

STATE OF THE PARKS REPORT
ON THE
NATURAL RESOURCES
OF
ZION NATIONAL PARK

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1. Introduction

Zion National Park (the Park) encompasses some of the most scenic canyon country in the United States and protects a spectacular region of soaring cliffs; narrow, sculpted canyons; one of the last mostly free-flowing rivers on the Colorado Plateau; and a diverse array of plant and animal communities. In addition, its location at the junction of the Colorado Plateau, Great Basin, and Mojave Desert provinces means that the Park encompasses a variety of life zones and provides the Park remarkable plant and animal diversity.”¹

Water and elevation are key physical elements of the Park, with rivers and streams having carved many of its most striking features. The Park’s highest point is Horse Ranch Mountain, near the northwestern edge of the Park, at 2660 m (8,726 ft); its lowest point is Coalpits Wash, at the southwestern edge of the Park, at 1128 m (3,700 ft).² The Park includes 160 miles of perennial streams.³ The best known of these, the North Fork of the Virgin River, runs for 18 miles through the Park⁴ including through Zion Canyon, the largest and most visited canyon in the Park. The Narrows portion of the canyon has walls rising 2,000 feet with only the 20-30 foot width of the river in between. The southern part of the park is a lower elevation desert area, with colorful mesas bordered by rocky canyons and washes. The northern sections of the park are higher plateaus covered by forests.”⁵ Together these features create a region characterized by high plateaus, a maze of narrow, deep, sandstone canyons, and striking rock towers and mesas.

The Park’s 99-mile perimeter boundary⁶ is largely comprised of straight lines that do not represent watersheds or topographical boundaries. Much of the Park is a roughly rectangular shape, with a small addition (the Kolob Canyons region) contiguous to the northwest. Visitor access is through three primary access points: the Kolob Canyon region off of Interstate 15 on the northwest side of the Park, the town of Springdale on the south side of the Park, and from the east on Utah highway 9.⁷ Most visitor and operational developments are concentrated at the south Park entrance and in Zion Canyon. The Park contains only 57 miles of roads, including both paved and gravel.⁸

Zion was one of the earliest additions to the national park system. Part of the land that is now the Park was first protected in 1909, when President Taft created the 15,200-acre Mukuntuweap National Monument. In 1918 the Monument was expanded to 76,800 acres, and its name was changed to Zion National Monument. In 1919 the Monument was changed to a National Park by an act of Congress. In 1937 the Kolob Canyons region was protected by creation of another National Monument, also (confusingly) called Zion National Monument; this region was added to the Park in 1956.⁹ There were a total of eight Presidential Proclamations and Acts of

¹ <http://www.nps.gov/zion/>

² National Park Service 2002, p. L-73

³ <http://www.nps.gov/zion/ParkProfile.htm>

⁴ <http://www.nps.gov/zion/ParkProfile.htm>

⁵ General Management Plan, p. 3

⁶ <http://www.nps.gov/zion/ParkProfile.htm>

⁷ Cogan 2004, p. 14.

⁸ <http://www.nps.gov/zion/ParkProfile.htm>

⁹ General Management Plan, p. 3.

Congress that created and added to the Park, the last one in 1976;¹⁰ the Park now totals 146,598 acres.¹¹

The purposes for which the Park was established, interpreted in the 1977 version of the General Management Plan, include to:

- “Preserve and protect the scenic beauty and unique geologic features: labyrinth of remarkable canyons, volcanic phenomena, fossiliferous deposits, brilliantly colored strata, and rare sedimentation.
- Preserve the dynamic natural processes of canyon formation as an extraordinary example of canyon erosion.”¹²

This second purpose, in particular, is significant in that there are few places in the American southwest where largely unfettered rivers are continuing the erosion processes which produced the spectacular landscapes preserved in the region’s parks. Zion is the rare case in which this canyon formation process continues today.

Park visitation is about 2.5 million people per year;¹³ visitation levels doubled between 1982 and 1997.¹⁴ Backcountry use has risen even more quickly, from 7,807 people camping in the backcountry in 1986 to 21,002 in 1999.¹⁵ Zion was one of the first in the National Park System to implement a shuttle service, in the spring of 2000. The mandatory shuttle operates on the popular and crowded six-mile Zion Canyon Scenic Drive between April and October. The system carried 2,417,000 passengers in 2003, up 2.6% from 2002.¹⁶

Despite successful visitor management efforts, Zion is threatened by its very beauty and popularity. Its location in a rapidly developing region, alongside an interstate highway that connects it to Las Vegas and the huge population of southern California, has resulted in both high levels of visitation and increasing development around its boundaries. Unlike many other parks in Utah and in other parts of the western U.S., Zion adjoins large amounts of private land and is within a day’s drive of tens of millions of people. It is a Park in danger of being strangled by its popularity.

This report serves to document the status of Park natural resources, identify chief threats and degradations, and make recommendations regarding future Park management.

¹⁰ Utah Department of Natural Resources 2000, Appendix A.

¹¹ <http://www.nps.gov/zion/pphtml/facts.html>

¹² National Park Service 2002, p. L-73.

¹³ <http://www.nps.gov/zion/pphtml/facts.html>

¹⁴ General Management Plan, p. 1.

¹⁵ General Management Plan, p. 21.

¹⁶ <http://www.nps.gov/zion/ParkProfile.htm>

2. Zion geographic context and physical description

Zion National Park lies at the intersection of three biophysical provinces: the Mojave Desert to the south and southwest, the Colorado Plateau to the north and east, and the Basin and Range to the west.¹⁷

The Mojave Desert¹⁸ encompasses 131,000 sq km, stretching west and southwest of the Park to the Sierra Nevada and California Montane Scrub, and north to the Basin and Range Province. Its elevation ranges from below sea level to over 1600 meters, but much of it is high desert between 610 and 1220 meters. Characteristic plant species include creosote bush (*Larrea tridentata*), brittlebush (*Encelia farinosa*), and desert holly (*Atriplex hymenelytra*).

The World Wildlife Fund rates the Mojave's conservation status as "relatively stable" and notes that roughly half the region remains as intact habitat, further stating that the other half "has not been heavily altered by human activity." Large parts of the ecoregion are protected, especially in California. Main threats to the region that are relevant to the area near Zion are from urban and suburban development, grazing, and off-road vehicles.

The Colorado Plateau¹⁹ comprises 326,000 sq km²⁰ primarily to the north and east of Zion. The Plateau is bounded on the east by the southern Rocky Mountains, on the north by the central Rocky Mountains, and on the south and west by the Basin and Range Province. It is characterized by high elevation and an arid to semi-arid climate. The region is dominated by red rock deserts and canyons, but also includes isolated mountain ranges reaching as high as 3,960 m (12,870 ft). Because of its large elevation range it encompasses numerous vegetation types, commonly including pinyon-juniper woodland (*Pinus edulis* and *Juniperus* spp.) and big sagebrush (*Artemisia tridentata*).

The conservation status of the Plateau is rated "relatively stable" by World Wildlife, but only about 15 percent remains as intact habitat. While little of the remaining 85 percent has been heavily altered by human activity, all show some signs of stress. Riparian areas and areas with mineral resources have been the hardest hit. The main reason for habitat loss in the region is grazing, and there is widespread grazing damage in the ecoregion."²¹ A reason for the relatively stable status is the presence of numerous large protected areas totaling about 8.3% of the land area on the Plateau;²² these include Canyonlands, Capitol Reef, and Arches National Parks, Grand Staircase/Escalante National Monument, and numerous smaller BLM wilderness study areas.²³

¹⁷ National Park Service 2002, p. L-74. These vegetative zones are used by the Park Service and are similar to but not exactly the same as some others, for example Ricketts et. al.

¹⁸ Description from Ricketts, et. al. 1999, p. 335-337.

¹⁹ Except where otherwise noted description is from Ricketts et. al. 1999, p. 332-335.

²⁰ Nabhan, 2002, p. 3. The size of the Plateau quoted above is for the "core" area; a larger figure of 526,000 sq km is also given.

²¹ Ricketts, et. al. 1999, p. 333.

²² Nabhan, et. al., 2002, p. 7.

²³ Wilderness study areas (WSA) are designated by the BLM as having wilderness characteristics, thus making them worthy of consideration by Congress for wilderness designation. While Congress considers whether to designate a

The Basin and Range²⁴ covers 336,000 sq km to the north and northwest of the Park, stretching west to the Sierra Madre and north to the Columbia Plateau. It is composed of a series of mountain ranges and valleys that comprise a completely self-contained drainage. The region is the most northerly of the American deserts, and due to being further north and having higher elevations than other deserts it includes cold-temperate vegetation. Dominant species include sagebrushes (*Artemisia*), saltbrushes (*Atriplex*), and rabbitbrushes (*Chrysothamnus* spp.).

Although World Wildlife rates the Basin and Range as “relatively stable,” it also notes that “virtually the entire basin has been grazed and browsed, and less than 10 percent remains as intact habitat.” The main degradation is establishment of exotic species including cheatgrass (*Bromus tectorum*) and Russian thistle (*Salsola paulensii*); other threats are from urban/suburban development.

2.1 Park geology and representative topographic features

Zion is best known for its geologic features. The park is characterized by a series of deep canyons and rock towers interspersed with high plateaus and mesas. Zion is part of a geological feature called the Grand Staircase, a series of colorful cliffs formed by sedimentary rocks that have been uplifted and are now eroding, stretching from the Grand Canyon to the south to Bryce Canyon to the north.

The area that is now Zion was, over a long period, the bottom of a shallow sea, a coastal plain, and a desert. Into these areas was deposited about 10,000 feet of sediment that, over time, turned into various types of sedimentary rock including limestone, sandstone, and shale. This sedimentary rock was later part of a larger, regional uplift, which created the elevation gradient to allow rivers and streams to accelerate the erosion that has carved the spectacular canyons of the Park. These canyons reveal the following layers of rock, from highest elevation to lowest:

- Dakota Formation: conglomerate and sandstone
- Carmel Formation: limestone, sandstone, and gypsum
- Temple Cap Formation: sandstone
- Navajo Sandstone: sandstone
- Kayenta Formation: siltstone and sandstone
- Moenave Formation: siltstone and sandstone
- Chinle Formation: shale, loose clay, and conglomerate
- Moenkopi Formation: shale, siltstone, sandstone, mudstone, and limestone
- Kaibab Formation: limestone.²⁵

Interspersed within these strata are layers of alluvium, volcanic rocks, and lake, pond, and slide deposits.²⁶

Wilderness Study Area (WSA) as permanent wilderness, the BLM manages the area to prevent impairment of the area's suitability for wilderness designation. From the BLM website, <http://www.blm.gov/nlcs/wilderness.htm>.

²⁴ Description from Ricketts, et. al., p. 328-330. Note that Ricketts calls this region the Great Basin Shrub Steppe.

²⁵ From “The Geology of Zion National Park,” undated, no author, accessed at <http://www.nps.gov/zion/pphtml/maps.html>

²⁶ Cogan 2004, p. 16

2.2 Park zoning

The National Park Service is currently managing about 90% of the land within the Park (not counting inholdings) as wilderness and has recommended that these 132,615 acres formally be designated as wilderness; an additional 4,175 acres of private lands and water rights within the park boundary remain identified as potential wilderness additions.²⁷ In 2004 Zion designated nine Research Natural Areas covering just over 9,000 acres, or 6% of the Park. These areas include hanging gardens and relict mesa top vegetation communities that have never been logged or grazed. Recreational use is not allowed in these areas, while educational trips and scientific research are allowed.^{28, 29}

2.3 Climate³⁰

Zion is characterized by a dry climate that is very hot in the summer, and cool or even cold at times in the winter. Average highs in July are around 100 degrees F; average lows in December and January are around 30 degrees F. A high of 115 degrees F and a low of -2 degrees F have been recorded within the past 25 years. Annual precipitation in Zion Canyon is 15 inches, most of which falls as rain in the spring, followed by a dry summer interrupted by prevalent monsoons or afternoon thunderstorms between late July and mid-September.³¹ Some snow falls in the Park in the winter, with greater amounts at the Park's highest elevations, which receive slightly higher total precipitation than the lower elevations in the southerly portion of the Park.

2.4 Land use history³²

Human use of the region that is now Zion dates back to about 6000 B.C. Up until the late 1700s use was almost entirely by Native Americans; at that time the first explorers came through the area, and the Old Spanish Trail paralleled the Virgin River. Over the next century traders came through the region on trails that connected Santa Fe with California, and in the 1830s John Wesley Powell's travels brought him to the area. The first permanent settlements were established by Mormon settlers starting in the late 1840s, and homesteads and small towns were established in Zion Canyon and nearby areas over the next decades. Many of the early settlers abandoned the immediate area in the canyon, however, due to a lack of arable land and the flooding of the river.

Because of the remoteness of the region, when the area of the Park was first protected in 1909 much of the land had seen fewer human impacts than many other lands that became national parks. The main exception to this was overgrazing and associated vegetation changes and erosion in higher elevations of the Park.³³ These areas are the closest and best summer grazing areas for a large region at lower elevations that could be grazed in winter. These summer ranges where livestock were concentrated were "grazed hard."³⁴ Some logging also took place in the

²⁷ General Management Plan, p. 18.

²⁸ From two memos to and from the Superintendent of Zion, dated 9/13/03 and 2/23/04.

²⁹ This designation also deauthorized three areas earlier designated as RNAs: Bighorn (8,313 acres), West Rim-Phantom Valley (22,409 acres), and Kolob Mesas (279 acres). Recreation had been allowed in these areas and their status as RNAs was unclear. Kezia Nielson, Environmental Protection Specialist, personal communication August 10.

³⁰ Summary climate data available at <http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?utzion>

³¹ Cogan 2004, p. 18.

³² <http://www.nps.gov/zion/HumanHistory.htm>

³³ National Park Service 1999, p. 108.

³⁴ Dave Sharrow, National Park Service Hydrologist, personal communication August 10.

upper elevations, which along with fire suppression, have changed the vegetation structure of these forests.³⁵ Once the original Zion National Monument was established, these activities were gradually phased out (with some trespass cattle exceptions) and were replaced by the increasing levels of visitation and associated development including campgrounds, the Zion Lodge, and the highway into the Park from the east.

2.5 Adjacent land use

Zion lies on the western edge of a string of national parks and monuments in Utah that include Bryce National Park, Grand Staircase/Escalante National Monument, Glen Canyon National Recreation Area, and Capitol Reef, Canyonlands, and Arches National Parks.³⁶ The Park is located in Washington, Iron, and Kane Counties in southwestern Utah, an area with significant amounts of public land, although Zion is bordered by more private land and is closer in proximity to population centers than other protected areas in Utah. The land immediately adjacent to the Park is a mix of private (42.4%) and public (Bureau of Land Management about 52% and state about 6%);³⁷ with the BLM land managed primarily for grazing, though a considerable portion is designated as Wilderness Study Areas. Most of the nearby private land is near the town of Springdale, at the south entrance of the Park, and to the north of the Park in the Kolob Terrace area. Two units of the Dixie National Forest lie to the west and northwest of the Park, close by although not contiguous, and a bit farther away to the northeast. In addition, state lands in small parcels are scattered throughout the region.

There are no major metropolitan areas very close to the Park, but it is close enough to Las Vegas, NV, Salt Lake City, UT and cities in California to receive significant visitation from these regions. Las Vegas is the closest major city, 254 km (158 miles) to the southwest; Salt Lake City is 523 km (325 miles) to the northeast. The small gateway town of Springdale (population about 500 people³⁸) is less than a mile from the park's south entrance. Other nearby towns include Kanab (66 km (41 miles) from the Zion Canyon Visitor Center, population about 3,500), St. George (72 km (43 miles), population about 54,000), and Cedar City (97 km (60 miles), population about 21,500).

2.6 Additional Park resources

The Park also has the benefit of natural quiet, dark night skies, and paleontological resources. None of these, however, is well studied or being actively managed at this time, although management planning is underway in some cases.

2.5.1. Soundscape

The natural quiet of Zion and other parks in southern Utah is a valuable resource. The Resource Management Plan, written before the implementation of the shuttle system in Zion Canyon, noted that “most of the traffic noise in Zion Canyon was created by tour buses and that they were distinctly audible at elevated viewpoints.”³⁹ The implementation of the shuttle system has been a success in eliminating this source of noise, among other successes.

³⁵ Meeting with Resource Management staff, August 3.

³⁶ Geographical information, except where otherwise noted, is based on a review of the *Utah Atlas and Gazetteer*.

³⁷ David Sinton, Zion National Park GIS Technician, personal communication August 10.

³⁸ <http://eire.census.gov/popest/data/cities/tables/SUB-EST2002-09-49.pdf>. All subsequent population numbers are taken from this same Census Bureau source.

³⁹ National Park Service 1999, p. 86.

While Zion's soundscape still provides natural quiet away from developed front country areas, it is threatened by an increasing number of overflights, discussed in section 5.5. These flights threaten the goal in the General Management Plan, to have "natural sounds in an unimpaired condition...[and t]he sounds of civilization...generally confined to developed areas."⁴⁰

2.5.2. Dark night skies

Although Park managers recognize the value of dark night skies as a resource, and make efforts within Zion to limit lighting to the level that is necessary, the Park does not have comprehensive efforts to limit light pollution from outside the Park. Springdale, located immediately outside the Park's southern entrance, has an ordinance that prohibits bright or flashing signs. While this certainly helps alleviate light pollution, the glow of other nearby towns and lights from development in adjacent and nearby private lands are a threat to the Park's natural darkness.

2.5.3 Paleontological resources

Zion contains many fossils from plants and animals from the mid-Permian and Cretaceous ages (280 to 80 million years ago), but paleontological resources have not been inventoried and are largely unknown.⁴¹

3. Communities and species of concern

Due to its location at the intersection of three biophysical provinces, plus its elevation gradient, Zion shelters 894 species of vascular plants--the richest diversity of plants in Utah, and the third largest inventory of plants among national parks in the Rocky Mountain region.⁴² The Park also contains 78 species of mammals, 290 species of birds, 44 species of reptiles and amphibians, and 8 species of fish.⁴³ The Park contains a stretch of one of the last largely natural rivers in the region, the Virgin River, and provides habitat for wide ranging species such as mountain lions, threatened and endangered species and species of concern such as the Mexican spotted owl, desert tortoise, Shivwits milkvetch, and peregrine falcon, and rare or endemic species such as the Zion snail.

Inventory and monitoring of species in the Park is mixed; as with many parks species surveys have tended to focus on vascular plants, vertebrates, and similar high-profile species. For example, a survey was conducted in 1989 of vascular plants but there has not been a survey of non-vascular plants; lichens were surveyed in Zion Canyon but not in any part of the upper elevations of the Park; and there have been no studies of the cryptobiotic soil crusts in the Park.⁴⁴ Some invertebrates have been studied, such as snails and arthropods, while others (crustaceans, diplopods (millipedes) and chilipods (centipedes) have not been studied more than sporadically.⁴⁵ Even the status of some megafauna are relatively unknown—both mountain lions

⁴⁰ National Park Service 2001, p. 12.

⁴¹ National Park Service 1999, p. 88.

⁴² National Park Service 1999, p. 1.

⁴³ Statistics in this section, except where noted, taken from <http://www.nps.gov/zion/ParkProfile.htm>

⁴⁴ National Park Service 1999, p. 73-75.

⁴⁵ National Park Service 1999, p. 81.

and black bears are known to inhabit the Park, but population numbers and dynamics are unknown.⁴⁶

Surveys by the Northern Colorado Plateau Network were undertaken to look for amphibians and reptiles in 2001 and 2002. A total of 5 amphibians, 1 tortoise, 12 lizards, and 10 snakes were documented (two of the snakes were identified by photos provided by Park staff, not live in the field. The inventory of Zion is thought to be 82% complete.⁴⁷

3.1. Natural systems within the Park

The vegetative communities of Zion are largely defined by elevation and water. For this study, the following systems were identified in consultation with Park staff and published literature.⁴⁸

- Rivers and streams
- Riparian areas
- Seeps, springs, and hanging gardens
- Desert shrubland
- Pinyon-juniper woodlands
- Mountain shrub/transition zone
- Coniferous forests

In addition to these communities, of note are several relict vegetation areas on mesa tops. These are generally a mix of coniferous forests and mountain shrub, notable for being isolated from grazing, logging, and all other human uses; as such they provide examples of areas relatively free from human influence.⁴⁹ Some of these relict communities are protected within Research Natural Areas in which recreation is prohibited⁵⁰—an important protection designation given the increase in climbing activity in the Park.

3.1.1 Rivers and streams

The Virgin River and its tributaries make up the rivers and streams of Zion. The two largest rivers are the East Fork and the North Fork of the Virgin River (both have perennial base flows of between 20 and 60 cubic feet per second from groundwater); smaller perennial tributaries include North Creek, Deep Creek, Goose Creek, Kolob Creek, and Shunes Creek. Total riparian area along perennial streams is nearly 25 miles.⁵¹ The river system is “one of the last mostly free flowing river systems contributing to major canyon formation on the Colorado Plateau”;⁵² all the rivers and creeks with the exception of Kolob Creek run naturally. (A reservoir exists on Kolob Creek upstream of the Park.) Natural flow regimes still exist, with “highly variable daily flows” that are characterized by snowmelt runoff from April to June, and summer thunderstorms in July and August.

⁴⁶ National Park Service 1999, p. 96.

⁴⁷ Platenberg 2003.

⁴⁸ Based on National Park Service 2002, p. L-74, and several meetings with Park Resource Management staff.

⁴⁹ Van Pelt 1991. With increasing human-caused global climate change it may be inaccurate to say that any place is entirely free of human influence, but these relict areas show no sign of human use.

⁵⁰ Martin 2004.

⁵¹ National Park Service 1999, p. 74.

⁵² National Park Service 2002, p. L-74

Likely due to the natural flow regimes, the North and East Forks of the Virgin River contain four species of native fish whose population size greatly outnumbers the population of exotic fish even though the number of non-native fish species outnumbers native species by thirteen to six, according to a study in 1985.⁵³ The four native fish are the Virgin spinedace (*Lepidomeda mollispinis*), flannelmouth sucker (*Catostomus latipinnis*), desert sucker (*Catostomus clarki*), and speckled dace (*Rhinichthys osculus*). Two species found downstream of the Park are endangered: woundfin (*Plagopterus argentissimus*) and Virgin River chub (*Gila seminude*). The spinedace is managed under a multi-agency conservation agreement, and in the Park is managed as if it were listed.⁵⁴ A fairly recent river study, from 1994, found that “stream habitats in and immediately below Zion National Park, for the present time, sustain a native fish assemblage that continues to resist being dominated by non-native fishes.”⁵⁵

3.1.2 Riparian areas

Riparian vegetation lines numerous streams in the Park and is found near springs and seeps. These areas are critically important to wildlife; for the southern Utah canyon country as a whole the Utah Division of Wildlife Resources estimates that riparian areas that make up one to two percent of the landscape support 75-80% of the wildlife in the region.⁵⁶ The National Park Service states “[t]hese areas are critical oases in an arid environment, providing productive and unique habitats for wetland plant species and a high diversity of aquatic invertebrates, amphibians, ...birds, fish, native pollinators, and other organisms.”⁵⁷ Due to a variety of human uses including agriculture and grazing, plus the impacts of invasive species, riparian areas are considered “regionally at-risk,”⁵⁸ making the relatively intact systems in the Park even more critical. Riparian vegetation in the Park includes Fremont cottonwood (*Populus fremontii*), velvet ash (*Fraxinus velutina*), box elder (*Acer negundo*), and seepwillow (*Baccharis* spp.).⁵⁹

The channelization of the Virgin River in the Park has had serious deleterious effects on that riparian zone. Within Zion Canyon flood prevention and channelization of the river has largely eliminated flooding which is necessary for riparian flora generation, and the riparian vegetation is comprised of an “overstory of mature cottonwoods, boxelder, and velvet ash, many of which are dead or dying...regenerating woody vegetation is mostly non-native species...[causing] loss or degradation of wildlife habitat.”⁶⁰ See section 4.2.1 for a discussion. Native riparian and floodplain herbaceous and shrub vegetation are highly degraded as a result of exotic species encroachment and altered floodplain ecological processes.

Another habitat based on available moisture, although not necessarily in riparian zones, is the hanging gardens. Springs and seeps are created by water moving downward through the porous Navajo sandstone until it reaches a layer of rock that it can no longer pass through, and is forced out along the side of the canyon. The moisture along the canyon wall allows for growth of the

⁵³ Cross 1985, quoted in National Park Service 2002, p. III-57

⁵⁴ National Park Service 2002, p. III-56.

⁵⁵ Gregory and Deacon 1994, quoted from National Park Service 2002, p. 111-56

⁵⁶ Schelz, 2001, page 2.

⁵⁷ National Park Service 2002, p. L-74

⁵⁸ National Park Service 2003, p. 75.

⁵⁹ National Park Service 2002, p. L-74

⁶⁰ National Park Service 2002, p. L-76

hanging gardens, which, although not well studied, contain a diversity of plant life including some endemic species, as well as the endemic Zion snail (*Physa zionis*). More common plants include maidenhair ferns (several species) and golden columbine (*Aquilegia chrysantha*). The flowers and plants provide food for insects and hummingbirds, a nesting area for the American dipper (*Cinclus mexicanus*), and the combination of water and a food source in the arid desert make the hanging gardens ecologically valuable despite their small size. This value is recognized by the Park, which has protected hanging gardens within Research Natural Areas.^{61, 62}

3.1.4 Desert shrubland

At the Park's lowest elevations, vegetation is sparse and soils are covered with cryptobiotic "crusts." Common plant species are blackbrush (*Coleogyne ramosissima*), four-wing slatbrush (*Atriplex canescens*), and mesquite (*Prosopis glandulosa*).⁶³ This vegetation community lies below 4000 feet and is in only a small part of the Park.⁶⁴

3.1.5 Pinyon-juniper woodlands

At slightly higher elevations, between about 4000 and 5,500 feet,⁶⁵ and away from water, pinyon-juniper woodland is common. There are two types of pinyon (*Pinus edulis* and *P. monophylla*) and one-seed juniper (*Juniperus osteosperma*). Gambel oak (*Quercus gambelli*) and live oak (*Quercus turbinella*) are also found in this region. Interspersed in this area are sand and big sagebrush (*Artemisia filifolia* and *A. tridentate*), rabbitbrush (*Ericameria nauseosa*), and pockets of grasses such as sand dropseed (*Sporobolus cryptandrus*) and Kentucky bluegrass (*Poa pratensis*).⁶⁶ Much of Zion Canyon is in this zone (aside from the riparian area).⁶⁷

3.1.6 Mountain shrub/transition zone

This zone, from 5,500 to 7,500 feet, makes up a large portion of the Park.⁶⁸ This is a transition zone that contains some of the juniper and oak from lower elevations. Ponderosa pine (*Pinus ponderosa*) appears here as well as greenleaf manzanita (*Arctostaphylos patula*) and dwarf mountain mahogany (*Cercocarpus intricatus*). In north facing and sheltered areas are stands of Douglas fir (*Pseudotsuga menziesii*).⁶⁹

3.1.7 Coniferous forests

Coniferous forests in the Park are restricted to the Park's highest elevations. These forests are made up of ponderosa pine, white fir (*Abies concolor*) and quaking aspen (*Populus tremuloides*) and are becoming "decadent" due to fire suppression.⁷⁰ Shrubs commonly found at this elevation are Gambel oak, common serviceberry (*Amelanchier alnifolia*), and bigtooth maple (*Acer grandidentatum*).⁷¹

⁶¹ <http://www.nps.gov/zion/TeacherCorner/TeacherMaterialsSelfGuidedRiverside.htm>

⁶² National Park Service 2001, p. 40.

⁶³ Cogan 2004, p. 19.

⁶⁴ National Park Service 1999, p. 75

⁶⁵ Elevation from National Park Service 1999, p. 75.

⁶⁶ Cogan 2004, p. 19.

⁶⁷ National Park Service 1999, p. 75

⁶⁸ National Park Service 1999, p. 75

⁶⁹ Cogan 2004, p. 19.

⁷⁰ National Park Service 2002, p. L-74

⁷¹ Cogan 2004, p. 19.

3.2 Threatened and endangered species and species of special concern

Zion provides habitat for several threatened, endangered, and species of special concern. These are:⁷²

Endangered plants:

Shivwits milkvetch (*Astragalus erectimus* var. *ampullarioides*)

Threatened or endangered animals:

Mexican spotted owl (*Strix occidentalis lucida*)

Southwest willow flycatcher (*Empidonax traillii extimus*)

Desert tortoise (*Gopherus agassizii*)

Species of concern

Zion snail (endemic, *Physa zionis*)

Virgin spinedace (*Lepidomeda mollispinis mollispinus*)

Peregrine falcon (*Falco peregrinus*)

Northern leopard frog (*Rana pipiens*)

The National Park Service reports that at least 20 rare, but not listed, plant species inhabit the Park, mostly plants that grow in sand or sandstone crevices. Ten of these were on the U.S. Fish and Wildlife Service Category 2 species list, a pre-listing designation that is no longer used.

These plants are:

Nevada willowherb (*Epilobium nevadense*)

Canaan daisy (*Erigeron canaanii*)

Zion daisy (*Erigeron sionis*)

Jones golden-aster (*Heterotheca jonesii*)

Cliff jamesia (*Jamesia Americana* var. *zionis*)

Utah spikemoss (*Selaginella utahensis*)

Zion tansy (*Sphaeromeria ruthiae*)

Paria scurf-pea (*Pediomelum pariensis*)

Sand-loving beardtongue (*Penstemon ammophilum*)

Cedar Breaks goldenbush (*Haplopappus zionis*)⁷³

The Park has not been completely inventoried, and it is possible that additional rare species inhabit hanging gardens or isolated mesa tops that have not been surveyed.

Due to its location, elevation gradient, and the presence of water, the Park is truly a haven for some species for which it provides critically important habitat. For Mexican spotted owls, the Park's habitat may be the best of any in the region and the park is considered a source for populating other nearby areas of the Colorado Plateau; the same can be said of the stretch of the Virgin River and its tributaries in the Park for the Virgin spinedace. The Park contains all the habitat for the Zion snail, an endemic species, and for the Shivwits milkvetch, the Park

⁷² From <http://www.nps.gov/zion/ParkProfile.htm>, except for the northern leopard frog which is noted in National Park Service 2002, p. L-75. Species of concern are noted by the Park but this is not a formal designation.

⁷³ From National Park Service 1999, p. 76, from a 1992 listing of Category 2 species.

represents one of the few areas of protection (plants are not protected from “take” on private land under the Endangered Species Act in the same way that animals are.)

3.2.1 Mexican spotted owl

The Mexican spotted owl (MSO) (*Strix occidentalis lucida*), a spotted owl subspecies that lives in the southwestern U.S. and Mexico, was listed as threatened by the U.S. Fish and Wildlife Service in 1993 due primarily to timber harvest across the region.⁷⁴ Zion National Park provides excellent habitat for the species, especially in many small slot “side” canyons that are off of or tributaries to the Virgin River;⁷⁵ in 1992 30 of 97 birds surveyed in Utah and Colorado were found in the Park.⁷⁶

The Park is managing for Mexican spotted owls with occasional closures and visitor limitations via a permit system for slot canyons during breeding season (March 1-August 31) as recommended in the General Management Plan, based on zoning canyons as transitional, primitive, pristine, or research natural area (RNA). Transitional canyons have unlimited use, primitive are limited to 50 people per day, pristine are limited to one group of up to twelve people, and RNAs are restricted to researchers. Researchers believe that these protections “most likely benefit” MSOs, and surveys in 2003 found more birds than had ever been previously recorded—one or two adults in each of fourteen territories, plus two fledglings in each of five territories. However, researchers note that the increase may reflect greater survey efforts, increased knowledge of where to look for the birds, and a year of average winter and spring rains after several years of drought.⁷⁷

3.2.2 Peregrine falcon⁷⁸

Peregrine falcons (*Falco peregrinus*) have a broad range stretching from Alaska to Baja California, but their numbers declined dramatically in the 20th century due to effects of ingesting DDT. The bird was placed on the endangered species list, and with the banning of DDT recovered to the point that it was removed from the list in 1999 with the stipulation that populations be monitored for five years. This monitoring has shown 15 historical territories in the Park, of which 13 were occupied in 2003. In 2003 in the thirteen occupied territories eleven pairs were determined to be breeding, and eight were determined to have successfully reproduced. Total productivity of 1.4 young per pair of adults exceeds the goal of 1.25 young/pair in the 1984 Peregrine Falcon Recovery Plan.⁷⁹ Management for the species in the Park, which consists primarily of climbing closures on cliff faces that support peregrine aeries during breeding and nesting periods, appears to have been successful and has been consistent with the broader recovery of the species, largely due to banning the use of DDT.

3.2.3 Zion snails

The Zion snail (*Physa zionis*) is an endemic species that inhabits hanging gardens in the Park. It is tiny, with a length of about half a centimeter.⁸⁰ Although some studies have been done in the

⁷⁴ USDI, 1995, page ix.

⁷⁵ National Park Service 2001, p. 11.

⁷⁶ National Park Service 1999, p. 79

⁷⁷ Maller 2003. (Page numbers are not included in the report.)

⁷⁸ Information in this section from Hetzler 2003, except where otherwise noted. (Page numbers are not included in the report.)

⁷⁹ U.S. Fish and Wildlife Service. 1984.

⁸⁰ Whipple 1988, p. 1.

past, no studies have been conducted in the past ten years, and the status of the snail is unknown.⁸¹ A study in 1988 concluded that the snail “is fairly common within its narrowly restricted range and has a wider distribution than previously thought, including three extensive populations within Orderville Canyon.”⁸² The same study found that a main factor influencing mortality is dessication, thus the water rights agreement protecting groundwater that in turn creates the hanging gardens is a key success for the survival of this species. Another success for the protection of the snail was the designation in 2004 of a Research Natural Area protecting a hanging garden used by the snail from recreational use.⁸³

3.2.4 Virgin spinedace⁸⁴

Zion National Park provides a protected haven for the native fish of the Virgin River. The river and its tributaries are largely free-flowing upstream of the Park and in the Park (exceptions are a small reservoir on one tributary, and the channelization of the Virgin River through part of the Park, which is being considered for rehabilitation.) Downstream of the Park, water quality and flow are both significantly reduced; one report notes that in the past there were 75 river miles of native fish habitat, which by the early 1990s had dwindled to about 20 miles.⁸⁵ Water is diverted for Park use and for the town of Springdale at the lower end of the Park, and outside the Park much more water is diverted for a variety of uses including flood irrigation; return flows from this irrigation degrade water quality. In addition, non-native riparian trees such as tamarisk and Russian olive which consume large amounts of water and degrade streamside fish habitat are controlled in the Park and common outside it.

The Virgin spinedace (*Lepidomeda mollispinis mollispinis*) may be the best indicator of the health of the river. The spinedace is a small fish that is not on the endangered species list due to a habitat conservation agreement between several land management agencies including the National Park Service.⁸⁶ The fish has declined due to flow depletion, water diversion, increased sedimentation, and non-native species competition and predation.⁸⁷ Zion has the largest population of the fish and the best habitat; the Park works with the state and county to monitor populations and conduct habitat surveys. The fish is found in the north fork and east fork of the Virgin River and some larger tributaries; smaller populations are found downstream of the Park. In 1991 the population was estimated at just under 12,000 fish in the North Fork and just over 42,000 in the East Fork.⁸⁸

Even though the spinedace population in the Park is healthy now, the Park’s proposed river restoration (see section 4.2.1) should augment habitat in the section of river to be restored; one study concludes that the restoration “could only benefit the native fish population in the area by improving the long-term health of the aquatic ecosystem.”⁸⁹

⁸¹ Meeting with Resource Management Staff, August 3.

⁸² Whipple 1988, p. 41.

⁸³ Martin 2004.

⁸⁴ Except where noted otherwise this section is based on discussion with Resource Management Staff, August 3.

⁸⁵ National Park Service 1999, p. 106.

⁸⁶ National Park Service 2002, p. L-75

⁸⁷ National Park Service 1999, p. 106.

⁸⁸ National Park Service 1999, p. 80.

⁸⁹ Fridell 2003, p. 7.

3.2.5 Desert tortoise⁹⁰

The desert tortoise (*Gopherus agassizii*) is a federally listed species⁹¹ inhabiting the southwestern U.S. (southern California, southern Nevada, and a very small area of southwestern Utah) and northern Mexico. Its population has declined steeply due to habitat loss from urbanization and agriculture, and mortality from shooting and motor vehicles (cars and ATVs); disease has also had an impact on some populations. It has been extirpated from significant portions of its range and survives in small areas.⁹²

Zion represents the extreme eastern edge of the population, and in fact there had been speculation that the presence of the tortoise in Zion was due to release of captive animals and not a naturally occurring population. Researchers now believe that this is not the case, pointing to the presence of other reptiles associated with the tortoise such as the Gila monster (*Heloderma suspectum*). Due to the Zion population being at the edge of the species' range this is an important population and gene pool for the long-term survival of the species.

A survey in 2000 of 410 hectares found tortoises and signs in 8% of the area, indicating a small population that Park staff estimate at 20-30 animals that is very close to the edge of the Park near Springdale.⁹³ The survey in 2000 did not find any young, but subsequent surveys found young for the first time in 2003. Park managers have been exploring new ways to survey for tortoises in recent years, recognizing that earlier efforts had resulted in population estimates with a large degree of uncertainty.⁹⁴

Park managers are concerned about impacts from people and dogs because the population is so close to the edge of the Park and to the town. Dogs can kill young tortoises, and although direct mortality of older animals is less likely, an encounter with a dog can have a deleterious effect on a tortoise that could impact survival and reproduction. Because the population in the Park is small there are also some concerns about genetic diversity and inbreeding, but studies indicate that tortoises can travel surprisingly far distances—as much as 1 km in a day,⁹⁵ which may mitigate this concern.

3.2.6. Shivwits milkvetch⁹⁶

Shivwits milkvetch (*Astragalus ampullarioides*) is a member of the pea family that was listed as federally endangered in 2001. The plant is very restricted in range and exists only on a soil type derived from Chinle formation, primarily in Washington County, Utah. At the time of listing five populations were known to exist, all but the population in the Park are threatened by off-road vehicles, grazing, suburban development, and in the case of one population mining activities. The total population was estimated to be about 1,000 individuals, with between 30% and 50% living in the Park. There is little research being done to determine the plant's management needs.

⁹⁰ Based on meeting with Resource Management Staff, August 3.

⁹¹ The species is divided into two populations for listing purposes; the Mojave population, north and west of the Colorado River, is listed. McLuckie 2000, p. 1.

⁹² Fish and Wildlife Service 1994, p. 1-7.

⁹³ McLuckie 2000, p. 1.

⁹⁴ Kim, 2002.

⁹⁵ Berry 1986, quoted in McLuckie 2000, p. 12.

⁹⁶ Except where otherwise noted based on meeting with Resource Management Staff, August 3.

3.3 Extirpated species

Two species likely to have inhabited the Park that are no longer found there are wolves (*Canis lupus*) and grizzly bears (*Ursus arctos horribilis*). Both are wide ranging and likely inhabited at least the upper elevation portion of the Park. The last grizzly in Utah was killed about 6 miles north of where the Park is today in the 1880s.⁹⁷

The existence of many native species suggests that the Park is in relatively good ecological condition. The lack of data on many species such as invertebrates and non-vascular plants, however, suggests that some species may have been lost that were never documented.

One clear success to date is the continued presence of all native fish in the Virgin River in significant populations. Most rivers in the western U.S. have been degraded to the point where they have either lost native species, or at least seen significant population decreases of native fish.

4. Physical conditions

The health of Zion's natural communities is in large part determined by the health of its underlying physical and chemical components. In Zion these are largely made up of water quality and flow in the Virgin River and its tributaries, ground water, and air quality throughout the Park.

4.1 Air quality

Zion National Park is designated a Class I area under the Clean Air Act; under the Act, Class 1 areas are to be managed to prevent significant deterioration of air quality.⁹⁸ The Park lists its "desired condition" for air quality as "...no significant degradation. Nearly unimpaired views of the landscape both within and outside the park are present. Scenic views...are substantially unimpaired."⁹⁹ While air quality in the Park is generally good, the two major air quality concerns are regional haze and ozone.

4.1.1 Haze/visibility

Regional haze is the main air quality concern in Zion. There has not yet been major degradation, but there are concerns about future impacts due to urban and suburban development in southern California, the San Joaquin Valley, Las Vegas, and St. George, and power plants including southern Arizona smelters, the Mojave Generating station, and the Reid Gardner Generating Station. There is not yet good data on these sources, and air quality source information is based largely on studies related to the Grand Canyon and other parks. There is a possibility that the area around Salt Lake City contributes to haze in Zion more than in the Grand Canyon,¹⁰⁰ suggesting the need for Zion-specific studies. In 2000 an IMPROVE (Interagency Monitoring of Protected Visual Environments) monitoring station was established in the park to measure

⁹⁷ National Park Service 1999, p. 96.

⁹⁸ National Park Service 1999, p. 85.

⁹⁹ General Management Plan, p. 10.

¹⁰⁰ Dave Sharrow, National Park Service Hydrologist, personal communication August 11.

visibility impairment through scene, optical and aerosol sampling. Because the site is still collecting baseline data, no trend analysis is yet available.¹⁰¹

A key issue with visibility are recent proposals for expanding coal-fired power plants in central Utah, and for new plant construction in southern Nevada. One concern in particular is that the reviews for these plants look at visibility and other pollution issues based on each proposal individually, instead of looking at cumulative effects. The Park's General Management Plan states that the National Park Service will "review, comment on, and recommend actions to minimize or reduce emissions from sources being proposed within 64 miles (100 kilometers) of Zion."¹⁰² The Park should also consider commenting on emissions sources that are further away, as they can easily affect Park air quality. Also, the Park should consider cumulative effects, as has been highlighted by other parks and NPS offices in addressing the new power plant in Delta.

4.1.2 Ozone

Ozone monitoring was begun in 2004, in response to evidence of ozone damage to oakbrush sumac in the Park.¹⁰³ Therefore there is some cause for concern about ozone levels, which should continue to be monitored, but there is not historical data. Initial monitoring has shown ozone levels to be below the threshold of concern for human health. The EPA sets a standard of 85 ppb average over an 8 hour period as "unhealthy," and anything under 64 ppb as "good."¹⁰⁴ Recent levels in Zion have been around 40 ppb or below.¹⁰⁵

4.1.3 Deposition

Wet and dry deposition are monitored at Bryce Canyon and Grand Canyon National Parks, but not in Zion. The Park has not yet determined whether it believes this monitoring is adequate for Zion, and is planning to do this assessment as part of the Phase III of the Northern Colorado Plateau Inventory and Monitoring program.¹⁰⁶ The National Park Service is concerned about the potential for a "hot spot" of nitrogen deposition in and around Zion due to emissions in St. George and Las Vegas, based on computer modeling.¹⁰⁷

4.1.4 Data from Bryce Canyon National Park

Air quality has not been monitored in Zion for more than the past 3 years, so no trend data are available as of yet. The Park Service monitors air quality in Bryce Canyon National Park, where trends have been mixed:¹⁰⁸

Index	Status	Trend
Haziness based on 20 best days	Much better than NPS average	Significant improvement

¹⁰¹ Jeff Bradybaugh, Chief, Resource Management and Research Division, personal communication September 3.

¹⁰² National Park Service 2001, p. 10.

¹⁰³ Dave Sharrow, National Park Service Hydrologist, personal communication August 11.

¹⁰⁴ <http://www2.nature.nps.gov/air/data/current/advisory.htm>

¹⁰⁵ http://www2.nature.nps.gov/air/data/current/data_ZION.htm

¹⁰⁶ National Park Service 2003, p. 73.

¹⁰⁷ National Park Service 2003, p. 73.

¹⁰⁸ National Park Service 2002a, Appendix A. The categories and ratings are all directly from tables in the report appendix, not an interpretation of data.

Haziness based on 20 worst days	Much better than NPS average	Degradation (not significant)
Mean sulfate ion concentration	Better than NPS average	Significant improvement
Sulfate wet deposition	Better than NPS average	Improvement (not significant)
Nitrate ion concentration	NPS average	Improvement (not significant)
Nitrogen wet deposition	NPS average	Improvement (not significant)

4.2 Water quantity and quality

Water is a critical resource in the arid environment of Zion National Park. Water quality and quantity in rivers and streams directly affect aquatic species, as well as species adjacent to the river in the riparian zone. Zion is also “well known for the abundance and diversity of groundwater-dependent ecosystems in the Park (e.g. hanging gardens).”¹⁰⁹

The main drainages in the Park are the East and North Forks of the Virgin River, and several perennial tributaries including North, La Verkin, Deep, Kolob, and Pine Creeks. All of these are “substantially natural and free flowing”¹¹⁰—a rarity in the western U.S. and particularly the Colorado Plateau. Even more importantly, the water is protected through a significant water rights agreement--the 1996 Zion National Park Water Rights Settlement Agreement between the United States, the State of Utah, the Washington County Water Conservancy District, and Kane County Water Conservancy District.¹¹¹ The agreement identified state appropriative rights and federal reserved water rights to help ensure that the National Park Service maintains groundwater, stream flows, and spring discharges within the park. While the agreement allows for some potential future development of water above the park,¹¹² the agreement recognizes the United States’ reserved rights to “all water underlying, originating within or flowing through Zion National Park ... that was unappropriated as of the dates of reservation of the lands now within the boundaries of the park, which waters are to remain in a free flowing condition.” The rights comprise both surface and groundwater within the “Virgin River Drainage Area.”¹¹³ The scope and importance of this agreement to the Park cannot be understated—a report prior to the water rights agreement noted that the Utah Division of Water Resources had identified 33 potential dam sites in the Virgin River basin upstream of the Park, and had proposed a hydroelectric dam on the North Fork above the Park.¹¹⁴ These water developments would have

¹⁰⁹ National Park Service 2003, p. 73.

¹¹⁰ National Park Service 2001, p. 10.

¹¹¹ Utah Department of Natural Resources 2000, p. 1.

¹¹² The allowed water development is small—for example in the East Fork drainage a total depletion of 5,000 acre-feet per year (AFY), of which 3,250 can be from surface sources; and a total of 6,000 AFY (2,500 AFY from surface sources) combined from the North Fork, Ash Creek, La Verkin Creek, North Creek, and Shunes Creek. From Utah Department of Natural Resources p. 2-3.

¹¹³ Utah Department of Natural Resources 2000, p. 1.

¹¹⁴ National Park Service 1999, p. 90.

forever altered the character of the river basin and greatly degraded one of Zion's key natural resources.

4.2.1 River channelization

The success of the water rights settlement is slightly marred by the existing channelization of the Virgin River in the Park. In the 1920s the National Park Service built stone revetments along a four mile stretch of the North Fork, and while many of them have since washed away, for about 2 miles near the Zion Lodge the structures were reinforced with wire mesh and still exist.¹¹⁵ In this area the channelization has deepened the river channel and lowered the water table and "isolated the river from its floodplain,"¹¹⁶ leading to a riparian community that "has lost viability as evidenced by the even-aged, decadent overstory with no recruitment of new trees..."¹¹⁷ This is due to the need of many riparian tree and shrub species for disturbance and watering provided by flooding of the flood plain, which can no longer occur because of the revetments. Given the age of the existing cottonwoods in the Canyon, they are expected to die in the next 30 years.¹¹⁸

In addition to impacts on the floodplain vegetation, channelization has effects on aquatic species as well, although studies have shown mixed results. One limited study found no negative impact on native fish from the revetments,¹¹⁹ while other surveys have shown that Virgin spinedace populations are much higher where the river has not been channelized than where it has.¹²⁰

The Park, noting that "[r]estoring part of the river's floodplain will be consistent with the park purpose to preserve the dynamic processes that formed the canyon,"¹²¹ is planning this restoration and has conducted some preliminary studies, although the timing of the restoration is unknown, as funding is currently unavailable.¹²²

4.2.2 Water quality

Little water quality monitoring is done within the Park;¹²³ although some monitoring is done downstream of the Park, there are enough impacts to water quality immediately downstream of the Park that the downstream monitoring is not necessarily representative of water quality in the Park. One study that was done in the Park showed high levels of fecal coliform bacteria in the North Fork, likely due to infiltration of upstream livestock fecal waste, improper human waste disposal, and or wildlife wastes.¹²⁴ Water quality in the Park is believed to be good in most streams and springs and there are no known major degradations or concerns, although Park scientists acknowledge that much of the focus on water has been on quantity, not quality.¹²⁵

¹¹⁵ McMahon 2001, p. 2.

¹¹⁶ Fridell 2003, p. 1.

¹¹⁷ National Park Service 2001, p. 23.

¹¹⁸ McMahon 2001, p. vi.

¹¹⁹ Fridell 2003, p. 7.

¹²⁰ National Park Service 2001, p. 23.

¹²¹ National Park Service 2001, p. 23.

¹²² Jeff Bradybaugh, Chief, Resource Management and Research Division, personal communication September 3.

¹²³ Meeting with Resource Management Staff, August 3, and National Park Service 2003, p. 103. The latter says the Park "has no monitoring program," however some monitoring is done although not as a formal program.

¹²⁴ National Park Service 2003, p. 103.

¹²⁵ Dave Sharrow, National Park Service Hydrologist, personal communication August 10.

The Park has identified four priority sites for water quality monitoring: the Temple of Sinawava and at the road crossing upstream of the Park on the North Fork of the Virgin River, La Verkin Creek, and North Creek. Monitoring would include (across all four sites) a combination of nutrients, trace elements, macroinvertebrates, microbes, total dissolved solids, suspended solids, and turbidity.¹²⁶

This monitoring is especially important for two reasons: 1) visitor impacts on water resources are largely unknown at this time, and visitor use is heavily concentrated in riparian areas, and 2) the existence of coal bed methane leases outside the Park could impact water quality if they are developed. Three exploratory wells have been drilled for coal bed methane, thus far they have been unsuccessful, but if methane is found and produced, water quality in the Park will be threatened.¹²⁷

4.3 Soil quality¹²⁸

Soils in Zion are “an extremely fragile resource and an almost ephemeral support for” vegetation and wildlife. This is due to several factors. Most soils in the Park are derived from sandstone¹²⁹ and developed on Mesozoic terrestrial sedimentary rocks, “which are characteristically deficient in some important plant nutrients and contain large amounts of alkali.” The aridity of the region contributes to generally low levels of primary productivity and low biomass. In addition, heavy levels of grazing prior to establishment of the Park led to loss of vegetative cover and erosion.

One soil survey done across Utah’s Washington County yielded a good description of the soils in a small part of the southern part of the Park that was later described for desert tortoise surveying—this is important habitat for the desert tortoise, and soil condition is critical for the species because of its burrowing. This description found four soil types:¹³⁰

- Mathis-rock outcrop complex: this soil is most common in the southern part of the Park, and is comprised primarily of stony, loamy, fine sand.
- Rock land soils: a mix of 60-80% rock outcrop and 20-40% very shallow soils over bedrock
- Badland: actively eroding shale, sometimes with sandstone or gypsum, supporting little vegetation
- Clovis fine sandy loam: well-drained soils on old alluvial fans.

Although this survey was describing only a small part of the Park, it gives a generally accurate sense that much of the Park has poorly developed soils that, combined with arid conditions, are a limiting factor for vegetation.

In the northern part of the Park, where there was significant historic grazing and now, just outside the Park, potential road building for houses, there are concerns about erosion.¹³¹ This is not well documented, however.

¹²⁶ National Park Service 2003 and Dave Sharrow, National Park Service Hydrologist, personal communication August 10.

¹²⁷ Dave Sharrow, National Park Service Hydrologist, personal communication August 10.

¹²⁸ This section except where otherwise noted based on National Park Service 1999, p. 108-109.

¹²⁹ Dave Sharrow, National Park Service Hydrologist, personal communication August 10.

¹³⁰ From Mortenson, et. Al. 1971, taken from McLuckie 2000 p. 2-3.

¹³¹ Dave Sharrow, National Park Service Hydrologist, personal communication August 10.

Biological soil crusts are an important soil resource over large portions of the Park, although not well studied in the Park. In other areas in southern Utah, studies have shown that soil crusts have been impacted by historic grazing, past and current visitor use, and possibly air pollution. These impacts have led to a reduction in cover of lichens, invasion of cheatgrass, soil loss and thus nutrient loss. Impacts lead to soil compaction, resulting in less water infiltration, less nitrogen fixation, fewer plants, greater soil erosion, and plants being less nutritious for wildlife.¹³²

¹³² Background information on biological soil crusts based on conversation and emails with Dr. Jayne Belnap, U.S. Geological Survey, April 20 and 21; this research was done for the Canyonlands National Park natural resources assessment and adapted to Zion, where little research on soil crusts has been done.

5. Park degradations and threats

In addition to the threats and degradations identified in the previous chapter, Zion faces several other issues:

5.1 Exotic species¹³³

Like most parts of the western United States, Zion is home to many non-native plants—over 100 species in all. Many of these, however, are not invasive and not significant management concerns. Sixteen species have been identified by the Park as invasive species of concern:

- Tamarisk (*Tamarix ramossissima*)
- Russian olive (*Elaeagnus angustifolia*)
- Cheatgrass (*Bromus tectorum*)
- Ripgut brome (*Bromus diandrus*)
- Red brome (*Bromus rubens*)
- Scotch thistle (*Onopordum acanthium*)
- Bull thistle (*Cirsium vulgare*)
- White top (*Cardaria draba*)
- Knapweed (*Centaurea* spp.)
- Yellow starthistle (*Centaurea solstitialis*)
- Woolly mullein (*Verbascum thapsus*)
- Showy nightshade (*Solanum elaeagnifolium*)
- Russian thistle (*Salsola pestifer*)
- Tree-of-heaven (*Ailanthus altissima*)
- Johnson grass (*Sorghum halepense*)
- Yellow sweet clover (*Melilotus officinalis*)

Tamarisk (*Tamarix* spp.) and Russian olive (*Elaeagnus angustifolia*) are common species that have invaded riparian areas throughout the western U.S. Through intensive eradication efforts they have been controlled and largely eliminated from the Park—a rare success in controlling these plants which are so common in other areas along the Virgin River system. Eradication efforts have been helped by two factors: the headwaters of many streams are located within the Park, and in cases where they are outside the Park they are typically higher elevation than tamarisk is found. These factors mean that areas in the Park which have been cleared of tamarisk are not re-infested from upstream, making further control efforts much easier than they would be otherwise.¹³⁴

Cheatgrass (*Bromus tectorum*) and ripgut brome (*Bromus diandrus*) have invaded millions of acres throughout the western U.S. In Zion they cover about 8,000 acres and are noted as major threats to “native plant communities within floodplains and increasingly in the uplands.” Red brome (*Bromus rubens*) is “becoming a major concern at lower elevations because of its

¹³³ From National Park Service 2002, p. L-75, except where noted otherwise, and National Park Service 2004, p. 53-54. Note that these two sources are not in complete agreement with one another; the summary in this report is based on a combination of both.

¹³⁴ Kezia Nielson, Zion Environmental Protection Specialist, personal communication, August 10.

abundance and flammability.” These species generally germinate earlier than native grasses, providing them a competitive advantage over the natives.

The other invasive species are most commonly found around disturbed areas such as the developed campgrounds, roads, and trails. They are being controlled by the Park, which notes knapweed and yellow starthistle as “great potential threats.”¹³⁵ Several thistle species are found in higher elevation areas of the Park, especially where stock ponds created when the area was grazed prior to Park establishment still exist.¹³⁶

In addition to the plants listed above, trespass cattle from outside the Park and from within inholdings are an ongoing problem. Brown trout are found within the Virgin River, but appear to be at a population level that is not having a significant effect on native species.¹³⁷

5.2 Development near the Park

Zion is located relatively close to a major metropolitan area (Las Vegas) that offers easy air transportation from cities across the country, and it is within a long weekend drive of the huge population of southern California. This proximity, made even more accessible by Interstate 15, means that along with high levels of visitation, second home development in the region is an issue facing the Park.

Exacerbating this issue is the amount of private land bordering the Park—over 40% of the Park boundary adjoins private land.¹³⁸ Compared to some Parks in the eastern and midwestern U.S. this is low or average, but compared to many parks in the western U.S. this is a very high percentage. Bryce and Canyonlands National Parks, for example, have very low percentages of adjoining private land (e.g., only .6% of Canyonlands’ boundary adjoins private land).

The Park’s General Management Plan states development issues succinctly: “The park...is in a rapidly developing region...With the predicted population growth for Washington, Iron, and Kane Counties, lands adjacent to the park will be subject to increased development — a trend already apparent... As more people move into the area, residential and second-home development has been increasing on lands adjacent to the park. There most likely will be more development in the future, particularly near the south entrance, the Kolob Canyons entrance, and on land east of the park. Private developments and management practices may affect the scenic views from the park, night sky, ambient sound levels, solitude, soil erosion, composition of native plant and animal communities, and wildlife migration/ habitat corridors. Access may be restricted or closed off to parts of the park. Park managers must determine how to manage park resources in light of the development that is occurring, or may occur, adjacent to the park. If no actions are taken, park resources and the visitor experience will most likely degrade in parts of the park. Current access may be restricted or eliminated in some parts of the park.”¹³⁹

¹³⁵ National Park Service 2004, p. 54.

¹³⁶ Kezia Nielson, Zion Environmental Protection Specialist, personal communication, August 10.

¹³⁷ Based on discussion of Virgin spinedace in Fridell 2003.

¹³⁸ David Sinton, Zion National Park GIS Technician, personal communication, August 10.

¹³⁹ General Management Plan, p. 6 and p. 24.

Development in the region that does not immediately adjoin the Park also has impacts, particularly to dark night skies, soundscapes, air quality, and regional wildlife and wildlife management.¹⁴⁰

5.2.1 Road claims

Related to the development of private lands near the Park is the RS2477 road claims issue being actively pursued by the state of Utah and some counties and private groups. A recent memorandum of understanding (MOU) between the state and the U.S. Department of the Interior (DOI) resolved some issues and in it the state agreed not to pursue road claims in national parks (and some other land designations such as wilderness areas). However some counties are not satisfied with the Utah–DOI agreement and may continue to press roads claims. While most claims are being pursued outside national parks and no claims have been filed within the Park,¹⁴¹ one specific concern is with the Kolob Terrace road on the west side of the Park. This road bisects the Park and also runs along private land to the north and south of the Park. Only part of the road is plowed in winter, and it is at a high elevation that receives substantial snowfall, thus it is reasonable to believe that the lack of snowplowing and winter access may be limiting development. If the county was to push for an “improvement” that involved winter access, further development of private lands near the Park might be spurred.

5.2.2 Private Land Inholdings

The Park includes several inholdings that are potential development threats, mostly in the Kolob Terrace area where private land inholdings comprise 3,490 acres.¹⁴² The Park General Management Plan identifies three areas of particular concern primarily due to potential for development and road building:

- “the Kolob Terrace area south of Spendlove Knoll (1,500 acres)
- the Anasazi Plateau subdivision area east of the Rockville Bench (400 acres)
- parcels in the North Fork of the Virgin River near the northeast corner of the park (320 acres)”¹⁴³

5.3 Visitor use

Visitor use has been rising in Zion, both in terms of total visits and backcountry use. Visitation is about 2.5 million people per year;¹⁴⁴ and visitation levels doubled between 1982 and 1997.¹⁴⁵ Backcountry use has risen even more quickly, from 7,807 people camping in the backcountry in 1986 to 21,002 in 1999.¹⁴⁶ Both types of use are disproportionately focused on two overlapping activities and areas: hiking and canyoneering in riparian areas and canyons. In the North Fork in particular, swimming, wading, and hiking have led to concerns about water quality (including sedimentation, turbidity, and spread of human waste), soil erosion, and effects on sensitive species.¹⁴⁷ For example, one study of fish assemblages in the North Fork found that areas with

¹⁴⁰ Meeting with Resource Management Staff, August 3.

¹⁴¹ National Park Service 2003a and Kezia Nielson, Environmental Protection Specialist, personal communication August 10. The Briefing Statement details that the state has classified as “unimproved roads” numerous paths classified as “foot trails” by the Park.

¹⁴² General Management Plan, p. 3.

¹⁴³ National Park Service 2001, p. 53.

¹⁴⁴ <http://www.nps.gov/zion/pphtml/facts.html>

¹⁴⁵ General Management Plan, p. 1.

¹⁴⁶ General Management Plan, p. 21.

¹⁴⁷ National Park Service 2001, p. 25.

“high levels of wading and float tubing contained altered population distributions and altered community structure”¹⁴⁸ compared to areas without high levels of recreational use. The same study suggested that flash floods “reset” the system and restored areas impacted by recreation, but given ongoing high levels of visitation and recreational use it is not clear what the long-term impacts are. Canyoneering also can adversely affect park resources, especially disturbing sensitive species (e.g., peregrine falcons, spotted owls, and desert bighorn sheep), trampling vegetation, and forming social trails.¹⁴⁹ Taken together, these impacts cause degradation of the Park’s ecological functions.¹⁵⁰

Some of these impacts are made worse because visitation is compressed in time as well as place, with 11,000 visitors per day in the peak months of July and August;¹⁵¹ there are about four times as many visitors in the busiest months as in the winter months of December and January.¹⁵² There has also been a 400% increase in canyoneering permits in the last 3 years.¹⁵³

Visitor impacts to Zion Canyon may have been exacerbated by the very success of the shuttle system, which has eliminated the de facto limitation on access that existed because less than 500 parking spaces were located in the canyon. Availability of the shuttle bypasses this restriction, and while no one would eliminate the shuttle system for this reason, the increase in visitation does call for increased visitor management. The Park’s General Management Plan has several visitor management recommendations, some of which have been implemented at least in part:

- “Limit damage or loss of vegetation and associated species (including Zion snails) in hanging gardens through visitor education and the use of delineated trails, barriers, and signs.
- Employ erosion control measures or place barriers to control potential impacts on rare plants from trail erosion or social trailing.
- Employ a variety of techniques, including visitor education programs, restrictions on visitor activities, and ranger patrols, to reduce impacts on wildlife during sensitive times.
- Use designated river access/crossing points, barriers, and closures to prevent trampling and loss of riparian vegetation.
- Use interpretive displays and programs, ranger patrols, and regulations on use levels to minimize water pollution.”¹⁵⁴

5.4 Fire

The area that is now Zion historically had periodic fires that typically burned often enough to thin shrubs and trees and keep large amounts of dead vegetation from accumulating. Many fires were started naturally by lightning, and there is evidence that Native Americans burned grasslands in Utah as well.¹⁵⁵ This changed with the arrival of European settlers who grazed, logged, and farmed the area beginning about 150 years ago; these settlers also started the practice of fire suppression that continued after the Park was created and continued for much of the

¹⁴⁸ Sappington 1998, p iii.

¹⁴⁹ National Park Service 2001, p. 25.

¹⁵⁰ National Park Service 2002, p. L-75

¹⁵¹ <http://www.nps.gov/zion/ParkProfile.htm>

¹⁵² <http://www.nps.gov/zion/visitation%20statistics.htm>

¹⁵³ Meeting with Resource Management Staff, August 3.

¹⁵⁴ National Park Service 2001, p. 11.

¹⁵⁵ National Park Service 2004, p. 2.

1900s. These decades of fire suppression have created unnaturally high vegetation densities and fuel loadings in some areas. This has altered native vegetation communities, and the concentration of both live vegetation and dead fuels means that fires have the potential to burn hotter and over greater areas than they did historically.¹⁵⁶ In addition, the presence of some non-native species has altered fire regimes. This is an impact of both tamarisk and *Bromus* species, for example. *Bromus*, which covers about 8,000 acres in the Park, forms a more continuous cover than native bunch grasses, changing the way in which fire spreads. Tamarisk, which has largely been eradicated though continuing control efforts, “alters riparian communities which typically have moderate fire severity and intensity to a vegetation community type with a high or extreme fire severity and intensity.”¹⁵⁷

Zion is now completing a fire management plan that continues efforts to revert to a condition where fire plays a more natural role in the Park. While fires will still be monitored and some, particularly those close to buildings and other development, will be controlled, others will be allowed to burn under specific prescriptions. The plan calls for using fire to protect and enhance native vegetation communities and calls for vegetation succession that “reflects the natural range of variability under conditions that would occur under historical fire regimes.”¹⁵⁸ The plan also calls for preventing “unnatural catastrophic fires, resulting from high fuel loads and denser vegetation that may adversely affect wildlife habitat.”¹⁵⁹

5.5 Park soundscape and overflights

An issue that represents a long-range threat, and already a significant problem, is the degradation of the Park soundscape. Noise degrades visitors’ experiences and is a threat to wildlife as well.¹⁶⁰ Existing sources of noise in the Park are primarily from National Park Service activities and visitors (e.g. campground generators, facilities operations).¹⁶¹ These, however, are highly localized, and the Park soundscape has improved due to the implementation of the shuttle system that has greatly reduced auto and bus traffic in Zion Canyon. The Park has studied the soundscape in Zion as a preliminary step towards completion of a soundscape management plan.¹⁶²

The long-term threat to the Park soundscape is from commercial, military, and scenic overflights.¹⁶³ There are several reasons that overflights are of concern. One is that there are plans for expansions at numerous airports near the Park: St. George, Cedar City, and Hildale, Utah; and Mesquite and Las Vegas, Nevada.¹⁶⁴ The increased capacity that these expansions cumulatively represent is very large and could have a significant impact on Park noise levels because not only does it represent an increase in total capacity, but also an increase in the size of planes that would be able to access these airports. A second reason for concern about overflights is that the Park does not have an Air Tour Management Plan (ATMP) in place or in

¹⁵⁶ National Park Service 2004, p. 1.

¹⁵⁷ National Park Service 2004, p. 53-54.

¹⁵⁸ National Park Service 2004, p. 13.

¹⁵⁹ National Park Service 2004, p. 14.

¹⁶⁰ National Park Service 1994, p. 1.5.

¹⁶¹ National Park Service 2004a, p. 26.

¹⁶² Hobbs 2003.

¹⁶³ Meeting with Resource Management Staff, August 3.

¹⁶⁴ National Park Service 2003b.

development—thus planning for this issue is not yet fully underway.¹⁶⁵ In addition, while the Air Tour Management Act capped scenic flights at the existing level until a new plan is in place, the information about number of scenic flights is based on self-reporting by flight operators and may reflect desired numbers of flights instead of actual numbers.

6. Conclusion and recommendations

Zion National Park protects spectacular canyons, one of the last free-flowing river systems on the Colorado Plateau, and, due to its location at the intersection of several vegetation communities and its elevation gradient, a large diversity of flora and fauna. The Park has also had a number of notable management successes, chief among them the water rights settlement that protects the flow of the Virgin River, and the innovative shuttle system that transports increased numbers of visitors into Zion Canyon, creating an improved visitor experience while minimizing impacts of cars in the canyon. Both of these successes are models for other parks around the country.

Zion also faces challenges. It is located in a fast-growing region close to the exploding population of Las Vegas, and only a bit farther away the megalopolis of southern California. The easy interstate highway access to the Park from these regions means that tens of millions of people have access to enjoy the Park during a long weekend. This, coupled with the relatively high proportion of private land bordering the Park, means that the Park and region are threatened of being “loved to death.” The development and high levels of visitor use threaten to degrade the Park and the Park’s surroundings, and make some management (e.g., fire management, soundscape protection, vistas and visual quality) difficult.

Increasing development and visitor use, along with other threats such as air quality degradation, make a strong research, inventory, and monitoring program essential for the Park so that it can better document, understand, anticipate and react to developing threats, and mitigate impacts.

With these challenges in mind, recommendations that fall under the umbrella of research, inventory and monitoring are:

- At a general level, continue the Northern Colorado Plateau Plan for Natural Resources Monitoring and maintain a long-term commitment to inventory, monitoring and research.
- Implement water quality monitoring as recommended within the Northern Colorado Plateau Vital Signs report.¹⁶⁶ This is especially important because it allows for monitoring visitor use impacts, and creates a baseline of information that will be critical if coal bed methane leases outside the Park, but in the watershed, are developed. In addition, monitoring of aquatic invertebrates as an indicator of habitat quality is essential (and was recognized as such in the Northern Colorado Plateau Vital Signs report).¹⁶⁷

¹⁶⁵ <http://www.atmp.faa.gov/zion.htm>

¹⁶⁶ National Park Service 2003, p. 103.

¹⁶⁷ National Park Service 2003, p. 75

- Implement and/or continue research efforts with regards to Mexican spotted owls, desert tortoises, and Virgin spinedace; and implement monitoring for amphibians and reptiles.
- Conduct inventories for rare plants to better understand their abundance and distribution.

Additional recommendations are related to management activities by the Park. These are no less important than research-related recommendations:

- Restore the Virgin River channel to undo the damage done to the river by previous flood control efforts. This effort should be combined with an inventory of aquatic vegetation in the Park and monitoring to determine any hydrologic changes over time.¹⁶⁸
- Continue to manage increased visitation with a view towards protecting the resource as a first priority, especially regarding water quality in the heavily used Zion Canyon/North Fork of the Virgin River.

Finally, the Park is heavily impacted by activities outside its boundaries. Thus, other recommendations for protecting the Park fall to agencies and organizations other than the National Park Service, although the Park should monitor these issues. These are:

- Determine cumulative air quality impacts from power plants and other sources when permitting any new sources.
- Continue to monitor road claims that may impact the Park, and publicize impacts of roads on parks and other resource sensitive areas.
- Monitor coal bed methane leases on BLM and private land outside the Park but within the watershed that could degrade water quality.

Zion National Park combines a stunning combination of geologic and biotic resources and scenic beauty. Some of its resources are largely intact (e.g. the upper portion of the Virgin River and its tributaries); others would benefit from an increase or change in management that is planned (e.g. fire management). Previous successes such as implementation of the shuttle system, the water rights settlement, and controlling of riparian invasive species suggest that the Park will be able to manage for visitation, development, and other pressures it faces if given the resources to do so.

¹⁶⁸ This recommendation is similar to one made in the Resource Management Plan (National Park Service 1999, p. 74).

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Appendix A: Threatened, endangered, and extirpated species of Zion

EXTIRPATED

Gray Wolf - *Canis lupus*

Grizzly Bear - *Ursus arctos*

Desert Bighorn - *Ovis canadensis nelsoni*: Extirpated but reintroduced into the Park.

THREATENED OR ENDANGERED ANIMALS

Mexican spotted owl - *Strix occidentalis lucida*

Southwest willow flycatcher - *Empidonax traillii extimus*

Desert tortoise - *Gopherus agassizii*

THREATENED OR ENDANGERED PLANTS

Shivwits milkvetch (*Astragalus erectimus* var. *ampullarioides*)

SPECIES OF SPECIAL CONCERN

Zion snail - *Physa zionis*, endemic

Virgin spinedace - *Lepidomeda mollispinis mollispinus*

Peregrine falcon - *Falco peregrinus*

Northern leopard frog - *Rana pipiens*

Species formerly on the U.S. Fish and Wildlife Service Category 2 species list

Nevada willowherb - *Epilobium nevadense*

Canaan daisy - *Erigeron canaanii*

Zion daisy - *Erigeron sionis*

Jones golden-aster - *Heterotheca jonesii*

Cliff jamesia - *Jamesia Americana* var. *zionis*

Utah spikemoss - *Selaginella utahensis*

Zion tansy - *Sphaeromeria ruthiae*

Paria scurf-pea - *Pediomelum pariensis*

Sand-loving beardtongue - *Penstemon ammophilum*

Cedar Breaks goldenbush - *Haplopappus zionis*¹⁶⁹

¹⁶⁹ From National Park Service 1999, p. 76, from a 1992 listing of Category 2 species.

Appendix B: Mammals of Zion¹⁷⁰

Shrews (Insectivora)

- Merriam's Shrew - *Sorex merriami*: Unknown, may occur in arid areas.
Montane Shrew - *Sorex monticolus*: Uncommon, higher elevations.
Water Shrew - *Sorex palustris*: Uncommon, along streams in canyons.
Desert Shrew - *Notiosorex crawfordi*: Uncommon, lower regions of Zion Canyon.

Bats (Chiroptera)

- California Myotis - *Myotis californicus*: Fairly common, lower elevations.
Western Small-footed Myotis - *Myotis ciliolabrum*: Fairly common, higher elevations.
Long-eared Myotis - *Myotis evotis*: Uncommon, parkwide.
Little Brown Myotis - *Myotis lucifugus*: Unknown, coniferous forests.
Fringed Myotis - *Myotis thysanodes*: Uncommon, parkwide.
Long-legged Myotis - *Myotis volans*: Fairly common, parkwide.
Yuma Myotis - *Myotis yumanensis*: Fairly common, parkwide, near water.
Western Red Bat - *Lasiurus blossevillei*: Uncommon, migrant, wooded areas.
Hoary Bat - *Lasiurus cinereus*: Uncommon, migrant, wooded areas.
Silver-haired Bat - *Lasionycteris noctivagans*: Fairly common, higher elevations.
Western Pipistrelle - *Pipistrellus hesperus*: Common, lower elevations.
Big Brown Bat - *Eptesicus fuscus*: Fairly common, lower elevations.
Spotted Bat - *Euderma maculatum*: Uncommon, parkwide.
Townsend's Big-eared Bat - *Plecotus townsendii*: Uncommon, in canyons.
Allen's Big-eared Bat - *Idionycteris phyllotis*: Unknown, likely to occur in forested areas.
Pallid Bat - *Antrozous pallidus*: Fairly common, in canyons, lower elevations.
Brazilian Free-tailed Bat - *Tadarida brasiliensis*: Fairly common, canyons-low desert.
Big Free-tailed Bat - *Nyctinomops macrotis*: Uncommon, canyons.

Pike, rabbits, hares (Lagomorpha)

- American Pika - *Ochotona princeps*: Rare, high elevation talus.
Desert Cottontail - *Sylvilagus audubonii*: Common, below 5,000 ft elevation.
Mountain Cottontail - *Sylvilagus nuttallii*: Uncommon, above 5,000 ft elevation.
Black-tailed Jackrabbit - *Lepus californicus*: Fairly common, parkwide.

Rodents (Rodentia)

- Cliff Chipmunk - *Tamias dorsalis*: Fairly common, middle elevations, near cliffs.
Least Chipmunk - *Tamias minimus*: Fairly common, on plateau in shrubby areas.
Uinta Chipmunk - *Tamias umbrinus*: Fairly common, on plateau in pine-fir zone.
Yellow-bellied Marmot - *Marmota flaviventris*: Uncommon, middle and upper elevations.
White-tailed Antelope Squirrel - *Ammospermophilus leucurus*: Common, lower elevations.
Golden-mantled Ground Squirrel - *Spermophilus lateralis*: Uncommon, higher elevations.
Rock Squirrel - *Spermophilus variegatus*: Common, rocky areas, parkwide.
Red Squirrel - *Tamiasciurus hudsonicus*: Fairly common, on plateau in pine-fir zone.
Northern Flying Squirrel - *Glaucomys sabrinus*: Uncommon, higher elevations.

¹⁷⁰ <http://www.nps.gov/zion/MammalList.htm>

Botta's Pocket Gopher - *Thomomys bottae*: Fairly common, canyons and lower elevations.
 Northern Pocket Gopher - *Thomomys talpoides*: Fairly common, upper elevations.
 Great Basin Pocket Mouse - *Perognathus parvus*: Uncommon, middle and upper elevations.
 Little Pocket Mouse - *Perognathus longimembris*: Uncommon, mid-high elevations.
 Long-tailed Pocket Mouse - *Chaetodipus formosus*: Uncommon, lower elevations.
 Merriam's Kangaroo Rat - *Dipodomys merriami*: Fairly common, sandy areas, lower elevations.
 Chisel-toothed Kangaroo Rat - *Dipodomys microps*: Unknown, sandy areas, lower elevations.
 Ord's Kangaroo Rat - *Dipodomys ordii*: Uncommon, sandy areas, middle elevations.
 American Beaver - *Castor canadensis*: Fairly common, along water courses.
 Western Harvest Mouse - *Reithrodontomys megalotis*: Common, parkwide.
 Brush Mouse - *Peromyscus boylii*: Fairly common, low and middle elevations.
 Canyon Mouse - *Peromyscus crinitus*: Fairly common, low and middle elevations.
 Cactus Mouse - *Peromyscus eremicus*: Uncommon, low and middle elevations.
 Deer Mouse - *Peromyscus maniculatus*: Fairly common, parkwide.
 Piñon Mouse - *Peromyscus truei*: Fairly common, piñon-juniper zone.
 Northern Grasshopper Mouse - *Onychomys leucogaster*: Uncommon, middle elevations.
 Southern Grasshopper Mouse - *Onychomys torridus*: Uncommon, lower elevations.
 Bushy-tailed Woodrat - *Neotoma cinerea*: Uncommon, rocky areas.
 Desert Woodrat - *Neotoma lepida*: Fairly common, low and middle elevations.
 House Mouse - *Mus musculus*: Uncommon, buildings. Non-native.
 Long-tailed Vole - *Microtus longicaudus*: Fairly common, grassy areas, upper elevations.
 Montane Vole - *Microtus montanus*: Fairly common, grassy areas, upper elevations.
 Common Muskrat - *Ondatra zibethicus*: Uncommon, along water courses in Zion Canyon.
 Common Porcupine - *Erethizon dorsatum*: Fairly common, parkwide.

Carnivores (Carnivora)

Coyote - *Canis latrans*: Fairly common, parkwide.
 Kit Fox - *Vulpes velox*: Rare, lower elevations.
 Red Fox - *Vulpes vulpes*: Rare, parkwide.
 Common Gray Fox - *Urocyon cinereo-argenteus*: Fairly common, low and middle elevations.
 Black Bear - *Ursus americanus*: Rare migrant, high country.
 Ringtail - *Bassariscus astutus*: Common, parkwide.
 Ermine - *Mustela erminea*: Uncommon, high elevations.
 Raccoon - *Procyon lotor*: Uncommon, lower elevations.
 Long-tailed Weasel - *Mustela frenata*: Uncommon, parkwide.
 American Badger - *Taxidea taxus*: rare, parkwide.
 Western Spotted Skunk - *Spilogale gracilis*: Uncommon, rocky areas, lower elevations.
 Striped Skunk - *Mephitis mephitis*: Common, parkwide.
 Mountain Lion - *Felis concolor*: Fairly common, parkwide.
 Bobcat - *Lynx rufus*: Uncommon, parkwide.

Even-toed ungulates (Artiodactyla)

Elk - *Cervus elaphus*: Uncommon, higher elevations.
 Mule Deer - *Odocoileus hemionus*: Common, parkwide.
 Desert Bighorn - *Ovis canadensis nelsoni*: Extirpated, reintroduced, uncommon, east side on steep rocky areas.

Appendix C: Reptiles and Amphibians of Zion¹⁷¹

Amphibians

Great Basin Spadefoot-*Scaphiopus intermontanus*

Red-spotted Toad-*Bufo punctatus*

Arizona Toad-*Bufo microscaphus microscaphus*

Canyon Treefrog-*Hyla arenicolor*

Northern Leopard Frog-*Rana pipiens*

Tiger Salamandar-*Ambystoma tigrinum*:

Reptiles

Utah Banded Gecko-*Coleonyx variegatus utahensis*

Collared Lizard-*Crotaphytus bicinctores*:

Leopard Lizard-*Gambelia wislizenii*

Western Chuckwalla-*Sauromalus obesus obesus*

Yellowback Spiny Lizard-*Sceloporus magister uniformis*

Northern Plateau Lizard-*Sceloporus undulatus elongatus*

Northern Sagebrush Lizard-*Sceloporus graciosus graciosus*

Side-blotched Lizard-*Uta stansburiana*

Northern Tree Lizard-*Urosaurus ornatus wrighti*

Short-horned Lizard-*Phrynosoma douglassii*

Northern Desert Horned Lizard-*Phrynosoma platyrhinos platyrhinos*

Western Whiptail-*Cnemidophorus tigris*

Plateau Striped Whiptail-*Cnemidophorus velox*

Great Basin Skink-*Eumeces skiltonianus utahensis*

Wandering Gartersnake-*Thamnophis elegans vagrans*

Regal Ringneck Snake-*Diadophis punctatus regalis*

Red Coachwhip-*Masticophis flagellum piceus*

Desert Striped Whipsnake-*Masticophis taeniatus taeniatus*

Mojave Patch-nosed Snake-*Salvadora hexalepis mojaviensis*

Great Basin Gopher Snake-*Pituophis melanoleucus deserticola*

California Kingsnake-*Lampropeltis getula californiae*

Sonoran Mountain Kingsnake-*Lampropeltis pyromelana*

Ground Snake-*Sonora semiannulata*

Desert Night Snake-*Hypsiglena torquata deserticola*

Sonora Lyre Snake-*Trimorphodon biscutatus lambda*

Great Basin Rattlesnake-*Crotalus viridis lutosus*

Species occurring within 50 miles of the Park that may be in the Park as well

Woodhouse Toad-*Bufo woodhousii woodhousii*

Bullfrog-*Rana catesbeiana*

Texan Spiny Softshell-*Apalone spinifera emoryi*

Desert Tortoise-*Gopherus agassizii*

¹⁷¹ <http://www.nps.gov/zion/ReptAmphList.htm>

Banded Gila Monster-*Heloderma suspectum cinctum*
Zebra-Tailed Lizard-*Callisaurus draconoides*
Desert Night Lizard-*Xantusia vigilis vigilis*
Utah Blind Snake-*Leptotyphlops humilis utahensis*
Desert Glossy Snake-*Arizona elegans eburnata*
Western Longnose Snake-*Rhinocheilus l. lecontei*
Southwestern Blackheaded Snake-*Tantilla hobartsmithi*
Mojave Desert Sidewinder-*Crotalus c. cerastes*

Appendix D: Common Plants of Zion

Trees

Birch Family

Black/Water birch

Elm Family

Hackberry

Juniper Family

Arizona cypress

Utah juniper

Rocky Mountain juniper

Maple Family

Bigtooth maple

Boxelder

Oak or Beech Family

Gambel oak

Shrub live oak

Wavyleaf oak

Olive Family

Singleleaf ash

Desert/Velvet ash

•Paradise Tree Family

Tree of heaven

Pea Family

New Mexico locust

Black locust

Pine Family

White fir

Piñon

Single-leaf piñon

Ponderosa pine

Douglas fir

Rose Family

Apple tree
Pear tree

Tamarix Family

Tamarisk

Willow Family

Fremont cottonwood
Quaking aspen
Willow (11)

Shrubs**Agave Family**

Datil yucca
Utah yucca

Barberry Family

Creeping mahonia
or Oregon grape

Buckwheat Family

Golden eriogonum

Cashew/Sumac Family

Squawbush
Poison ivy

Composite Family

Old man sagebrush
Big sagebrush
Waterwillow (2)
Rabbitbrush (5)
Broom/Snake weed
Bush encelia

Dogwood Family

Red-osier dogwood

Goosefoot Family

Four-wing saltbush

Grape Family

Canyon grape

Heath Family

Manzanita (2)

Honeysuckle Family

Elderberry (2)

Snowberry (3)

Joint-Fir Family

Mormon tea (3)

Mint Family

Desert sage

Mustard Family

Prince's Plume

Oleaster Family

Russian olive

Roundleaf buffaloberry

Herbs**Bellflower Family**

Cardinal flower

Borage Family

Yellow forget-me-not

Golden cryptanth (10 other)

Puccoon (3)

Buckwheat Family

Slickrock sulfurflower

Zion desert trumpet

White-flowered

Thompson eriogonum

Wild rhubarb

Buttercup Family

Golden columbine

Western columbine

Larkspur (3)
Sand buttercup (6 other)

Cactus Family

Purple torch
Hedgehog cactus
Claret cup (2)
Utah beavertail
Cholla (2)
Engelmann prickly pear
Cliff prickly pear
Prickly pear (5)

Caper Family

Yellow beeplant

Cattail Family

Cattail (2)

Composite Family

Western yarrow
Pussy toes (4)
Tansy aster (2)
Glaucous aster
Siskiyou aster (3 other)
Desert marigold (2)
Arrowleaf balsamroot
Arizona thistle
New Mexico thistle
Utah thistle (5 other)
Utah daisy
Zion daisy (12 other)
Sunflower (6)
Goldenaster (3)
Broom senecio (6 other)
Goldenrod (6)
Wirelettuce (3)
Goatsbeard (2)

Duckweed Family

Duckweed

Evening-Primose Family

Yellow day primrose
White tufted evening primrose

Pale evening-primrose
Hummingbird trumpet

Figwort Family

Early paintbrush
Giant red paintbrush
Wyoming paintbrush
Slickrock paintbrush
Scarlet monkeyflower (6 other)
Eaton penstemon
Low penstemon
Jones penstemon
Royal penstemon
Palmer penstemon
Utah penstemon (10 other)
Flannel mullein

Flax Family

Lewis/Blue flax (2 other)

Four O'clock Family

Fragrant sand verbena
Colorado four o'clock

Gentian Family

Elkweed
Whitemargin gentian

Geranium Family

Filaree
Wild geranium

Goosefoot Family

Russian thistle

Gourd Family

Wild or Coyote gourd

Lily Family

Tapertip onion
Patis onion
Benstem mariposa
Sego lily
Bluedicks

Death camas (2)
False solomon-seal (2)

Madder Family

Bedstraw (7)
Madder

Mallow Family

Globemallow (4)

Milkweed Family

Butterfly milkweed (4 other)

Mistletoe Family

Juniper mistletoe

Mustard Family

Rockcress (4)
Chorispora
Zion draba (4 other)
Western wallflower
Watercress
Twinpod (3)

Orchid Family

Giant helleborine

Orpine Family

Stonecrop (2)

Pea Family

Stinking milkvetch
Zion milkvetch (21 other)
Zion sweetpea (2 other)
Deerclover (6)
Lupine (8)
Thompson peteria
Sweet-clover (2)
Utah clover (3 other)
Vetch (2)

Phlox Family

Skyrocket or Scarlet gilia
Arizona skyrocket

Nuttall gilia
Desert/Mountain phlox
Zion Canyon phlox

Pink Family

Sandwort (4)
Common chickweed

Pondweed Family

Leafy pondweed

Potato Family

Sacred datura
Groundcherry (2)
Nightshade (4)

Primose Family

Zion shooting star

Purslane Family

Spring beauty
Bitterroot (2)
Miners lettuce

Rose Family

Rockmat/Rockspiraea

Saxifrage Family

Alumroot
Woodland star (2)

Spiderwort Family

Spiderwort

Spurge Family

Whitemargin spurge

Violet Family

Wanderer violet (2 other)

Waterleaf Family

Phacelia (11)
Scorpion weed

Grass-like plants

Grass Family

Big bluestem
Purple/ Red three-awn
Side-oats grama (4 other)
Cheatgrass
Jones reedgrass
Fescue (5)
Needle and thread grass
Indian ricegrass

Rush Family

Rush (8)

Sedge Family

Sedge (12)
Bulrush (6)

Ferns and allies

Fern Family

Maidenhair fern (2)

Scouring Rush Family

Meadow horsetail
Scouring rush (3)

Appendix E: Birds of Zion ¹⁷²

Loons and grebes

Common Loon
Pied-billed Grebe
Horned Grebe
Eared Grebe
Western Grebe
Clark's Grebe

Pelicans and cormorants

American White Pelican
Double-crested Cormorant

Hérons, ibises, and storks

American Bittern
Great Blue Heron
Great Egret
Snowy Egret
Cattle Egret
Green Heron
Black-crowned Night Heron
White-faced Ibis
Wood Stork

Vultures

Turkey Vulture
California Condor

Swans, geese, and ducks

Tundra Swan
Snow Goose
Canada Goose
Wood Duck
Green-winged
Mallard
Northern Pintail
Blue-winged Teal
Cinnamon Teal
Northern Shoveler
Gadwall

¹⁷² From <http://www.nps.gov/zion/BirdList.htm>

American Wigeon
Canvasback
Redhead
Ring-necked Duck
Lesser Scaup
Oldsquaw
Surf Scoter
White-winged Scoter
Common Goldeneye
Bufflehead
Hooded Merganser
Common Merganser
Red-breasted Merganser
Ruddy Duck

Osprey, eagles, hawks, and falcons

Osprey
Bald Eagle
Northern Harrier
Sharp-shinned Hawk
Cooper's Hawk
Northern Goshawk
Common Black-Hawk
Red-shouldered Hawk
Broad-winged Hawk
Swainson's Hawk
Zone-tailed Hawk
Red-tailed Hawk
Ferruginous Hawk
Rough-legged Hawk
Golden Eagle
American Kestrel
Merlin
Peregrine Falcon
Prairie Falcon

Pheasants, grouse, turkey, and quail

Ring-necked Pheasant
Blue Grouse
Wild Turkey
Gambel's Quail

Rails and cranes

Virginia Rail

Sora

American Coot

Sandhill Crane

Shorebirds

Black-bellied Plover

Snowy Plover

Semipalmated Plover

Killdeer

Mountain Plover

Black-necked Stilt

American Avocet

Greater Yellowlegs

Lesser Yellowlegs

Solitary Sandpiper

Willet

Wandering Tattler

Spotted Sandpiper

Long-billed Curlew

Marbled Godwit

Sanderling

Western Sandpiper

Least Sandpiper

Baird's Sandpiper

Pectoral Sandpiper

Long-billed Dowitcher

Common Snipe

Wilson's Phalarope

Red-necked Phalarope

Red Phalarope

Gulls and terns

Franklin's Gull

Bonaparte's Gull

Ring-billed Gull

California Gull

Herring Gull

Caspian Tern

Forster's Tern

Black Tern

Pigeons and doves

Rock Dove
Band-tailed Pigeon
White-winged Dove
Mourning Dove
Inca Dove

Cuckoos and roadrunners

Yellow-billed Cuckoo
Greater Roadrunner

Owls

Barn Owl
Flammulated Owl
Western Screech-Owl
Great Horned Owl
Northern Pygmy-Owl
Spotted Owl
Long-eared Owl
Short-eared Owl
Northern Saw-whet Owl

Goatsuckers

Lesser Nighthawk
Common Nighthawk
Common Poorwill
Whip-poor-will

Swifts

Black Swift
Vaux's Swift
White-throated Swift

Hummingbirds

Broad-billed Hummingbird
Blue-throated Hummingbird
Magnificent Hummingbird
Black-chinned Hummingbird
Costa's Hummingbird
Anna's Hummingbird
Calliope Hummingbird
Broad-tailed Hummingbird
Rufous Hummingbird

Kingfishers

Belted Kingfisher

Woodpeckers

Lewis' Woodpecker

Acorn Woodpecker

Red-naped Sapsucker

Williamson's Sapsucker

Ladder-backed Woodpecker

Downy Woodpecker

Hairy Woodpecker

Three-toed Woodpecker

Northern Flicker

Flycatchers

Olive-sided Flycatcher

Western Wood-Pewee

Willow Flycatcher

Hammond's Flycatcher

Dusky Flycatcher

Gray Flycatcher

Cordilleran Flycatcher

Black Phoebe

Eastern Phoebe

Say's Phoebe

Vermilion Flycatcher

Ash-throated Flycatcher

Cassin's Kingbird

Western Kingbird

Eastern Kingbird

Shrikes

Northern Shrike

Loggerhead Shrike

Vireos

Bell's Vireo

Gray Vireo

Plumbeous Vireo

Warbling Vireo

Jays and crows

Gray Jay
Steller's Jay
Western Scrub-Jay
Pinyon Jay
Clark's Nutcracker
Black-billed Magpie
American Crow
Common Raven

Larks

Horned Lark

Swallows

Tree Swallow
Violet-green Swallow
N. Rough-winged Swallow
Bank Swallow
Cliff Swallow
Barn Swallow

Chickadees, titmice, and bushtits

Black-capped Chickadee
Mountain Chickadee
Juniper Titmouse
Verdin
Bushtit

Nuthatches and creepers

Red-breasted Nuthatch
White-breasted Nuthatch
Pygmy Nuthatch
Brown Creeper

Wrens and dippers

Rock Wren
Canyon Wren
Bewick's Wren
House Wren
Winter Wren
Marsh Wren
American Dipper

Kinglets and gnatcatchers

Golden-crowned Kinglet
Ruby-crowned Kinglet
Blue-gray Gnatcatcher

Thrushes

Western Bluebird
Mountain Bluebird
Townsend's Solitaire
Swainson's Thrush
Hermit Thrush
American Robin
Varied Thrush

Mockingbirds and thrashers

Gray Catbird
Northern Mockingbird
Sage Thrasher
Brown Thrasher
Crissal Thrasher

Starlings

European Starling

Pipits, waxwings, and phainopepla

American Pipit
Bohemian Waxwing
Cedar Waxwing
Phainopepla

Warblers

Orange-crowned Warbler
Nashville Warbler
Virginia's Warbler
Lucy's Warbler
Yellow Warbler
Yellow-rumped Warbler
Black-throated Gray Warbler
Townsend's Warbler
Hermit Warbler
Grace's Warbler

Black-and-white Warbler
American Redstart
Ovenbird
Northern Waterthrush
MacGillivray's Warbler
Common Yellowthroat
Hooded Warbler
Wilson's Warbler
Painted Redstart
Yellow-breasted Chat

Tanagers

Summer Tanager
Western Tanager

Towhees, sparrows, and juncos

Green-tailed Towhee
Spotted Towhee
Abert's Towhee
Rufous-crowned Sparrow
American Tree Sparrow
Chipping Sparrow
Brewer's Sparrow
Black-chinned Sparrow
Vesper Sparrow
Lark Sparrow
Black-throated Sparrow
Sage Sparrow
Savannah Sparrow
Fox Sparrow
Song Sparrow
Lincoln's Sparrow
Swamp Sparrow
White-throated Sparrow
Harris' Sparrow
Golden-crowned Sparrow
White-crowned Sparrow
Dark-eyed Junco
Chestnut-collared Longspur
Snow Bunting

Grosbeaks and buntings

Rose-breasted Grosbeak
Black-headed Grosbeak

Blue Grosbeak
Lazuli Bunting
Indigo Bunting

Blackbirds, meadowlarks, and orioles

Red-winged Blackbird
Western Meadowlark
Yellow-headed Blackbird
Rusty Blackbird
Brewer's Blackbird
Great-tailed Grackle
Brown-headed Cowbird
Hooded Oriole
Bullock's Oriole
Scott's Oriole

Finches

Gray-crowned Rosy-Finch
Pine Grosbeak
Cassin's Finch
House Finch
Red Crossbill
Pine Siskin
Lesser Goldfinch
American Goldfinch
Evening Grosbeak

Weaver finches

House Sparrow

Appendix F: Herptofauna of Zion¹⁷³

Amphibians

Tiger salamander (*Ambystoma tigrinum*)
Arizona toad (*Bufo microscaphus*)
Canyon treefrog (*Hyla arenicolor*)
Red-spotted toad (*Bufo punctatus*)
Great Basin spadefoot (*Spea intermontana*)

Tortoises

Desert tortoise (*Gopherus agassizii*)

Lizards

Great basin collared lizard (*Crotaphytus bicinctores*)
Longnose leopard lizard (*Gambelia wislizenii*)
Chuckwalla (*Sauromalus obesus*)
Mountain short horned lizard (*Phrynosoma hernandesi*)
Sagebrush lizard (*Sceloporus graciosus*)
Desert spiny lizard (*Sceloporus magister*)
Eastern fence lizard (*Sceloporus undulates*)
Tree lizard (*Urosaurus ornatus*)
Side-blotched lizard (*Uta stansburiana*)
Western skink (*Eumeces skiltonianus*)
Western whiptail (*Cnemidophorus tigris*)
Plateau striped whiptail (*Cnemidophorus velox*)

Snakes

Coachwhip (*Masticophis flagellum*)
Striped whipsnake (*Masticophis taeniatus*)
Gopher snake (*Pituophis catenifer*)
Mojave patch-nosed snake (*Salvadora hexalepis*)
Ground snake (*Sonora semiannulata*)
Common kingsnake (*Lampropeltis getula*)
Sonoran mountain kingsnake (*Lampropeltis pyromelana*)
Ringneck snake (*Diadophis punctatus*)
Wandering garter snake (*Thamnophis elegans vagrans*)
Great Basin rattlesnake (*Crotalus viridis lutosus*)

Additional species thought to possibly exist, but unconfirmed

Northern leopard frog (*Rana pipiens*)
Night snake (*Hypsiglena torquata*)
Lyre snake (*Trimorphodon biscutatus*)
Banded gecko (*Coleonyx variegatus*)
Gila monster (*Heloderma suspectum*)

¹⁷³ Platenberg 2003.

Desert horned lizard (*Phrynosoma platyrhinos*)