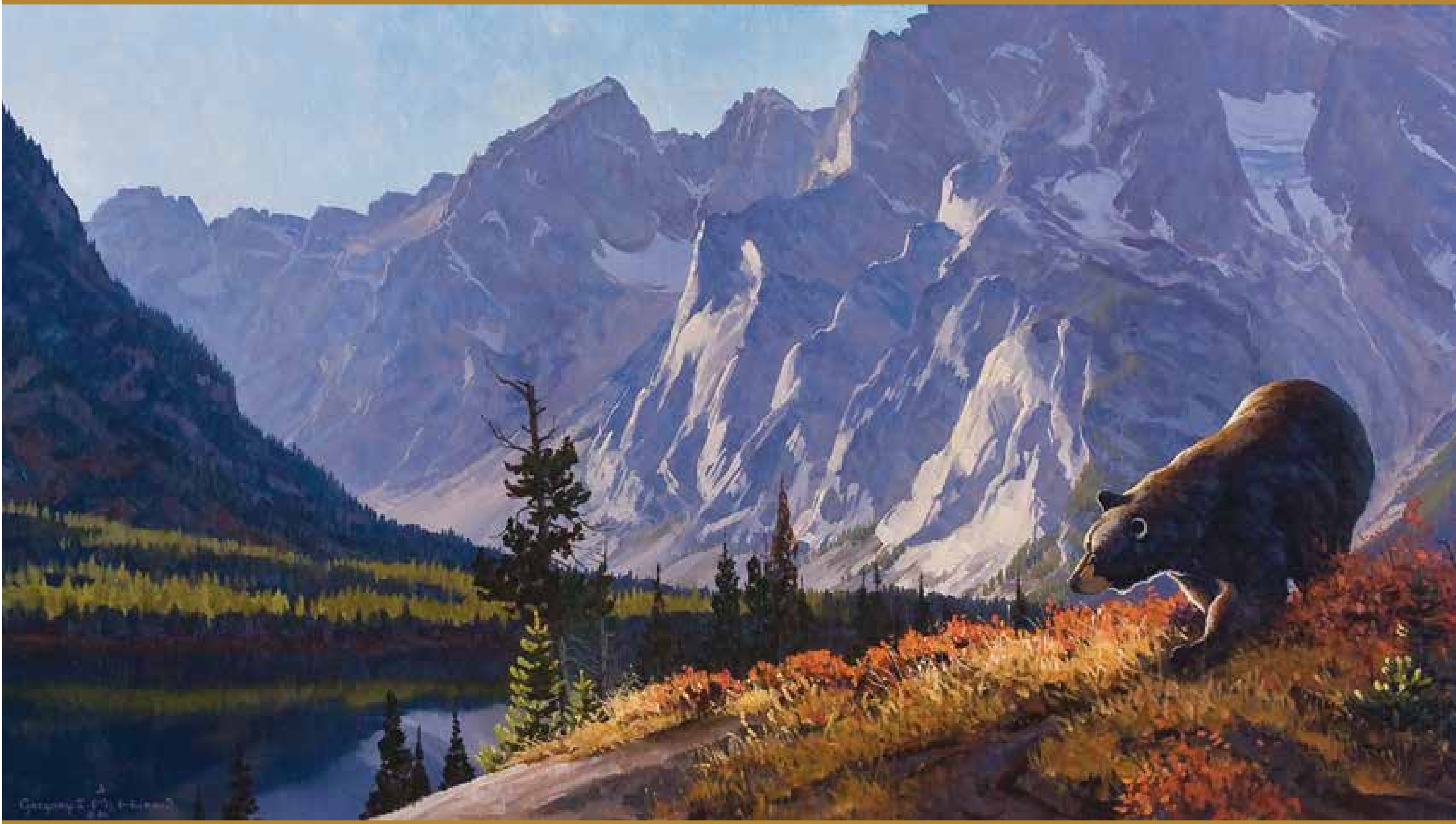
Science and Resource Management
Grand Teton National Park
& John D. Rockefeller, Jr. Memorial Parkway

National Park Service
U.S. Department of the Interior



GRAND TETON NATIONAL PARK
& John D. Rockefeller, Jr. Memorial Parkway

Natural and Cultural Resources

VITAL SIGNS 2016

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Grand Teton National Park Foundation and Grand Teton Association.

Science and Resource Managment
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Cover painting: Leigh Lake Berrypicker by Greg McHuron. Painted 1984. Gift from the Grand Teton Association to Grand Teton National Park.

Where not otherwise indicated, photos in this report are courtesy of the National Park Service.

A pair of trumpeter swans and a grizzly bear take note of each other.

Why We Monitor the Park's Resources

The National Park Service was established in 1916 with the mission of protecting the resources of the parks and providing for the public enjoyment of those same resources in such manner that the resources will remain unimpaired for future generations. While Grand Teton National Park was not created until 1929 (and expanded in 1950), the mission remains the same. To protect and manage the wide variety of natural and cultural resources held within the park, resource management staff monitor and study individual resources and ecological processes—vital signs—to better inform decisions made in the park. Systematic monitoring is complicated by the fact that air, water resources, and many of the animals' seasonal migrations cross the boundaries of the park where other factors influence their condition. Inside the park, plant and animal species have been introduced both accidentally and intentionally that may change or affect native species. Pressure from humans, both within Grand Teton National Park and outside, may also affect conditions in the park. Data collected on some resources may be too limited to predict significant trends, but hopefully will provide a baseline for future study. Resources summarized in this report are monitored because of their significance to or influence on this ecosystem.

Vital Signs Summaries

Grand Teton's vital signs summaries are grouped into four categories for purposes of this report. They include:

- **Climate and Environment** (air quality, climate, fire, glaciers, soundscape, and water) are primarily the result of natural processes that operate on a distinctly larger scale than the park, but can be affected by human activities both within and outside the park.
- **Natural Resources:** selected plants and animals that
  - are or have been listed under the federal Endangered Species Act (bald eagle, gray wolf, grizzly bear, and peregrine falcon).
  - have experienced declines in the park and surrounding areas or are of special concern due to the lack of data (golden eagle, great blue heron, great gray owl, greater sage-grouse, moose, trumpeter swan, and whitebark pine).
  - have relatively small populations in the park and are considered vulnerable (bighorn sheep, Columbia sharp-tailed grouse, common loon, harlequin, pronghorn, and red fox).
  - have a significant impact on the ecosystem and park management based on such factors as their large number, size, and movement outside the park, or where they are harvested (bison, elk, and mule deer).
  - are considered important indicators of ecosystem health because they are especially sensitive to environmental pollutants, habitat alteration, and climate change (sagebrush steppe, amphibians, and osprey).
- **Cultural Resources** (archeological sites, historic structures, and museum collections) are significant representations of the human evidence in or on the park and are inventoried, protected, and monitored to ensure that these resources and the information associated with them are passed along to future generations.
- **Challenges** (nonnative plants and animals, grazing, park visitation, plant restoration, wildlife collisions, and the human-bear interface) are generally caused or largely influenced by human activity.

Comparison to Reference Conditions

The table on the following page summarizes the current status of selected resources. In most cases, a reference condition is indicated that can be used for comparison purposes. Because conditions may fluctuate widely over time in response to natural factors, the reference condition is not considered the "desired" condition unless it is one that has been specified by government regulation or a plan. In other cases, the reference condition simply provides a measure for understanding the current condition, e.g., a historical range or scientific opinion as to the level needed to maintain biological viability.

Vital Signs Summary

TBD = to be determined

Resource	Indicators	Current Condition 2016 (or latest available)	Reference Condition
Climate and Environment			
Air Quality	Basic air quality parameters at 1 site	Class I Airshed	Clean Air Act
Climate	Average min., max. daily temp. (Moose) Annual precipitation (Moose) Growing degree days (Moose)	24°F, 55°F 24.91″ 2,733 days (2012)	22°F, 52°F (1958–2016 average) 21.33″ (1958–2016 average) 2,367 (1958–2012 average)
Fire	Acres burned per year by wildfire	19,211 acres	1–19,211 (1997–2016 range)
Glaciers	Extent of 10 named glaciers	1.5 km²	Long-term decline
Water Quality	Basic water quality parameters- 2 river sites Basic water quality parameters- 3 alpine lakes	Iron exceeds state standards Nitrogen in Delta Lake exceeds federal reference	State water quality standards Federal ambient water quality reference conditions
Natural Resources			
Amphibians	% of potential sites suitable for breeding	69%	TBD
Bald Eagles	Breeding pairs	11 pairs	12 pairs (2007–2016 average)
Bighorn Sheep	Teton Range herd estimate	80–100 sheep	TBD
Bison	Jackson herd winter count (includes areas outside park)	666 bison	500 bison
Common Loon	Breeding pairs	1 pair	TBD
Elk	Jackson herd winter count (includes areas outside park) Summer count (portion of park herd)	11,200 elk ≥1051 elk	11,000 elk ≤1600
Gray Wolves	Wolves in Wyoming (outside of Yellowstone) Breeding pairs in WY (outside of Yellowstone)	269 wolves (37 in park) 18 pairs (2 in park)	≥100 wolves ≥10 pairs
Great Blue Heron	Active nests	26 nests	20 nests (1991–2016 average)
Greater Sage-grouse	Active leks	7 leks (6 in park)	9 occupied leks (8 in park)
Grizzly Bears	GYE population estimate Distribution of females with cubs Mortality: Independent females (≥ 2 yrs old) • Independent males (≥ 2 years old) • Dependent young (human-caused only)	690 17 bear management units 5.0% 15.5% 4.2%	≥500 grizzly bears ≥16 bear management units not > 9% not > 20% not > 9%
Moose	Jackson herd winter count	≥228 (63 in park)	TBD
Osprey	Breeding pairs	10 pairs	12 pairs (2007–2016 average)
Peregrine Falcon	Breeding pairs	5 pairs	4 pairs (2007–2016 average)
Pronghorn	Jackson Hole/Gros Ventre herd estimate	953 pronghorn	Increasing trend
Trumpeter Swans	Occupying breeding territories (includes areas outside park) Pairs producing young	9 pairs (6 pairs in park) 3 pair (7 cygnets fledged)	18 historic territories (13 in park) TBD
Whitebark Pine	Blister rust infection (% of trees in park)	52% of trees	TBD
Cultural Resources			
Archeological Sites	Percentage of park inventoried Percentage of documented sites in good condition	4.5% of the park 42%	TBD TBD
Historic Structures	Percentage assessed in good condition	72%	TBD
Museum Collections	Percentage that has been catalogued	80%	100%
Challenges			
Aquatic Invasive Species	Presence of non-native species	13	0 (limit spread & effects on native sp.)
Fish	Species present	12 native 9 non-native	12 native 0 (limit spread & effects on native sp.)
Human-Bear Conflicts	Injuries, food obtained, or property damaged	8 in park	13 (2008–2016 annual average)
Invasive Plants	Species present Acres treated	28 invasive species 1568 acres	0 (limit spread & effects on native sp.)
Mountain Goats	Estimated number in park	60–80 goats	0 (limit spread & effects on native sp.)
Plant Restoration	Restoring native plant communities in former agricultural fields (Kelly hayfields)	1263 acres under restoration treatment	100% of 4500 acres in the former Kelly hayfields area

Reference condition specified by government regulation or management plan. (shaded rows: Air Quality, Water Quality, Bison, Elk, Gray Wolves, Grizzly Bears, Plant Restoration)

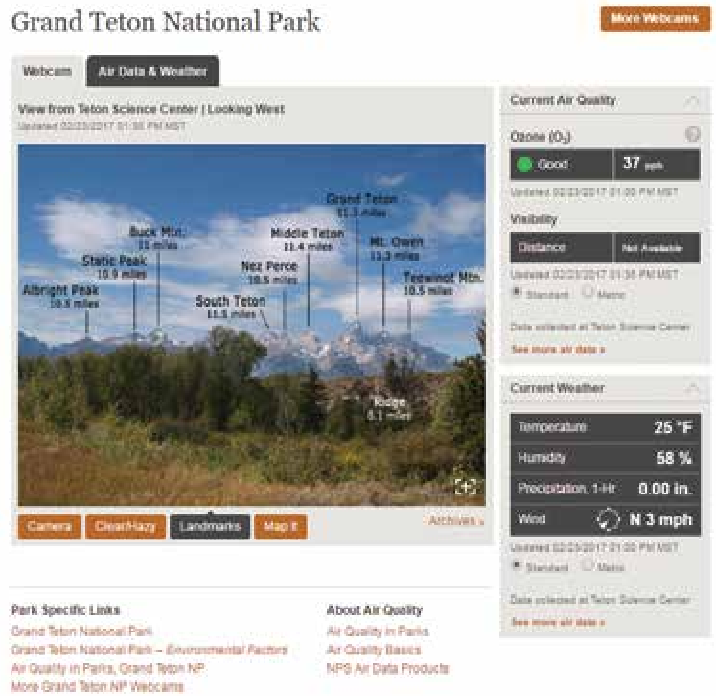
Air Quality

While Grand Teton National Park experiences good air quality, the park is downwind of significant pollutant sources including power plants, agricultural areas, industry, and oil and gas development. Pollutants emitted from these sources can harm the park's natural and scenic resources such as surface and ground waters, soils, vegetation, fish, and visibility.

As a federally designated Class I airshed, Grand Teton is required to meet high standards for air quality. Since 2011, Grand Teton operates an air quality monitoring station that measures wet deposition, primarily nitrogen, meteorological data, ozone, ammonia, and visibility. In 2016, we renewed the 5-year agreement with the State of Wyoming and the NPS Air Resource Division to continue operating the station. The link for real-time results from this station, including a webcam is http://www.nature.nps.gov/air/WebCams/parks/grtecam/grtecam.cfm. Data from this station and other scientific research indicate that the park is in compliance with federal standards for human health for ozone, sulfur dioxide, and particulate matter. However, air quality trends may be affecting other aspects of the ecosystem.

Nitrogen and sulfur compounds deposited from air pollution can harm surface waters, soils, and vegetation. High-elevation ecosystems in the park are particularly sensitive to sulfur and nitrogen deposition. Not only do these systems receive more deposition than lower elevation areas because of greater amounts of snow and rain, but short growing seasons and shallow soils limit the capacity of soils and plants to buffer or absorb sulfur and nitrogen. High-elevation lakes, especially, are sensitive to acidification from sulfur and nitrogen deposition and excess nitrogen enrichment. Acidification may cause loss of sensitive macroinvertebrates and fish, while enrichment may alter lake diversity. Alpine plant communities are also vulnerable to nitrogen enrichment, which may favor some species at the expense of others. Measurements indicate higher atmospheric nitrogen inputs to the north of the park and lower levels to the south—a gradient reflected in nitrogen concentrations in rain and snow, soils, and plants. Concentrations of ammonium in wet deposition from regional agricultural sources are elevated and increasing at sites in or near to the park.

Ozone, a criteria pollutant regulated under the National Ambient Air Quality Standards, varies by hour of the day and by season. Grand Teton has generally lower levels than nearby Yellowstone, but patterns in the data suggest that local sources of pollutants affect the daily levels.



The Grand Teton National Park webpage for air quality includes the distance of landmarks visible on the webcam for reference.

Visitors come to Grand Teton to enjoy spectacular views of the Teton Range and the Jackson Hole valley. Sometimes the park's scenic vistas are obscured by haze caused by fine particles in the air. Many of the same pollutants that ultimately fall out as nitrogen and sulfur deposition contribute to this haze and visibility impairment. Additionally, organic compounds, soot, and dust reduce visibility. In the region, average natural visual range is reduced from about 180 miles (without the effects of pollution) to about 120 miles because of pollution. The visual range is reduced to below 70 miles on high pollution days and can be even less on days with smoke. While natural fire is recognized for its ecological benefits, smoke from forest fires significantly contributes to particulate matter in the region. Periods of reduced visibility from forest fire smoke is typical in late summer and was a factor even prior to human occupation.

Glaciers

Grand Teton National Park has 10 named glaciers, formed during a short cold period called the Little Ice Age (1400-1850). Some of these glaciers are active, while others are considered remnant because they have lost so much volume they have stopped flowing. Glaciers store water at high elevations that provide critical input to the landscape and to aquatic systems, particularly in years of below-average precipitation. Changes in glacial extent and volume are significant indicators of changing climate and, as in nearly all glaciated areas of the globe, recent studies show significant and rapid retreat and volume loss of glaciers in the Greater Yellowstone Ecosystem. High-elevation areas of the Rocky Mountains are experiencing changes such as rising temperatures, shrinking snowpacks, and earlier meltouts at a more rapid rate than the region overall. The Teton glaciers are also iconic features of the park landscape, prompting efforts to monitor their evolution under current and future climate regimes.

Scientists documented significant glacier retreat despite some short term advances from 1929 to 1963. A 1993 winter mass balance study of the Teton Glacier provided a baseline for future comparisons. In 2010, researchers documented surface area declines in three park glaciers ranging from 25% (Middle Teton Glacier) to 60% (Teepe Glacier). Ongoing monitoring of volume change in Teton Range glaciers includes use of remote sensing and historic aerial photography. With new data on high-elevation climate, researchers may be able to connect periods of growth and retreat in glaciers and permanent snowfields to regional climate trends.

In 2015, staff from NPS, USFS, and USGS units in the GYE collaborated with scientists involved in glacier monitoring and research at North Cascades National Park and elsewhere to create monitoring protocols and test elevation survey methods on the Middle Teton Glacier—chosen for its relative safety and accessibility. Staff also installed temperature sensors to provide data for a GYE-wide sensor network, as well as time-lapse cameras to provide images of glaciers that are too difficult or hazardous to monitor directly. The park's objective is to monitor glacier movement and changes over time.

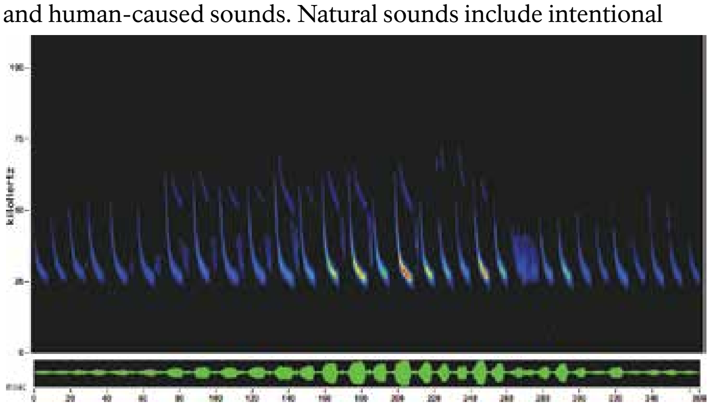
Park staff collected photographs and air temperature readings to monitor Schoolroom Glacier.

In 2016, hydrology staff and climbing rangers developed a glacier monitoring protocol for the park and completed a second GPS elevation survey of Middle Teton Glacier; results showed a net loss in surveyed volume of approximately 34,000 cubic meters (the equivalent of an 18 cm decrease in surface elevation across the glacier) compared to 2015. The protocol provides a model for a safe, cost-effective method to also monitor glaciers in the Absaroka and Beartooth Mountain Ranges of the ecosystem.

Soundscape

Since 2003, a bioacoustic ecologist has monitored and researched 58 locations throughout the park in various management zones, ecological habitats, and elevations from the Snake River to the summit of Grand Teton. Throughout the year, he collects digital recordings and sound levels that characterize and quantify the park's soundscape and acoustic resources. Park managers use this information to aid in park planning and management decisions.

The soundscape of Grand Teton is composed of natural and human-caused sounds. Natural sounds include intentional sounds (singing and bugling), adventitious sounds (footsteps and wingbeats) of animals, and sounds created by physical processes (raindrops, thunder, flowing water, rockfalls, avalanches, and wind). The most widespread and numerous human-caused sounds are from surface, air, and water transportation activities. Airplanes and road vehicles are present all year; motorboats operate in the non-winter months.



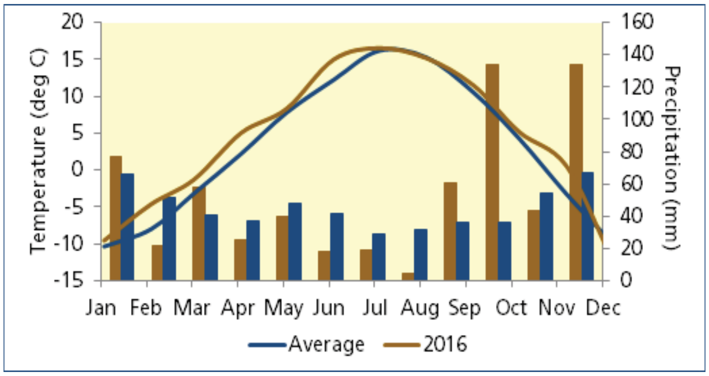
Ultrasonic recording of the big brown bat's echolocation.

The natural soundscape of Grand Teton is fully intact and functioning. However, noise from human-caused sounds affects the natural soundscape and can interfere with ecological functioning. Noise impacts on the natural soundscape tend to increase with higher visitation and administrative activity. Noise is most prominent nearest transportation corridors, but can propagate for long distances, especially when the ambient sound levels are very low. Seventy-five percent of the park is within two miles of a road or lake that allows motorboats. The National Park Service works to mitigate these impacts through education, quiet technology, and changing park protocols. New in 2016, the park soundscape research has expanded to include an inventory of bats using ultrasonic recordings. And the park's new web-based acoustic map can be accessed at https://www.nps.gov/yell/learn/management/yellowstone-soundscapes-program.htm

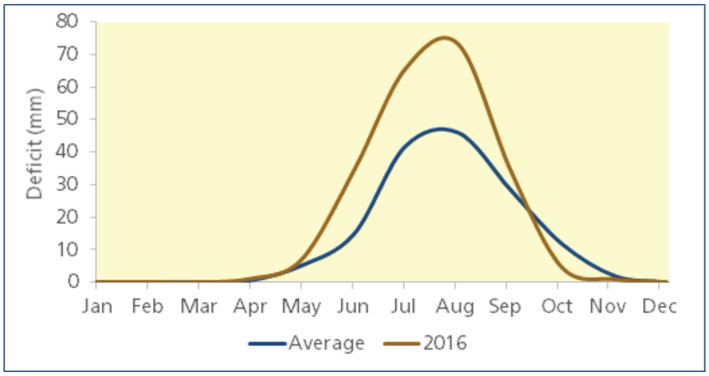
Climate

The 2016 Berry Fire, largest in Grand Teton National Park's recorded history, occurred in the fifth warmest year and fourteenth wettest year recorded since 1960 at the Moose, WY weather station. These seemingly benign annual conditions were offset by the early season warm drought. Between January and August, the temperature was 1.5 degrees Celsius warmer and precipitation 15% below average. The combined effect resulted in an August and September water deficit (indicator of drought) in soil and vegetation that was well above long-term average. Seemingly small deviations in precipitation and temperature combined to set the stage for extreme fire conditions that were finally extinguished in October 2016 by precipitation that was 97 mm above long-term average.

While 2016 was the warmest year in recorded history globally, it wasn't unusually warm or dry for the entire year at Moose, but early season drought conditions resulted in dry fuels for large wildfires. Interestingly, the water deficit in August of 2016 was the fourth highest since 1960.



Monthly comparison of 2016 temperature (lines) and precipitation (bars) in Grand Teton NP compared to the 1960-2016 average.



Monthly comparison of 2016 water deficit (lines) for soil and vegetation in Grand Teton NP compared to the 1960-2016 average.

The 2016 Berry Fire burned in riparian areas as well as drier forest fuels.

Fire

The Berry Fire builds in the late afternoon on the west shore of Jackson Lake at Wilcox Point, 2016.

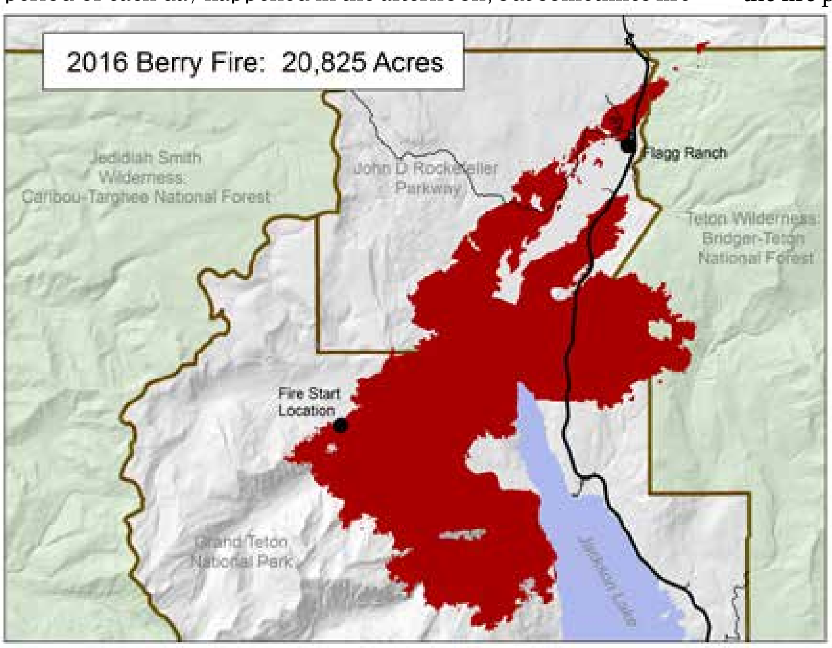
In 2016, Grand Teton National Park experienced the largest wildland fire since the establishment of the park. A passing aircraft first detected the lightning-caused Berry Fire on July 25th. Since it was a small fire tucked back in a remote area on the west side of Jackson Lake, far from developed areas and surrounded by several large fuel breaks from older fires, the Berry Fire presented a management opportunity to allow natural fire to fulfill its ecological role in an area of the park managed as wilderness. The park's fire management committee and superintendent's office discussed and approved this approach, in consultation with adjacent jurisdictions. Fire managers selected a strategy to maximize the fire's benefit to the ecosystem while protecting the visiting public and other identified values at risk. Assigned resources and incident complexity climbed and shrank over the life of the incident responding to conditions and expected activity. Fire management objectives included protecting the public and both park and forest infrastructure, while allowing fire to operate naturally on other parts of the landscape.

Forest fires in Grand Teton spread in three ways. With "surface fire," the fire burns along the ground in the forest litter. This is usually fairly slow, especially if the understory plants are green and moist. Another way fire spreads is "torching" when fire consumes a standing tree. Windblown embers that loft from torching conifers can move fire rapidly, spotting or jumping up to a half mile at a time. Trees burn and torch more intensely when the foliage is dry due to drought stress. When these drier conditions occur,"crown fire" can carry between tree tops regardless of the surface fuels, especially when strong winds push the flames across the gaps in the canopy. These fires are very hot and intense, and spread fairly fast, often accompanied by long-distance spotting of a mile or more.

Over several weeks, the Berry Fire showed all three kinds of fire spread, as the winds and weather changed. The peak burning period of each day happened in the afternoon, but sometimes fire carried in the night on the hills above the cool valley air. Cloudy periods slowed the fire for days at a time, while high pressure and frontal passages made the fire more active. On the ground, these fluctuations led to different patches of burn severity and fuel consumption. Fuels and vegetation also influenced fire effects. Moist meadows did not burn while stands of dense forest were blackened. Interestingly, areas of forest regrowth that had burned in 1988 fires, as well as a couple of more recent 2000 fires did not serve as barriers to fire spread. There were enough extremely dry logs on the ground and young trees to burn again in 2016. Samples of these logs showed less than 10% moisture content, the driest they have measured in Grand Teton's 21 years of monitoring.

The Berry Fire experienced two major fire growth days, when the combined forces of high winds, dry air masses, and hot temperatures reached the especially receptive fuels. On August 22, the fire pushed five miles across the north end of Jackson Lake, crossing the Teton Park Road north of Lizard Creek, and burning into the Bridger-Teton National Forest. While firefighters cleared the road and stopped the fire from spreading along the road corridor for public safety, they did not suppress the fire on the east flank where it burned toward the Teton Wilderness. On September 11, another strong wind event pushed a narrow finger of the fire seven miles northeast through the Flagg Ranch developed area. Firefighters had prepositioned sprinkler systems and the forest fuels had been manually thinned around the structures, so no buildings were lost.

A big fire like the Berry Fire can only be managed to burn on the landscape as freely as it did when certain conditions align. It takes careful risk assessment, hard work, and a balance of approaches including the ability to do fire suppression if needed. It also requires that developed areas and infrastructure are defendable. The result, however, is that a powerful natural process can act on the landscape, mostly unhindered, as it has done for thousands of years.



Water

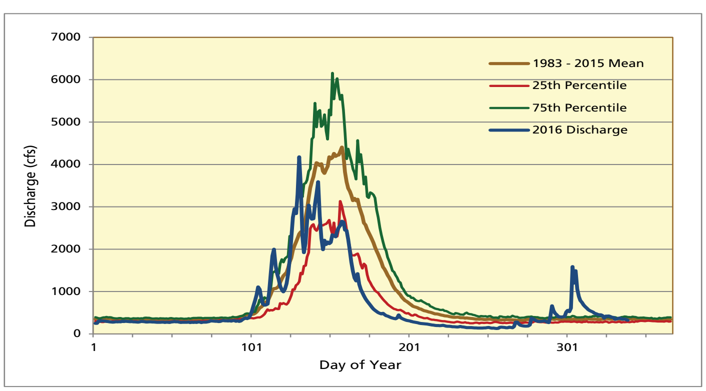
Aerial of the Snake River, Grand Teton NP.

Approximately 10% of Grand Teton National Park is covered by surface water. The park contains more than 100 alpine lakes, with surface areas ranging from 1 to 60 acres, and many above 9,000 ft in elevation. All surface and groundwater in the park drains to the Snake River. The Snake River is of considerable significance to the biological diversity and functioning of not only Grand Teton NP and the Greater Yellowstone Ecosystem, but also to the health and vitality of gateway and downstream communities.

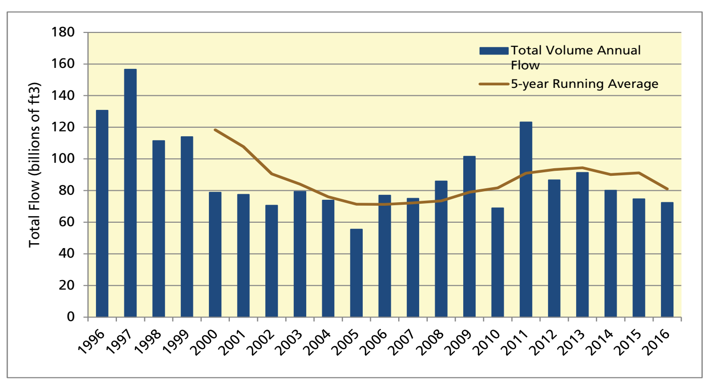
The uppermost reaches of the Snake River in Wyoming are characterized by good water quality with relatively low levels of dissolved nutrients and other anthropogenic compounds (e.g., pesticides). Good water quality and the presence of native fish, including cutthroat trout, are not surprising given that the headwaters of the Snake River include parts of Grand Teton and Yellowstone National Parks. Maintenance of high quality waters and continued support of native freshwater assemblages are among the highest management objectives for Grand Teton National Park. The State of Wyoming also recognizes and values this important resource and has designated the upper Snake River and all surface waters within the park as Outstanding or Class 1 waters—recognized for their exceptional quality and therefore "no further water quality degradation by point source discharges other than from dams will be allowed" (WYDEQ 2001). The Snake River headwaters also received Wild and Scenic River designation by Congress (Snake River Headwaters Legacy Act, 2009), designed to preserve the Snake River headwaters' outstanding natural, cultural, and recreational values for the enjoyment of present and future generations.

The U.S. Geologic Survey monitors flow levels of the Snake River at two locations—Flagg Ranch and Moose, Wyoming. Discharge in 2016 was low relative to the record for the Flagg Ranch site (1983 to 2016) and peak flows at Flagg Ranch, Wyoming ranked as the 5th lowest in the 33-year monitoring record. In addition, peak flows occurred two weeks earlier than the average for this site. Snake River flows at Moose were similar to the 25th percentile of record of flows for that site (1995 – 2016) but are strongly modified by Jackson Lake Dam. Total volume of annual flow at the Moose monitoring location ranked 18th out of the 21-year record, but the date of half discharge (the day when half of the annual volume of water occurred, June 26, 2016) was similar to the two-decade record for this location. NPS resource staff also have monitored water quality in the Snake River at these same locations for over a decade. Results from 2016 confirm that concentrations of primary nutrients (nitrogen and phosphorus) remained low or below detection. Trace metals (i.e., arsenic, copper, and selenium) are found in the watershed and are often naturally present in measurable concentrations, but below the State of Wyoming's aquatic life criteria. In 2016, copper and selenium were generally low and below detection levels. Total arsenic concentrations increased to measureable amounts during low flow at both sites with higher concentrations being found at the Flagg site several times while at the Moose site it was only measurable once. Conversely, total iron concentrations are highest in the Snake River during spring runoff. After measuring below the State of Wyoming's aquatic life criterion in 2015, iron concentrations returned to the norm of exceeding the criterion in 2016. Because most of the watershed in the upper Snake River is undeveloped, scientists believe that iron and other trace metals are naturally occurring and that natural fluctuations in iron levels are driven by elevated spring discharge.

In 2006, Grand Teton park staff began a monitoring study of three alpine lakes (Amphitheater, Delta, and Surprise Lakes). The 2016 sampling events in July and September showed that water quality varied between sampling dates. Delta Lake has consistently had the highest levels of nitrogen compared with the other monitored lakes. The presence of glacier ice in alpine watersheds of the American Rocky Mountains has been shown to strongly influence nitrogen concentrations. Therefore, glacial contributions may help explain elevated nutrient levels documented in Delta Lake.



Summary of the average daily discharge in the Snake River near Flagg Ranch, Wyoming. River flows are presented by day of year.



Graph of annual river flow totals (in billions of cfs) for the Snake River at Moose, WY. A 5-year moving average is included to smooth annual variations for a clearer examination of trends.

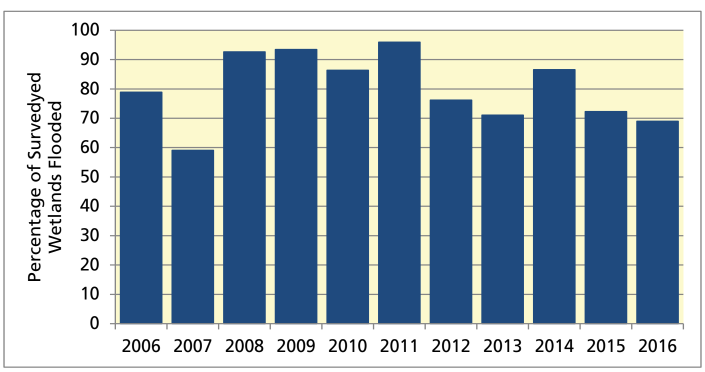
Amphibians

Biologists recognize four species of native amphibians in Grand Teton and Yellowstone National Parks: western tiger salamander (*Ambystoma mavortium*), boreal chorus frog (*Pseudacris maculata*), western toad (*Anaxyrus boreas*), and Columbia spotted frog (*Rana luteiventris*). The boreal chorus frog and the Columbia spotted frog are the most widely distributed species while the distribution of the western tiger salamander and western toad is more restricted. The northern leopard frog was historically documented in Grand Teton National Park, but there has been only one confirmed sighting since the 1950s. Plains spadefoot toads (*Spea bombifrons*) were recently documented in Yellowstone's Lower Geyser Basin, but their presence in Grand Teton has not been documented.

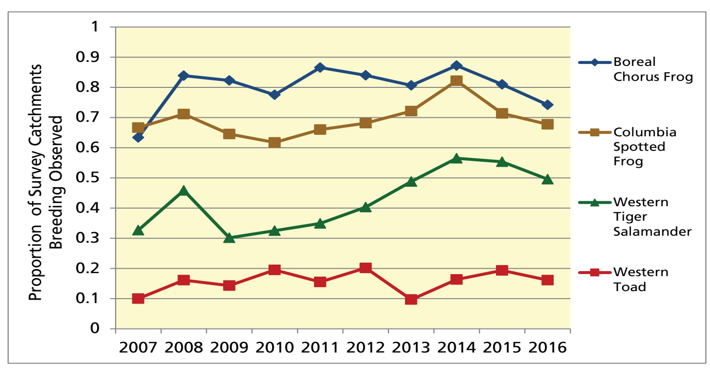
The National Park Service collaborates with the Northern Rockies Conservation Cooperative, U.S. Geological Survey, and university scientists to monitor amphibians in the Greater Yellowstone Ecosystem (GYE). Annually since 2006, these biologists have monitored and documented amphibian breeding activity in 31 catchments. Encompassing about 500 acres each, these catchments or watersheds are defined by topography and vary in amounts of seasonal and permanent water. Within these 31 catchments, researchers visited 335 individual wetland sites in 2016, and surveyed 229 that had standing water present. Biologists documented breeding activity using visual surveys to detect eggs, larvae (e.g., tadpoles), and metamorphic forms (i.e., transitional forms between aquatic and terrestrial life stages). Of these sites, 62% were occupied by at least one species of breeding amphibian. In 2016, none of the 31 catchments contained breeding evidence of all four species (referred to as amphibian "hotspots"). In contrast biologist found two hotspot catchments in 2015 and four in 2014, illustrating the breeding variability that takes place even in protected areas.

Western tiger salamander.

Annual variations in breeding may be tied to hydrologic fluctuations that are driven by unique meteorological conditions each year. Such annual variations alter the extent and mosaic of wetland breeding sites, which can affect amphibian reproduction. The percentage of visited wetlands that supported surface water suitable for breeding varied between 59% in 2007 and 96% in 2011; in 2016, nearly 69% of visited wetlands were flooded. All amphibians in the GYE require wetlands for breeding, but individual habitat needs differ and may leave some species more vulnerable to changes in wetland condition (e.g., cumulative loss of seasonal water bodies or shrinkage of year-round ponds). Increasing temperatures are predicted for this region and could alter wetland habitats and influence amphibian breeding; these impacts are expected to disproportionately impact amphibians relying on shallow wetlands.



Percentage of surveyed wetlands with standing water suitable for breeding.



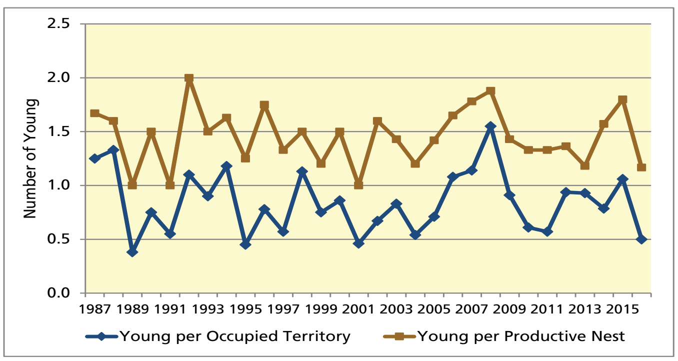
Proportion of surveyed catchments where breeding was observed for each species.

Bald Eagles

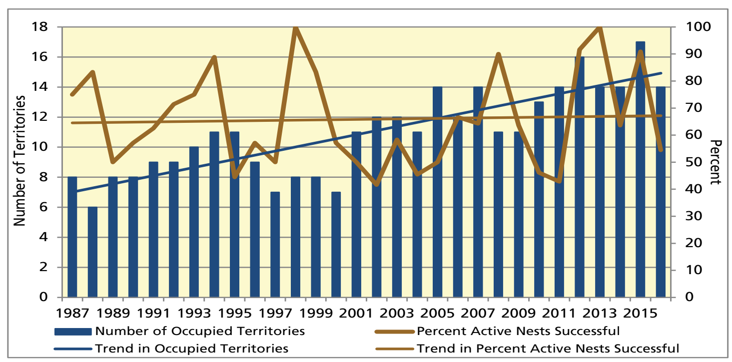
Bald eagles (*Haliaeetus leucocephalus*) are large, primarily fish-eating predators that generally nest in trees, close to water bodies. They also feed on small mammals, waterfowl, and carrion. Within Grand Teton, breeding sites are found along the shores of Jackson Lake and the Snake River.

Of 20 bald eagle territories monitored in 2016, 14 pairs occupied territories. Eleven pairs nested and fledged seven eaglets, which is a decrease from 2015, but ranks right around the 10-year average levels. While the number of occupied territories (14), breeding pairs (11), and productive nests (6) were at or close to the 10-year averages (13.8, 11.8, and 8.2 respectively), the number of young fledged (7) was below the 10-year average (12.3).

Bald eagles, once listed as endangered under the Endangered Species Act, were delisted in 2007. Over the past few decades, bald eagles experienced a dramatic recovery in Grand Teton, mirroring their recovery throughout the Greater Yellowstone Ecosystem. The number of territorial pairs in the park has almost doubled over the past 25 years. In accordance with the Greater Yellowstone Bald Eagle Management Plan (1995), park managers implement temporary closures around active bald eagle nest sites to minimize disturbances. In 2016, closures were established at nest sites along the Snake River.



Counts of bald eagle young produced by territories and nest.



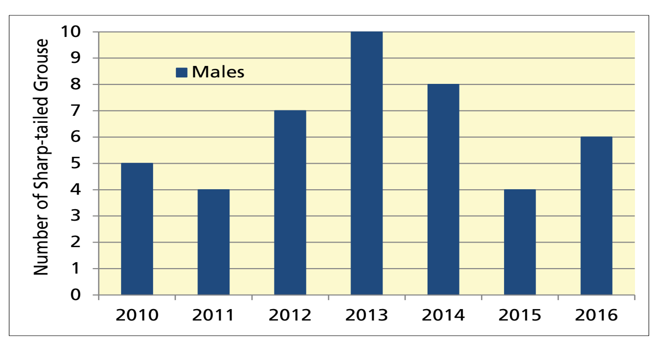
Bald eagle pairs occupying territories and successfully producing young.

Columbian Sharp-tailed Grouse

Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*) are endemic to sagebrush, shrub-steppe, mountain shrub, and riparian shrub communities. Once found in nine states and British Columbia, Canada, this subspecies now occupies less than 10 percent of its historic range. Excessive hunting in the 19th century combined with habitat alteration and degradation contributed to local population declines and range reduction. Sharp-tailed grouse are considered a species of greatest conservation need in Wyoming.

Similar to greater sage-grouse, sharp-tailed grouse males display in the spring to attract females to breeding grounds called leks. Leks are typically positioned on elevated sites with flat, open areas. Columbian sharp-tailed grouse leks tend to have taller vegetation and more shrub cover than leks of other subspecies of sharp-tailed grouse. Little is known about the sharp-tailed grouse population in Jackson Hole. Several incidental observations of small groups of sharp-tailed grouse were recorded in Grand Teton over the last several years but no leks were found prior to 2010, and the nearest known lek was in Idaho along the western slope of the Tetons.

In the spring of 2010, biologists located a sharp-tailed grouse lek near the southeast boundary of the park, where they observed five males displaying. This marked the first known sharp-tailed grouse lek in the park in over 40 years. In 2016, biologists observed a maximum of six adult males strutting at the lek, but did not see any females at the lek. However, staff recorded three separate observations of a hen with three or four chicks in July and August within two miles of the lek, indicating that successful breeding occurred.



Annual counts of male Columbian sharp-tailed grouse displaying at the lek in Grand Teton National Park, 2010-2016.

Bighorn Sheep

A bighorn ram forages for food in deep snow.

Bighorn sheep (*Ovis canadensis*) were once widely distributed throughout the mountains and foothills of the Rocky Mountain west. They persist today in small, fragmented populations that remain at risk of further decline and extirpation. The Teton Range herd is Wyoming's smallest and potentially most isolated native sheep herd. The herd now lives year-round at high elevation along the Teton crest and in the steep canyon areas on the east and west slopes of the range. Sheep in this herd endure harsh winter weather in windblown areas above 9,500 feet due to the loss of low-elevation winter ranges to residential and recreational encroachment.

Biologists estimate the Teton Range bighorn population contains 80–100 individuals, distributed in two segments at the north and the south ends of the range. In a 2016 mid-winter helicopter survey, Wyoming Game and Fish Department (WGF) personnel counted a total of 47 sheep (13 in the south end of the range and 34 in the north end). Counting conditions were not optimal thus raising debate over whether the low count resulted from a large number of individuals going undetected or herd decline. Annual ground classification surveys started in 1990 provide composition, distribution, and trend information. Biologists from the park and WGF counted a total of 37 sheep during the mid-August ground surveys (28 in the south and 9 in the north). Visibility was particularly poor in the northern portion of the range due to the Berry Fire and other nearby fire activity. Herd ratios were estimated at 42 lambs, 21 yearlings, and 37 rams per 100 ewes. Since ratios derived from summer ground counts are highly variable over time, the counts primarily provide confirmation that the herd is still reproducing and that some of the lambs survive their first year to join the herd.

Research on the herd conducted in the mid-1990s found that avalanches and falls accounted for the majority of known mortalities recorded for 16 radio-collared and 7 non-radio-collared bighorn sheep. Predation and starvation caused a small percentage of deaths. More recent studies determined that the north and south segments of the herd are genetically differentiated, increasing concerns for the health of the population. The herd does not migrate and is isolated from neighboring populations. While small population size, high lamb mortality, possible reduction in genetic fitness due to inbreeding, and extremely limited winter range all jeopardize the long-term sustainability of this herd, managers recognize limited winter range in avalanche-prone, high-elevation areas as the greatest potential threat. Since winter is already a time of stress and hardship for bighorn sheep, park managers close crucial sheep winter ranges to human entry to reduce the potential for disturbance and further stress on sheep wintering in the park. No incursions into sheep winter range were reported in 2016.

Common Loons

Common loons (*Gavia immer*) are long-lived birds with a prolonged period of maturation and low reproductive rates. Arriving shortly after lakes become ice free in the spring, loons breed on freshwater lakes throughout the northern US and migrate to coastal areas for winter. Loons that nest in Grand Teton National Park reside at the southeasternmost extent of the species' range in the interior mountain west. The Wyoming population is small and appears isolated from other breeding populations. Long-term monitoring shows reductions in the number of territorial pairs and chicks fledging in the Greater Yellowstone population. The State of Wyoming lists loons as a species of greatest conservation need primarily because of the small size of the nesting population and its restricted distribution.

In 2016, Grand Teton park rangers observed a pair of loons with a loonlet on Jackson Lake. This is the southernmost nesting pair observed in the western US, and the first documented pair of loons observed on Jackson Lake since the 1980s. Additionally, researchers observed a lone adult loon exhibiting territorial behavior on Emma Matilda Lake, but it was never observed with a mate. No loons were observed during surveys of Leigh or Jenny Lakes.

V. Spagnuolo

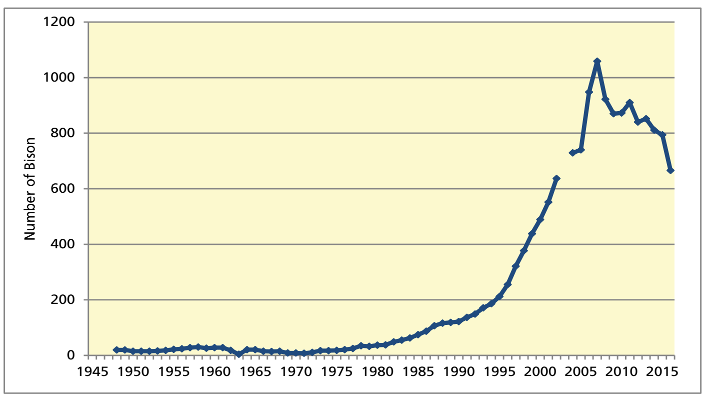
A loon paddles around with two loonlets following.

Bison

Bison (*Bison bison*), native to Jackson Hole, were extirpated from the area by the mid 1800s. In 1948, twenty animals from Yellowstone National Park were introduced to the fenced 1,500-acre Jackson Hole Wildlife Park near Moran. In 1963, after testing positive for brucellosis, all adult bison in the small herd were destroyed while nine vaccinated yearlings and calves remained. Twelve bison from Theodore Roosevelt National Park were added to the population. The herd escaped from the wildlife park in 1969 and was allowed to remain free. Present-day Jackson bison are descendants of those bison and some subsequent migrants from Yellowstone. During the winter of 1980, bison moved onto the National Elk Refuge and began using supplemental feed intended for elk. Returning annually to exploit this food source, the bison altered their natural population dynamics.

With unusually low winter mortality and no significant predation, the herd grew steadily since the 1980s, reaching more than 1,000 by the winter of 2007. Although some bison began using areas east of the park and the refuge in the late 1990s, herd distribution has changed little in the past two decades. Jackson bison summer primarily in Grand Teton National Park. Depending on winter severity and native forage availability, nearly the entire herd moves to the refuge for the winter, where they remain until April or May. In some years, individuals or small groups remain in the park all winter.

Mature bull bison.



Population size of the Jackson bison herd, 1950-2016.

A joint Bison–Elk Management Plan approved in 2007 allowed bison hunting on the National Elk Refuge in an effort to maintain the herd at about 500 animals. While the expanded hunt area helped increase the number of legal harvests and brought the herd closer to a sustainable population given available forage, observation suggests that only consistently high hunter harvests focused on cows will bring the population to the desired level.

During the winter of 2016, biologists counted 618 bison using the National Elk Refuge feedlines and adjacent areas. Forty-eight bison foraged on native winter range in the Elk Ranch area of the park. The herd-wide total of 666 is a slight decrease from the 691 counted in 2015 and continues the downward trend from the population high of 1,059 in 2007. Of 285 known bison mortalities in 2016, 96% resulted from legal harvest outside the park. Six bison were involved in collisions with vehicles, five of which were confirmed dead.

Golden Eagles

Golden eagles (*Aquila chrysaetos*) are large aerial predators well suited to the Teton Range, with its abundance of cliff faces for nest sites and diversity of prey found in the canyons. In the 1980s, biologists located golden eagle nests in Death, Avalanche, Cascade, and Webb Canyons but did not regularly monitor the Teton Range golden eagle population. Concerns about golden eagle populations throughout the western US have arisen recently, primarily because of loss and alteration of their native habitats. Like many raptors, golden eagles are sensitive to disturbance around their nest sites.

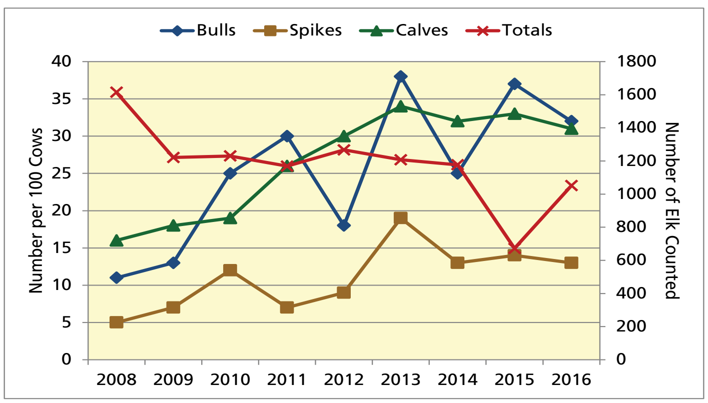
In 2016, park biologists partnered for the second year with Craighead Beringia South to conduct ground surveys for golden eagles and their nesting territories. Biologists spent 14 days searching for nests throughout Granite, Death, Avalanche, Cascade, and Leigh Canyons. Occupied territories were confirmed in all of those canyons, except for Cascade. Successful nests were confirmed in both Death and Avalanche canyons, each nest fledging a single eaglet. A pair of eagles was observed and believed to be successful in Leigh Canyon based on occupancy and behavior, but biologists could not locate the nest site to confirm. Two nests were located in Granite Canyon and a pair of eagles was observed in the area, but they either did not nest in 2016 or their nest failed early in the season. In addition to the mountain territories, a new territory was found on the east side of the park, on Uhl Hill near Elk Ranch Reservoir. This pair successfully fledged two eaglets in 2016. Biologists will continue to monitor these known territories as well as survey other suitable habitats to determine occupancy status and better assess the population.

Elk

The velvet covering that supplies a bull elk's antlers with blood and nutrients as they grow is partially scraped away.

Grand Teton National Park and the John D. Rockefeller, Jr. Memorial Parkway support a migratory Rocky Mountain elk (*Cervus canadensis*) population that is part of the larger Jackson elk herd. Elk summer throughout these parklands and occur at relatively high densities in low elevation open sagebrush, willow, and forested habitats. Most of the elk migrate to winter range on the National Elk Refuge near Jackson, but a small number winter in the eastern portion of the park. Other portions of the herd migrate through the park/parkway between the National Elk Refuge and summer ranges in Yellowstone and the Bridger-Teton National Forest. The Jackson elk herd is one of the largest in North America. Its migratory routes cross multiple jurisdictional boundaries as elk travel between seasonal ranges. As Grand Teton's most abundant ungulate, elk have significant effects on park ecology. Their grazing and browsing may affect plant productivity and, as prey and carrion, elk provide sustenance to carnivores and scavengers. They are also popular with park visitors.

Park biologists counted and classified 1,051 elk in 2016 during the annual summer helicopter survey. The total number of elk counted was almost 380 more than in 2015. Overall numbers were remarkably consistent the previous 6 years, but abruptly declined in 2015 and rebounded in 2016. Herd ratios and composition in the standard survey area were 32 mature bulls, 13 spike bulls, and 31 calves per 100 cow elk. More mature bulls were counted than in 2015, but bull ratios decreased, primarily because more cows were also counted. Calf ratios decreased slightly compared to 2015, but remain well above the low documented in 2008. In general, calf ratios were lower in areas north of Moose and in the Willow Flats.



Grand Teton mid-summer elk count and classification, 2008–2016.

In mid-winter 2016, the Jackson herd numbered 11,200 elk, meeting the 11,000 objective set by the Wyoming Game and Fish Department in the 2007 Bison–Elk Management Plan for Grand Teton National Park and the National Elk Refuge. Estimated at above 19,000 during the early-mid 1990s, the Jackson herd is reduced by annual harvest on the national forest and the refuge, in addition to an elk reduction program in the park (authorized by Congress in 1950 to help manage herd size when necessary). Non-harvest mortality (e.g., from winterkill) averages an unusually low 1–2% of the herd. The total annual harvest for 2016 numbered approximately 1500 for the Jackson elk herd. The park reduction program accounted for 9% of that total and numbered 131 elk.

Great Gray Owls

The great gray owl (*Strix nebulosa*) is associated with old-growth boreal forest habitats in western Wyoming and is considered a species of greatest conservation need in Wyoming. Little is known about their population status and tends. Since boreal forests in Wyoming are currently at risk due to drought, insect outbreaks, disease, and logging; concern for the status of great gray owls is growing.

Starting in 2013, Grand Teton National Park partnered with the Teton Raptor Center on a project to collect baseline data on territorial occupancy, demographics, nest success, prey use, and year-round habitat use of the Jackson region great gray owl population. This data will aid area land managers in developing management guidelines. Additional goals in 2016 included examining juvenile survivorship, movements, and dispersal; and investigating how snow and prey conditions relate to habitat use and nest success.

For the nine territories within Grand Teton National Park, biologists monitored owl occupancy and productivity. Eight of the territories successfully fledged a minimum of 17 owlets. Biologists captured and banded six owlets. Additionally biologists outfitted three of the banded owlets with temporary VHF transmitters to study fledgling movements and to help locate them once fully grown to outfit with backpack transmitters for further study.

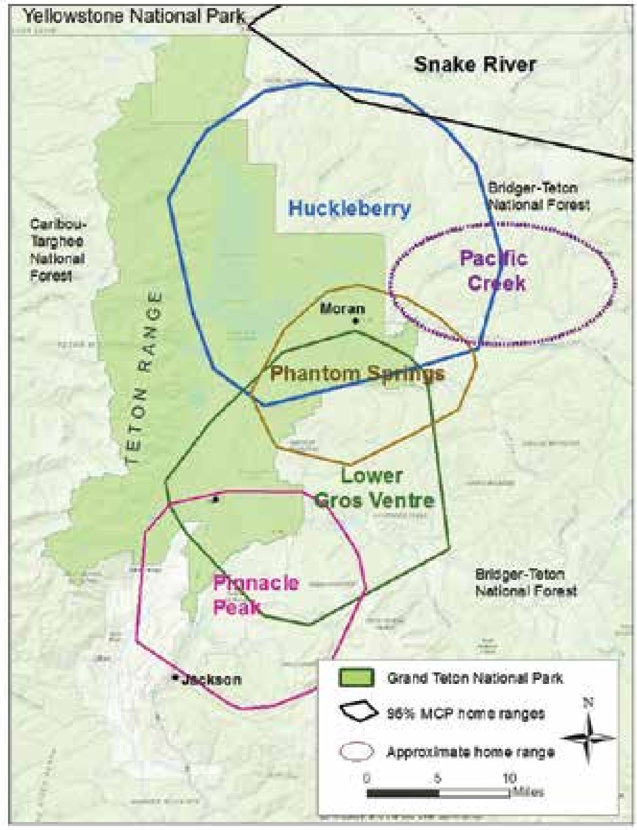
Great great owlet captured to fit with a tracking device.

Gray Wolves

After the U.S. Fish and Wildlife Service and National Park Service reintroduced gray wolves (*Canis lupus*) into Yellowstone National Park in 1995–96, wolves dispersed to Grand Teton National Park and surrounding areas. In 1999, a wolf pack denned in Grand Teton and produced a litter of pups—the first in the park in over 70 years. Since then, wolves continue to live and reproduce in the Jackson Hole area, including Grand Teton and the John D. Rockefeller, Jr. Memorial Parkway. The reintroduction of wolves restored a predator-prey relationship absent since humans eradicated wolves from the ecosystem in the early 20th century.

At the end of 2016, a minimum of 58 wolves in 6 packs resided in the Jackson Hole area. Seven packs had persisted in the area since 2012 until the Lower Slide Lake pack dissolved in 2016. In 2016, pack size ranged from 4 (Phantom Springs) to 14 (Snake River) wolves. The six Jackson Hole packs produced a total of 20 pups that survived at least until the end of the year: Huckleberry (5), Lower Gros Ventre (3), Pacific Creek (3), Phantom Springs (2), Pinnacle Peak (2), and Snake River (5). The Huckleberry and Phantom Springs packs denned within the park. To minimize human disturbance of wolves raising young, park managers implemented closures around den and rendezvous sites for the Phantom Springs and Huckleberry packs.

At least five wolves dispersed from their packs in 2016. Two males from the Lower Slide Lake pack dispersed out of the area, and the female joined the Lower Gros Ventre pack. The lone Phantom Springs male left the pack in May, but was replaced by a male from the Lower Gros Ventre pack. Five adult collared wolves from the Jackson Hole area died in 2016. Three males died after dispersing from the area; Pinnacle Peak 550F died at the age of 10; and Lower Gros Ventre 891F, the former breeding female of the pack, was killed by wolves in early February.

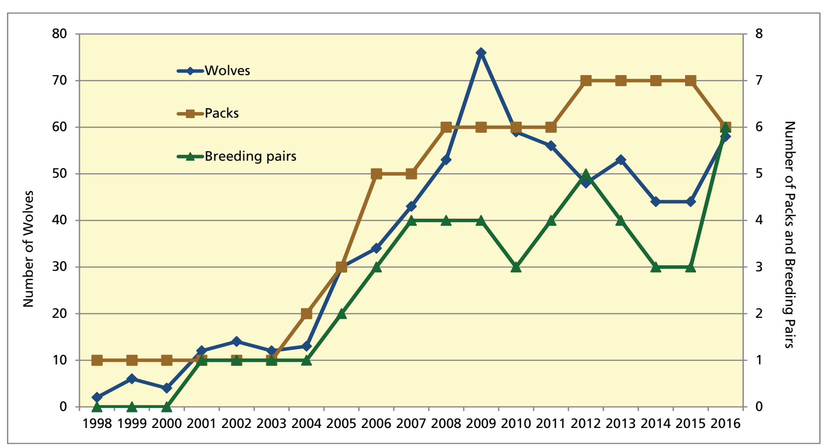


Distribution of Jackson area wolf packs, 2016. MCP (Minimum convex polygons) are home ranges based on locations of collared pack members.

The return of wolves to Grand Teton and the surrounding area presents researchers with an opportunity to study the complex relationships of an ecosystem with an intact suite of carnivores and ungulates. Wolves and other predators affect prey populations and behaviors. In a five-year study, biologists found that in the winter when elk densities were relatively low, wolves preyed primarily on elk (71%) and moose (26%) and fed on deer and bison infrequently (3%). In the summer, when elk densities in the park were high, wolves preyed almost exclusively on elk and their calves represented more than half of the kills in June and July.

Wolves also prey on other species, including livestock, which bring wolves into conflict with humans outside the parks. A long history of controversy surrounds wolf management and the effects of wolves on ungulates and livestock. Wolves in Wyoming were removed from the federal list of threatened and endangered species in September 2012. In 2013, the State of Wyoming implemented a wolf hunt in the trophy management area of northwest Wyoming outside national parks, parkway, refuge, and the Wind River Indian Reservation. On September 26, 2014, a court ruling suspended the hunt and again granted Wyoming wolves federal protection. However, on March 3, 2017, the US Court of Appeals for Washington DC ruled to reverse the 2014 decision and once again remove Wyoming wolves from the Endangered Species list, which became official April 25, 2017.

Collecting blood samples from a captured wolf.

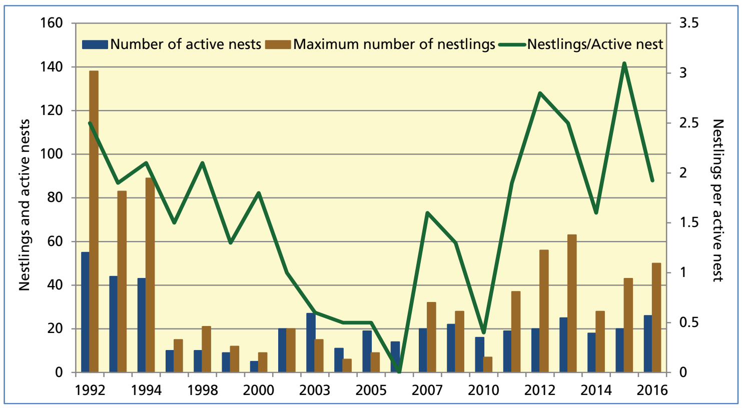


Population growth of Jackson area wolves, including those in Grand Teton, 1998-2016.

Great Blue Herons

Great blue herons (*Ardea herodias*) are colonial water birds dependent on wetlands for feeding, nesting, and habitat security. Colonial nesters are highly vulnerable to human disturbance. Human activities near heron colonies (heronries) may influence heron occupancy, disrupt nesting behaviors, change foraging behavior, increase predation, or lead to heronry abandonment. In addition, heronries are vulnerable to predation. Monitored since 1987 in Grand Teton National Park, heron occupancy and reproductive success varies widely with overall productivity declining. Over the last decade herons abandoned several historic heronries, most recently two along the Buffalo Fork. Bald eagles in particular can have devastating impacts on the survival of young herons. Biologists do not know if bald eagles nesting near the Buffalo Fork led to the demise or displacement of heronries in that area.

A great blue heron perched on a nest.



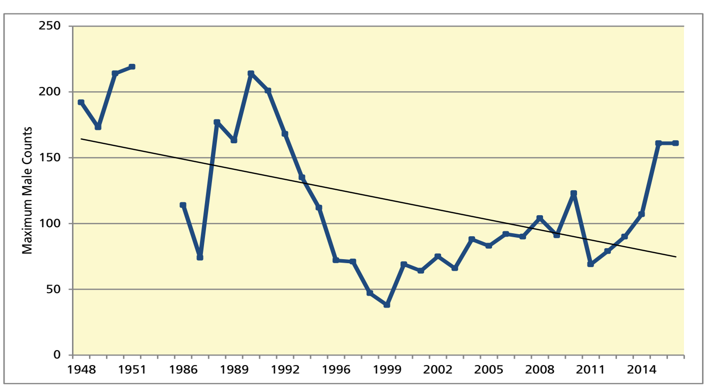
Great blue heron productivity in Grand Teton NP, 1991-2016. Arizona Lake heronry, discovered in 2007, is located just outside the park's boundary and since 2009 is included in the park's monitoring program. Monitoring of heronries was not conducted in 1996, 1997, 2002, or 2008.

Herons have nine known historic colonies located in or adjacent to the park plus a new site at Sawmill Ponds discovered in 2015. Of these sites, the Arizona Lake, Pinto Ranch, and Sawmill Ponds colonies were active in 2016. At Arizona Lake, herons produced 39 young from 18 active nests. All nests in the Arizona Lake heronry were active and successful. At Pinto Ranch, there were five active nests which produced a total of five young. Since its discovery last year, the Sawmill Ponds site increased by one nest from 2015 for a total of three active nests producing six young. In 2016, biologists recorded the highest number of active nests since 2003; however, this trend has been relatively stable during the last 10 years. With 50 total nestlings in 2016, the number of nestlings was higher than the average of 39.2 nestlings, but remained lower than the totals for 2012 or 2013, and considerably less than the average of 101 recorded from 1991-1994.

Greater Sage-grouse

Historically, the greater sage-grouse (*Centrocercus urophasianus*) occurred in sagebrush habitats across much of Wyoming and the American West. Sage-grouse populations declined throughout their range during the past 50 years, most likely due to increased livestock grazing, farming, residential development, invasive plants, and oil and gas development. The Jackson Hole sage-grouse population also declined, despite occurring in an area with a high density of public lands and protected habitat.

Sage-grouse congregate on display areas, or leks, during their breeding season each spring. Lek sites are usually open areas such as rocky slopes, burned areas, or gravel pits. Males perform a unique strutting display to attract females for breeding. Biologists began monitoring sage-grouse leks in Grand Teton National Park in the 1940s to document population trends.



Counts of male sage-grouse with a trend line on Grand Teton NP leks 1948-2016. No monitoring data for sage-grouse 1952-1985 and 1993.

In 2016, of the nine historically known leks (eight in Grand Teton National Park and one located on adjacent National Elk Refuge land), sage-grouse consistently occupied seven leks (Airport, Bark Corral, Moulton, RKO, Spread Creek, Timbered Island, and North Gap-NER). Two other historically occupied leks (active in the last 10 years) were inactive in 2016 (Airport Pit and McBride).

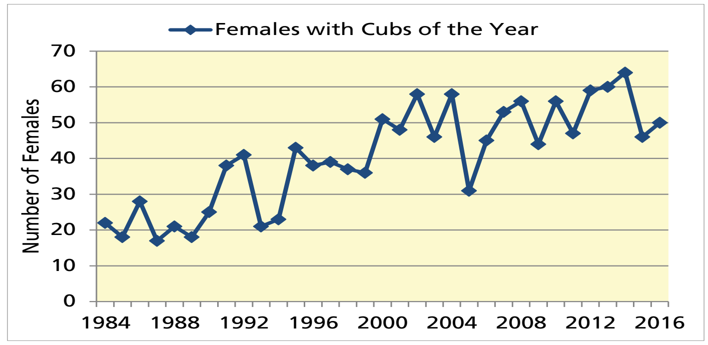
For the six active leks within Grand Teton National Park, the total maximum count of all sage-grouse was 217, and maximum male count was 161. Both of these counts are higher than the 10-year averages of 166.2 and 107.5, respectively. Of the six active leks within Grand Teton National Park, only the Airport lek was considerably below 10-year average levels (7 males and 19 total grouse in 2016 compared to 14.1 males and 32.3 total grouse for the 10-year average). All other leks were close to the 10-year averages or well above. While this data provides useful information on general trends of sage-grouse attendance at leks, the relationship of these numbers to the local sage-grouse population is not known.

Grizzly Bears

Predator eradication programs eliminated grizzly bears (*Ursus arctos*) from most of the western U.S. by the 1950s. Due to its isolation, the Greater Yellowstone Ecosystem (GYE) became one of the last refuges for grizzly bears south of the Canadian border. In the first half of the 20th century, garbage became a significant food source for bears throughout the region. In an effort to return bears to a diet of native foods, garbage dumps in the GYE were closed in the 1960s and 1970s. Following the dump closures, human-caused mortality increased significantly and the population declined from an estimated 312 grizzly bears, prior to the dump closures, to 136 bears in 1975. That same year the grizzly bear was federally listed as a threatened species.

Intensive conservation efforts over the next 40 years allowed grizzly bears to make a remarkable recovery. For 2016, the GYE grizzly bear population was estimated at 690 (95% confidence interval = 615–764). There are more grizzly bears today, occupying a larger area (25,038 mi^2), than there were in the late 1960s prior to the closure of the garbage dumps (312 bears occupying 7,813 mi^2). Grizzly bears now occupy areas where they were absent for decades including all of Grand Teton National Park and the John D. Rockefeller, Jr. Memorial Parkway. The high visibility of bears foraging on native foods in roadside meadows makes Grand Teton a popular bear viewing destination.

In addition to ungulates, spawning cutthroat trout, army cutworm moths, and whitebark pine, grizzly bears in the GYE consume a diversity of foods. Recent research identifies at least 266 known grizzly bear foods in the GYE, 39 of which are used frequently. The availability of these foods has certainly played a part in the recovery of grizzly bears throughout the GYE. However, the high mortality of whitebark pine trees from mountain pine beetles has caused concerns over the capability of grizzly bears to continue to use this high caloric food source. Since whitebark pine is a masting species that does not produce a seed crop every year, past poor seed production years provide an indication of what bears might rely on in the fall if whitebark pine becomes functionally extinct. For example, more ungulate meat, roots, and false truffles are consumed during years with poor whitebark pine seed production. The decline in whitebark pine appears to have abated since 2009, and research published in 2015 does not support the hypothesis that the recent slowed growth rate of grizzly bears since 2002 in the GYE was a product of the reduced availability of whitebark pine. On the contrary, the evidence suggests the slowed growth rate of the population is due to density dependence (i.e., population may be approaching carrying capacity). Thus, as their varied diet suggests, grizzly bears are well suited to adapt to changes in the abundance of individual foods. After careful consideration of the research from this and other studies, the U.S. Fish and Wildlife Service proposed to delist GYE grizzly bears from their federal status as a threatened species in the lower 48 states in March 2016. Subsequently, the guiding document for conservation and management of grizzly bears upon delisting (Final Conservation Strategy 2016- https://www.fws.gov/mountain-prairie/es/FINALCS.DRAFT_Feb_19_2016_FINAL.pdf) was revised and signed by several state and federal wildlife and land management agencies in December 2016. The U.S. Fish and Wildlife Service received over 650,000 comments in response to the delisting rule. Grizzlies were officially delisted in July 2017.



Estimates of grizzly bear females with cubs of the year, 1983–2016, are used to calulate the total grizzly population estimate within the USFWS-designated Yellowstone Ecosystem Suitable Habitat. One recovery criteria is a population of at least 48 grizzly bears females with cubs of the year.

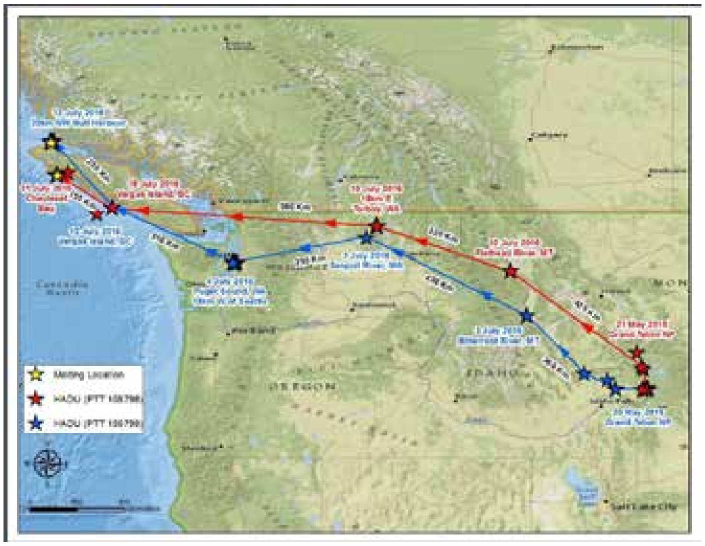
G. Pollock

Harlequin Ducks

M. Gocke, WGFD

Biologists about to release a pair of harlequin ducks.

The harlequin duck *(Histrionicus histrionicus)* is a relatively small species that breeds in northern boreal regions of eastern Canada, the Pacific Northwest of the US and Canada, Alaska, and the Rocky Mountain regions. The population status for North American harlequin ducks is regionally variable; however, in the Rocky Mountain region they are considered a sensitive species and the Wyoming Game and Fish Department lists them as a species of greatest conservation need. Harlequin duck core breeding range exists in Alaska, Washington, Oregon, Idaho, Montana, and Wyoming. The population in Wyoming represents the extreme southern and eastern extent of the western North American breeding population. The harlequin duck is one of the rarest breeding birds in Wyoming and its current breeding range appears to be limited to the Yellowstone and Grand Teton National Parks, and the Bridger-Teton and Shoshone National Forests. Little information is available on survivorship, migration movements, winter habitat use areas and general breeding ecology. Better understandings of these subjects are needed in order to conserve the harlequin duck population of Wyoming.



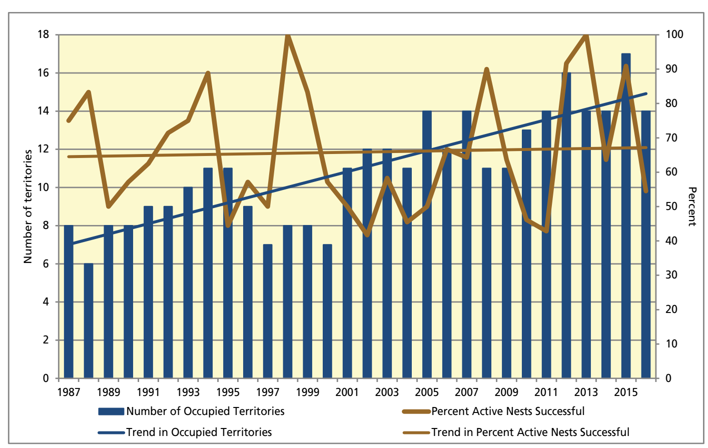
Locations of male harlequin duck movements during migration to molting and wintering areas. Map courtesy of Biodiversity Research Institute.

In 2016, biologists in Grand Teton collaborated with both the Wyoming Game and Fish Department and the Biodiversity Research Institute to locate and capture two breeding pairs, in the lower sections of Berry and Moose Creeks. The males were equipped with specialized implantable satellite transmitters and a small geolocator device was attached to the leg bands of captured females. In mid-August, biologists returned to conduct a survey of Berry, Owl and Moose Creeks to locate the females and their broods. A total of four broods were located–three of the broods had adult females without leg bands and the last brood did not have a female present.

Ospreys

Ospreys (*Pandion haliaetus*) are medium-sized hawks that prey almost exclusively on fish. The population of osprey in Grand Teton is migratory and research documents that osprey from the park migrate as far as the Mexican gulf coast and Cuba for the winter. Park monitoring of occupied osprey nests began in 1968. From 1972–1981 only 6–9 nests were occupied each year. More recently, ospreys occupy 16 territories annually. Generally, nests are found near the low-elevation lakes in the park and along the Snake, Gros Ventre, and Buffalo Fork Rivers and their tributaries.

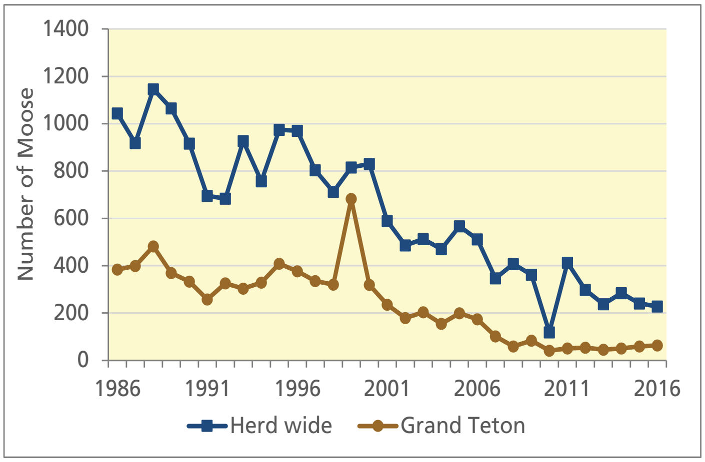
In 2016, ospreys occupied 13 (62%) of 21 monitored territories. Breeding activity occurred at 10 of these sites and 7 pairs successfully fledged a total of 15 young, close to twice the number of young fledged in 2015 (8) and slightly higher than the 10-year average (12.4). The number of territorial pairs declined since 1990. The decline in the number of occupied territories coincides with an increase in the number of territorial bald eagles. Compared to bald eagles, osprey populations recovered relatively quickly following the banning of DDT and now that eagles are more prevalent on the landscape, osprey populations may be responding by stabilizing at a lower level.



Territorial and successful osprey pairs, Grand Teton National Park, 1990-2016.

Moose

Moose (*Alces alces*) were rare or absent from Grand Teton National Park prior to 1912, but became numerous by 1950. They are better adapted to survival in deep snow than other ungulates in the Greater Yellowstone Ecosystem. Except during the rut, moose are usually found alone or in small family groups. Grand Teton moose are part of the Jackson herd which includes animals in areas outside the park boundaries. The herd experienced a decline from an estimated high of over 4,000 in 1990 to less than 1,000 since 2008. This partially migratory herd moves between distinct but overlapping summer and winter ranges. The Wyoming Game and Fish Department conducts an annual aerial count of moose to estimate population size. The count for 2016 totaled 228 moose (63 within Grand Teton), producing a Jackson herd estimate of 450 animals. Ratios were estimated at 45 calves and 74 bulls per 100 cows.



Jackson moose herd mid-winter counts, 1986-2016 (data from Wyoming Game and Fish Department). These counts are used to estimate overall herd size.

The moose herd decline likely results from a combination of interacting factors. The ecological landscape of today is dramatically different than the turn of the 20th century when moose populations expanded. At that time, large-scale predator reduction programs were ongoing throughout the west and wildfire suppression was widespread. Today, grizzly and wolf populations have recovered, large-scale wildfires affected portions of the herd unit in 1988, 2000, and 2010, and hunting is currently at very low levels. Studies suggest that nutritional quality of moose forage in areas burned in 1988 is significantly lower than in unburned areas. Individuals summering in these areas have lower pregnancy and calf survival rates. Conversely, winter habitat availability does not appear to be limiting the growth of the Jackson moose population. Moose have narrow temperature tolerances. Temperatures above 57°F trigger moose to seek cooler locations. Many of the shady mature forests bordering the riparian forage areas preferred by moose remain absent after large fires. Additionally, warming temperatures associated with climate change may be affecting moose, by altering their feeding and other activities, potentially affecting food intake.

Biologists are also studying parasites, like carotid artery worms and ticks, to evaluate their effects on moose populations. Recent research indicates that carotid artery worm is found in 50% of the hunter-harvested moose in Wyoming. Using photographs for a study started in 2012, park biologists assess the extent of hair loss caused by winter ticks in moose. Hair loss leaves moose unable to properly thermoregulate. In 2016, the mean total hair loss for all individuals (broken and bare patches) was 27.6%. Males had a 29.7% mean hair loss, and females had a 29.2% mean hair loss. Moose photographed in 2016 had the highest amount of total hair loss in the five years of monitoring efforts. Earlier studies elsewhere demonstrated that severe winter tick infestations can negatively impact calf survival and tick reproductive success is positively affected by earlier springs and milder winters. While a direct correlation between parasites and the population decline is unknown, it is clear that these parasites may be having an impact on the overall health of the moose population.

A moose with obvious patchy hair loss has less protection from the cold on a spring morning.

Mule Deer

Mule deer (*Odocoileus hemionus*), one of the many park animals that are seasonal residents, undertake annual migrations to distant wintering areas to meet their biological needs. Migrations showcase the behavioral strategies species use to exploit seasonal resources in otherwise inhospitable environments. Despite their intrinsic and ecological value, animal migrations have received little conservation attention until recently. Documenting animal movements is an essential first step to meaningful conservation actions.

In 2013, park biologists initiated a pilot study aimed at documenting migration patterns of the mule deer that summer within Grand Teton National Park. Previous studies of mule deer movements documented both long and short-distance migrations for deer that summered in the southern portion of the park. Earlier research by Idaho Fish and Game biologists confirmed that mule deer migrate from Idaho winter ranges to summer in the Tetons, but did not delineate these routes. Specific objectives for the mule deer migration research include: identifying important migration routes and seasonal use areas both inside and outside the park; determining the timing of migrations and assessing the variations in mule deer movements; evaluating land use patterns along migration routes to identify potential movement barriers and conservation needs; and working with partners to facilitate conservation of migration routes and important seasonal habitats.

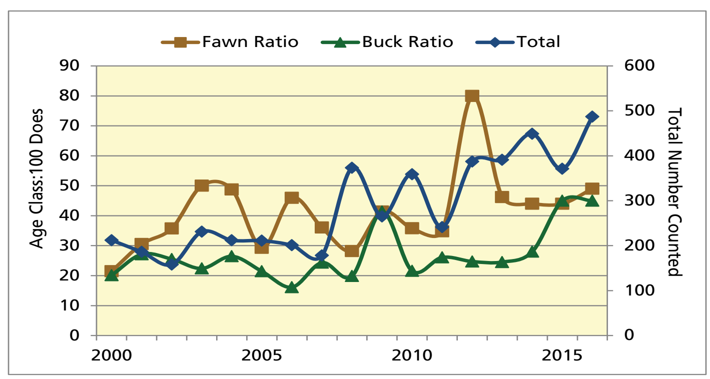
Fall and Spring migrations of 12 adult mule deer captured in Grand Teton NP, 2013-2015.

Since 2013, data from 18 GPS-collared deer has led to the discovery of five new long-distance migration routes. In 2016, park biologists deployed six GPS collars on mule deer summering in the park. Three deer were captured near Colter Bay, one near Moran Junction, one near Signal Mountain, and another near Moose. Biologists documented a new southern migration that follows the "Path of the Pronghorn" to Pinedale where it continues south along a portion of the Red Desert to a Hoback migration route used by other deer. Another deer migrated to the Teton River corridor in Idaho, using a route similar to a deer collared in 2015. Preliminary spatial analyses using data from 12 radio-collared deer were completed. These analyses evaluated the context of each corridor in terms of land ownership patterns and current land uses and identified stopover sites. Using outreach through video appearances, news interviews, presentations, and social media updates, park biologists hope to raise awareness and foster conservation of these migration paths.

Pronghorn

The pronghorn (*Antilocapra americana*) that summer in Grand Teton National Park are a segment of the Sublette herd that undertakes one of the longest terrestrial mammal migrations in the Western Hemisphere. In the fall, these fleet-footed animals cover up to 30 miles a day on a roughly 100-mile route, one-way, that follows the Gros Ventre River to its headwaters, and down to winter range in the upper Green River drainage. Pronghorn bones found at the Trappers' Point archeological site support that these animals have been using this narrow pathway for at least 6,000 years. Concern for this migratory segment of the pronghorn herd exists because development (residential and energy) occurs along the southern portion of the route and in the winter range.

Park biologists track the number of pronghorn summering in the Jackson Hole and the Gros Ventre River drainage by conducting aerial line transect surveys. This survey technique corrects for groups missed and provides an estimate of pronghorn abundance with a level of precision. During the 2016 survey, biologists counted 396 pronghorn (353 in the central valley of Jackson Hole and 43 in the Gros Ventre River drainage). Based on this count, biologists estimated the herd size at 953, although this estimate had a high degree of uncertainty. Park and Wyoming Game and Fish Department personnel conduct ground surveys in late summer to count and classify pronghorn after fawns are born. A total of 487 pronghorn were counted during the 2016 survey. Ratios were estimated at 49 fawns and 45 bucks per 100 does. The reproduction rate in this herd segment is typically low, but varies widely. Low pronghorn fawn counts are often seen following a severe winter or a cool, wet spring. Fawn ratios returned to average after reaching the highest level seen in more than a decade in 2012. In general, a ratio of 25 bucks per 100 does is needed to maintain good recruitment for the population.



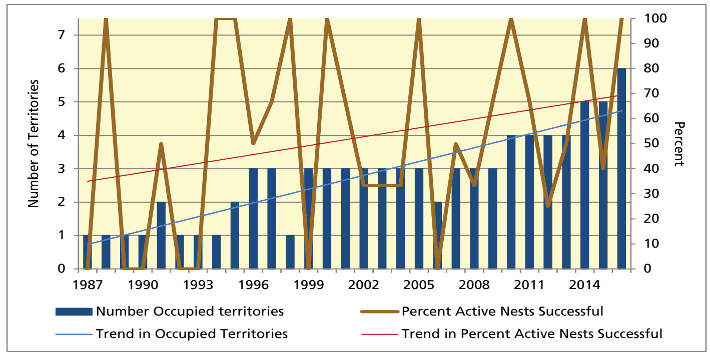
Pronghorn count and age/sex ratios during late summer classification counts, 2000-2016 (data from Wyoming Game and Fish Department).

Peregrine Falcons

Peregrines (*Falco peregrinus*) are cliff-nesting falcons that mainly eat other birds. The lower elevations of the major Teton Range canyons provide peregrines with excellent cliff-nesting and diverse foraging opportunities. Decimated by DDT (used in the US until the 1970s), peregrine falcons were extirpated from the Greater Yellowstone Ecosystem by the 1960s. Between 1980 and 1986, 52 fledgling falcons were released at several sites in Grand Teton National Park and the John D. Rockefeller, Jr. Memorial Parkway. Peregrine falcons first attempted nesting in 1987 at Glade Creek and successfully fledged young the next year. Peregrines, once listed as threatened under the Endangered Species Act, were delisted in 1999. Recently peregrines used territories in Garnet Canyon, Cascade Canyon, Webb Canyon, Blacktail Butte, and Glade Creek. In 2016, biologists confirmed two new territories within the park and parkway at Steamboat Mountain and Death Canyon. On several occasions park staff also observed peregrines on the east side of Mount Moran, although, it was not confirmed as a territory. Biologists also confirmed a new peregrine territory near Davis Hill, about two miles outside the eastern park boundary.

In 2016, peregrines occupied six of the seven territories monitored within the park and parkway. Of those six occupied territories, peregrines successfully bred at five eyries. In total, these peregrine falcons fledged 11 chicks in 2016. The Glade Creek eyrie was not occupied this year. The Davis Hill eyrie fledged at least one chick. A pair of adult peregrines occupied the new Death Canyon territory; however, an eyrie location was not found nor was breeding confirmed. In 2016, after adult peregrines displayed courtship behavior near Baxter's Pinnacle in Cascade Canyon, park managers established a temporary closure in the area to protect the nesting pair from disturbance due to the popular climbing route located close to the eyrie. The closure was lifted after biologists confirmed that the young had fledged.

Historically the percent of successful pairs is highly variable and appears to be influenced by breeding season weather events. But by many perspectives, 2016 was the most successful year on record for peregrine falcons in Grand Teton—three of the five successful territories fledged three chicks each (Webb Canyon, Blacktail Butte, and Garnet Canyon).



Territorial and successful peregrine falcon pairs, Grand Teton NP, 1987-2016.

Red Fox

Habituation of red foxes (*Vulpes vulpes*) in national parks to humans appears to be increasing in recent years. Habituated foxes have been documented at Acadia, Crater Lake, Grand Teton, and Mount Rainier National Parks. Anthropogenic food sources undoubtedly attract foxes. This includes the purposeful feeding of individual foxes by park visitors, ingestion of fish remains left by anglers during winter, as well as accidental feeding by park employees in developed areas. Habituation can cause numerous issues, including harm to the wildlife ingesting processed foods, traffic hazards for wildlife and humans, property damage, and health and safety concerns (e.g., aggression and disease transmission) for park visitors and employees. Therefore, minimizing the potential for human-fox conflicts while maintaining this valued ecological and wildlife viewing resource is a priority issue for park resource management staff.

To address habituation issues and to make effective management decisions, park staff began a monitoring project to gain a better understanding of fox ecology. Data collected from this project will aid in assessments of temporal and spatial movements, distribution, foraging patterns, and diets of this resourceful and charismatic species. Increased ecological understanding of foxes coupled with enhanced outreach and education efforts will greatly reduce human-fox conflicts in Grand Teton, as well as provide a template for addressing this wildlife management issue in parks throughout the country.

In 2016, biologists trapped, collared or marked, and collected samples from several foxes in four park developed areas: Moose, Teton Science School (Kelly Campus), Colter Bay, and Signal Mountain. Blood and hair samples were collected for disease and diet analyses, and foxes were individually marked with ear tags and/or fitted with a collar (GPS or VHF), when appropriate.

A habituated red fox approaches a visitor on Jackson Lake.

Sagebrush Steppe

Sagebrush steppe is a sensitive vegetation type occupying much of the valley floor in Grand Teton National Park. Incredibly diverse, the sagebrush steppe has a greater variety of plant species than any other plant community in the park except for wetlands. Home to sage-grouse, a species of concern, as well as a myriad of other wildlife species, the health of sagebrush ecosystems is likely to be influenced by the direct and indirect effects of climate change. Approximately 15% of the park's sagebrush steppe acreage has been impacted by the effects of human habitation and agriculture over the past two hundred years. Biologists are studying the overall health of this plant community to understand and aid in conservation efforts where there is disturbance.

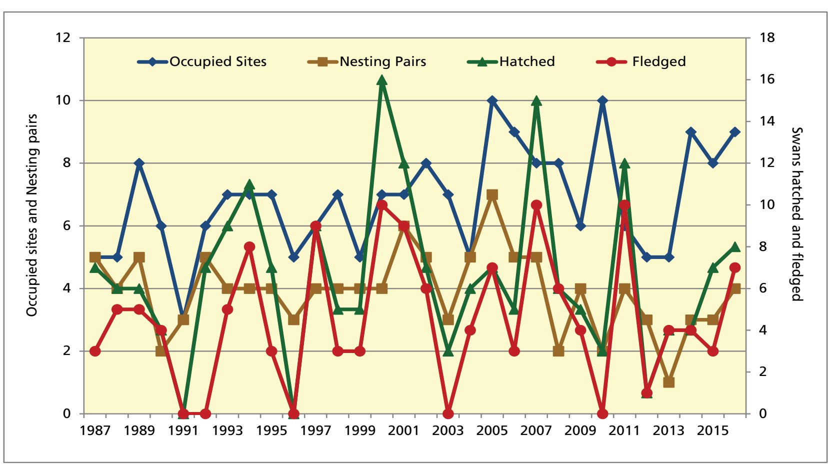
This year was the fifth year that vegetation biologists conducted monitoring studies of intact sagebrush communities, as well as some areas that are undergoing restoration activities. Park biologists examine changes in vegetation composition on intact sites and use the data as reference conditions for the eventual full restoration of former agricultural sites. In 2016, biologists sampled more than 700 micro-plots in 14 sample frames distributed throughout native sagebrush steppe communities. They compared these plots to earlier study results to examine the types and rates of change that are occurring in the sagebrush steppe community. In 2009, park managers initiated long-term restoration of the Kelly Hayfields—sagebrush steppe lands that were converted to agricultural use then abandoned when they became park lands. Today seven different units totaling 1,235 acres are in various stages of restoration including 925 acres seeded with native plant species (235 acres seeded in 2016). Monitoring efforts in 2015 revealed that the species composition on sites seeded prior to 2013 show a clear trend of increasing native plants, though portions of most sites retain significant populations of non-native species mixed in with the native grasses, forbs, and shrubs that were seeded into the sites. In 2016, biologists observed sage-grouse using the restoration units for the first time since treatments began.

Also in 2016, park biologists initiated high elevation (alpine/sub-alpine) monitoring in the upper South Fork of Cascade Canyon. They located monitoring sites in dry and mesic areas to capture changes in vegetation due to both climate and the predicted melt-out of Schoolroom Glacier over the next quarter century.

Trumpeter Swans

Nearly exterminated in the contiguous 48 states by the turn of the 20th century, trumpeter swans (*Cygnus buccinator*) made a comeback after intensive captive breeding programs, habitat conservation measures, and protection from hunting. Despite these efforts, swan population growth is low in the tri-state region (the Greater Yellowstone Ecosystem and surrounding areas in MT, ID, and WY). Many factors likely inhibit recovery, including competition with migratory flocks of swans, marginal winter range, variable reproduction rates, limited and low-quality nesting habitat, and high cygnet mortality. Monitored since 1987, Grand Teton provides important nesting habitat for swans.

Biologists monitor 18 historic nesting territories: 13 within the park and parkway plus 5 outside but adjacent to park boundaries. In 2016, swan pairs exhibited breeding behavior at 4 territories, and produced young at Pinto Pond (4 cygnets hatched), Glade Creek Cliffs Slough (3 cygnets hatched), and the Swan Lake Slough (unknown number hatched). All 4 of the Pinto Pond cygnets fledged, 2 of the Glade Creek Cliff cygnets fledged, and 1 of the Swan Lake cygnets fledged. The number of occupied swan sites, nesting pairs, and young hatched and fledged fluctuated widely over the 30 years since monitoring began. In 2016, the number of occupied and active territories, as well as the number of cygnets hatched and fledged, were above or near the historic averages. Swan pairs have disappeared from some traditional park nesting sites that were occupied for decades. Substantially decreased water levels due to drought and other undetermined causes likely led to abandonment of some sites while increased human activity and predation may affect occupancy and productivity at other sites.



Trumpeter swan productivity at territories in and adjacent to Grand Teton National Park, 1987-2016.

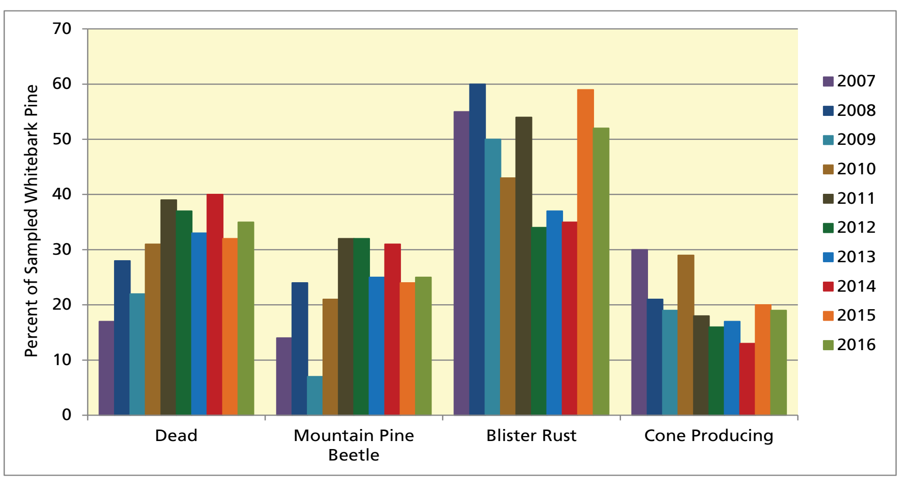
Whitebark Pine

Verbenone pouches mimic the natural pheromone that beetles emit signaling other beetles to find another tree. Park staff place these pouches on a whitebark "plus" trees to protect healthy rust-resistant trees in otherwise heavily infested stands.

Whitebark pine (*Pinus albicaulis*) is a slow growing, long-lived pine, often the only conifer species capable of establishing and surviving on high-elevation sites with poorly developed soil, high winds, and extreme temperatures. As a keystone species with a significantly higher ecological role compared to its abundance, whitebark influences biodiversity and forest structure. These trees maintain water availability by trapping snow, regulating snowdrift retention and melt, and preventing erosion of steep sites while also producing seeds that are an important food source for wildlife including Clark's nutcrackers, grizzly and black bears, squirrels, and other species.

In the past decade whitebark pine has experienced unprecedented mortality due to the combined effects of native mountain pine beetle, nonnative white pine blister rust, and changing climate conditions. Overflights of the Greater Yellowstone Ecosystem in 2009 found visible beetle activity in 90% of all watersheds containing whitebark pine. Overflights by the US Forest Service in 2016 indicate that there are remaining areas of mountain pine beetle activity in Grand Teton and the GYE. Grand Teton National Park and the John D. Rockefeller, Jr. Memorial Parkway include a total of 28,500 acres of whitebark pine forests. Of these, 9,726 acres are dominated by whitebark pine and 18,775 acres are stands in which whitebark is co-dominant with other conifer species. White pine blister rust, found throughout the park and parkway, is causing extensive damage to cone-bearing branches, seedlings, and saplings.

Grand Teton began annual whitebark pine monitoring in 2007 using 26 permanent transects. Park staff monitor a small number of these transects annually and the remainder in rotation. The annual data summary graph depicts the transects monitored in a specific year which accounts for some of the variability, but does not mask the trends. Overstory mortality associated with the mountain pine beetle epidemic has decreased slightly since 2014, although additional overstory mortality occurs annually and areas of intense beetle activity remain in Grand Teton. Over 50% of individual whitebark are infected with blister rust and blister rust is present in 92% of the sampled transects. The severity of rust infection is increasing annually, indicated by the number of rust cankers counted on each sampled whitebark. The proportion of live whitebark that produce cones has decreased slowly and overall seed quantity has decreased with increased overstory mortality. Among whitebark sampled in 2016, 35% were dead, 25% attacked by beetles, 52% were infected with blister rust, and 19% produced cones. Whitebark regeneration was present on all transects. Regeneration was 98% rust-free with a seedling density ranging from 100 to 2,000 whitebark <1.4 meters tall per hectare. Beetle activity and blister rust severity were greater at elevations less than 9,500 feet and on transects with a south aspect; blister rust severity was greatest on larger diameter trees. Individual whitebark with greater rust severity had a higher incidence of mountain pine beetle attack.



Distribution by status of individual whitebark sampled in Grand Teton National Park 2007-2016.

Aerial view of whitebark overstory mortality in Grand Teton NP.

Archeological Sites

Grand Teton National Park and the John D. Rockefeller, Jr. Memorial Parkway contain 495 identified archeological sites. These sites range from prehistoric base camps, lithic quarries, and scatters, which date to as early as 11,000 years before present, to historic homesteads, roads, trails, irrigation ditches, and trash dumps dating from the late 19th century and early 20th century. Since archaeological work began in 1970, cultural resource staff have surveyed approximately 4.5%, or 14,980 acres, of the 310,000 acres within Grand Teton and the parkway. Archeologists continue to find and record new sites every year.

The majority of sites within Grand Teton are identified and recorded when archeologists survey an area before construction activities begin. In 2016, the park completed field surveys before trail reroutes, hazardous fuel treatments, wastewater infrastructure improvement, and several large planning projects. If significant sites are located within a project area, archeologists assess the extent and integrity of the site to determine if the project will cause any damage. Throughout the process of recording, testing, and mitigating, Grand Teton consults with 24 traditionally associated American Indian tribes. These consultations aid collaboration and inform decision-making. In 2016, Grand Teton conducted eight consultations in person, four in writing, and three via teleconference.

During the summer of 2016, an intern working on a doctorate in historical archeology conducted an archeological survey focused on the settlement history and water rights for the network of irrigation ditches in the Mormon Row Historic District and Antelope Flats area. Other current research in the park includes a second year of the Ice Patch Archeological Survey, looking at receding ice patches for evidence of human occupation (e.g. artifacts and ecofacts eroding out of the ice) conducted by the Office of the Wyoming State Archeologist. The large Jenny Lake Renewal Project affects a prehistoric site eligible for the National Register of Historic Places (NRHP). Archeologists monitored the site during construction activities and recovered several artifacts. In the fall of 2016, while assisting the park archeologist, the Grand Teton dive team located a sunken boat in Jackson Lake, likely from the 1920–1930s, with the logo “W – O Dude Ranch” on the stern.

Sunken boat found in Jackson Lake, Grand Teton NP, 2016.

Park Service archeologists also assess the condition of previously discovered sites. By the end of 2016, archeologists determined that 206 sites are in good condition; 124 sites are in fair condition; 77 sites are in poor condition; 1 site has been destroyed; and a total of 87 sites are lacking data or the site condition is unknown. Of the 495 archeological sites within Grand Teton and the parkway, 182 sites are listed in or eligible for the NRHP, 255 sites are considered ineligible for the National Register, and 58 sites remain unevaluated.

Museum Collection and Archives

Grand Teton’s archival collection documents the complex history of Grand Teton National Park. The archives—the two-dimensional paper based unpublished materials—include reports, photographs, and maps documenting subjects ranging from land management, park history, and natural resources to the Tetons’ extensive climbing history. The park collection of early summit records is comprised of traditional registers and a variety of unique items, such as library cards and candy wrappers which were left atop peaks documenting the first ascents of numerous climbers, including Paul Petzoldt and Yvon Chouinard. With finding aids to assist with research, the archives are a well organized resource available by appointment to park staff and the public.

Grand Teton’s museum collection preserves objects that represent the human historical record, such as archeological materials (projectile point and scrapers), historic vehicles, a significant fine art collection, regional handmade furnishings, and the renowned David T. Vernon Collection of ethnographic materials. While Grand Teton National Park does not currently have a museum facility that adequately meets the storage, research, and conservation needs of the collection, some materials are held in repositories maintained by other institutions outside the park, such as the Midwest Archeological Center in Lincoln, Nebraska, where a large percentage of the park’s archeological collection is stored. The majority of the Vernon Collection is also currently housed off site at the National Park Service’s Western Archaeological and Conservation Center located in Tucson, Arizona, to ensure the preservation of the materials. A small number of pieces from the Vernon Collection are displayed in two of the park’s visitor centers. A few other items from the museum collection are on exhibit outside of the park in local museums such as the National Museum of Wildlife Art and the Teton Valley Museum. The park is exploring options to develop appropriate facilities for the park collections.

In partnership with Idaho State University’s Geosciences and Geography Department, Grand Teton’s museum program is working to document the history of recreational use in Grand Teton. Research in 2016 focused on collecting oral histories from Jenny Lake climbing rangers in addition to park concessionaires operating river trips on the Snake River since the mid-1950s.

As of 2016, 80% of the one million item collection is processed and cataloged. While the park curator completed a full inventory of the collection, updates to the collections management database are still in progress to document Grand Teton’s natural and cultural history.

Historic Structures

Volunteers stabilizing the curing house at the historic 4 Lazy F Ranch in Moose.

Grand Teton National Park, in accordance with the National Historic Preservation Act of 1966, evaluates park properties for historic significance and integrity. Following these criteria, 736 historic resources within the park are listed or determined eligible for the National Register of Historic Places (NRHP). Many of these buildings, linear resources (trails, roads, ditches), and cultural landscape features are organized within 44 historic districts. These properties reflect prominent historic themes that define the character of Jackson Hole and the park, such as homesteading, agriculture, dude ranching, conservation, recreation, and tourism. Two properties possess exceptional national significance and have been designated National Historic Landmarks (NHL)—the Murie Ranch for its association with the conservation movement and Jackson Lake Lodge as the first example of modern architecture within a national park. In 2016, the cultural resource team completed two new determinations of eligibility, finding the Deadman's Bar Road and Grassy Lake Road not eligible for listing in the NRHP.

In addition to evaluating properties, the park develops treatment plans outlining appropriate preservation work for individual properties. In 2016, park staff along with a contractor completed a preservation maintenance plan to guide typical maintenance activities at the Colter Bay guest cabins and tent village. Similarly, through a partnership with the University of Pennsylvania Architectural Conservation Lab, the park is developing a historic structures report for the Jackson Lake Lodge NHL. The report includes the history and construction chronology of the property, a detailed condition assessment, as well as recommendations for preserving and maintaining this iconic property.

In 2016, volunteer labor provided valuable preservation of park properties, particularly those with no active use. Inspired by the dedication of past volunteers and determined to better support these efforts, the park with support from the Grand Teton National Park Foundation launched the Grand Teton Hammer Corps in 2016, the official volunteer program for cultural resource projects. The formalized program focuses on increasing volunteer capacity, purchasing materials and supplies for projects, employing an experienced group leader, and developing tailored work plans based on a range of skill sets and volunteer availability. By harnessing a reliable volunteer work force, park staff hope to effectively tackle annual preservation maintenance needs and provide opportunities for interested members of the public to get involved preserving these special places. In 2016, the Grand Teton Hammer Corps repaired roofs, repaired chinking and daubing, and stabilized a porch and curing house at the historic 4 Lazy F Ranch. Overall, Grand Teton Hammer Corps hosted 222 residential and day group volunteers who contributed over 3,000 hours of service in 2016. The park plans to continue and expand this program in 2017, with the Foundation's support. The establishment of the Hammer Corps was inspired in part by the relentless dedication of building conservator, Harrison Goodall, who received a 2016 NPS IMR Hartzog Award for over 20 years of volunteer service, mostly in Grand Teton.

Building off of preservation efforts started in 2013, the Mormon Row Historic District remained a 2016 focus property. The park with financial support from the Grand Teton National Park Foundation partnered with the Montana Conservation Corps to create a new Tribal Youth Corps program. Their work focused on Mormon Row cultural landscape preservation; tasks included irrigation ditch clean-up, construction of footbridges, installation of positive drainage, repair of existing fences and gates, general site clean-up, and visitor data collection. The primary goals of the program are to connect American Indian youth with the Grand Teton landscape, assist with cultural resource projects, and introduce participants to careers in the National Park Service. The program was a huge success that involved 15 youth crew members who contributed over 1,600 hours of work. Additional building preservation at the Roy Chambers and John Moulton properties on Mormon Row was completed by a crew of preservation specialists from the NPS Western Center for Historic Preservation. Professional consultations from the NPS intermountain region historical architect, NPS Vanishing Treasures structural engineer, and Harrison Goodall were also completed during the 2016 field season to identify and inform future work at Mormon Row.

Other preservation projects completed during 2016 took place at the historic Geraldine Lucas/Harold Fabian Property and the Bar BC Dude Ranch. Through a collaborative effort, the NPS Western Center for Historic Preservation, Grand Teton trails crew, and volunteers, repaired five roofs, repaired or replaced deteriorated logs, and widened the existing path to meet Architectural Barriers Act standards at the Lucas/Fabian Historic District. The University of Pennsylvania Historic Preservation Field School returned to the park and students stabilized one more sleeping cabin at the Bar BC Dude Ranch.

In addition to identifying, evaluating, and preserving these historic resources, the park is responsible for assessing how park activities will affect historic properties. To help guide this process, park staff are finalizing a Historic Properties Management Plan. Although more than half of the park's historic properties are in good condition and three-quarters are actively used with an assigned purpose, the comprehensive plan will assist the park in future management decisions, providing overall direction for treatment and use of key properties.

Aquatic Invasive Species

Aquatic invasive species (AIS) are aquatic organisms that are not native in a particular watershed. These species vary in size and phylum and are most often, but not solely, introduced to a new watershed via watercraft. Once introduced the species can thrive without the presence of their natural predators or competitors. This can result in major alterations to native ecosystems, and adversely affect recreation, water utilization, and the local economy. A few examples of species that have recently expanded their range near Grand Teton National Park include curly leaf pondweed (*Potamogeton cripus*), flowering rush (*Butomus umbellatus*), and fish species such as burbot (*Lota lota*). Quagga and zebra mussels (*Dreissena bugensis and D. polymorpha,* respectively), two of the most impactful invasive species in the US, greatly expanded their range over the last 10–20 years. In 2016, staff at two Montana reservoirs found one or more positive tests for mussel species while conducting early detection monitoring. It is the first time these species were detected in Montana and is also the closest these species were detected in proximity to the Greater Yellowstone Area.

In order to prepare for such a discovery in the park, Grand Teton hosted and participated in an exercise of a mock dreissinid mussel discovery in Jackson Lake. Several federal and state agencies gathered, formed an Incident Command System at the University of Wyoming NPS Research Station, and made decisions considered what appropriate steps should follow such a discovery in a system that sits at the headwaters of two major drainages, the Snake and Columbia Rivers.

For several weeks in 2016, Montana land managers closed over 183 miles of the Yellowstone River and many miles of its tributaries to all recreational use due to a fish kill associated with a population explosion of the parasite (*Tetracapsuloides bryosalmonae*). The nativity of this pathogen is unknown, but fish overwhelmed by the parasite often succumb to proliferate kidney disease (PKD). Tens of thousands of fish were killed by PKD in that river system. A similar but smaller scale fish kill caused by PKD in the Snake River of southeastern Idaho in 2016.

Grand Teton's waters are a major recreational draw for many visitors and the park is attempting to prevent the introduction of AIS by inspecting watercraft and educating boaters on preventing the spread of unwanted species. 2016 was the first year the park had watercraft inspection stations at two locations operating daily. The inspection stations were open nine hours a day during prime visitation periods (May 18–September 18) and inspected 15,264 watercraft, with an additional 3,688 commercial rafts passing through the stations. Staff preformed 57 decontaminations to reduce the risk of the introduction of an AIS. Boaters can help prevent AIS introductions and speed inspections by ensuring they drain, clean and dry their watercrafts after every use.

Kelly Warm Spring

Kelly Warm Spring is a thermal feature that has a long history of aquarium dumping leading to the proliferation of non-native species in the spring. Non-natives persisted throughout the warm spring effluent and, as in the past, biologists found some warm water species in Ditch Creek, a tributary to the Snake River. Starting in 2012, goldfish (*Carassius auratus*), native to east Asia, and tadpole madtoms (*Notorus gyrinus*), native in much of eastern North America, were found in Ditch Creek. Biologists annually monitor the dispersal of non-native fishes originating from the warm spring and consistently find these fish in Ditch Creek, some within 10 yards of the Snake River.

Biologists also found American bullfrogs (*Lithobates catebeianus*), another species with a wide latitudinal native range introduced for unknown reasons in the 1950's, continue to thrive in the thermal feature and its effluent. The bullfrog is implicated in the decline of native amphibian populations throughout the world due to both direct and indirect factors. In Grand Teton National Park native amphibians are nearly wholly absent in the bullfrog's occupied range with only a couple boreal toads being found on the periphery of bullfrog inhabited waters.

In 2016, the National Park Service began a study on the fall movements and over wintering habitat utilized by American bullfrogs. In order to track the bullfrogs, a small harness holding a VHF radio transmitter capable of emitting a signal for 64 days was fitted on post metamorphic frogs throughout their occupied range in September 2016. Biologists subsequently tracked the frogs' locations weekly until the tag was recovered or the battery died.

Biologists measure a bullfrog captured in Kelly Warm Spring after fitting it with a tracking harness.

The frogs displayed more upstream movements than downstream movements with a majority of their largest movements occurring before October 11, 2016, which coincided with the first cold snap of the season (October 2–8). By the end of November, frogs greater than 400 yards from the warm spring appeared to be in wintering habitat with at least two locations where several frogs were found together (1 burrow had 3 frogs stacked on one another). The winter range was more widespread than managers had hoped leaving the species less vulnerable to mechanical removal efforts.

These efforts to gain a better understanding of the ecology and potential threats in Kelly Warm Spring and its effluent will help inform future management decisions with the goal of returning the spring to a more natural state.

CHALLENGES

Fisheries

One priority of Grand Teton's fisheries program is to understand the life history requirements of the native species that inhabit the park's lakes. Cold water lakes may act as refuge for native cold-water reliant species, such as Snake River fine spotted cutthroat trout (*Oncorynchus clarkia*), if climatic shifts continue to alter hydrologic and thermal regimes of river systems. Surveys of the species indicate that spawning of cutthroat trout in the northern portion of the park differs significantly from those in the southern portion. Additionally, cutthroat runs in the park's lakes are smaller than expected given the size of the aquatic system and amount of available habitat; this is likely a consequence of predation and competition from non-native species, such as lake (*Salvelinus namaycush*), brook (*Salvelinus fontinalis*) and brown (*Salmo trutta*) trout—species historically stocked in park lakes by sportsmen and the Wyoming Game and Fish Department (WGFD) prior to 2006.

Utah suckers, native to many of the park's waters, exhibit a variety of life histories. They typically congregate to spawn at predictable locations each year in the shallow water of park lakes and streams. Since 2012, twenty Utah sucker (*Catastomus ardens*) spawning sites were documented in seven different lakes in the park. Groups of the fish eating birds have been seen to number near 60 individuals. These spawning locations are targeted by predators such as pelicans. Some evidence suggests that bears may be using spawning suckers as an annual food source.

Entrainment (i.e., fish getting "lost" in irrigation ditch systems that often leads to the death of the fish) is also a concern of park fisheries managers. Irrigation ditches draw from several drainages in the park for agricultural purposes on land adjacent to the park. Increasing the efficiency of these ditches and encouraging water rights holders to only draw as much water as they need are strategies that could help keep the fishery healthy. Resource managers have reached out to park partners such as Wyoming Game and Fish Department, Bridger-Teton National Forest, Trout Unlimited, and the Snake River Fund to help rescue fish stuck in irrigation systems near Spread Creek, where 100–300 cutthroat have been returned to the stream from a nearby irrigation ditch each year since 2012.

Camera traps photographed numerous pelicans working in groups to push spawning Utah suckers into shallow water to feed on them.

Fish populations depend on healthy habitat. Fragmentation and degradation are major concerns for fisheries managers. One fragmented system in the park, Ditch Creek, has seen decades of fish passage obstructions in the form of culverts. These culverts prevented fish such as the Snake River fine spotted cutthroat trout, and bluehead (listed by the WGFD as a species of concern), Utah, and mountain suckers from reaching preferred spawning habitats. In the fall of 2014, baffles were retrofitted in the two culverts that blocked these fish migrations. Other human caused changes to the landscape have led to a fish passage disruption that is preventing fish from using more than 23 miles of fish habitat. With the assistance of the Grand Teton National Park Foundation, resource managers are currently working to find viable long-term solutions to this problem and others as they preserve wild waterways for native species and processes.

Human-Bear Interface

Grand Teton National Park and the John D. Rockefeller, Jr. Memorial Parkway provide ideal habitat for free-ranging black (*Ursus americanus*) and grizzly (*Ursus arctos*) bears. Grand Teton receives more than 4 million visitors per year, most of whom visit during the peak summer season. Consistently high levels of human recreation in prime bear habitat create a high potential for human-bear interactions.

In an effort to decrease conflicts, park staff strictly enforce food storage regulations and all park facilities have bear-resistant garbage receptacles. The park emphasizes "Be Bear Aware" public educational messages and provides annual bear safety training to park and concession employees. The primary focus is to keep human foods away from bears. Since 2008, the park, with generous support from Grand Teton National Park Foundation, installed a total of 599 bear-resistant food storage lockers in park campsites and picnic areas toward that goal.

Human-bear confrontations are incidents when bears approach, follow, charge, or act aggressively toward people, enter front-country developments, or enter occupied backcountry campsites without inflicting human injury. Human-bear conflicts are incidents when bears damage property, obtain human foods, injure or kill humans, or are injured or killed by humans. In 2016, park staff recorded 80 human-bear confrontations and eight human-bear conflicts. Five of the conflicts involved black bears—one incident in which a black bear received a food reward, three incidents in which black bears were hit and killed by a motor vehicle, and one incident in which a black bear was hit by a car but was able to run off. The other three conflicts involved grizzly bears, two of which were killed and one that ran away from the scene of a motor-vehicle collision. The extent of injuries or deaths from collisions where bears are able to run away is unknown.

There was only one report of a bear receiving a food reward in 2016. This incident involved a black bear that gained access to human foods abandoned by two picnickers who were startled by the bear.

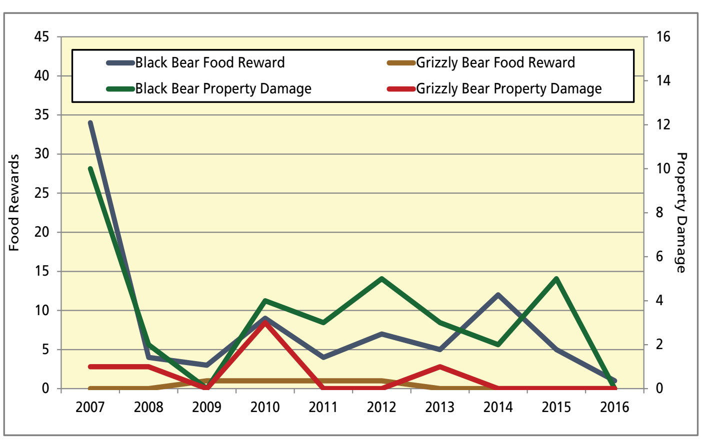
Park staff work diligently to prevent bears from developing nuisance behaviors. When humans fail to secure their food, bears can develop unwanted behaviors. In an effort to discourage bears from frequenting developed areas and roadways, trained staff follow an established protocol of hazing. Grand Teton staff hazed bears 46 times in 2016, using noise (yelling, horns, sirens, or cracker shells) or non-leathal projectiles at the bears,

G. Pollock

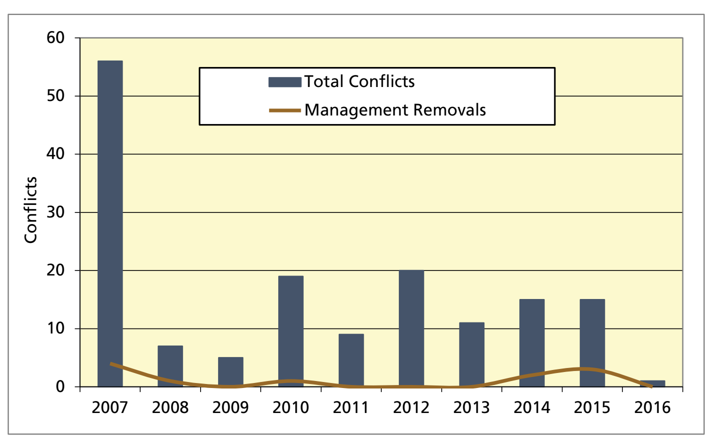
Black bear cub climbing an aspen.

Park managers also implement seasonal closures to protect bear habitat and to address human safety concerns. In 2016, bear managers enacted two annual closures (Grassy Lake Road closed to motorized use from April 1–May 31 and Willow Flats closed to public entry from May 15– July 15 to protect grizzly bear foraging opportunities) and one special management area closure (Moose-Wilson Road to protect fall foraging opportunities beside the narrow road), along with six temporary closures (around carcasses and foraging areas).

Since 2007, Grand Teton employs the Wildlife Brigade, a corps of paid and volunteer staff, to manage traffic and visitors at roadside wildlife jams, promote ethical wildlife viewing, patrol developed areas to secure bear attractants, and provide bear information and education. In 2016, they recorded 459 wildlife jams including 99 grizzly bear jams, 109 black bear jams, 20 unknown species bear jams, 168 moose jams, and 63 jams for other species such as bison, elk, and great gray owl.



Bears receiving human-food rewards or causing property damage in Grand Teton.



Bear conflicts and removals in Grand Teton.

Invasive Plants

The survey and control of invasive nonnative plants remains a high priority for Grand Teton vegetation staff. Invasive plants alter habitats by displacing native vegetation communities, affecting wildlife distribution, and limiting ungulate foraging opportunities. During the 2016 field season, vegetation staff, along with partners and contractors, actively surveyed 8,306 weed infested acres, specifically treating 1,568 acres within these areas for 28 invasive nonnative plant species.

Invasive plants have multiple origins. In addition to accidental introductions from Eurasia, early homesteaders planted nonnative cultivar and ornamental plant species prior to establishment of the park, and many of these species still persist. Today, humans contribute to the spread of invasive species by inadvertently transporting weed seeds on their vehicles, clothing, and in construction materials. Wildlife and domestic stock and feed also transport weed seeds in the park. Areas particularly at risk to invasive plant infestations include disturbed areas along roads, levees, pathways, trails, utility corridors, and building sites. Formerly disturbed sites within the park such as prior homesteads, hayfields, and gravel pits remain a management challenge.

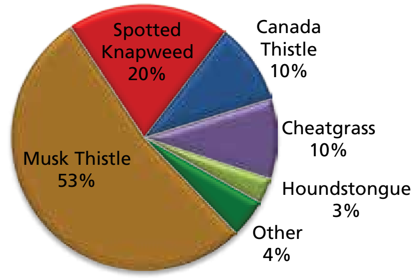
Grand Teton biologists prioritize control efforts according to invasive plant species, abundance, and site characteristics, based on threats posed to ecological processes and prospects for successful treatment. Some infestations can be eradicated if treated when the outbreak is still small and a seedbank not well established. Other species have become so ubiquitous that containment of current infestations is now the primary goal. Invasive plants listed as federal, state, or county“noxious weeds” are particularly aggressive plants and legally deemed to be detrimental to agriculture, navigation on inland waterways, fish and wildlife, and/or public health. Grand Teton National Park staff focus efforts on locating and using the best treatment practices to address listed noxious plant species. Examples of sites where noxious weeds have been successfully managed over the past five or more years include: Barker meadow (multiple weed species), Moran Cemetery (Dalmatian toadflax), Bradley-Taggart Trailhead and meadow (yellow toadflax), and Kelly Hayfields (musk thistle). Salt cedar (Tamarisk), a priority focus in the Snake River corridor, was found in very limited numbers in 2016, and is very close to complete eradication.

Management actions in 2016 included herbicide treatments with pressurized backpacks; horse-mounted, truck-mounted, and UTV-mounted spray equipment; handgun spray systems, and a tractor-mounted boom sprayer. Herbicides are carefully selected to minimize impacts to non-targeted species and water sources. Staff and volunteer groups also implemented mechanical treatments, hand pulling and removal with shovels or cutting tools. The majority of labor hours were invested in disturbed portions of the sagebrush-steppe communities that dominate the lower elevations of the park. Additionally, invasive plant treatment as part of the Kelly Hayfields restoration, which aims to return nearly 4,500 acres of former agricultural land to native habitat, continues to increase and consume a large portion of program resources.

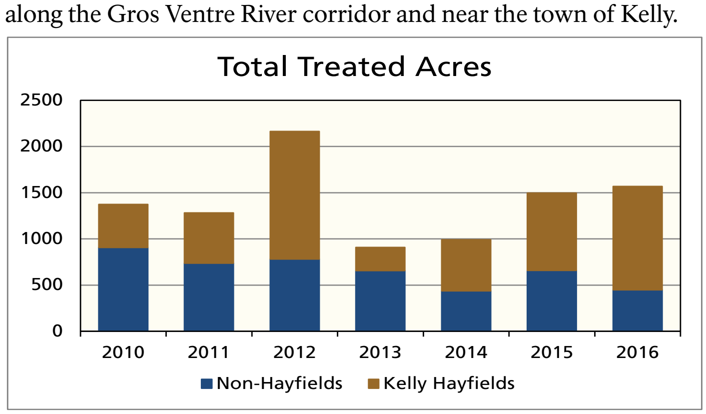
Preventing the spread of invasive species into backcountry and other less degraded areas of the park remains a priority. Backcountry weed surveys continued with a focus this year on the upper reaches of Cascade Canyon. Also, a multi-year project along the Snake River was initiated in 2016, with the goal of updating invasive plant inventories and treating priority species along the length of the river’s riparian corridor within the park. In 2016, invasive plant crews surveyed a total of 2,046 backcountry acres, traveling 644 miles over 45 days.

Partnerships with Teton County Weed and Pest District, Jackson Hole Weed Management Association, the Northern Rockies Exotic Plant Management Team, and the Greater Yellowstone Coordinating Committee are very important to successful invasive plant management. In July 2016, Grand Teton National Park and Teton County Weed and Pest hosted a collaborative invasive plant spray event where over 80 invasive plant managers throughout the Greater Yellowstone Area participated in collective herbicide treatments of invasive weeds along the Gros Ventre River corridor and near the town of Kelly.

Most Commonly Treated Species



Tractor with a boom sprayer treating invasives in the former Kelly hayfields.



Annual comparison of acres treated.

Livestock Grazing

Moving cattle to grazing pasture in the park, Grand Teton NP, 2015.

Grand Teton National Park, like several other National Park Service units, allows livestock grazing due to traditional land use that existed prior to the park's establishment. Grand Teton National Park was initially created in 1929. When it was expanded in 1950, the enabling legislation allowed ranches on inholdings to retain their grazing allotments indefinitely while another 26 ranches were granted grazing privileges for the lifetime of immediate family members. Collectively, these provisions allowed livestock grazing and trailing on about 69,000 acres (22% of the park). Over time, these grazing allotments were substantially reduced through attrition and the park's acquisition of inholdings through purchase or donation.

In 2009, to address concerns about grazing impacts on riparian vegetation and to minimize the potential for cattle depredation, park managers moved the largest remaining cattle allotment from open range on split National Park Service/US Forest Service lands to the park's fenced and irrigated Elk Ranch pasture which also predates the park's establishment.

In 2016, four ranches used a total of approximately 5,000 acres within park boundaries for livestock grazing and trailing. These included two park inholdings with grazing permits: the Moosehead Ranch grazed 64 horses and the Pinto Ranch grazed 290 yearling steers; Triangle X Ranch, a concessionaire operating a historic dude ranch within the park, grazed 120 horses; and Teton Valley Ranch, operating on an agricultural lease that dates back to the 1940s, grazed approximately 34 longhorn steers. Grand Teton National Park maintained another 33 horses and mules to support backcountry operations in the park and the State of Wyoming owns a 640-acre inholding that is leased for grazing.

Current livestock grazing in the park has been reduced by approximately 89% from historic grazing use. Park staff manage the remaining horse and cattle grazing with the goals of minimizing conflicts between stock and park wildlife, maintaining sufficient irrigation while balancing park aquatic resources, and reducing the spread of invasive nonnative plant species.

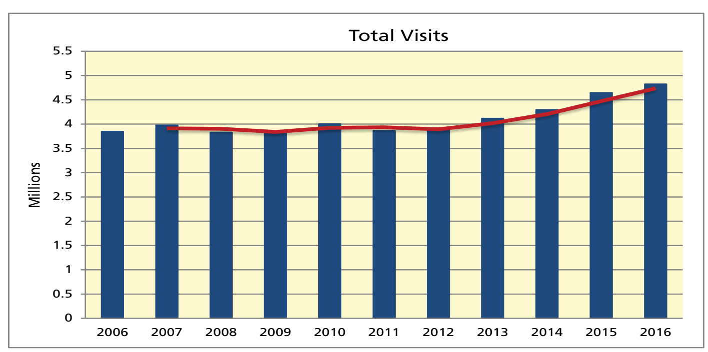
Visitor Use

Use of the park by visitors is both a primary reason for the establishment of Grand Teton National Park and a factor influencing resource condition. Increases in visitation may affect natural and cultural resources, as well as quality visitor experiences. Some factors that may influence visitation to parks include economic conditions, weather, gasoline prices, and National Park Service promotions such as the "Find Your Park" and "Every Kid in a Park" campaigns.

In 2016, the national parks had record annual visitation with more than 500 million visits, collectively. Grand Teton National Park followed this trend with record visitation for the third consecutive year. In 2016, the park received more than 4.8 million visits, a 3.8% increase from last year's visitation, and a 23% increase in visitation over the past four years. The majority of visitation (66%) occurred between June and September, with nearly 20% of the year's visitation occurring in July alone. Some popular trails, such as Taggart and String Lake trails have had use increases of 20% and 15%, respectively, from 2015 to 2016.

In 2016, the park visitors made a total of 530,846 overnight stays. Frontcountry camping ranked first in visitor accommodations accounting for 56% of the overnight stays, followed by lodging with 37%. While almost half of the park (44%) is considered backcountry, only 6.8% of the overnight stays were in backcountry campsites. Although there are no day-use limits, lodging and campgrounds in the park have limited available space, and on some summer nights, one or more forms of accommodation are full.

Hiking on the busy Taggart Lake Trail.



Annual Grand Teton NP total visitation 2006–2016.

Mountain Goats

Remote motion-sensing camera photo of several mountain goats, Grand Teton NP, 2016.

Mountain goats (*Oreamnos americanus*) are native to many rugged mountains of the northwest US, however not to the Greater Yellowstone Ecosystem. The nearest native mountain goat population occurs in the Lemhi Range of Idaho, approximately 125 miles northwest of Grand Teton National Park. From 1969 to 1971, the Idaho Department of Fish and Game released goats into the Snake River Range south of the park for the benefit of hunters. This transplanted population grew and some individuals dispersed to new areas. Observations of mountain goats in the Teton Range began in 1977, with the first sighting in the park by 1979. Until 2008, mountain goat observations were sporadic and thought to represent a few transient individuals. Since then park biologists have documented adult female mountain goats (nannies) with young (kids) each year, indicating that a breeding population is now established in the park.

The Teton Range is also home to a native bighorn sheep population, a species of concern because of its small size, isolation from neighboring herds, low genetic diversity, and loss of historic winter range. Teton bighorns live year-round at high elevation where conditions are extreme, especially in the winter. As mountain goats and bighorn sheep share similar habitats and forage, the potential for competition and the risk of disease transmission between the species could pose additional threats to the already stressed sheep population.

To better understand goat distribution, numbers, movements, and reproduction in the Tetons, park biologists captured and radio collared five mountain goats (4 nannies and 1 male kid) in 2014 and four mountain goats (3 nannies and 1 female kid) in 2015. A 2016 capture attempt was unsuccessful. Biologists collected samples from each captured goat to assess disease exposure. Field crews deployed two remote camera traps from early July through mid-September 2016 in the North Fork of Cascade Canyon to aid with monitoring efforts. In addition, "Wanted" posters displayed at trailheads on the east and west slopes of the Tetons solicited mountain goat observations from park visitors and staff.

All locations for radio-collared goats were within the park during the winter; however, several goats moved back and forth between Teton Canyon on the Caribou-Targhee National Forest and Cascade Canyon/Paintbrush Canyon within the park during the summer. Summer distributions of collared goats were generally between Cascade Canyon and Snowshoe Canyon. Preliminary analysis of radio collar data indicates that the elevational movements of goats were variable throughout the year. Two goats spent time at higher elevations during the winter months, descended to lower elevations during spring and fall, and then returned to higher elevation in the summer.

Six out of the seven (86%) collared nannies reproduced in 2016. Four of these goats had one kid each and two had twins. Goat 04, the only collared nanny that did not reproduce in 2016, was estimated to be eight years old. She was observed with a yearling at her heel in 2015, indicating she last reproduced in 2014.

In 2016, park visitors, staff, cooperators, and other agency personnel reported 100 mountain goat sightings in the Teton Range. These observations spanned the full length of the range with a single goat observed in Webb Canyon at the north end of the park in May. The furthest south observation was outside the park near Cody Peak on the Bridger-Teton National Forest in August. Biologists estimate that 60–80 mountain goats live in the Teton Range. The park is preparing a mountain goat management plan and environmental assessment to address options for their control.

CHALLENGES

Native Plant Restoration

Park staff collecting native slender wheatgrass seed for use in the Kelly Hayfields restoration.

Native plant revegetation and ecological restoration are both processes of managing vegetation in disturbed areas in an effort to return degraded or damaged habitats to functioning ecological systems. A primary goal of vegetation management in Grand Teton National Park is to restore disturbed ecosystems to provide habitat for the diverse wildlife species that inhabit the park. The propagation and planting of genetically local native plant species encourages the recovery of native plant communities and minimizes the establishment of invasive, nonnative plants. Revegetation seeks to rapidly establish native plants and initiate vegetation recovery, while restoration is intended to restore the native plant community and ecosystem that existed before disturbances occurred. All revegetation and restoration work conducted in Grand Teton National Park is accomplished by conserving local top soil and using plant materials that originate within the boundaries of the park and are suited to the natural ecotypes associated with a specific plant community. Research shows that using native locally occurring plant materials adapted to the environment translates into greater success of restoration and revegetation efforts.

In 2016, vegetation crews worked on 13 separate revegetation projects (19 total acres of disturbance) associated with park infrastructure improvements such as waterline replacements, building construction and repairs, and road and trail construction and rehabilitation. These areas were seeded with ecologically appropriate seed mixes consisting of 24 different species of grasses, forbs, and shrubs. Total native seed used on all projects combined was 344 lbs. All planted seed originated from materials hand collected and processed by vegetation management staff. In 2016, park seed collection efforts totaled 492 hours which amounted to 784 pounds of bulk material and 104 pounds of clean seed.

Native seed for restoration and revegetation projects is generated by one of two methods: seed collection or seed increase. Seed increase is the process where locally hand collected seed is planted and grown in a field or agricultural setting, to generate a greater quantity of seed that can be harvested directly off the fields. In this manner, large quantities of native seed can be produced in a controlled setting. The park has interagency agreements for seed increase/propagation with the Natural Resources Conservation Service's Plant Materials Centers in Aberdeen, ID; Bridger, MT; and Bismarck, ND. Additionally, vegetation management staff initiated planting of a three-acre seed increase field within the boundaries of the park. This relatively unique undertaking in the National Park System has the potential to provide native seed that is both genetically appropriate and free of nonnative plant seed that can contaminate seed grown in fields located outside the park. Park staff harvested some seed from these fields in 2016, and yields will improve in subsequent years as the plants become more established. The field should eventually be a significant source for locally grown native seed that will help support the park's plant restoration and revegetation needs.

Park vegetation crews continue in the long-term effort to restore 4,500 acres of nonnative hayfields in the Antelope Flats area to the native sagebrush steppe community which provides important habitat for elk, bison, antelope, and sage grouse. Restoration of these lands may include herbicide applications to remove nonnative hay crop species and invasive plants, native seed collection and seeding, monitoring, and adaptive follow-up treatments. Currently 1,263 acres of the 4,500 former Kelly Hayfields is under restoration treatment, including intensive invasive plant treatments for smooth brome, musk thistle, cheatgrass, and other invasive species. Approximately 275 acres are currently fenced to minimize wildlife pressure during early native plant establishment. Additional acres may be temporarily fenced as needed to promote successful restoration. As of December, 2016, 926 acres were seeded with native vegetation and 132 acres (Aspen Ridge and Elbo West) are considered fully restored. Crews continue to monitor treated acres for native plant establishment and possible cheatgrass or other invasive plant infestations. Park staff will adaptively adjust treatments of these areas to restore and maintain healthy native plant communities.

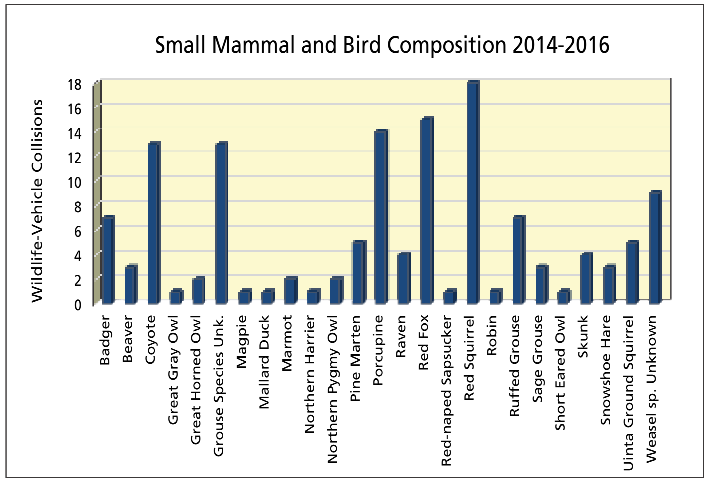
Wildlife-Vehicle Collisions

Wildlife casualties from motor vehicle collisions on Grand Teton National Park roads are common resulting in property damage and personal injury for humans. This wildlife mortality, when combined with other sources, has the potential to negatively affect some wildlife populations. Since 1991, park staff record data on wildlife-vehicle collisions (WVCs), to help identify appropriate measures to lower the number of WVCs, and improve the safety of park roads for humans and wildlife.

In 2016, 196 WVC incidents occurred involving 199 animals, continuing the increasing trend of the past two decades. The long-term increase may reflect, in part, greater effort in recent years to document all WVCs, including those involving smaller bodied species; however, data collection for the larger mammals remains consistent providing a relatively unbiased trend. The number of ungulates involved in WVCs varies annually, but the trend is increasing (7% annually since 2001). There is a slight decreasing trend for elk and moose collisions, and a slight increasing trend in deer and pronghorn, while bison collisions remain unchanged. In 2016, 82% of WVCs resulted in a confirmed animal death. In incidents where a carcass could not be located near the road, some animals may have died later from injuries sustained in the collision.

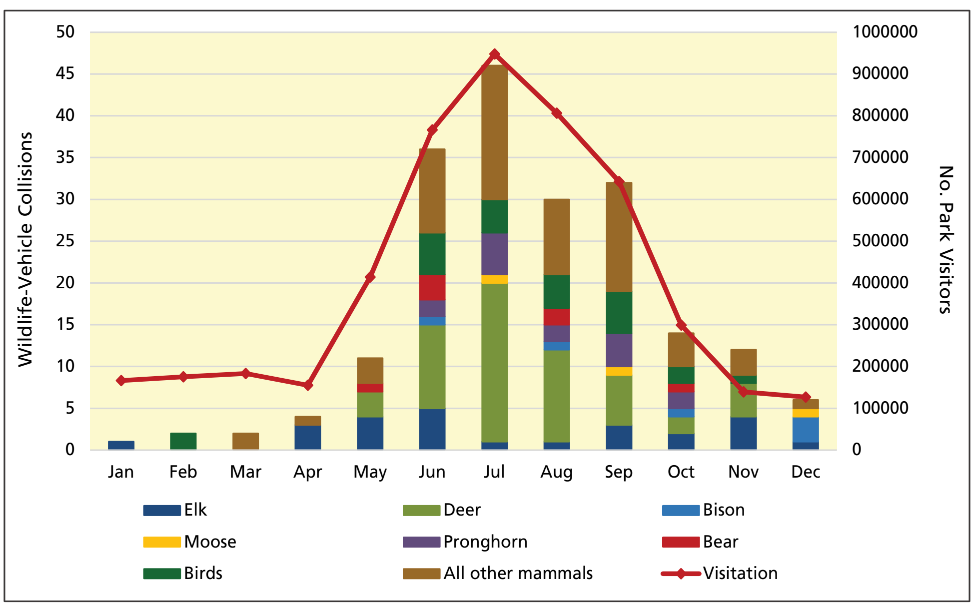
A total of 28 species, 18 mammals and 10 birds, were involved in WVCs in 2016. Large mammals made up 113 of the 199 animals involved. Ungulates comprised 53% of individuals involved in WVCs, birds 12%, and small mammals 31%. Birds and small mammals are likely underrepresented because they rarely cause property damage, are less conspicuous, and are thus probably under reported.

When possible, park staff record the time of day that an wildlife-vehicle collision occurred (73% of all WVCs have a time recorded). One hundred percent of collisions involving bison and moose and 60% involving elk occurred at night or under diminished light conditions (twilight). Deer and pronghorn are hit equally during the day and night/twilight. In 2016, 51% of known deer and 60% of known pronghorn collisions occurred during the day. The majority of collisions occurred during the snow-free months (169 collisions May–October). A mid-summer peak coincided with a peak in visitation, strongly suggesting the number of WVCs is largely a function of traffic volume.



Park staff documented the highest number of WVCs on US Hwy. 89/191/26 (43%), followed by the North Park Road (29%), Teton Park Road (20%), Kelly-Antelope Flats loop (2%), Moose-Wilson Road (1%), and other roads (5%). On US Hwy. 89/191/26, most WVCs occurred between Moose and Snake River Overlook (26%) followed by Spread Creek–Moran (13%) and Gros Ventre Junction–Airport Junction (13%). The majority of incidents with bison, moose, and elk occurred on US Hwy. 89/191/26. Forty percent of deer collisions occurred on US Hwy. 89/191/26, 35% occurred on the North Park Road (between Moran and Yellowstone National Park) and 18% on the Teton Park Road. Almost all (87%) pronghorn collisions occurred on US Hwy. 89/191/26.

The park implemented several mitigation measures to address WVCs, including the permanent reduction in nighttime speed limit from 55 to 45 mph on US Hwy. 89/191/26; continued use of variable message signs at strategic locations to inform drivers of current wildlife activity near roadways; the installation of permanent digital speed readers at Moose Alley, S-curves, Spread Creek, and Gros Ventre Junction; and painting wider road surface lines on park roads to delineate narrower travel lanes. In 2016, after a WVC killed a grizzly bear cub-of-the-year, the Jackson Hole Wildlife Foundation and some concerned citizens donated an additional set of vehicle speed-reading signs to remind drivers to maintain safe speeds in the park.



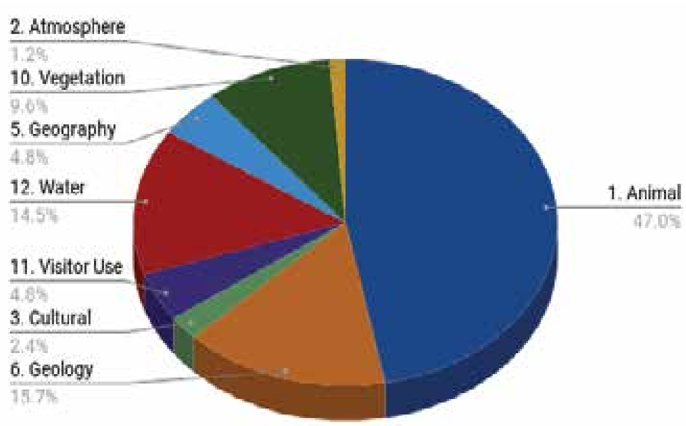
Animals killed in wildlife-vehicle collisions by month during 2016, in Grand Teton NP.

Research Permits

Grand Teton National Park and the John D. Rockefeller, Jr. Memorial Parkway (JDR) use the National Park Service's computerized Research Permit and Reporting System (RPRS) to manage research permits submitted to the park. Research within the park has occurred since the park's creation, but with the online RPRS system there is a more complete record of permits from 2001–2016. Since the implementation of this system, the number of permits entered into the database increased. In 2001, 50 permittees researched in the park and parkway. Since then the number of finalized permits fluctuated between a low of 42 permits in 2004 and a high of 88 permits in 2016, with a general upward trend in interest for performing research within Grand Teton and JDR.

Prospective researchers submit proposals to the park through the RPRS system. Park staff with subject matter expertise review proposals to determine if the study will contribute to the science of the ecosystem and to minimize impacts on visitors and park resources, both natural and cultural.

One of Grand Teton's earliest partnership for research was with the University of Wyoming in the 1940s. Since then institutions from across the country and world have conducted research in the park and parkway. In 2015, the database expanded to include recording the institutions represented by the researchers. During the span of 2015–2016, the database lists 81 separate institutions that operated within the boundaries of Grand Teton and JDR with 164 permits. The University of Wyoming had the most permits 24, followed closely by the US Geological Survey with 22 permits. Another major partner in the Greater Yellowstone Ecosystem, The Wyoming Game and Fish Department, held five permits during the past two years.



Percentage of 2016 research permits for Grand Teton NP listed by subject.

Park biologist collaring and animal for research in a mule deer study.

The more detailed records for 2015 and 2016 disclose that 85% of the permits issued during that period were for new research with the remainder issued for renewed permits. The average annual field season for permittees was 135 days (range of 2–351 days). While the average study lasted 3.9 years (range 2–101 years, with the USFS annual land inventory being the longest running study).

Since the inception of RPRS, the database records information on the various subjects that researchers study within the park and parkway. Animals remained the primary focus of research requests in 2016. The park issued 16 permits for research on birds and 9 for mammals, showing a change from the more mammal dominated research of 2001–2016 with 392 finalized permits for animal studies (152 mammals, 93 birds, 79 invertebrates/insects, 29 fish, 20 reptiles/amphibians, and 19 animal communities). Other leading topics for research included hydrology/water resources (61 permits), geology (26), geography (21), fire ecology (11), plant communities (9), and glaciers (8).

Research by scientists working for the National Park Service and those working for other institutions aids in furthering the understanding of the unique Greater Yellowstone Ecosystem and its many components.