Humboldt-Toiyabe National Forest, 2001.
Note: HTNF visitor day estimates are for 1996 and NBLM estimates are for 2000.

The increasing uses noted in outdoor recreation activity have come with an environmental price. Concern has grown over the proliferation of sport utility vehicles, personal all terrain vehicles, dirt bikes, mountain bikes, personal watercraft, and snowmobiles. These and other motorized and mechanized modes of

transportation on land and water opens the door to a new legion of outdoor recreation participants during all seasons. Vehicles are not merely transportation to recreation areas, but have become the recreation themselves. The consequences of irresponsible and unmanaged dispersed recreational vehicle use can be costly resource damage. One type of impact is the expanding spider web of trails, roads, and vehicle tracks, which exacerbate slope and channel erosion, water quality degradation, habitat damage, and wildlife disturbance. Increased regulation, enforcement, and restrictions may become necessary to deal with these problems on public lands. Trail-rider and off highway vehicle associations have implemented programs in an attempt to raise public awareness about proper use of motorized vehicles in Nevada's wildlands and watersheds.

Other problems are related to the larger numbers of recreationists converging on limited developed resources, resulting in overuse. Some campsites and picnic areas, for example, have become trampled with heavy foot traffic. Soil compaction affects the health of surrounding trees and shrubs. Campers are notorious for hanging lanterns on trees, not realizing that this will cause "lantern scars" where the cambium layer is killed due to the heat. Trails have been constructed through riparian areas, poorly drained areas, or on steep slopes that are very sensitive to even moderate traffic, regardless of whether travel is on foot, horseback, mountain bikes, or motorized vehicles. This problem is difficult to control. Insufficient trail maintenance of problem areas, for example where fallen trees, boulders, or other obstacles are not removed in time, leads to trampling of the area and proliferation of new trail sections. Lack of sanitary facilities commensurate with the level of use is a widespread problem. While the environment can generally sustain light human usage without the benefit of sanitary facilities, more intensive use can be detrimental to the environment and human health.

The intensity of outdoor recreation on public and private lands will continue to increase as the population of Nevada and surrounding states grow. Both rural and urban communities are advertising nearby outdoor recreation attractions to boost local tourism revenues. Many of the state's most scenic, wildest, and water-associated recreation resources include unique and sensitive habitats and species. Anticipating that the state's special places will receive more visitors, decision makers can take proactive steps to provide the funding and technical assistance that agencies will need for enhanced resource monitoring, research, and management. Everyone benefits by positive actions taken to ensure that outdoor recreation activities are compatible with the sensitivity and carrying capacity of Nevada's most enjoyable and precious natural resources.

References

Humboldt-Toiyabe National Forest. 2001. Personal communication between Nevada Division of State Parks and HTNF outdoor recreation program.

Nevada BLM. 2001. Personal communication between Nevada Division of State Parks and Nevada BLM outdoor recreation program.

Nevada Division of State Parks. 2001. Database of visitor counts at state parks.

Nevada Division of State Parks. 2002. Personal communication. Results of Outdoor Recreation Use Citizens Survey, 2001.

Nevada Division of Wildlife. 2001. Personal communication.

U.S. Fish and Wildlife Service and U.S. Census Bureau. 1998. *1996 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, Nevada.*

U.S. Fish and Wildlife Service and U.S. Census Bureau. 2002. *2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, State Overview, Preliminary Findings.*