STATE OF THE PARKS REPORT

ON THE

NATURAL RESOURCES

OF

BRYCE CANYON NATIONAL PARK

January, 2005

National Parks Conservation Association
State of the Parks Program
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1. Introduction

"Now I know what awesome means," said a first time visitor to one of the many viewpoints in Bryce Canyon that overlooks the Park's spectacular rock formations.[1] The region's unusual scenic beauty, among other attributes, prompted creation of the National Monument in 1923; the Park's hoodoos, spires and other erosional features, carved out of the edge of the Paunsaugunt Plateau, create a series of striking vistas against the backdrop of Utah's Grand Staircase. "The interaction of light, color, and shadows on these formations create a breathtaking landscape that challenges the limits of the imagination."[2]

The Park comprises part of the top and the eastern rim of the Paunsaugunt Plateau, an upthrust fault block forming the highest step of the Grand Staircase north of the Colorado River. The fault exposes the Pink Cliffs, a series of stunning formations of Cretaceous age limestone, sandstone, and shale that range in color from white to pink to deep orange. The name Bryce "Canyon" is a misnomer, for instead of true canyons, the Park is comprised of a series of fourteen amphitheaters along the rim

Because Bryce was created specifically to protect these geological formations and not a larger landscape, it is a relatively small Park of 35,835 acres.[3] It is also uniquely shaped, being generally long and narrow, extending roughly 24 miles from northeast to southwest, but only between about 1 and 7 miles wide. With a road running almost its entire length, the result is a primarily front country Park that allows visitors easy and close access to the incredible rock formations. Visitation is lower than other parks in the region but high for a small park: 1,414,237 in fiscal year 2003, up from just over a million visitors in fy 2001.[4] Visitation is heavily concentrated along the road and in the 252-acre developed area that includes the campground and visitor center, which lies near the park's main amphitheater.[5]

Bryce Canyon is almost completely surrounded by public land managed by the Forest Service (FS) and Bureau of Land Management (BLM), and therefore does not face significant development pressures from adjacent private lands. The Park maintains a generally good and collaborative working relationship with the other public lands agencies. However, recent changes in FS and BLM administrative priorities towards developing oil and gas resources and lessening protection of roadless areas may have the potential to impact Bryce and its visitors. Bryce also faces threats of diminished air quality, overflights, and light pollution that threaten the Park's vistas, quiet, and dark night skies.

This report serves to document the status of Park natural resources, identify chief threats and degradations, and make recommendations regarding future Park management. When made available to lawmakers and private citizens, this information will direct efforts to prioritize and correct problems within the Park.

[1] This is one of many accounts from Park staff of first time visitors' reactions to seeing the rock formations.
[2] Bryce Canyon National Park Staff 1996, p. 4.
[3] http://www.nps.gov/brca/pphtml/facts.html
[4] www.nps.gov/stats
[5] Bryce Canyon National Park Staff 2000, p. 10.

2. Bryce geographic context and physical description

Bryce Canyon National Park lies at the intersection of two vegetative zones: the Colorado Plateau to the north and east, and the basin and range to the west. A visitor standing on the eastern rim of the Park, looking across the hoodoos and into Utah's Grand Staircase, is looking into the Colorado River watershed with the Great Basin at her back; the plateau that forms the Park divides these huge watersheds. To the south and east is the Paria River, draining eventually into the Colorado River and Pacific Ocean. To the west of the plateau, water drains into the Sevier River, which runs into the Great Basin and dries there.

The Colorado Plateau[6] is a vast area of 326,000 sq km,[7] 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 spectacular 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; these include pinyon-juniper woodland (*Pinus edulis* and *Juniperus* spp.) and big sagebrush (*Artemisia tridentata*) communities.

The conservation status of the Plateau is rated "relatively stable/intact" by the World Wildlife Fund, which states "approximately 15 percent of the Colorado Plateau 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."[8] One reason for the Plateau's relatively intact status is the presence of numerous large protected areas totaling about 8.3% of the land area on the Plateau;[9] in addition to Bryce these include Grand Canyon, Capital Reef, Canyonlands, Zion, and Arches National Parks, Grand Staircase/Escalante, Natural Bridge, Rainbow Bridge, and Cedar Breaks National Monuments, Glen Canyon National Recreation Area, and numerous smaller BLM wilderness study areas.[10]

The Basin and Range Province[11] covers 336,000 sq km to the north and west of the Park, stretching west to the Sierra Mountains 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, being further north and having higher elevations than other deserts, it hosts a cold-temperate vegetative community. Dominant species include sagebrushes (*Artemisia sp.*), saltbrushes (*Atriplex sp.*), and rabbitbrushes (*Chrysothamnus sp.*).

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[6] Except where otherwise noted description is from Rickets et. al. 1999, p. 332-335.
[7] 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.
[8] Ricketts, et. al. 1999, p. 333.
[9] Nabhan, et. al., 2002, p. 7.
[10] 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 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.
[11] Description from Ricketts, et. al., p. 328-330. Note that Ricketts calls this region the Great Basin Shrub Steppe.

Although the World Wildlife Fund rates the Basin and Range region 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 cause of habitat degradation is the establishment of exotic species, including cheatgrass brome (*Bromus tectorum*) and Russian thistle (*Salsola paulensii*); other threats stem from urban/suburban development.

2.1 Park geology and representative topographic features

Bryce Canyon National Park was created to recognize and preserve its geologic features. The Park's hoodoos, striking rock formations in the amphitheatres along the eastern rim, are its centerpiece and main attraction. The hoodoos and other geologic features are the result of differential erosion of colorful sedimentary rock: fine grained limestone, calcareous mudstone, and fine-grained sandstone, in colors ranging from red to orange to white. The differential erosion is a result, in part, of areas with greater amounts of clay and silt eroding quickly, and more resistant areas containing greater amounts of dolomite eroding more slowly. Generally, erosion rates are very high, with the rim retreating .5 meters every hundred years. This is in part due to Bryce experiencing up to 275 freeze-thaw cycles per year.[12]

Bryce is also significant as it is located at the top of Utah's Grand Staircase, a series of topographic benches and cliffs that rise in elevation from south to north. The bottom of the staircase is the top of the Kaibab uplift, just north of the Grand Canyon, and the formation rises through a series of cliffs and terraces: the Chocolate Cliffs, the Shinarump Flats, the Vermillion Cliffs, Wygaret Terrace, the White Cliffs, Skutumpah Terrace, the Gray Cliffs, the Pink Cliffs, and finally culminating in the Paunsaugunt Plateau, on which Bryce Canyon National Park sits.[13] The Park consists of the eastern portion of the top of the plateau and the breaks fall away from the rim to the east and south.

The Park is long and narrow, aligned roughly in a north-south line along the plateau. The plateau rises in elevation from north to south, gaining about 336 meters (1,100 feet) along its length, from 2438 meters (8000 feet) at Park headquarters near the north to 2774 meters (9100 feet) at the southern end. The name Bryce "Canyon" is a misnomer, for the Park is not a canyon but instead a series of 14 amphitheatres along the eastern rim of the plateau, at the breaks. From the rim to the Park boundary to the south and east are the magnificent hoodoos for which the Park was created.[14]

The Park's distinction as the top step of the Grand Staircase is emblematic of Bryce's small size belying the experience it provides its visitors, and signifies the importance of the surrounding region for the visitor experience. One of the main attractions of the Park is the view of the Staircase features from many of the Park's viewpoints, providing a long panorama behind the immediate hoodoos. These vistas depend on maintaining the good air quality of the region, which is currently threatened (see section 4.1).

[12] Foos 1999, p. 4-5.
[13] Doelling, et. al., 2000, p. 191.
[14] Elevations taken from National Park Service 2002, p. L-12

2.2 Land use history[15]

The area that is now the Park was impacted by livestock grazing and timbering prior to Park establishment. Mormon settlers used the land for cattle and sheep grazing beginning around 1870. Grazing was concentrated on top of the plateau in summer and in lower elevations in the winter. Up until the late 1920s, when the Park was established and later expanded, grazing levels were high and led to a large decline in forage abundance.

Timber was also harvested in the region, with two sawmills operating in the northeastern area of what is now the Park. In addition, around 1890 the Tropic Ditch was dug to transport water from the East Fork of the Sevier River to the Bryce Valley for irrigation. This ditch, dug through what is now private and US Forest Service land, dumps into Water Canyon, flowing west to east through the Park. The Tropic Ditch created a vector for aquatic species to pass from the Great Basin to the Colorado River Basin.

The largest historical impact to present day Park lands, however, may be the decades of fire suppression. As with many areas throughout the western U.S., fire suppression has resulted in changing vegetation communities as conifer spread has created stands of many small trees in unnaturally high densities. Aspens, which re-colonize areas disturbed by fire or other stand-clearing events, have also lost habitat due to conifer encroachment. (See section 5.6 for further discussion.)

2.3 Adjacent land use

Bryce was created out of Dixie National Forest lands (then the Powell National Forest), and is surrounded largely by public land. Dixie National Forest borders the park on the west, south, east and northeast. About 10% of the Park boundary is adjacent to BLM land, and the 1.9 million acre BLM-managed Grand Staircase-Escalante National Monument lies to the east and south of the Park. Only about 10% of the land bordering the Park is private, primarily to the west of the northern part of the Park, where there is some visitor development (a restaurant, lodge, and gas station). Just to the east of the Park lies the small town of Tropic, whose boundaries reach a small portion of the eastern edge of the Park. Tropic is considering a zoning change that would re-zone the land adjoining the Park as "pristine," thereby preventing development on lands adjacent to the park.

Bryce faces relatively few issues from adjacent land use at this time, but with increasing threats. The main current impact resulting from adjacent land use is from trespass cattle entering the Park, degrading wetland areas and spreading invasive weeds. (See section 5.4 for further discussion.) The Forest Service manages a roadless area to the east of the Park, and even with the Bush Administration's recent move toward rollback of roadless area protection, the region is still managed through the Forest Management Plan to protect the viewshed from Bryce[16]—a significant success for the Park that is representative of its good working relationship with adjacent public lands agencies. The Forest Service has permitted timber operations to the west of the Park, but these have been small in scale and not in an area impacting Park resources or visitors. BLM land nearby is part of the Grand Staircase-Escalante National Monument, where oil and gas leasing permits have been issued and are currently proposed. Oil and gas

[15] National Park Service 2000, p. A-11.
[16] Craig Axtell, Bryce Canyon NP Superintendent, personal communication, August 4.

development at these sites could negatively impact park resources such as night skies, natural soundscapes, and air quality. The possible oil and gas leasing to the north and northwest of the park, on federal, state and private lands, could be cause for concern in the future.

2.4 Population centers

There are no major metropolitan areas close to the Park. Tropic, on the eastern boundary of the Park, has a population of about 500. Hatch, Panguitch, Kanab, and Escalante are all within 80 miles but all are small, with populations between a few hundred and about 3,500. The nearest mid-size cities are Cedar City and St. George, which are 137 kilometers (85 miles) and 212 kilometers (132 miles) distant, with populations of 21,500 and 54,000, respectively. Los Vegas (400 kilometers (250 miles)) and Salt Lake City (440 kilometers (275 miles)) are the nearest big cities.

2.5 Additional Park resources

Park managers identify three additional resources as having significant value: paleontological resources, dark night skies, and natural soundscapes.

2.5.1 Paleontological resources[17]

In part because Bryce contains an eroding escarpment that exposes the Claron Formation, it has significant and valuable paleontological resources, although they have not been systematically studied. Studies in nearby public lands, the Grand Staircase Escalante National Monument and the Dixie National Forest,[18] have revealed extensive fossil resources that have, for the most part, not yet been inventoried in Bryce. Invertebrates have been studied more than vertebrates, but there is a need for a baseline survey of paleontological resources. One study documented Quaternary resources including Pleistocene faunal remains, alluvial deposits, and the potential for pollen recovery from alluvial sediments.[19] Another found that the Kaiparowitz Formation is present in the Park, and also found a Late Campanian salamander, *Habrosaurus*.[20] A second study looking at the Kaiparowitz Formation in the Park found a wide variety of fossils including mammals, dinosaurs, turtles, crocodilians, fish, herptiles, gastropods, and ostracods.[21]

2.5.2 Dark night skies[22]

Dark night skies are a valuable resource in Bryce, which experiences some of the darkest skies in the conterminous U.S. Of the 44 parks that have been measured, Bryce Canyon is among the five darkest (others include Capital Reef and Natural Bridges, which are darker, and Great Basin, for which there is not yet data). Night sky viewing, already excellent due to the dark skies, is enhanced by Bryce's good air quality and high elevation. These factors make the night sky a more valuable visible resource for visitors than the night sky in parks that are also dark, but where poor air quality and/or humidity obscure the stars.

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[17] Based on personal communication with Gayle Pollock, Executive Director and Geologist, Bryce Canyon Natural History Association, October 13, except where noted.
[18] Schierup undated.
[19] Agenbroad 1992.
[20] Munk 1998.
[21] Eaton undated.
[22] Chad Moore, Bryce Canyon Night Sky Coordinator, pers comm. October 12.

The dark skies are threatened by light pollution from both near and more distant sources. Nearby sources include the town of Tropic and development along the highway to the north of the Park. More distant sources include Cedar City and St. George. The nearby light sources are small, while the larger sources are far enough away not to have a significant impact on the Park. The resource is threatened, however, because a single significant new light source nearby could have a negative impact on the Park, and Park managers have limited ability and authority to control new light sources outside of the park. The Night Sky Coordinator for the NPS, who is currently stationed at Bryce, is working with local communities to raise awareness of night sky concerns, which have historically been largely overlooked. Servicewide, the NPS Night Sky Team is working with many parks to increase people's awareness of night sky concerns and provide individual parks with the resources and data to counter the problem of proliferating light sources both within and outside their boundaries.

2.5.3 Soundscape

Natural quiet is another resource of value to the Park and its visitors. One study in Bryce found that 30% of 410 visitor groups named solitude and quiet as a reason for visiting the Park. This is especially remarkable given the front country nature of Bryce; many visitors never get far away from roads, parking lots, and crowded overlooks. The quiet, however, is degraded by the high number of overflights, comprised of both intercity commercial air service and tour operators providing flightseeing tours. This issue is discussed in section 5.5.

3. Communities and species of concern

Due to its location near the intersection of two vegetative zones, its elevation gradient, and the unique breaks environment, Bryce supports a high level of species diversity. An estimated 522 plant species,[23] 59 species of mammals, and 130 species of birds have been recorded in the park.[24] While systematic studies of reptiles and amphibians have not been done, one source listed 11 reptile species and 4 species of amphibians as occurring in the park.[25] There have not been any systematic surveys of invertebrates conducted in the Park.

3.1. Natural systems within the Park

The vegetative communities of Bryce are defined primarily by elevation, as Park lands range in elevation from 2438 meters (8000 feet) to 2774 meters (9100 feet). For this study, the following systems were identified in consultation with Park staff and published literature:[26]

- Fir-spruce-aspen forest
- High plateau sagebrush
- Subalpine open and semi-moist meadows
- Ponderosa pine forest
- Pinyon-juniper woodland

[23] National Park Service 2000, p. A-10.
[24] Bryce Canyon National Park staff 1996, p. 9.
[25] Hallows 1982, in Bryce Canyon National Park Staff, p. 9.
[26] National Park Service 2002, p. L-12, and meeting with Resource Management Staff August 4. Most information in following subsections is based on the staff meeting unless otherwise noted.

- The breaks
- Springs and streams

Cryptobiotic soils, a key community of other desert parks, are not found extensively in Bryce, however there are some areas of cryptobiotic soils on the extreme north side of the Park, north of the highway that cuts through the Park. These are generally in good shape because there are no trails and few visitors utilize this area. The Park is mostly fenced, in an effort to keep cattle out (but see discussion of trespass cattle in section 5.4).

3.1.1 Fir-spruce-aspen forest

The fir-spruce-aspen forests are closed forests of white fir (*Abies concolor*), Douglas fir (*Pseudotsuga menziesii*), blue spruce (*Picea pungens*), and quaking aspen (*Populus tremuloides*). This community occurs in the high elevation southern portion of the Park. Common understory plants include Oregon grape (*Mahomia repens*), greenleaf manzanita (*Arctostaphylos patula*), and common juniper (*Juniperus communis*). This is a fairly intact system, although due to fire suppression aspen are not regenerating at natural rates and Park scientists believe that the forest composition is likely changing. There are no definitive studies that demonstrate this, however. One member of the Park resource staff suggests that the change in canopy from aspen to coniferous species likely affects the hydrology of the forest due to changes in snow interception.[27] Goshawks, which are a state species of concern and sometimes considered an indicator of forest health, may be found within this community, although they are not being monitored by the Park. Also of note, spruce beetles are found both outside and inside the Park. While they have caused significant mortality outside the Park, they have not yet become a problem inside the Park.

3.1.2 High plateau sagebrush

The high plateau sagebrush meadows occur within the ponderosa forest and are dominated by black sage (*Artemesia nova*). These open meadows have a mix of shrubs, perennial grasses, sedges, and rushes. The Park identifies "a dozen or more" of these late seral meadows.[28] Fire suppression has led to older and larger sagebrush growth than meadows subjected to natural fire regimes. In both sagebrush and moist meadows there is some speculation that historic grazing has led to streams in the meadows being incised more deeply than a natural state, leading to lowering of the water table and an overall drying of these areas. This theory, however, is not well supported by research and is not generally accepted,[29] and Park managers acknowledge that they don't know how a pristine area would appear because they are so rare.

3.1.3 Subalpine open and semi moist meadows

Meadows are interspersed with forested areas at higher elevations and are more extensive at lower elevations. Soil composition and soil moisture retention differ between meadow and sagebrush communities, with the meadows having higher soil moisture. These meadows contain numerous species including Thurber's fescue *(Festuca thurberi)*, speargrass (*Stipa comata)*, and Indian ricegrass *(Stipa hymenoides)*. The federally listed Utah prairie dog has been reestablished

[27] Chad Moore, Program Manager/Physical Scientist, personal communication August 4.
[28] National Park Service 2002, p. L-12.
[29] Chad Moore, in a Resource Management staff meeting on August 4, made this suggestion. Craig Axtell, Park Superintendent, noted that compared to areas outside the Park that are being grazed the meadows in the Park are in far better condition, and speculates that any hydrologic changes may be natural.

in some of the meadows and its reintegration into these communities is an important management issue for the Park (see section 3.2.1).

3.1.4 Ponderosa pine forest

The ponderosa pine community (*Pinus ponderosa*) is distributed mostly above the rim in the northern portions of the Park. This forest contains a variety of shrubs, including black sage (*Artemisia nova*), bitter brush (*Purshia tridentata*), and greenleaf manzanita (*Arctostaphylos patula*). This community occurs primarily between 7,000 and 8,500 feet.[30] There is some encroachment of fir into this system due to fire suppression.

3.1.5 Pinyon-juniper forest

The pinyon-juniper woodlands are open forests of two-needle pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*). These woodlands have a wide variety of deciduous and evergreen shrubs and tend to have a sparse understory of grass and forbs. This plant community is distributed along the east side of the park at lower elevations below the rim. It is of unnaturally high density due to lack of fire and is mixed with mountain mahogany (*Cercocarpus* sp.) and Gambel's oak (*Quercus gambelii*). Beetle kill has not been an issue but Park managers are aware of beetle impacts elsewhere and the potential for beetle outbreaks in the Park.

3.1.6 The breaks

The breaks communities of Bryce occur along the cliffs and badlands of the Park. This community type is characterized by widely scattered trees, including bristlecone pine *(Pinus longaeva)*, ponderosa pine *(Pinus ponderosa)*, and limber pine *(Pinus flexilis)*. It also contains a perennial forb component of soil and substrate adapted endemics. The breaks make up the region for which the Park is known—the hoodoos and other geologic formations just below the plateau rim. Vegetation in this area tends to be sparse but unique, containing the majority of the rare plants found within the Park. The soils are also unique, with some of the fastest erosion rates found in North America, but they are poorly developed, with parent material being of the Claron Formation.[32] This region is the most arid in the Park due to the inability of soils to retain water and the steep slope gradients. Bristlecone pine *(Pinus longaeva)* found in this area takes on a different form than higher elevation specimens.

3.1.7 Streams and springs

Bryce has limited riparian and wetland areas. There are three perennial streams: Yellow Creek, Willow Creek, and Sheep Creek. Other streams are ephemeral or intermittent. Thirty-three springs,[31] documented in 1996, create wetlands that are at most very small and sometimes almost nonexistent. Sheep Creek is notable due to the possible presence of the southwestern willow flycatcher (*Empidonax traillii extimus*), a federally listed species—the bird was heard once in the Sheep Creek area, but no evidence of nesting has been found during subsequent surveys.

Springs and seeps have been minimally researched and, given the importance of wetland areas to plants and wildlife, a better understanding of wetlands resources is a research priority for the Park.

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[30] Elevation figures for vegetation communities from Bryce Canyon National Park staff 1996, p. 11.

[31] Bryce Canyon National Park staff 1996, p. 10. The Resource Management Plan does not give a citation for this number, nor additional information.

3.2 Threatened and endangered species and species of special concern[32]

Bryce provides habitat for numerous species of concern. These are:

Plants:

There are 23 taxa at Bryce considered "sensitive." These species are found within the breaks, the area of highest visitor use in the Park, and some (marked with an asterisk) have been monitored "over time and seem little affected by the current level and location of visitor activities."[33]

These species are:

- Ward milkvetch (*Astragalus wardii*)
- Reveal indian paintbrush* (*Castilleja parvula* var. *revealii*)
- Yellow-white catseye* (*Cryptantha ochroleuca*)
- Cedar Breaks biscuitroot (*Cymopterus minimus*)
- Abajo daisy (*Erigeron abajoensis*)
- Jone's gentian (*Gentianella tortuosa*)
- Cedar Breaks goldenbush (*Haplopappus zionis*)
- Jones golden-aster (*Heterotheca jonesii*)
- King's ivesia (*Ivesia kingii*)
- Intermountain ivesia (*Ivesia sabulosa*)
- Bryce bladderpod *(Lesquerella rubicundula*)
- Little desert parsely (*Lomatium minimum*)
- Jones' locoweed (*Oxytropis oreophilla* var. *jonesii*)
- Paria breadroot* (*Pediomelum pariense*)
- Red Canyon phlox (*Phlox gladiformis*)
- Red Canyon beardtongue* (*Penstemon bracteatus*)
- Markagunt beardtongue (*Penstemon leiophyllus* var. *leiophyllus)*
- Lepidota twinpod (*Physaria chambersii* var.*membranacea*)
- Podunk groundsel (*Senecio malmstenii*)
- Peterson catchfly* (*Silene petersonii*)
- Wyoming rock-tansy (*Sphaeromeria capitata*)
- Townsendia (*Townsendia minima*).
- Widtsoe Buckwheat *(Eriogonum aretioides)*

Animals:

There are five species of animals that are considered threatened or endangered by the federal government or listed as a species of concern for the state of Utah.

These species are:

- Utah prairie dog *(Cynomys parvidens)*
- Southwestern willow flycatcher (*Empidonax traillii extimus*)
- Western yellow-billed cuckoo *(Coccyzus americanus occidentalis)*

[32] This section based on National Park Service 2002, p. L-12, and meeting with Resource Management Staff August 4.

[33] National Park Service 2002, p. L-13.

- Bald eagle *(Haliaeetus leucocephalus)*
- California condor *(Gymnogyps californianus)*
- Northern goshawk (*Accipiter gentilis*)

Some of these species are of particular management concern and are described further below.

3.2.1 Utah prairie dog

The Utah prairie dog (*Cynomys parvidens*) is the only federally listed species known to breed in the Park. The species has been threatened historically by eradication efforts, impacts from livestock grazing, and loss of habitat due to development and other human activities. The Utah prairie dog was extirpated from the Park in the 1950s and was reestablished into the Park from 1974 through 1986. In 1995 an outbreak of sylvatic plague reduced the population in the Park by 60%.[34] Since its reestablishment the population has fluctuated between about 40 and 250 adults[35] and in 2004 the main population, in an area called the mixing circle, was about 180 adults and 200 pups.

The mixing circle colony exists in an area heavily impacted by both NPS and concessioner administrative activities such as a vehicle storage area, a recycle collection center, a burn pile, and a concessioner-run horse corral operation. Since 1995, a visiting researcher has also been intensively studying the prairie dogs in this colony, which includes the trapping, handling, marking and monitoring of the animals. The population is doing well in this area, probably in part due to the human presence, which habituates the animals and keeps potential prairie dog predators from entering the colony. The activities, specifically the concession-run horse operation, provide an unnatural food source in the form of hay cubes and horse manure. The research that has been done on the prairie dogs in the mixing circle since 1995 has never been addressed through the NEPA process and Park managers are concerned that neither the benefit nor the impact of this research on this threatened species has been fully addressed. Although the continued presence of prairie dogs in Bryce is a success for the Park, Park managers believe that putting in place a prairie dog management plan, based on the recovery plan developed by the US Fish and Wildlife Service, is necessary for the Park to manage this population.

3.2.3 Southwestern willow flycatcher and western yellow-billed cuckoo

In 1995, park staff located a solitary Southwestern willow flycatcher (*Empidonax traillii extimus*) within the Park, in Yellow Creek. The following year, two southwestern willow flycatchers were located in Swamp Canyon and one was located in Yellow Creek. There have been no sightings of this species within the Park since then, and it is not known to be nesting at any location within the park.[36] Surveys in 2000 and 2002 revealed suitable habitat in Swamp Canyon as well, but no birds.[37, 38] The Western yellow-billed cuckoo *(Coccyzus americanus occidentalis)* was sighted only once, in Sheep Creek, by park staff in 2002.

[34] Bryce Canyon National Park Staff 1996, p. 12
[35] Bryce Canyon National Park Staff 2000, p. 17
[36] Resource Management Staff, personal communication, August 4.
[37] Bryce Canyon Resource Management Division. 2000
[38] Cahill 2002.

3.2.2 Bald eagles and California condors

Both of these species have been recorded in Bryce periodically, but have not been seen nesting in the Park.[39]

3.2.4 Northern goshawks

There have been several reported sightings of northern goshawk (*Accipiter gentilis*) by Park employees throughout the Park dating back to 1961. In both 1999 and 2000 a nesting pair with young was identified by Park staff outside of formal goshawk survey routes.[40]

3.2.5 Other species

Mexican spotted owls *(Strix occidentalis lucida)* are not known to inhabit the Park, but they are federally listed and present in the region so Park managers are aware of the possibility of their presence in the future, and associated management issues. Surveys in 1994 and 1995 did not find any birds.[41]

3.3 Other notable flora and fauna

Flora and fauna in the Park are generally typical of those found on the Northern Colorado Plateau. The following list includes some of the details of known species assemblages, weighted towards those based on studies that are either more recent or more complete.

3.3.1 Mammals

About 75 mammal species are believed to be found in the Park, although only 59 species have been confirmed. Common species include least and Uinta chipmunks *(Tamias minimus* and *Tamias umbrinus)*, deer mice *(Peromyscus maniculatus)*, gray fox (*Urocyon cinereoargenteus*) and mule deer *(Odocoileus hemionus).* Mountain lion *(Felis concolor)* and black bear *(Ursus americanus)* sign have been observed in the Park, but observations of these animals are rare. Elk *(Cervus elaphus)*, pronghorn *(Antilocapra Americana)*, and coyotes *(Canis latrans)* are also present or transient.[42] Coyotes are rare in the area because they are hunted for bounty outside of the park. In other states where no bounty exists, coyotes are common. (Mountain lions are hunted as game but not pests, and thus are managed with strict harvest regulations.)

3.3.2 Reptiles and amphibians

There have been four historical surveys within the Park looking for reptiles and amphibians between 1930 and 1997, but none that could be considered a systematic survey. The most recent and comprehensive of these, in 1997, found nine species of herptofauna. More recently, the Northern Colorado Plateau monitoring effort conducted surveys over the course of eight visits to the Park in 2001 and 2002, documenting four lizard, two snake, and one frog species. The scientists believe that the inventory is 54% complete, and there are six species potentially in the Park but not yet confirmed. These species are listed in Appendix B.

3.3.3 Fish[43]

[39] National Park Service 2000, p. A-10.
[40] Parker 2000 and Ames-Curtis 1999.
[41] Burch 1994 and Burch 1995.
[42] National Park Service 2000, p. A-10, and meeting with Resource Management staff August 4.
[43] National Park Service 2000, p. C-11.

No systematic fish surveys have been done, but due to most streams being intermittent or ephemeral Park scientists believe there is little to no habitat available. There are two anthropomorphic water bodies that may have fish—the Tropic Ditch and a pool constructed from a spring in the East Creek drainage that has had a population of introduced brook trout.

3.4 Extirpated species

Bryce Canyon retains most of its native species; however, due to a lack of data, the exact number of extirpated species is unknown. Wolves *(Canis lupus)* and grizzly bear (*Ursus arctos*) likely roamed the region and are now extirpated. Bighorn sheep *(Ovis canadensis)* may have also been present. While other species have been reduced in number (e.g. Utah prairie dogs), no other species are known to have been extirpated.

4. Physical conditions

Concerns about the physical conditions in Bryce focus mostly on air quality, particularly on potential impacts of new power plant construction and expansion of existing plants. Water quality is not well monitored but thought to be good, while soil quality is largely unstudied.

4.1 Air quality

Bryce Canyon National Park is designated a class I area under the Clean Air Act, and air quality in the Park is "generally excellent."[44] Clean air and long-range visibility are key characteristics of Bryce—the Resource Management Plan states "the exceptional clarity of the air…and the surrounding area provides the rare opportunity to experience panoramic vistas."[45] This is due both to the low moisture content of the air and to a relative lack of pollutants. Views extend for up to 200 miles into southern Utah and northern Arizona, giving an excellent panorama of the Grand Staircase; according to a report from 1996, visibility of at least 75 miles occurred 90% of the time.[46] Air quality also plays a role in the quality of night sky viewing in the Park. The Park has been involved with IMPROVE and ADEP for 8 years; it has not been tracking dry deposition or ozone.

The following air quality measures have been tracked in Bryce; trends have been mixed:[47]

Index	Status	Trend
Haziness based on 20 best days	Much better than NPS average	Significant improvement
Haziness based on 20 worst days	Much better than NPS average	Degradation (not significant)
Mean sulfate ion concentration	Better than NPS average	Significant improvement

[44] Bryce Canyon National Park staff 1996, p. 13.
[45] Bryce Canyon National Park staff 1996, p. 4.
[46] Bryce Canyon National Park staff 1996, p. 13
[47] National Park Service 2002a, Appendix A.

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)

Park managers believe that there hasn't been much degradation of air quality to this point, yet there are clear threats on the horizon. Several power plants have been proposed for the region around Bryce, and there are concerns that the permitting processes do not take into account the cumulative effects of multiple emissions sources on the air quality in the park.[48] See section 5.3 for discussion.

4.1.2 Ozone

The Park has not monitored ozone, but one small survey of vegetation in Bryce and other nearby parks found "foliar symptoms characteristic of ozone injury."[49] These symptoms can be caused by other factors, however, so while the researchers believe that ozone injury is a probable cause, in the absence of ozone data being collected in the Park it is impossible to declare ozone as the definite cause.

4.2 Water quantity and quality

Water resources in Bryce consist of 33 springs located throughout the Park, with 20 of these having measurable flow, plus numerous streams that are intermittent or ephemeral.[50] There is "little to no"[51] monitoring of water quality in Bryce at this time, although the Park is hoping to implement monitoring in the near future. Despite the lack of monitoring there are not significant concerns about water quality because of the Park's location on top of the plateau, which means that nearly all water sources originate within the Park and there are no water pollution sources flowing into the Park from outside.[52] In fact the greater concern regarding water is from the town of Tropic, for which the Park comprises part of the watershed providing drinking water; because of this the Park is careful with any management practices that might degrade water quality, such as using chemical fire retardant near water resources as part of fire management practices.[53]

One concern regarding water quality in the Park is contamination of springs from visitor use. Although backcountry visitor use is not high and thus the problem is not similar in scale to parks with large numbers of campers near water sources such as Zion, there is still a concern due to the very low flows of many springs, meaning that even a small introduction of a pollutant can have a

[48] Resource Management Staff, personal communication, August 4.
[49] Scruggs 2000, p. 2.
[50] National Park Service 2000, p. A-10.
[51] Kristin Legg, Chief of Resource Management, personal communication October 10, 2004
[52] A review of Park maps shows one intermittent or ephemeral stream that starts outside the north end of the Park and flows within Park boundaries briefly before exiting to the east. The only other water flowing in from outside is the Tropic Ditch, which was dug to transport water and goes through the Park. The Tropic Ditch is addressed in the main text below.
[53] Kristin Legg, Chief of Resource Management, personal communication October 10, 2004

relatively larger impact.[54] A second concern is with water impacts from trespass cattle (see section 5.4).

The one exception to the Park being at the top of the watershed and having no water coming in from outside is with the Tropic Ditch, which was constructed in the 1890s to transport water from the East Fork of the Sevier River to the town of Tropic. The Sevier River is to the west of the Park, the town is to the east, and the Tropic Ditch runs through the northern portion of the Park and dumps into Water Canyon. This is the only year-round water flow from outside the Park, and is an outlier in terms of water quality in the Park due to the unusual circumstances.

Although there is no ongoing monitoring at this time, the National Park Service Water Resources Division published a baseline water quality analysis for the Park in 1999.[55] Details for each parameter reported are given in the following subsections. It is important to note, however, that the report looks at water quality within a study area that extends one mile downstream of the Park,[56] including, for example, the East Fork of the Sevier River and the Tropic Reservoir to the west. While water quality in these bodies of water is certainly of regional concern, aside from the water running through the Tropic Ditch, it is not a measure of water quality in the Park. While there were 81 study sites within the Park, only three stations supplied data over more than one year and none were considered long-term, thus no trend data are available. The report concludes "Without adequate data it is difficult to make definitive statements regarding water quality…however from the limited available data, water quality has generally been good."[57,58] There have been no subsequent survey reports, and no reason to believe that water quality has been significantly degraded since the report was published.

4.2.1 Dissolved oxygen

Dissolved oxygen was monitored 231 times at 17 stations. The only measures below the EPA level for supporting aquatic life were outside the Park in the Tropic Reservoir. Because the measuring was done at only 17 stations it is possible that this was not measured in the Park. [59]

4.2.2 pH

pH was measured 493 times at 115 stations, meaning that at least some measures were in the Park. The only measure within Park boundaries that was outside the EPA range for aquatic life

[54] Meeting with Resource Management Staff, August 4.
[55] National Park Service 1999.
[56] National Park Service 1999, p. 31. Total water quality study area is almost 176,000 acres, while the Park is only just over 36,000 acres. Data was taken from twice as many stations outside the Park (163) as inside (81).
[57] National Park Service 1999, p. viii.
[58] Another issue was raised by Resource Management Staff but is not addressed in detail here. The water supply for the Park is from a well to the west of the Park boundary, in and downstream of an area that is grazed by cattle. There is some concern about groundwater contamination from the grazing tainting the Park's water supply. Although this is a resource issue it is not addressed in this report because it is one of human health, not a broader Park resource.
[59] Details on dissolved oxygen and all the following parameters are taken from National Park Service 1999, p. vi-viii. If there aren't cases of degradation noted from sites within the Park I am making the assumption that there was some monitoring in the Park that showed no degradation. This may be a bit of a stretch, because it's possible that in fact all monitoring for any specific parameter is from outside the Park, but without going back to the original data—a highly daunting task—this seems to be a reasonable assumption.

was in the Tropic Ditch, and this was a small number of times, no more than 11 total and possibly fewer.[60]

4.2.3 Turbidity

Turbidity was measured 209 times at 20 monitoring stations. One reading, taken at Tropic Ditch, exceeded the screening criterion.

4.2.4 Total and fecal coliform concentration

Total coliform was measured 67 times at 24 monitoring stations. Ten concentrations at five locations within the Park exceeded bathing water screening criteria. These locations were South Fork Ponderosa Creek, Sheep Creek Spring, Swamp Canyon, and two along Yellow Creek. Fecal coliform was measured 136 times at 25 monitoring stations, and all concentrations above criteria levels were outside the Park.

4.2.5 Metals

Many metal concentrations measured at springs in the Park exceeded threshold criteria. This is likely due to geological weathering.

Metal	# Times measured	# Locations	# Times exceeding standard in the Park
Sulfate	198	74	4
Cadmium	67	25	9
Chromium	92	25	0
Copper	86	25	8
Lead	82	26	5
Mercury	65	23	6
Nickel	39	18	1
Silver	64	25	3
Zinc	84	25	3

4.3 Soil quality

Soils have not been well studied in Bryce. They generally fall into several orders including entisols, mollisols, alfisols, and inceptisols. In most places in the Park with soil, the soil is shallow and skeletal, producing low moisture availability.[61] The breaks are considered badlands and do not have developed soils, in these areas the surface material is derived from the Claron Formation; which is eroding quickly due to the high number of freeze-thaw cycles annually.[62]

Because of the small size of the Park relative to the number of visitors, and the concentration of visitors in a relatively small area, there have been significant visitor impacts to soils. One study, from 1981, looked at differences in soils between high use and low use areas, and found that

[60] I've given pH a rating of 3 despite the small number of readings out of range in the Tropic Ditch; we may want to discuss whether to drop from 3 to 2.
[61] Brcye Canyon National Park Staff 1996, p. 11.
[62] Brcye Canyon National Park Staff 1996, p. 4.

these areas varied significantly in bulk densities, infiltration rates, and sediment production.[63] The same study found that visitor impacts had extended to changes in vegetation as well.

5. Park degradations and threats

In addition to the threats and degradations identified in the previous chapter, several other issues relevant to the Park are worth highlighting.

5.1 Exotic species[64]

Bryce has fewer exotic species, fewer noxious weeds, and a smaller percentage of land area impacted by weeds than many other national parks in the western U.S. Sixty-seven species of non-native plants have been identified in the Park,[65] but none of these are as widespread as, for example, tamarisk along the rivers or cheatgrass in the fields of Canyonlands National Park. Key species that have warranted action in Bryce are:

- Tamarisk *(Tamarix spp.)*
- Russian olive *(Elaeagnus angustifolia)*
- Knapweed *(Centaurea spp.)*
- Russian thistle (*Salsola iberica*)
- Several taxa of thistle including bull thistle (*Cirsium vulgare*) and Canada thistle (*Cirsium arvense*)
- Several brome grasses—especially cheat grass (*Bromus tectorum*); these are being controlled because of the threat of them spreading and outcompeting and eliminating native vegetation that wildlife species depend on.[66]

Most exotic species occur in impacted areas: along Highway 12, along the Park road, in drainages, and in or near buildings, trails, parking lots, and campgrounds. Surveying and treatment of invasive species are focused on these areas.[67] Exotic plant control efforts have been in place in Bryce since 1993.[68]

The most recent survey for exotic plants,[69] in summer 2004, covered 4052 acres and found that only 1.34% of the surveyed land was infested with weeds. The species found, and total acreage for each, were:

Smooth brome (*Bromus inermis)*	29.459 acres
Downy brome (*Bromus tectorum)*	13.013 acres
Musk thistle (*Carduus nutans)*	0.003 acres
Bull thistle (*Cirsium vulgare)*	0.009 acres
Field bindweed *(Convolvulus arvensis*)	0.122 acres
Orchardgrass (*Dactylis glomerata)*	0.129 acres

[63] Call et. al. 1981, p. 52.
[64] Bryce National Park staff 1996, p. 11.
[65] Exotic plants of Bryce Canyon Updated 10-01-04 (Appendix E)
[66] Mark Biel, Resource Management Specialist, pers comm. October 11.
[67] Bryce Canyon Resource Management Division, 2002.
[68] Welch 2002.
[69] Dewey 2004.

Russian olive (*Elaeagnus angustifolia)*	0.255 acres
Leafy spurge *(Euphorbia esula)*	1.000 acres
Halogeton *(Halogeton glomeratus*)	0.001 acres
Horehound (*Marrubium vulgare)*	0.101 acres
Sweetclover (*Melilotus officinalis)*	4.015 acres
Timothy (*Phleum pretense)*	0.122 acres
Russian thistle *(Salsola kali)*	2.132 acres
Saltcedar (*Tamarix ramosissima)*	3.212 acres
Western salsify (*Tragopogon dubius)*	0.335 acres
Common mullein (*Verbascum thapsus)*	0.244 acres

5.2 Threats from adjacent public lands

Bryce Canyon is almost entirely bounded by public land managed by the Bureau of Land Management or Forest Service. The relationship between the Park and these agencies has been good, and this is a success for the Park. Because Bryce is a relatively small Park, it has worked cooperatively with neighboring agencies in some aspects of its management, for example fire management. This cooperative approach has allowed for better resource management and increased efficiency.

Much of the adjacent public land, however, is not protected from resource extraction activities. On BLM land just to the north of the Park there is discussion of leasing the land for oil and gas development. Energy development is increasing rapidly across western U.S. public lands and degrading wildlife habitat, water quality, and other aesthetic values. For Bryce Canyon, the presence of oil and gas development has the potential to degrade wildlife habitat and the visitor experience.

A second public land issue playing out across the western U.S. with ramifications for the Park is the protection of roadless areas in National Forests. Under the Clinton Administration the Forest Service moved to administratively protect roadless areas, but in the last several years the roadless rule has been revisited under the Bush Administration. Although the final outcome is unclear, roadless protections are threatened. Bryce Canyon is close to a roadless area of Forest Service land to the east of the Park that to this point is not threatened by logging or other extraction proprosals in the forest plan, but this designation is more easily changed if roadless protections are repealed.

5.3 Air quality

While air quality is generally good at Bryce, there are concerns about future air quality because of the recent increase in the number of power plants, especially coal-fired plants, being built in the region. This is not just a problem for Bryce, but affects national parks and other protected areas across the west. According to a study reported in the Washington Post, the number of requests for power plants within 62 miles of a national park since 2000 has quadrupled compared to the previous five years. In addition, because of the rising cost of natural gas, an increasing number of plants use coal, which is more polluting than natural gas. Taken together, these trends threaten the visibility at Bryce and other parks, and indeed Bryce has seen some degradation of visibility, although it is not yet considered significant.

Bryce and the National Park Service face an issue in that power plants are permitted one by one, but their effects are cumulative. Consequently, while no single power plant may be clearly responsible for a significant degradation of visibility, if enough plants are built, taken together they will have an air quality impact. The Park Service is attempting to address this issue, but given the Bush Administration's goal of increasing domestic energy production and "streamlining" permitting processes, it is not clear whether the Park Service's concerns will have an impact on new power plant construction.[70]

5.4 Trespass cattle

Ebeneezer Bryce, the early pioneer in the area for whom the Park is named, reportedly once said about Bryce Canyon "it's a hell of a place to lose a cow."[71] While this may have been true in the past, today the greater concern is for impacts of trespass cattle in the Park. The Park has a 65-mile boundary that is mostly fenced to keep out trespass cattle. The fence is "posted but not secure,"[72] and trespass cattle impact vegetation, especially in wetland areas. Impacted areas include Sheep Creek, East Creek, Riggs Springs, and Yellow Creek; for example, a survey of drainages for southwestern willow flycatchers in Swamp Canyon and Yellow Creek noted "cattle presence (fresh manure)…[and] grazing damage to young willow species."[73] In addition, a survey of 40 miles of the Park boundary in summer 2004 found that the fence near Yellow Creek appeared to have been intentionally cut, most likely to allow cattle into the Park.[74] The Forest Service land adjoining the Park is valuable grazing land that is grazed to the Park boundary, and Utah is a "fence out" state so the Park is responsible for keeping cattle out—ranchers do not have to make an effort to keep their cattle out. Taken together, these factors make trespass cattle an ongoing challenge facing the Park.

This challenge has led to a success for the Park as well. The Park has had Sierra Club work trip groups involved in building about 10 miles of fence along the Park boundary over ten years. The Sierra Club members worked closely with Park maintenance staff members, who are predominantly locals with knowledge and experience in ranching and other resource use activities. The Park feels that this collaboration between Sierra Club members and Park maintenance staff is a valuable interaction that benefits both as they work together to address the issue.[75]

5.5 Overflights[76]

Bryce is blessed with a natural soundscape that is degraded mainly by aircraft overflights. A study done in 1995 showed that aircraft could be heard throughout the Park 19% of the time; at Fairyland Overlook aircraft could be heard 29% of the time.[77] Aircraft are of three source types:

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[70] An example of attempts by the Park Service to influence power plant permitting is seen in a letter from John Bunyak Chief, Policy, Planning and Permit Review Branch, to the US EPA dated September 14, 2004. The letter concerns the Steag Desert Rock Project, but the issues are relevant to other power plants as well.
[71] Interpretive sign at Bryce Point.
[72] Bryce Canyon National Park Staff 2000, p. 11.
[73] Bryce Canyon Resource Management Division 2000
[74] Ruiz 2004.
[75] Meeting with Resource Management Staff, August 4.
[76] This section compiled from a combination of Bryce Canyon National Park Staff 1996, p. 13, and meeting with Resource Management Staff August 4.
[77] Foster 1997.

helicopters used for sightseeing, fixed wing aircraft used for sightseeing, and commercial jets. The latter are flying high overhead and are less disruptive for visitors throughout the Park.

The Park does not yet have an Air Tour Management Plan (ATMP) in place, and although the Federal Aviation Agency (FAA) is intending to create an ATMP, the Park is first planning to collect sound data and develop a sound management plan in order to quantify the impact of noise levels in the Park. Park managers believe that noise from overflights impacts the visitor experience, and impacts to wildlife are possible although unknown, thus the Park has concerns about a possible increase in air tours. The FAA ATMP process first asks existing operators how many flights they are conducting in order to create baseline data; Park managers point out that flight operators have an incentive to overstate their number of flights in order to create a higher baseline. Also, because sightseeing flights originate from as far away as Las Vegas, the number of flights is hard to track.

An economic impact study was done regarding the Bryce Canyon Airport, and although the results are not yet public at least one Park manager believes that the study will show significant benefits to the county. This fact, along with planned airport construction or expansion in numerous nearby towns (including Cedar City, St. George, and Colorado City), suggests that this may become a contentious issue in the near future.

5.6 Fire

As with forested landscapes across the western U.S., the forests in Bryce have been altered by historic fire suppression. Prior to Mormon settlement of the area, ponderosa pine forests in what is now the Park experienced fires, on average, every 3.3 years, while the higher elevation mixed conifer forests experienced fires every 7.5 years. Fire suppression throughout much of the 20th century has resulted in high fuel loads (some areas now have 1000 trees/acre where historic levels are 25-50 trees/acre[78]), creating the threat of unnaturally high-intensity fires. In response, the Park began prescribed burns in 1990.[79]

The Park is creating a new fire management plan that is slated to be released in early 2005. The new plan will continue the evolution of fire policy towards letting more fires burn naturally outside of suppression zones near structures. The Park is also working with the Dixie National Forest to include Bryce in the Forest Service fire plan.

5.7 Visitor impacts[80]

Visitation to Bryce Canyon has increased in the past couple of decades, with annual increases averaging 7.5% between 1980 and 1995. Visitation peaked at 1.7 million visitors in 1996 and since then has been roughly steady. Bryce is predominantly a front country park, with average visitation time of less than half a day and most visitors concentrated on the small, 252-acre developed portion of the Park. Only a very small number of visitors are backcountry campers.

The concentration of visitors in a small area has led to soil compaction and associated impacts, creation of social trails, trampling of vegetation, and wildlife becoming habituated to humans.

[78] Meeting with Resource Management Staff, August 4.
[79] Bryant 1995.
[80] National Park Service 2000, p. A-11.

The total area being impacted, however, is fairly small, and the larger concern regarding visitor impacts may be to the quality of the visitor experience, rather than to the Park resources. Fences built in some highly visited areas have been highly successful in reducing the number of social trails and in reducing impacts on soil and vegetation.[81]

6. Conclusion and recommendations

Bryce Canyon is unusual among the national parks of southern Utah—created specifically to protect a small area of geologic wonders, it is now attempting to protect not only the breaks and associated geologic processes, but also other natural resources and natural processes that take place on a landscape scale far larger than Bryce's 35,835 acres. Park staff have been largely successful in these attempts, which are made easier because Bryce is almost entirely surrounded by other public lands, and these other land management agencies (the Forest Service and Bureau of Land Management) have implemented some measures to manage their lands consistent with the preservation of the Park. Bryce resource managers, however, deserve credit for developing and maintaining these relationships that benefit the Park, and for proactively seeking out cooperative management when appropriate. A good example of this type of landscape level cooperative management is having the Forest Service play a cooperative role with fire management in the Park.

Bryce staff should be recognized for not letting turf battles obscure the reality that Bryce is tiny compared to the Dixie National Forest and Grand Staircase-Escalante National Monument. Less enlightened managers might attempt to manage their Park as a stand-alone entity; ignoring the ecological realities of resources existing and processes operating across land boundaries would at least increase costs and inefficiencies, and likely also result in poorer management. Bryce has also learned from adjacent lands; for example, significant fossil resources unearthed during fossil studies in the neighboring National Forest and National Monument lands have demonstrated the need for similar studies in the Park.

A main recommendation, therefore, is to continue this informal, cooperative management style, and indeed to look for ways in which to further this approach. For example, although Bryce and Zion are not contiguous, they are close enough together to potentially be able to share some resources. One possibility would be to share a full-time geologist, which would greatly increase the amount of staff time in Bryce devoted to geology—a must for a Park created to protect geological resources. A geologist might also be shared successfully with either Capitol Reef National Park or Cedar Breaks National Monument.

One area in which Bryce is lacking is in the existence of baseline natural resource data. Many parks would benefit from increasing their knowledge of their natural resources, but Bryce stands out (unfortunately) as having even less baseline natural resource information than some others. The efforts of the Northern Colorado Plateau Vital Signs Network are starting to address the lack of inventory and monitoring work, and there is much more to be done. The Resource Management Plan identified 18 areas of baseline information, of which half did not meet minimum data requirements.[82] While the Plan dates from 1996, conversations with Park

[81] Kristin Legg., Chief of Resource Management and Research, pers comm. October 13.
[82] Bryce Canyon National Park staff 1996, p. 7.

managers suggest that the information gaps still exist today. Interestingly, this is an area in which Bryce's small size may be of benefit, making inventories generally easier than those across larger parks.

Specific studies and management planning that should be undertaken include:

- Implement water quality monitoring: the arid landscape of the region accentuates the importance of Bryce's water resources, primarily its springs. Given degradations and threats from visitor use and trespass cattle, a stronger monitoring program should be in place.
- Study and document overflight impacts: the potential for a large increase in the number of overflights is a threat to the visitor experience and potentially to wildlife and other resources as well. The Park does not yet have an Air Tour Management Plan; having data on visitor impacts from overflights will make development of the ATMP easier and allow the Park to take a proactive approach to this threat.
- Create a prairie dog management plan to guide management of this species within the outlines of the US Fish and Wildlife Service prairie dog recovery plan. Because the majority of prairie dogs are living in a developed portion of the Park, a hands-off management approach is not an option over the long term.
- Conduct a baseline survey of paleontological resources. Several recent studies have demonstrated the presence of valuable fossil resources in Bryce. These studies, however, have not been systematic, and a comprehensive baseline survey would help the Park manage these resources.

Other recommendations are based on Bryce needing to consider the actions and activities outside Park borders that impact the Park. These include:

- Closely monitor new power plants and other sources of air pollution that impact air quality, dark night skies, and other resources.
- Continue efforts to work with communities surrounding the Park to minimize light pollution that degrades the dark night skies present in Bryce.
- Track changing policies within the National Forest Service and Bureau of Land Management that may lead to land use changes on nearby public lands. With the BLM this means watching oil and gas leases on lands near the Park; with the Forest Service this means monitoring nearby roadless areas that may be open to timber cutting or road building. Either of these activities could have effects on resources and visitors.

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Appendix A: Threatened, endangered, and extirpated species of Bryce Canyon

EXTIRPATED

Gray Wolf (*Canis lupus)*
Grizzly Bear (*Ursus arctos)*

ENDANGERED OR THREATENED

Utah prairie dog *(Cynomys parvidens):* Present and breeding in the Park
Southwestern willow flycatcher (*Empidonax traillii extimus*): A few sightings in Yellow Creek and Swamp Canyon
Bald eagle *(Haliaeetus leucocephalus):* Migratory but not resident.
California condor (*Gymnogyps californianus*): Migratory but not resident.
Western Yellow-billed Cockoo *(Coccyzus americanus occidentalis)*: Candidate species, one sighting in Sheep Creek

Appendix B: Herptofauna of Bryce Cayon

Amphibians
Northern leopard frog (*Rana pipiens)*

Lizards
Mountain short horned lizard (*Phrynosoma hernandesi)*
Sagebrush lizard (*Sceloporus graciosus)*
Eastern fence lizard (*Scelopurus undulates)*
Tree lizard *(Urosaurus ornatus)*

Snakes
Gopher snake *(Pituophis catenifer)*
Wandering garter snake *(Thamnophis elegans vagrans)*
Great Basin or Western Rattlesnake (*Crotalus viridis)*

Additional species thought to possibly exist, but unconfirmed
Tiger salamander *(Ambystoma tigrinum)*
Great Basin spadefoot *(Spea intermontana)*
Whipsnake *(Masticophis taeniatus)*
Western skink *(Eumeces skiltonianus)*
Western whiptail *(Cnemidophorus tigris)*

Appendix C: Endemic Plant Species of Bryce Canyon National Park[83]

Bryce Canyon NP has many regional endemic plant species, but none are restricted in distribution to just the Park. All of these regional endemics are classified as 'sensitive' on the rare plant list for the Park. The designation 'sensitive' means current information indicates that proposing to list as endangered or threatened is possible, but substantial biological information to support this proposal is lacking. Below is a list of the regional endemics that occur, or are likely to occur within Bryce Canyon National Park:

Castilleja parvula var. *revealii*, Reveal Indian Paintbrush – endemic to the central portion of the Paunsaugunt plateau (Red Canyon and Bryce Main Amphitheater Areas) on gravelly limestone soils within Ponderosa pine communities.

Cymopterus minimus, Cedar Breaks Biscuitroot – endemic to the Paunsaugunt and Markagunt plateaus on barren or sandy clay slopes.

Eriogonum aretioides, Widtsoe Wild Buckwheat - endemic to the Paunsaugunt and Markagunt plateaus on weathered limestone within Bristlecone pine, Ponderosa pine, Douglas-fir, and Mountain juniper communities.

Heterotheca jonesii, Jones Golden-aster - endemic to the lower elevations of the Paunsaugunt plateau, Markagunt plateau, and Zion NP on sandy soil and sandstone cliff crevices.

Lesquerella rubicundula, Bryce Bladderpod – endemic to the Paunsaugunt, Markagunt, and Aquarius plateaus on limestone soils in Bristlecone pine, Ponderosa pine, and spruce-fir communities.

Lomatium minimum, little Desert Parsely - endemic to the Paunsaugunt, Markagunt, and Aquarius plateaus on open, barren clay slopes.

Pediomelum pariense, Paria Breadroot – endemic to the central portion of Bryce Canyon NP and No Mans mesa (White cliffs) on limestone alluvium within Ponderosa pine communities.

Phlox gladiformis, Red Canyon Phlox – endemic to the Paunsaugunt plateau, Markagunt plateau, and Pine Valley mountains on cliffs and rocky slopes in Ponderosa pine and Pinyon-juniper communities.

Penstemon bracteatus, Red Canyon Beardtongue – endemic to the central Paunsaugunt plateau (Red Canyon and Bryce Main Amphitheater Areas) on dry gravelly slopes and talus in Ponderosa pine communities.

Penstemon leiophyllus var. *leiophyllus*, Markagunt Beardtongue – endemic to the Paunsaugunt plateau, Markagunt plateau, Aquarius plateau, Zion NP, and the Pine Valley mountains in various plant communities.

Physaria chambersii var. *membranaceae*, Lepidote Twinpod – endemic to the Paunsaugunt plateau in various plant communities.

Senecio malmstenii, Podunk Groundsel – endemic to the Paunsaugunt plateau, Markagunt plateau, and western Aquarius plateau on talus slopes.

Townsendia minima, least Townsendia – endemic to the Paunsaugunt plateau, Markagunt plateau, and western Aquarius plateau on open rocky slopes and talus.

[83] Unpublished document provided by Kristin Legg, Chief of Resource Management, Oct. 12

Appendix D: Sensitive Plant List Bryce Canyon National Park[84]

APIACEAE
Cymopterus minimus, Least Spring Parsely (G1)
Lomatium minimum, Least Lomation (G3)

ASTERACEAE
Erigeron abajoensis, Abajo Daisy (G1)
Haplopappus zionis, Cedar Breaks Goldenbush (G2)
Heterotheca jonesii, Jones' Goldenaster (G2)
Senecio malmstenii, Podunk Groundsel (G1)
Sphaeromeria capitata, Head Sphaeromeria (G3)
Townsendia montana var. *minima*, Bryce Canyon Townsendia

BORAGINACEAE
Cryptantha ochroleuca, Yellowish Cryptanth (G1)

BRASSICACEAE
Lesquerella rubicundula, Breaks Bladderpod (G3)
Physaria chambersii var. *membranacea*, Lepidote Twinpod (G2)

CARYOPHYLLACEAE
Silene petersonii, Maguire' Campion (G2)

FABACEAE
Astragalus wardii, Ward's Milkvetch (G3)
Oxytropis oreophila var. *jonesii*, Jones' Oxytrope
Pediomelum pariense, Paria Breadroot (G2)

GENTIANACEAE
Gentianella tortuosa, Jones' Gentian (G3)

POLEMONIACEAE
Phlox gladiformis, Cedar Canyon Phlox (G3)

POLYGONACEAE
Eriogonum aretioides, Widtsoe Buckwheat (G2)

ROSEACEAE
Ivesia kingii, King's Ivesia (G3)
Ivesia sabulosa, Sevier Ivesia (G3)

SCROPHULARACEAE

[84] Unpublished document provided by Kristin Legg, Chief of Resource Management, Oct. 12

Castilleja parvula var. *revealii*, Reveal's Paintbrush (G2)
Penstemon bracteatus, Platy Penstemon (G2)
Penstemon leiophyllus, Markagunt Penstemon (G3)

( ) Utah Natural Heritage Ranking
G1 – Critically Imperiled Globally (typically 5 or fewer occurrences)
G2 – Imperiled Globally (6 to 20 occurrences)
G3 – Rare or Uncommon (21 to 100 occurrences)

Appendix E: Exotic Plants of Bryce Canyon[85]

Updated 10-01-04

LATIN NAME	COMMON NAME	FAMILY
Agropyron cristatum	crested wheatgrass	Poaceae
*Amaronthus retroflexus**	pigweed	Amaranthaceae
Ambrosia artemisiifolia+	common ragweed	Asteraceae
Arctium minus	common burdock	Asteraceae
Arundo donax	giant reed	Poaceae
Asparagus officinalis	wild asparagus	Liliaceae
Bromus inermis	smooth brome	Poaceae
Bromus japonicus	meadow brome	Poaceae
Bromus tectorum	cheatgrass	Poaceae
Capsella bursa-pastoris	shepherd''s purse	Brassicaceae
Cardaria draba	whitetop	Brassicaceae
Carduus nutans	musk thistle	Asteraceae
Centaurea maculosa	spotted knapweed	Asteraceae
Centaurea repens	Russian knapweed	Asteraceae
*Chenopodium album**	lambsquarters	Chenopodiaceae
Chorispora tenella	blue mustard	Brassicaeceae
Cichorium intybus	chicory	Asteraceae
Cirsium arvense	Canada thistle	Asteraceae
Cirsium vulgare	bull thistle	Asteraceae
Conringia orientalis	hare's ear mustard	Brassicaceae
Convolvulus arvensis	field bindweed	Convolvulaceae
Cynoglossum officinale	houndstongue	Boraginaceae
Dactylis glomerata	orchard grass	Poaceae
Descuriana sophia	flixweed	Brassicaceae
Descuriana richardsonii	tansy mustard	Brassicaceae
Elaeagnus angustifolia	Russian olive	Eleagnaceae
Elymus hispidus	intermediate wheatgrass	Poaceae
Elymus junceus	Russian wildrye	Poaceae
Erodium cicutarium	storksbill or red filaree	Geraniaceae
Festuca pratensis	meadow fescue	Poaceae
*Hordeum vulgare**	barley	Poaceae
Kochia scoparia+	common kochia	Chenopodiaceae
Lactuca serriola	prickly lettuce	Asteraceae
Lepidium perfoliatum	peppergrass	Brassicaceae
Linum perenne spp. *lewisii+*	flax	Linaceae
Malcolmia africana	African mustard	Brassicaceae
Malus pumila	common apple	Rosaceae
Malva neglecta	common mallow	Malvaceae
Marrubium vulgare	hoarhound	Lamiaceae
Medicago lupulina	black medic	Fabaceae

[85] Unpublished document provided by Kristin Legg, Chief of Resource Management, Oct. 12.

Medicago sativa	alfalfa	Fabaceae
Melilotus officinalis	yellow sweet-clover	Fabaceae
Panicum capillare	witchgrass	Poaceae
Phleum pratense	timothy	Poaceae
Plantago lanceolata	English plaintain	Plantaginaceae
Poa compressa	Canada bluegrass	Poaceae
Poa fendleriana+	muttongrass	Poaceae
Poa pratensis	Kentucky bluegrass	Poaceae
Polygonum aviculare	prostrate knotweed	Polygonaceae
Polygonum convolvulus	wild buckwheat	Polygonaceae
Rubus idaeus	raspberry	Rosaceae
Rumex crispus	curly dock	Polygonaceae
Salsola iberica	Russian thistle	Chenopodiaceae
Setaria viridis	green bristlegrass	Poaceae
Sisymbrium altissimum+	tumble mustard	Brassicaceae
Solanum rostratum	buffalobur	Solanaceae
Solanum sarrachoides	hairy nightshade	Solanaceae
Solanum trifolium+	cutleaf nightshade	Solanaceae
Sonchus asper	spiny sowthistle	Asteraceae
Tamarix ramosissima	salt cedar	Tamaricaceae
Taraxacum officinale	common dandelion	Asteraceae
Thlaspi arvense	field pennycress	Brassicaceae
Tragopogon dubius	yellow salsify or goatsbeard	Asteraceae
Trifolium repens	white clover	Fabaceae
Verbascum thapsus	flannel mullein	Scrophulariaceae
Verbena bracteata	prostrate vervain	Verbenaceae
Verbesina encelioides	golden crownbeard	Asteraceae

TOTAL 67 species

*new exotic species in 2000
+new exotic species in 2004

Appendix F: Bryce Canyon Vascular Plant List - 1998[86]

(Native and Non-Native)

Aceraceae
Acer glabrum Torr. (Rocky Mountain Maple)
Acer grandidentatum Nutt. (Bigtooth Maple)

Agavaceae
Yucca angustissima Engelm. ex Trel. (Narrow-leaved Yucca)
Yucca harrimaniae Trel. (Harriman Yucca)

Amaranthaceae
Amaranthus blitoides Wats. (Prostrate Pigweed)

Anacardiaceae
Rhus aromatica Ait. var. *trilobata* (Nutt.) Gray (Skunkbush)

Apocynaceae
Apocynum androsaemifolium L. (Spreading Dogbane)

Asclepidaceae
Asclepias asperula (Decne.) Woodson (Spider Milkweed)

Compositae
Achillea millefolium L. ssp. *lanulosa* (Nutt.) Piper (Milfoil Yarrow)
Agoseris aurantiaca (Hook.) Greene var. *purpurea* (Gray) Cronq. (Orange Agoseris)
Agoseris glauca (Pursh) Raf. var. *lanciata* (D.C. Eaton) Smiley (Pale Agoseris)
Antennaria dimorpha (Nutt.) T. & G. (Low Pussytoes)
Antennaria microphylla (Nutt.) T. & G. (Low Pussytoes)
Antennaria parvifolia Nutt. (Common Pussytoes)
Antennaria rosulata Rydb. (Breaks Pussytoes)
Arnica chamissonis Less. (Chamisso Arnica)
Arnica cordifolia Hook. (Heartleaf Arnica)
Artemisia carruthii Wood ex Carruth (Carruth Wormwood)
Artemisia dracunculus L. (Terraton)
Artemisia frigida Willd. (Fringed Sagebrush)
Artemisia ludoviciana Nutt. (Louisiana Wormwood)
Artemisia nova A. Nels. (Black Sagebrush)
Artemisia pygmaea Gray (Pygmy Sagebrush)
Artemisia tridentata Nutt. (Big Sagebrush)
Aster chilensis Nees (Pacific Aster)
Aster eatonii (gray) Howell (Eaton Aster)
Aster glaucodes Blake (Blueleaf Aster)
Aster integrifolius Nutt. (Thickstem Aster)
Aster occidentalis (Nutt.) T. & G. (Western Aster)

[86] Unpublished document provided by Kristin Legg, Chief of Resource Management, Oct. 12.

Balsamorhiza macrophylla Nutt. (Cutleaf Balsamroot)
Balsamorhiza sagittata (Pursh) Nutt. (Arrowleaf Balsamroot)
Brickellia oblongifolia Nutt. (Mohave Brickellbush)
Centaurea repens L. (Russian Knapweed)
Chenactis douglasii (Hook.) H. & A. (Douglas Dustymaiden)
Chrysothamnus depressus Nutt. (Dwarf Rabbitbrush)
Chrysothamnus linifolius Greene (Spreading Rabbitbrush)
Chrysothamnus nauseosus (Pallus) Britt. var. *glabratus* (Gray) Cronq. (Rubber Rabbitbrush)
Chrysothamnus parryi (Gray) Greene (Parry Rabbitbrush)
Chrysothamnus vaseyi (Gray) Greene (Vasey Rabbitbrush)
Chrysothamnus visciflorus (Hook.) Nutt. (Viscid Rabbitbrush)
Cirsium arizonicum (Gray) Petrak var. *nidulum* (Jones) Welsh (Arizona Thistle)
Cirsium calcareum (Jones) Woot. & Standl. var. *pulchellum* (Greene) Welsh (Cainville Thistle)
Cirsium rydbergiim Petrak (Rydberg Thistle)
Cirsium undulatum (Nutt.) Sprengel (Gray Thistle)
Crepis intermedia Gray (Gray Hawksbeard)
Crepis occidentalis Nutt. (Western Hawksbeard)
Crepis runcinata (James) T. & G. var. *glauca* (Nutt.) Welsh (Meadow Hawksbeard)
Erigeron abajoensis Cronq. (Agajo Daisy)
Erigeron canus Gray (Hoary Daisy)
Erigeron compositus Pursh (Fern-leaf Daisy)
Erigeron divergens T. & G. (Spreading Daisy)
Erigeron eatonii Gray (Eaton Daisy)
Erigeron flagellaris Gray (Trailing Daisy)
Erigeron pumilus Nutt. ssp. *concinnoides* Cronq. (Vernal Daisy)
Erigeron simplex Greene (Greene Daisy)
Erigeron speciosus (Lindl.) DC. var. *macranthus* (Nutt.) Cronq. (Oregon Daisy)
Erigeron ursinus D.C. Eaton (Bear Daisy)
Grindelia squarrosa (Pursh) Dunal (Curly Gumweed)
Gutierrezia sorothrae (Pursh) Britt. & Rusby (Broom Snakeweed)
Haplopappus armerioides (Nutt.) Gray (Thrifty Goldenweed)
Helianthella uniflora (Nutt.) T. & G. (Onehead Sunflower)
Helianthus annus L. (Common Sunflower)
Heterotheca jonesii (Blake) Welsh & Atwood (Jones Goldenaster)
Heterotheca villosa (Pursh) Shinn. (Hairy Goldenaster)
Hymenopappus filifolius Hook. var. *cinereus* (Rydb.) Johnston (Hyalineherb)
Hymenopappus filifolius Hook. var. *nanus* (Rydb.) Turner (Hyalineherb)
Hymenopappus filifolius Hook. var. *nudipes* (Maguire) Turner (Hyalineherb)
Hymenoxys acaulis (Pursh) Parker (Stemless Woollybase)
Hymenoxys richardsonii (Hook.) Cockerell (Colorado Rubberweed)
Iva axillaris L. (Poverty Weed)
Lactuca serriola L. (Prickly Lettuce)
Lactuca tatarica (L.) C.A. Mey. ssp. *pulchella* (Pursh) Stebbins (Blue Lettuce)
Leucelene ericoides (Torr.) Greene (Rose-heath)
Lygodesmia grandiflora (Nutt.) T. & G. (Showy Rushpink)
Machaeranthera canescens (Pursh) Gray (Hoary Aster)

Machaeranthera grindelioides (Nutt.) Shinn. (Gumweed Aster)
Petradoria pumila (Nutt.) Greene (Rock Goldenrod)
Senecio atratus Greene (Black Groundsel)
Senecio multilobatus T. & G. (Uinta Groundsel)
Senecio spartioides T. & G. (Broom Groundsel)
Solidago missouriensis Nutt. (Missouri Goldenrod)
Solidago parryi (Gray) Greene (Parry Goldenrod)
Solidago sparsiflora Gray (Alcove Goldenrod)
Solidago spathulata DC. (Coast Goldenrod)
Stephanomeria spinosa (Nutt.) Tomb (Thorn Wirelettuce)
Stephanomeria tenuifolia (Torr.) Hall (Slender Wirelettuce)
Taraxacum officinale Weber ex Wiggers (Common Dandelion)
Tetradymia canescens DC. (Gray Horsebrush)
Townsendia exscapa (Richards.) T.C. Porter (Stemless Townsendia)
Townsendia incana Nutt. (Hoary Townsendia)
Townsendia montana Jones var. *minima* (Easw.) Beaman (Least Townsendia)
Tragopogon dubius Scop. (Goatsbeard)
Verbesina encelioides (Cav.) Benth. & Hook. (Crownbeard)
Viguiera multiflora (Nutt.) Blake (Showy Goldeneye)

Berberidaceae
Berberis fendleri Gray (Fendler Barberry)
Mahonia fremontii (Torr.) Fedde (Fremont Mahonia)
Mahonia repens (Lindl.) G. Don (Oregon Grape)

Betulaceae
Betula occidentalis Hook. (Water Birch)

Boraginaceae
Cryptantha abata Johnston (Low Cryptanth)
Cryptantha bakeri (Greene) Payson (Baker Cryptanth)
Cryptantha confertifolia (Greene) Payson (Golden Cryptanth)
Cryptantha fendleri (Gray) Greene (Cryptanth)
Cryptantha flava (A. Nels.) Payson (Yellow Cryptanth)
Cryptantha fulvocanescens (Wats.) Payson (Yellow-hair Cryptanth)
Cryptantha humilus (Greene) Payson (Dwarf Cryptanth)
Cryptantha cinerea (Torr.) Cronq. var. *jamesii* (Payson) Cronq. (James Cryptanth)
Cryptantha ochroleuca Higgins (Yellowish Cryptanth)
Cryptantha setosissima (Gray) Payson (Fish Lake Cryptanth)
Cryptantha virginensis (Gray) Payson (Virgin Cryptanth)
Lappula occidentalis (Wats.) Greene (Western Stickseed)
Lithospermum incisum Lehm. (Showy Stoneseed)
Lithospermum multiflorum Torr. (Pretty Stoneseed)
Mertensia arizonica Greene (Tall Bluebell)

Cruciferae

Arabis demissa Greene (Rockcress)
Arabis holboellii Hornem. var. *fendleri* Wats. in Gray (Holboell Rockcress)
Capsella bursa-pastoris (L.) Medicus (Shepherds Purse)
Caulanthus cooperi (Wats.) Payson (Cooper Spindlestem)
Caulanthus crassicaulis (Torr.) Wats. (Spindlestem)
Coringia orientalis (Torr.) Wats. (Spindlestem)
Descurainia richardsonii (Sweet) Schulz (Richardson Tansy-mustard)
Descurainia sophia (L.) Webb ex Prantl (Tansy-mustard)
Draba subalpina Goodman & Hitchc. (Breaks Draba)
Erysimum asperum (Nutt.) DC. (Wallflower)
Erysimum inconspicuum (Wats.) MacMillan (Lesser Wallflower)
Lepidium densiflorum Schrader (Densecress)
Lepidium montanum Nutt. (Mountain Pepperweed)
Lesquerella intermedia (Wats.) Heller (Watson Bladderpod)
Lesquerella kingii Wats. (King Bladderpod)
Lesquerella rubicundula Rollins (Breaks Bladderpod)
Malcolmia africana R. Br. in Ait. (African Mustard)
Physaria chambersii Rollins (Twinpod)
Physaria newberryi Gray (Newberry Twinpod)
Schoencrambe linifolia (Nutt.) Greene (Rush Mustard)
Stanleya pinnata (Pursh) Britt. (Prince's Plume)
Streptanthus cordatus Nutt. ex T. & G. (Twistflower)
Thelypodiopsis sagittata (Nutt.) Schulz var. *ovalifolia* (Rydb.) Welsh (Sagitate Thelypod)
Thlapsi arvense L. (Field Pennycress)

Cactaceae
Opuntia erinacea Engelm. (Pricklypear)
Pediocactus simpsonii (Engelm.) Britt. & Rose (Simpson Footcactus)

Campanulaceae
Campanula parryi Gray (Parry Bellflower)
Campanula rotundifolia L. (Bluebells of Scotland)

Capparaceae
Cleome lutea Hook. (Yellow Beeplant)
Cleome serrulata Pursh (Rocky Mountain Beeplant)

Caprifoliaceae
Sambucus caerulea Raf. (Blue Elderberry)
Symphoricarpos oreophilous Gray var. *utahensis* (Rydb.) A. Nels. (Mountain Snowberry)

Caryophyllaceae
Arenaria fendleri Gray (Fendler Sandwort)
Arenaria nuttallii Pax (Nuttall Sandwort)
Lychnis drummondii (Hook.) Wats. (Drummond Catchfly)
Paronychia sessilflora Nutt. (Creeping Nailwort)

Silene petersonii Maguire (Maguire Campion)
Stellaria jamesiana Torr. (Chickweed)
Stellaria longipes Goldie (Long-stalked Starwort)

Celastraceae
Pachistima myrsinites (Pursh) Raf. (Mountain Lover)

Chenopodiaceae
Atriplex canescens (Pursh) Nutt. (Four-wing Saltbush)
Atriplex gardneri (Moq.) D. Dietr. var. *tridentata* (Kuntze) Macbr. (Basin Saltbush)
Ceretoides lanata (Pursh) J. T. Howell (Winterfat)
Chenopodium atrovirens Rydb. (Mountain Goosefoot)
Chenopodium fremontii Wats. var. *incanum* Wats. (Fremont Goosefoot)
Chenopodium leptophyllum (Moq.) Wats. (Narrowleaf Goosefoot)
Salsola iberica Sennen & Pau (Russian-thistle)

Convolvulaceae
Convolvulus arvensis L. (Bindweed)

Cornaceae
Cornus sericea L. (Red-osier Dogwood)

Cupressaceae
*Juniper*us *communis* L. (Common Juniper)
Juniperus osteosperma (Torr.) Little (Utah Juniper)
Juniperus scopulorum Sarg. (Rocky Mountain Juniper)

Cyperaceae
Carex athrostachrya Olney (Slender-beaked Sedge)
Carex aurea Nutt. (Golden Sedge)
Carex canescens L. (Pale Sedge)
Carex douglasii F. Boot in Hook. (Douglas Sedge)
Carex stenophylla Wahl. (Narrowleafed Sedge)
Carex microptera Mack. (Small-wing Sedge)
Carex nebrascensis Dewey (Nebraska Sedge)
Carex oederi Retz. (Green Sedge)
Carex praegracilis W. Boott (Blackcreeper Sedge)
Carex rossii F. Boott (Ross Sedge)
Carex rostrata Stokes ex With. (Beaded Sedge)
Eleocharis pauciflora (Light.) Link (Spike-rush)
Eleocharis rostellata (Torr.) Torr. (Spike-rush)
Scirpus americanus Pers. (Olney Threesquare)

Elaeagnaceae
Shepherdia argentia (Pursh) Nutt. (Silver Buffaloberry)
Shepherdia canadensis (L.) Nutt. (Soapberry)

Shepherdia rotundifolia Parry (Roundleaf Buffaloberry)

Equisetaceae
Equisetum arvense L. (Meadow Horsetail)
Equisetum laevigatum A. Br. (Smooth Scouringrush)

Ephedraceae
Ephredra viridis Cov. (Green Ephedra/Mormon Tea/Brigham Tea)

Ericaceae
Arctostaphylos patula Greene (Greenleaf Manzanita)
Arctostaphylos pungens H.B.K. (Mexican Manzanita)
Arctostaphylos uva-ursi (L.) Sprengel) (Kinnikinnick/Bearberry/Sandberry)

Euphorbiaceae
Euphorbia fendleri T. & G. (Fendler Euphorb)
Euphorbia brachycera Engelm. in Emory. (Shorthorn Spurge)

Fagaceae
Quercus gambelii Nutt. (Gambel Oak)

Gentianaceae
Gentiana affinis Griseb. (Rocky Mountain Gentian)
Gentianella amarella (L.) Borner (Northern Gentian)
Gentianella tenella (Rottb.) Borner (Lapland Gentian)
Gentianopsis detonsa (Rottb.) Ma (Meadow Gentian)
Swertia radiata (Kellogg) Kuntze (Elkweed/Green Gentian)

Geraniaceae
Geranium caespitosum James (Small-leaf Geranium)
Geranium richardsonii Fisch. & Trautv. (Richardson Geranium)
Geranium viscosissimum Fisch. & Mey. (Sticky Geranium)

Gramineae
Agropyron cristatum (L.) Gaertner (Crested Wheatgrass)
Agrostis stolonifera L. (Redtop/Carpet Bentgrass)
Aristida purpurea Nutt. (Purple Threeawn)
Arundo donax L. (Giant Reed)
Bouteloua gracilis (H.B.K.) Lag. ex Stuedel (Blue Grama)
Bromus anomalus Rupr. ex Fourn. (Nodding Brome)
Bromus carinatus H. & A. (Mountain or California Brome)
Bromus ciliatus L. (Fringed Brome)
Bromus inermis Leysser (Smooth or Hungarian Brome)
Bromus japonicus Thunb. ex Murray (Japanese or Meadow Chess)
Bromus tectorum L. (Cheatgrass)
Calamagrostis scopulorum Jones (Jones Reedgrass)

Calamagrostis stricta (Timm) Koeler (Slimstem or Northern Reedgrass)
Dactylis glomerata L. (Orchard Grass)
Deschampsia cespitosa (L.) Beauv. (Tufted Hairgrass)
Elymus canadensis L. (Canada Wildrye)
Elymus elymoides (Raf.) Swezey (Squirreltail)
Elymus junceus Fisch. (Russian Wildrye)
Elymus lanceolatus (Scribn. & Sm.) Gould (Thickspike Wheatgrass)
Elymus salinus Jones (Salina Wildrye/Bullgrass)
Elymus scribneri (Vasey) Jones (Scribner or Spreading Wheatgrass)
Elymus smithii (Rydb.) Gould (Western Wheatgrass)
Elymus spicatus (Pursh) Gould (Bluebunch Wheatgrass)
Elymus trachycaulus (Link) Gould ex Shinners (Slender Wheatgrass)
Festuca ovina L. (Sheep Fescue)
Festuca pratensis Hudson (Meadow Fescue)
Glyceria striata (Lam.) A. S. Hitchc. (Fowl Mannagrass)
Hilaria jamesii (Torr.) Benth. (Galleta or Curlygrass)
Hordeum brachyantherum Nevski (Meadow Barley)
Hordeum jubatum L. (Foxtail Barley)
Koeleria macrantha (Ledeb.) Schultes (Junegrass)
Muhlenbergia andina (Nutt.) A. S. Hitchc. (Foxtail Muhly)
Muhlenbergia asperifolia (Nees & Mey.) Parodi (Scratchgrass)
Muhlenbergia montana (Nutt.) A. S. Hitchc. (Mountain Muhly)
Muhlenbergia pungens Thurber in Gray (Sandhill Muhly)
Muhlenbergia richardsonis (Trin.) Rydb. (Mat Muhly)
Oryzopsis micrantha (Trin. & Rupr.) Thurber (Littleseed Ricegrass)
Phleum pratense L. (Timothy)
Poa compressa L. (Canada Bluegrass)
Poa fendleriana (Steudel) Vasey (Muttongrass)
Poa pratensis L. (Kentucky Bluegrass)
Poa reflexa Vasey & Scribn. (Nodding Bluegrass)
Poa secunda Presl (Sandberg Bluegrass)
Puccinellia nuttalliana (Schultes) A. S. Hitchc. (Nuttall Alkaligrass)
Schizachyrium scoparium (Michx.) Nash in Small (Little Bluestem)
Sporobolus airoides (Torr.) Torr. (Alkali Saccaton)
Stipa comata Trin. & Rupr. (Needle-and-thread Grass)
Stipa hymenoides R. & S. (Indian Ricegrass)
Stipa lettermanii Vasey (Letterman Needlegrass)
Stipa nelsonii Scribn. (Nelson Needlegrass)
Stipa x Bloomeri Bolander (Bloomer Ricegrass)

Iridaceae
Iris missouriensis Nutt. (Missouri Iris)
Sisyrinchium demissum A. Dietr. (Purple-eyed Grass)

Juncaceae
Juncus articus Willd. (Wiregrass)

Juncus bufonius L. (Toad Rush)
Juncus ensifolius Wikstrom var. *brunnescens* (Rydb.) Cronq. (Swordleaf Rush)
Juncus longistylis Torr. in Emory (Longstyle Rush)
Juncus torreyi Cov. (Torrey Rush)

Juncaginaceae
Triglochin maritima L. (Maritime Arrowgrass)
Triglochin palustris L. (Marsh Arrowgrass)

Labiatae
Dracocephalum parviflorum Nutt. (Dragon's Head)
Hedeoma drummondii Benth. (Mock Pennyroyal)
Marrubium vulgare L. (Common Horehound)
Monardella odoratissima Benth. (Mountain Monardella)
Prunella vulgaris L. (Heal-all)

Leguminosae
Astragalus agrestis Dougl. ex G. Don (Field Milkvetch)
Astragalus amphioxys Gray (Crescent Milkvetch)
Astragalus argophyllus Nutt. ex T. & G. (Meadow Milkvetch)
Astragalus bisulcatus (Hook.) Gray (Two-grooved Milkvetch)
Astragalus calycosus Torr. ex Wats. (Torrey Milkvetch)
Astragalus convallarius Greene var. *convallarius* Lesser Rushy Milkvetch)
Astragalus desperatus Jones var. *desperatus* (Rimrock Milkvetch)
Astragalus hallii Gray var. *fallax* (Wats.) Barneby (Field Milkvetch)
Astragalus humistratus Gray (Groundcover Milkvetch)
Astragalus kentrophyta Gray (Kentophyta)
Astragalus lonchocarpus Torr. (Great Rushy Milkvetch)
Astragalus megacarpus (Nutt.) Gray (Great Bladdery Milkvetch)
Astragalus miser Dougl. ex Hook. (Weedy Milkvetch)
Astragalus newberryi Gray var. *castoreus* (Newberry Milkvetch)
Astragalus tenellus Pursh (Pulse Milkvetch)
Hedysarum boreale Nutt. (Northern Sweetvetch)
Lathyrus brachycalyx Rydb. (Rydberg Sweetpea)
Lotus utahensis Ottley (Utah Trefoil)
Lotus wrightii Ottley (Wright Trefoil)
Lupinus argenteus Pursh (Silvery Lupine)
Lupinus kingii Wats. var. *kingii* (King Lupine)
Lupinus sericeus Pursh var. *marianus* (Rydb.) Welsh (Silky Lupine)
Medicago lupulina L. (Black Medic)
Medicago sativa L. (Alfalfa)
Melilotus officinalis (L.) Pallas (Yellow Sweet-clover)
Oxytropis deflexa (Pallas) DC. var. *sericea* T. & G. (Stemmee Oxytrope)
Oxytropis jonesii Barneby (Jones Oxytrope)
Oxytropis oreophila Gray var. *oreophila* (Mountain Oxytrope)
Pediomelum pariense (Welsh & Atwood) Welsh (Paria Breadroot)

Trifolium repens L. (White Clover)
Viscia americana Muhl. ex Willd. (American Vetch)

Lilliaceae
Allium acuminatum Hook. (Wild Onion)
Allium biceptrum Wats. (Wild Onion)
Allium nevadense Wats. (Wild Onion)
Asparagus officinalis L. (Asparagas)
Calochortus flexuosis Wats. (Mariposa Lily)
Calochortus nuttallii T. & G. in Beckwith (Sego Lily)
Fritillaria atropurpurea Nutt. (Leopard-Lily)
Leucocrinum montanum Nutt. ex Gray (Star-Lily)
Smilacina stellata (L.) Desf. (False Solomon's Seal)
Zygadenus elegans Pursh (Elegant Death Camas)

Linaceae
Linum aristatum Engelm. (Broom-flax)
Linum kingii Wats. (Yellow Flax/King Flax)
Linum perenne L. (Blue Flax)

Loasaceae
Mentzelia multiflora (Nutt.) Gray (Blazing Star)

Malvaceae
Sphaeralcea coccinea (Nutt.) Rydb. (Common Globemallow)
Sphaeralcea parvifolia A. Nels. (Nelson Globemallow)

Nyctaginaceae
Abronia fragrans Nutt. ex Hook. (Fragrant Sand-verbena)
Abronia nana Wats. (Low Sand-verbena)

Onagraceae
Calylophus lavandulifolius (T. & G.) Raven (Lavendar-leaf Evening-primrose)
Eplibolium angustifolium L. (Fireweed)
Eplibolium ciliatum Raf. (Northern Willowherb)
Gayophytum humile A. L. Juss. (Ground Smoke)
Gayophytum racemosum T. & G. (Ground Smoke)
Oenothera caespitosa Nutt. (Morning-lily)
Oenothera coronopifolia T. & G. (Rootstock Evening-primrose)
Oenothera flava (A. Nels) Garrett (Yellow Evening-primrose)
Oenothera howardii (A. Nels.) W. L. Wagner (Bronze Evening-primrose)
Oenothera pallida Lindl. (Pale Evening-primrose)

Orchidaceae
Corallorhiza maculata Raf. (Spotted Coralroot)
Corallorhiza striata Chatel. (Early Coralroot)

Epipactis gigantea Dougl. ex Hook. (Helleborine)
Habenaria sparsiflora Wats. (Watson Bog-orchid)

Orobanchaceae
Orobanche fasciculata Nutt. (Cluster Cancerroot)

Papaveraceae
Eschscholzia californica Cham. (California Poppy)

Pinaceae
Abies concolor (Gord. & Glend.) Lindl. (White fir)
Picea pungens Engelm. (Blue Spruce)
Pinus edulis Engelm. (Pinyon/Two-needle Pinyon)
Pinus flexilis James (Limber Pine)
Pinus longaeva D. K. Bailey (Western Bristlecone)
Pinus ponderosa Lawson (Ponderosa Pine)
Pseudotsuga menziesii (Mirbel) Franco (Douglas Fir)

Plantaginaceae
Plantago eriopoda Torr. (Plantain)
Plantago lanceolata L. (Plantain)

Polemoniaceae
Gilia aggregata (Pursh) Sprengel (Scarlet Gilia)
Gilia congesta Hook. var. *congesta* (Ballhead Gilia)
Leptodactylon pungens (Torr.) Nutt. (Prickly Phlox)
Linanthastrum nuttalii (Gray) Ewan (False Phlox)
Phlox austromontana Cov. (Desert Phlox)
Phlox hoodii Richards (Carpet Phlox)
Phlox longifolia Nutt. (Longleaf Phlox)
Phlox muscoides Nutt. (Moss Phlox)
Polemonium caeruleum L. (Blue Jacobsladder)
Polemonium viscosum Nutt. (Viscid Jacobsladder)

Polygonaceae
Eriogonum alatum Torr. in Sitgr. (Winged Buckwheat)
Eriogonum corymbosum Benth. (Corymb Buckwheat)
Eriogonum microthecum Nutt. (Slender Buckwheat)
Eriogonum panguicense (Jones) Reveal (Panguitch Buckwheat)
Eriogonum racemosum Nutt. (Redroot Buckwheat)
Eriogonum subreniforme Wats. (Stokes Buckwheat)
Eriogonum umbellatum Wats. var. *subaridum* Stokes (Arid Buckwheat)
Polygonum aviculare L. (Creeping Jenny)
Polygonum douglasii Greene var. *johnstonii* Munz (Sawatch Knotweed)
Polygonum ramosissimum Michx. (Bushy Knotweed)
Polygonum viviparum L. (Alpine Bistort)

Rumex crispus L. (Curled Dock)
Rumex salicifolius Weinm. (Beach Dock)

Polypodiaceae
Cheilanthes feei Moore (Fee Lipfern)
Pteridium aquilinum (L.) Kuhn (Bracken Fern)

Primulaceae
Androsace septentrionalis L. (Rock Jasmine)
Dodecatheon pulchellum (Raf.) Merr. (Pretty Shooting-star)

Pyrolaceae
Pterospora andromedea Nutt. (Pinedrops)
Pyrola asarifolia Michx. (Liver-leaf Wintergreen)
Pyrola virens Schweigger in Schweigg. (Greeninsh Wintergreen)

Ranunculaceae
Aconitum columbianum Nutt. in T. & G. (Monkshood)
Anemone multifida Poir. (Cutleaf Anemone)
Aquilegia caerulea James (Colorado Columbine)
Aquilegia scopulorum Tidestr. (Rock Columbine)
Clematis ligusticifolia Nutt. (White Virgins-bower)
Clematis columbiana (Nutt.) T. & G. (Rocky Mountain Clematis)
Delphinium andersonii Gray *var. scaposum* (Greene) Welsh (Anderson Larkspur)
Ranunculus cymbalaria Pursh (Marsh Buttercup)
Ranunculus flammula L. (Creeping Spearwort)
Ranunculus inamoenus Greene (Drab Buttercup)
Ranunculus flabellaris Raf. (Yellow Water-crowfoot)
Thalictrum fendleri Engelm. ex Gray (Fendler Meadowrue)

Rhamnaceae
Ceanothus fendleri Gray (Fendler Mountain-lilac)
Ceanothus martinii Jones (Utah Mountain-lilac)

Rosaceae
Amelanchier utahensis Koehne (Utah Serviceberry)
Cercocarpus ledifolius Nutt. in T. & G. (Curl-leaf Mountain Mahogany)
Cercocarpus montanus Raf. (Aldeer-leaf Mountain Mahogany)
Fallugia paradoxa (D. Don) Endl. (Apache Plume)
Frageria vesca L. (Starvling Strawberry)
Frageria virginiana Duchesne (Mountain Strawberry)
Holodiscus dumosus (Nutt.) Heller (Mountain Spray)
Ivesia sabulosa (Jones) Keck (Sevier Ivesia)
Peraphyllum ramosissimum Nutt. in T. & G. (Squawapple)
Potentilla anserina L. (Common Silverweed)
Potentilla crinita Gray (Hair-tuft Cinquefoil)

Potentilla fruticosa L. (Shrubby Silverweed)
Potentilla gracilis Dougl. ex Hook. (Slender Cinquefoil)
Potentilla plattensis Nutt. (Platte Cinquefoil)
Prunus virginiana L. (Chokecherry)
Purshia mexicana (D. Don) Welsh (Cliff-rose)
Purshia tridentata (Pursh) DC. (Bitterbrush)
Rosa nutkana Presl (Nutka Rose)
Rosa woodsii Lindl. (Woods Rose)
Rubus idaeus L. (Raspberry)

Rubiaceae
Galium trifidum L. (Small Bedstraw)
Kelloggia Galioides Torr. (Pseudobedstraw)

Salicaceae
Populus angustiolia James (Narrowleaf Cottonwood)
Populus fremontii Wats. (Fremont Cottonwood)
Populus tremuloides Michx. (Aspen)
Salix bebbiana Sarg. (Bebb Willow)
Salix drummondiana Barratt in Hook (Drummond Willow)
Salix exigua Nutt. (Narrowleaf Willow)
Salix geyeriana Anderss. (Geyer Willow)
Salix lasiandra Benth. (Whipllash Willow)

Santalaceae
Comandra umbellata (L.) Nutt. (Bastard Toadflax)

Saxifragaceae
Lithophragma tenella Nutt. in T. & G. (Slender Woodlandstar)
Parnassia palustris L. (Grass-of-Parnassus)
Ribes aureum Pursh (Golden Currant)
Ribes cereum Dougl. (Wax or Squaw Currant)

Scrophulariaceae
Castilleja chromosa A. Nels. (Common Paintbrush)
Castilleja linariifolia Benth. (Narrowleaf Paintbrush)
Castilleja parvula Rydb. var. revealii (Tushar Paintbrush)
Cordylanthus kingii Wats. (King Birdsbeak)
Cordylanthus wrightii Gray (Wright Birdsbeak)
Mimulus guttatus DC. (Common Monkey-flower)
Mimulus rubellus Gray (Annual Monkey-flower)
Orthocarpus luteus Nutt. (Yellow Owl-clover)
Orthocarpus Purpureo-albus Gray (Owl-clover)
Pedicularis centranthera Gray (Pinyon-Juniper Lousewort)
Penstemon bracteatus Keck (Platy Penstemon)
Penstemon caespitosus Nutt. var. *desertipicti* (A. Nels.) N. Holmgren (Mat Penstemon)

Penstemon comarrhenus Gray (Dusty Penstemon)
Penstemon eatonii Gray (Eaton Penstemon)
Penstemon leiophyllus Pennell (Markagunt Penstemon)
Penstemon rostriflorus Kellogg (Bridges Penstemon)
Penstemon rydbergii A. Nels. (Rydberg Penstemon)
Penstemon utahensis Eastw. (Utah Penstemon)
Verbascum thapsus L. (Woolly Mullein)
Veronica americana Schwein. ex Benth. (American Brooklime)

Solanaceae
Solanum triflorum Nutt. (Cutleaf Nightshade)

Tamaricaceae
Tamarix ramosissima Ledeb. (Tamarisk; Salt Cedar)

Umbelliferae
Cicuta maculata L. (Water Hemlock)
Cymopterus lemmonii (Coult. & Rose) Dorn (Lemmon Spring-parsley)
Cymopterus purpurascsens (Gray) Jones (Widewing Spring-parsley)
Cymopterus purpureus Wats. (Variable Spring-parsley)
Ligsticum porteri Coult. & Rose (Southern Ligusticum)
Ligsticum filicinum Wats. (Fernleaf Ligusticum)
Lomatium kingii (Wats.) Cronq. (Stinking Lomatium)
Lomatium minimum (Mathias) Mathias (Least Lomatium)

Valerianaceae
Valeriana acutiloba Rydb. (Valerian)
Valeriana edulis Nutt. ex T. & G. (Tobacco Root)

Verbenaceae
Verbena bracteata Lag. & Rodr. (Prostrate Verain)

Violaceae
Viola adunca J.E.Sm. ex Rees (Blue Violet)
Viola purpurea Kellogg (Pine Violet)

Viscaceae
Arceuthobium cyanocarpum Coult. & Nels. (Limber Pine Dwarf-mistletoe)
Arceuthobium divaricatum Engelm. (Pinyon Dwarf-mistletoe)
Arceuthobium douglasii Engelm. (Douglas Fir Dwarf-mistletoe)
Arceuthobium vaginatum (Willd.) Presl in Bercht. (Southwestern Dwarf-mistletoe)
Phorodendron juniperinum Gray (Juniper Mistletoe)