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 2017

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The historic barns along Mormon Row are important cultural resources.

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 that may change or affect native species have been introduced both accidentally and intentionally. 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, rivers, and water quality) 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 (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 and habitat 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 2017 (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)	26°F, 56°F 28.49" 2,733 days (2012)	22°F, 52°F (1958–2012 average) 21.33" (1958–2012 average) 2,347 (1958–2012 average)
Fire	Acres burned per year by wildfire	1 acre	1–19,211 (1998–2017 range)
Glaciers	Extent of 10 named glaciers	1.5 km²	Long-term decline
Water Quality	Basic water quality parameters- 2 river sites	Iron exceeds state standards	State water quality standards
Natural Resources			
Amphibians	% of potential sites suitable for breeding	89%	TBD
Bald Eagle	Breeding pairs	11 pairs	11.5 pairs (2008–2017 average)
Bighorn Sheep	Teton Range herd estimate	60–80 sheep	100–125 sheep (1970–2000 estimate)
Bison	Jackson herd winter count (includes areas outside park)	546 bison	500 bison
Common Loon	Breeding pairs	no pairs	TBD
Elk	Jackson herd winter count (includes areas outside park) Summer count (portion of park herd)	10,766 elk ≥1192 elk	11,000 elk ≤1600
Gray Wolves	Wolves in Wyoming (outside of Yellowstone) Breeding pairs in WY (outside of Yellowstone)	250 wolves (30 in park) 20 pairs (4 in park)	≥100 wolves ≥10 pairs
Great Blue Heron	Active nests	23 nests	20.9 nests (2008–2017 average)
Greater Sage-grouse	Active lek	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)	718 17 bear management units 8.4% 13.2% 5.5%	≥500 grizzly bears ≥16 bear management units not > 9% not > 20% not > 9%
Moose	Jackson herd winter count	≥326 (72 in park)	TBD
Osprey	Breeding pairs	8 pairs	12.2 pairs (2008–2017 average)
Peregrine Falcon	Breeding pairs	5 pairs	4.3 pairs (2008–2017 average)
Pronghorn	Jackson Hole/Gros Ventre herd estimate	602 pronghorn	350–900 (modeled range)
Trumpeter Swans	Occupying breeding territories (includes areas outside park) Pairs producing young	3 pairs (2 pairs in park) 2 pair (3 cygnets fledged)	18 historic territories (13 in park) TBD
Whitebark Pine	Blister rust infection (% of trees in park)	55% of tree	TBD
Cultural Resources			
Archaeological Sites	Percentage of park inventoried Percentage of documented sites in good condition	4.5% of the park 42%	75–100% TBD
Historic Structures	Percentage assessed in good condition	73%	100%
Museum Collections	Percentage that has been cataloged	85%	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	3 in park	12 (2008–2017 average)
Invasive Plants	Species present Acres treated	27 invasive species 1547 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)	1320 acres under restoration treatment	100% of 4500 acres in the former Kelly hayfields area

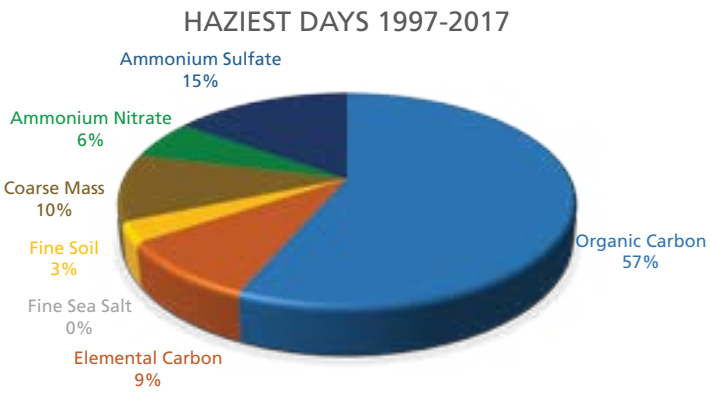
Reference condition specified by government regulation or management plan.

Air Quality

Grand Teton National Park experiences good air quality. As a federally designated Class I airshed, Grand Teton is required to meet high standards for air quality. In 2011, Grand Teton started operating 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. 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 Clean Air Act, affects human health as well as vegetation. Ozone concentrations vary by hour of the day and by season, particularly for areas near sources of man-made pollutants. Ozone is measured at Grand Teton as well as nearby Yellowstone NP. During the warmer months, when ozone concentrations are higher, ozone nighttime minimums are typically lower at Grand Teton than at Yellowstone and daytime peaks are often higher at Grand Teton. This suggests that local sources of pollution have a greater influence on ozone levels at Grand Teton, most likely local urban and mobile emissions. The collection of ozone data in the park is relatively new and does not represent a long enough period to evaluate trends, but the NPS does assess conditions in the park based on interpolated data from nearby ozone monitoring stations. The park's condition for both human and vegetation health risk is assessed as warranting moderate concern.

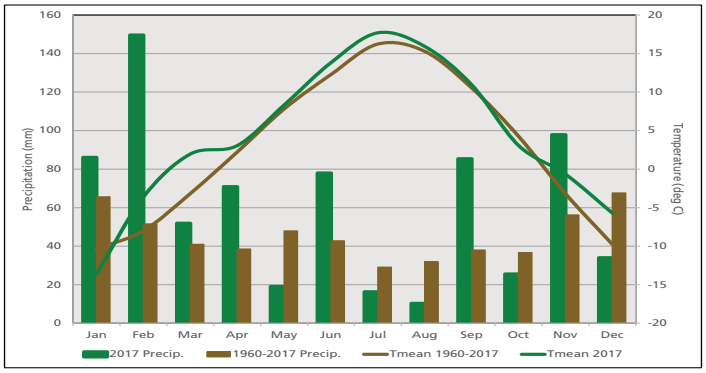


The average aerosol components causing light extinction near Grand Teton NP on the haziest days. Aerosols (particles and liquids suspended in the atmosphere) scatter and absorb light, reducing visibility. The loss of light due to this scattering and absorption is called extinction—the higher the extinction the lower the visibility. Days with a high percentage of organics are usually those affected by smoke. Elemental Carbon is produced directly from incomplete combustion of fossil fuels or forest fires. Ammonium sulfate and nitrate are often applied as fertilizer to supply additional nutrients for growing plants.

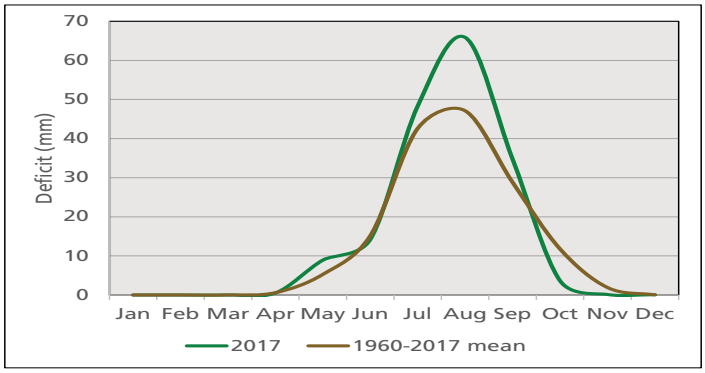
Visitors come to Grand Teton to enjoy spectacular views of the Teton Range and the Jackson Hole valley. Sometimes the park's scenic vistas are obscured by haze caused by fine particles in the air. Many of the same pollutants that ultimately fall out as nitrogen and sulfur deposition contribute to this 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 about 70 miles on the haziest 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 were a factor even prior to human occupation. Data from the nearby Yellowstone National Park monitor through 2015 show that visibility is improving on the clearest days, but there is no trend in visibility on the haziest days. The NPS assesses the visibility condition based upon estimated five-year average visibility on mid-range days (i.e., those from the 40th to 60th percentiles). The visibility condition at Grand Teton using 2011-2015 data is assessed as warranting moderate concern.

Climate

Warm and wet conditions characterized 2017, based on weather records collected at Moose, WY since 1960. Temperature and precipitation in 2017 were 1.5 degrees Celsius and 181 mm above average, respectively. This ranked 2017 in the 95th percentile for both temperature and precipitation. Warm season precipitation that fell as rain was 172 mm above average, making 2017 the highest annual rainfall on record. Even with above average precipitation early in the year, deficit (drought stress) climbed above the long-term average in July and August. In September precipitation well above average caused deficit to fall and stay low. By the end of the year annual deficit in 2017 was only 44 mm less than in 2016 when a large wildfire burned in the northern areas of the park. This indicates how important seemingly small changes in annual temperature can be in affecting water availability even in wet years.



Monthly comparison of 2017 temperature (lines) and precipitation (bars) in Grand Teton NP compared to the 1960-2017 average.



Monthly comparison of 2017 water deficit for soil and vegetation in Grand Teton NP compared to the 1960-2017 average.

Soundscape

The park's bioacoustic ecologist collected long-term acoustic data at 60 locations in the park from 2003–2017. Throughout the year, he collected digital recordings and sound levels that characterize and quantify the park's soundscape and acoustic resources across management zones, ecological habitats, and elevations from the Snake River to the summit of Grand Teton. 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.

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. Since the fall of 2015, the park soundscape research expanded to include an inventory of bats using ultrasonic recordings. More information is available on park's web-based acoustic map at https://www.nps.gov/yell/learn/management/yellowstone-soundscapes-program.htm

Fire

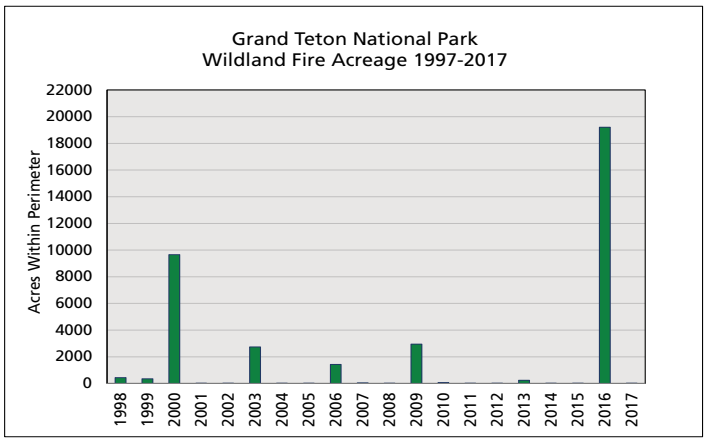
Fire is a natural process that has shaped the plant and animal communities of Grand Teton National Park since the last ice age. Current development within the park and the proximity of neighboring communities necessitates that wildland fire be managed to protect life and property. One important tactic used to protect developed areas is fuels thinning. Fire crews remove some of the vegetation around developed areas so that fires burn at a lower intensity, which gives firefighters a better chance to limit fire spread. This thinning, done in Grand Teton National Park's developed areas, provides a buffer so wildfires can be managed in the backcountry to continue the ecological cycle of disturbance and renewal.

Much of the conifer forest in the immediate vicinity of Colter Bay, Signal Mountain, several campgrounds, and administrative areas was thinned in the past 20 years. Summer fire crews work with chainsaws and pole saws to remove the lower branches of trees, reduce the seedlings and saplings, and pile up accumulated logs and sticks. These piles are burned later when snow is on the ground. Currently crews are thinning along the Signal Mountain Road, where a drive to the summit will reveal various stages of the thinning process.

In sagebrush areas, carefully planned prescribed fires reduced the shrubby fuels near the Granite Entrance, Shadow Mountain, and the town of Kelly. Sagebrush burns rapidly with high intensity. After a fire, herbaceous plants will dominate for 10–30 years as sagebrush gradually comes back. These herbaceous plants burn with shorter flames and are easier to wet down and control providing a buffer in these areas.

Historic buildings in Grand Teton are often surrounded by vegetation increasing the danger that a fast-moving fire could impact them. These wooden cabins and barns are protected by a special program of mowing to keep the grass and shrubs low to provide a firebreak. Summer fire crews take care of this task every year before the grass turns brown.

Photos of different mechanical treatments to improve defensibility of developed areas and historic structures. At the historic Luther Taylor homestead (above), made famous as a setting in the movie Shane, fire crews mowed around structures leaving patches of historic vegetation. At the same location (upper right), crews burned collected woody debris in the aspen grove to remove excess fuels during wetter conditions. In many developed areas (lower right), crews work during the summer months limbing up trees and collecting deadfall into piles that are allowed to cure until they are burned when snow is on the ground.



Northwest Wyoming did not have a very active fire season in 2017. Frequent rains kept the vegetation green and there were fewer thunderstorms to cause lightning strikes during the peak season between mid-July and mid-September. In 2017, Grand Teton National Park had two fires, one started by lightning and the other by an unattended campfire. They were both suppressed at less than a tenth of an acre in size. Fire seasons are quite variable, but an average of 1,858 acres burn in the park each year according to the 20-year average. The biggest fire season in Grand Teton's history took place in 2016 when the Berry Fire burned 19,198 acres within Grand Teton National Park and the John D. Rockefeller, Jr. Memorial Parkway.

Glaciers

Grand Teton National Park has 10 named glaciers, formed during a short cold neo-glaciation 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 (GYE). High-elevation areas of the Rocky Mountains are experiencing changes such as rising temperatures 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. In 2010, researchers documented surface area declines in three park glaciers ranging from 25% (Middle Teton Glacier) to 60% (Teepe Glacier).

Schoolroom Glacier taken from Hurricane Pass looking south. Top photo- Summer 1972. Bottom photo- Summer 2015.

Middle Teton Glacier from the summit of the Grand Teton showing the change in the equilibrium line (point where new snow gained by accumulation is equal to the amount of ice lost through ablation from 1966 (blue) to 2017 (red).

In 2015, staff from NPS, USFS, and USGS units in the GYE collaborated 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 and monitor seasonal snow pack on glaciers that are too difficult or hazardous to monitor directly. The park's objective is to monitor glacier movement, changes over time, and contribution to steamflow. The protocol provides a safe, cost-effective, long-term method to also monitor glaciers in the Wind River and Beartooth Mountain Ranges.

In 2016 and 2017, 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, and a loss of approximately 3,000 cubic meters from 2016 to 2017, despite a near-record May 1st snowpack across the Teton Range and beyond. A recent analysis comparing high-resolution satellite imagery to old aerial surveys indicates an average annual loss of 16 cm of water equivalent across the surfaces of Teton Glacier each year. That equals a loss of 8 meters of water equivalent (and an even greater thickness of ice) over the course of 50 years, an important metric for demonstrating glacial shrinking.

Comparison photos of Falling Ice Glacier from 1934 to 2016 show visible change with pronounced thinning of the glacier and a decline in the volume of detached ice blocks at the front.

Rivers

The rivers and streams of the Upper Snake River Basin and Grand Teton National Park drain the Teton Range, Absaroka Mountains, and Yellowstone Plateau. Spring snowmelt released from the surrounding high elevation areas drive annual floods throughout the park and depending on the waterway, can occur anytime from mid-May to mid-June.

The fluvial backbone of Grand Teton, the Snake River, alternates between a highly dynamic, multi-thread channel that occurs where the alluvial valley is wide and a single-thread channel when it is narrow. The Snake River, similar to other braided rivers, has a high bed load, erodible banks, and changes course frequently through lateral migration and avulsion. Tributaries feeding the Snake River come from the east off the Absaroka and Gros Ventre Ranges, and the west off the Teton Range. The major tributaries are Pacific Creek, Buffalo Fork, and Spread Creek, each contributing large amounts of sediment to an otherwise naturally sediment-deficient system below Jackson Lake.

Jackson Lake Dam, originally built in 1906–07 and reconstructed in 1916, raised the height of the natural lake by 38 feet, and completely dictates the flow of the Snake River until the Pacific Creek confluence 4.5 miles downstream. Studies show that the dam significantly changes the hydrology immediately downstream, but those changes become more muted as tributaries enter the Snake. Gage data from below the dam, as well as a historical record of natural inflows to Jackson Lake, provide a unique view of how the dam changes this system. Specifically, average peak flows decreased by 40% compared to unregulated flows, and base flows increased by 99%.

Aerial view of the Gros Ventre River in flood stage. Visible impacts include heavy sedimentation, movement of the river channel, and roadway bank erosion. The high water event continued after this picture and further impacted the road.

The sediment laden waters of Pacific Creek in flood stage flowing into the relatively clear Snake River.

In 2017, river runoff and snowpack were well above average, and caused significant changes to channels and riverbanks throughout the park. On May 1st, the snow water equivalent (SWE) in the Upper Snake River Basin was a staggering 188% of the 1981–2010 median, with several upper elevation sites measuring either the highest or second highest values over a 40-year record. Following an already large snowpack at the beginning of the month, the rest of May stayed wetter and cooler than average, as evidenced by a June 1 SWE of 336% of median. This record snow year did not cause an alarmingly large flood in terms of a peak magnitude, being only equivalent to a 10-year event, but it had a long duration at what is known as the "small flood" stage, which caused significant erosion on the bed and banks of many of the rivers and streams in Grand Teton. The duration of the small flood stage was approximately 90 days at the Moose gaging station, only exceeded by the 1997 water year during the period of record.

Some specific examples of where this had an impact on park infrastructure include the River Road along the western edge of the Snake River upstream of Moose and the Gros Ventre River's western edge a few miles downstream of Kelly. In both of these locations, the river was abutting a highly erodible Holocene outwash terrace as well as being influenced topographically westward towards the Teton Fault. Combined with these two fluvial and geologic factors, the river's long flood duration caused erosion to cut into the streambank 100–200 feet and take out portions of the road surface in each location. Much of Grand Teton's infrastructure continues to be adjacent to highly dynamic fluvial systems and because of unknown future changes to temperature and precipitation are likely to see more conflicts between natural and built systems as rivers and streams avulse and migrate.

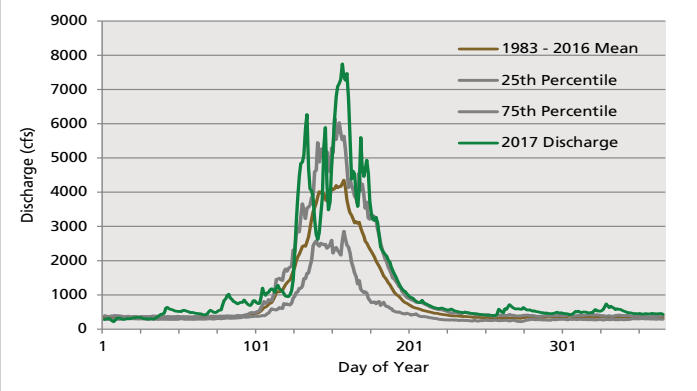
Water Quality

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 and the Greater Yellowstone Ecosystem, but also to the health and vitality of gateway and downstream communities.

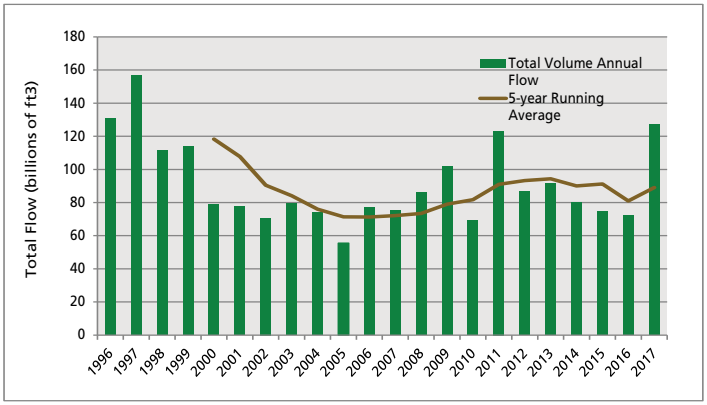
The uppermost reaches of the Snake River in Wyoming are characterized by good water quality with relatively low levels of dissolved nutrients and other anthropogenic compounds (e.g., pesticides). Good water quality and the presence of native fish, including cutthroat trout, are not surprising given that 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 where "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 US Geologic Survey monitors flow levels of the Snake River at two locations—Flagg Ranch and Moose, Wyoming. Discharge in 2017 was above average for the record at the Flagg Ranch site (1983–2017) and peak flows at Flagg Ranch, Wyoming ranked as the 12th highest in the 34-year monitoring record. In addition, peak flows occurred 11 days later than the average for this site. Snake River flows at Moose were similar to the 75th percentile of record of flows for that site (1995–2017) but are strongly modified by Jackson Lake Dam. Total volume of annual flow at the Moose monitoring location ranked 3rd out of the 22-year record, but the date of half discharge (the day when half of the annual volume of water occurred, June 18, 2017) was 10 days earlier than the 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 2017 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 2017, 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 while the Moose site was below detection in four of the seven sampling events; however, both sites were below the State of Wyoming's aquatic life criterion. Conversely, total iron concentrations are highest in the Snake River during spring runoff. Iron concentrations at the Moose monitoring location exceeded the State of Wyoming's aquatic life criterion in 2017. 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.

The Snake River twists across the valley floor, Grand Teton NP.



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



Annual Snake River flow totals (in billions of cfs) at Moose, WY. A 5-year average smooths annual variations for a clearer examination of trends.

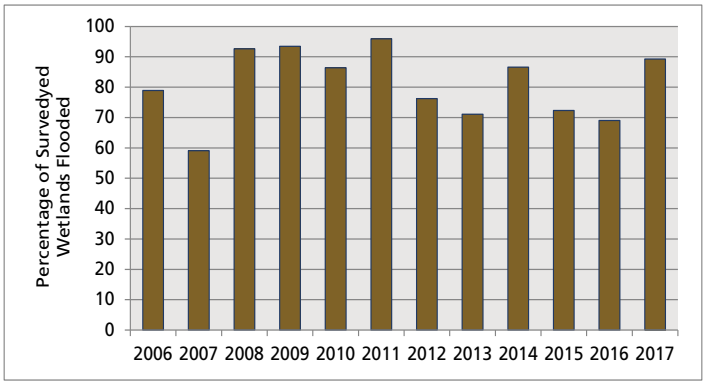
Amphibians

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.

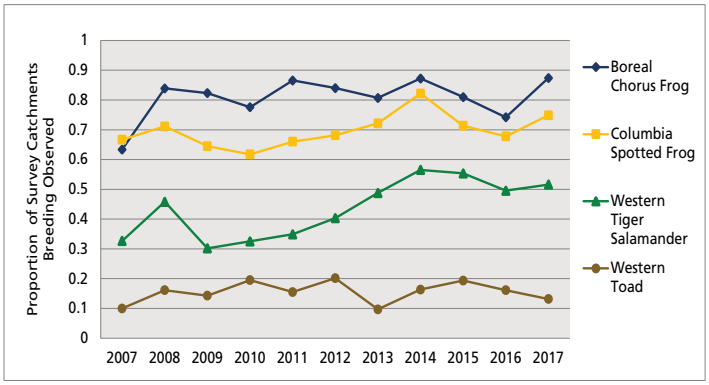
Once called boreal toads, these natives are now generally recognized as western toads by biologists.

The National Park Service collaborates with the Northern Rockies Conservation Cooperative, US 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 336 individual wetland sites in 2017, and surveyed 293 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, 59% were occupied by at least one species of breeding amphibian. In 2017, two of the 31 catchments contained breeding evidence of all four species (referred to as amphibian "hotspots"). In contrast biologists found no hotspot catchments in 2016, two in 2015, and four in 2014, illustrating the breeding variability that takes place even in protected areas.

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 2017, nearly 89% 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.

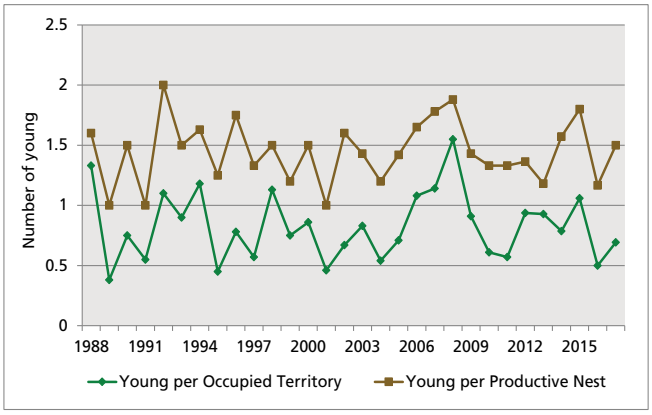
Bald Eagles

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.

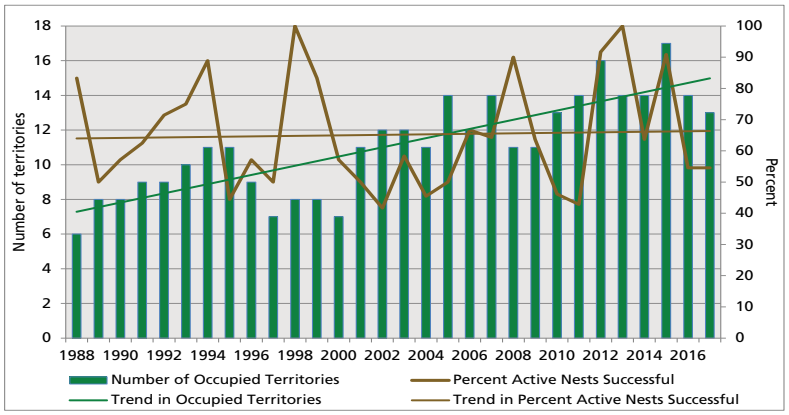
Of 20 bald eagle territories monitored in 2017, 13 pairs occupied territories. Eleven pairs nested and 6 territories fledged 9 eaglets. Most 2017 breeding statistics remained stable from the previous year and similar to the 10-year average. In 2017, there were 13 occupied territories (10-year average 13.7), 11 nesting pairs observed (11.5), 6 successful nests (7.9), and 9 young fledged (11.6).

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 30 years. In accordance with the Greater Yellowstone Bald Eagle Management Plan (1995), park managers may implement temporary closures around active bald eagle nest sites to minimize disturbances. In 2017, closures were established at Snake River nest sites.

Eagles often return to a nest adding new material each year, creating a dense stick nest like the one this eaglet occupies.



Counts of bald eagle young produced by territories and nest.



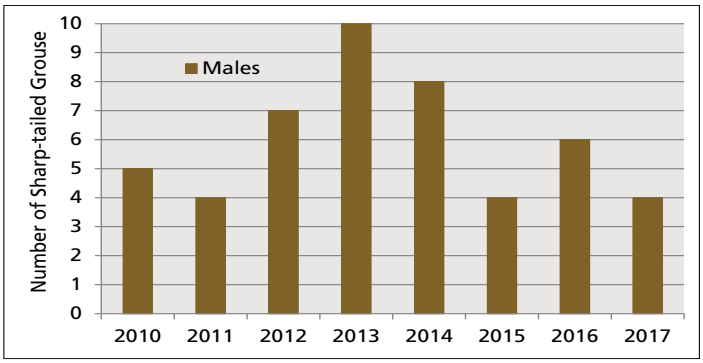
Bald eagle pairs occupying territories and successfully producing young.

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% 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 2017, biologists observed a maximum of four adult males strutting at the lek, but did not see any females at the lek. A maximum of ten males were observed on the lek in 2013. While staff never observed females on the lek during surveys, they did record three separate observations of a hen with chicks within two miles of the lek during the summer of 2016, suggesting that successful breeding occurred.



Annual counts of male Columbian sharp-tailed grouse displaying at the lek in Grand Teton National Park, 2010-2017.

Bighorn Sheep

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 core native sheep herd. The herd now lives year-round at high elevation along the Teton crest and in 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 60–80 individuals, distributed in two segments at the north and the south ends of the range. The herd has experienced a recent decline. In a 2017 late-winter helicopter survey, Wyoming Game and Fish Department (WGF) personnel counted a total of 48 sheep (22 in the south end of the range and 26 in the north end). This marked the third year in a row of low aerial counts. Annual ground classification surveys started in 1990 provide composition, distribution, and trend information. Biologists from the park, WGF, Bridger-Teton and Caribou-Targhee National Forests, Northern Rockies Conservation Cooperative, and Wyoming Wild Sheep Foundation, as well as several volunteers from the local community counted a total of 23 sheep during the early September ground surveys (16 in the south and 7 in the north). Storm activity curtailed survey efforts on portions of several days and caused several survey teams to return from the backcountry early. The low number of sheep observed likely reflects the poor survey conditions. Herd ratios were estimated at 55 lambs, 27 yearlings, and 27 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.

Park and WGF personnel conducted joint captures in January and December of 2017, capturing a total of 18 bighorns. Each animal was sexed, aged, weighed, and sampled for pneumonia pathogens. Biologists fitted adult animals with GPS radio collars. The information collected will be used to track survival, better estimate population size, track habitat use and investigate factors that influence it, and assess the potential for disease transmission between bighorn sheep and nonnative mountain goats. Two of the six ewes captured in January 2017 died before summer. Biologists suspect one of these mortalities is due to an avalanche. Compared to surrounding bighorn sheep populations, relatively few pneumonia pathogens were found in Teton Range bighorn sheep. This result is surprising because historically domestic sheep (the typical source of pneumonia in wild sheep) grazed in the Tetons and may have mingled with bighorns.

A biologist collects samples from a captured bighorn to check for disease.

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. Small population size, high lamb mortality, possible reduction in genetic fitness due to inbreeding, and extremely limited winter range jeopardize the long-term sustainability of this herd. Since winter is already a time of stress and hardship for bighorn sheep, park managers have for several decades closed some sheep winter ranges to human entry to reduce the potential for disturbance and further stress on sheep. No incursions into these sheep winter ranges were reported in 2017.

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 2017, researchers observed two unpaired loons within the boundaries of Grand Teton National Park (one on Jackson Lake and one on Two Ocean Lake). They did not observe any breeding activity, but spotted the loon on Two Ocean Lake several times throughout the summer, suggesting territorial behavior. Biologists conducting surveys on Leigh and Jenny Lakes observed no loons.

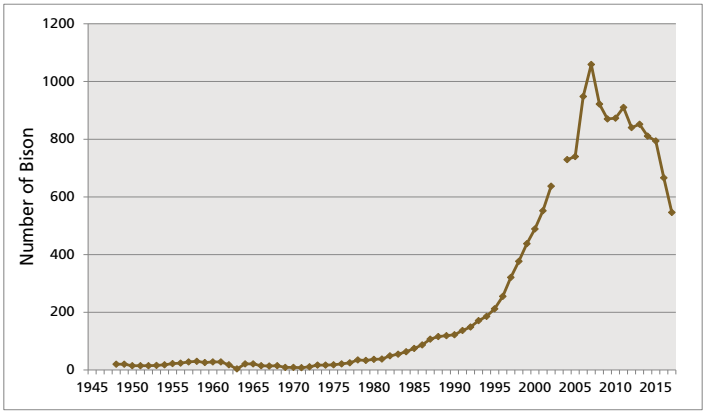
Bison

Bison (*Bison bison*), a species 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, 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.

During the winter of 2017, 504 bison used the National Elk Refuge (NER) feedlines and adjacent areas. Forty-two bison foraged on native winter range mainly in the park, but also on adjacent national forest and land the north end of the NER in the Gros Ventre riverbottom. The herd-wide total of 546 is a decrease from the 666 counted in 2016 and continues the downward trend from the population high of 1,059 in 2007. The winter of 2016/2017 was relatively severe. Consequently, several groups of bison wintering on native winter range in the north central portion of the park attempted to head south in February and March. Not surprisingly given the snow depths, the bison opted to travel along the plowed highway. Park personnel escorted four groups of bison along several road segments over multiple days to facilitate safe passage. Nonetheless, one bison was struck and killed at night while walking the road without escort.

With massive heads and strong neck muscles, bison sweep snow aside to reach winter forage. Increased snow depths drive bison to migrate to lower elevations.



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. The refuge hunt also helps disperse the herd. While the expanded hunt area helped increase the number of legal harvests and brought the herd closer to a sustainable population given available forage, biologists suggest that only consistently high hunter harvests focused on cows will bring the population to the desired level. Of 82 known bison mortalities in 2017, 75 were legally harvested outside the park, including five bison harvested by associated tribes. Fourteen bison were involved in collisions with vehicles resulting in at least seven (50%) bison deaths.

Golden Eagles

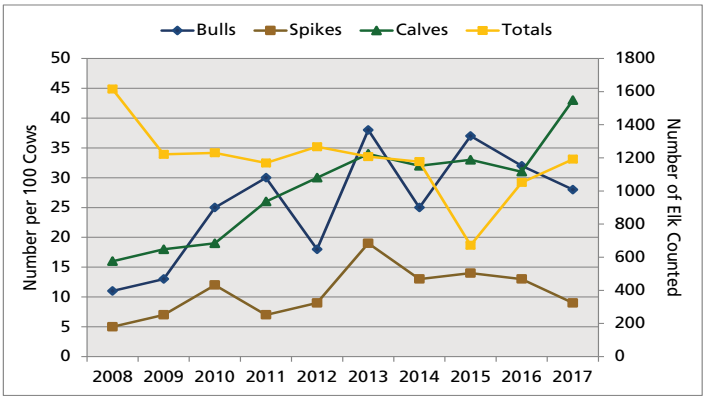
Golden eagles (*Aquila chrysaetos*) are large aerial predators well suited to the Teton Range, with its abundance of cliff faces for nest sites and diversity of prey found in the canyons. In the 1980s, biologists located golden eagle nests in Death, Avalanche, Cascade, and Webb Canyons but did not regularly 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 2017, park biologists partnered with Craighead Beringia South for the third year to conduct ground surveys for golden eagles and their nesting territories. Biologists searched for golden eagles throughout Granite, Death, Avalanche, Cascade, and Leigh Canyons, as well as the Uhl Hill area. Occupied territories were confirmed in Avalanche Canyon and the Uhl Hill area. Of those two occupied territories, only the Avalanche Canyon pair initiated nesting. That pair successfully fledged two eaglets in 2017.

Elk

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.

During the summer, park biologists count and classify elk from a helicopter in a portion of the park with high elk density and visibility. The survey is not intended as a census of elk in the entire park, but provides a minimum count of elk within the area surveyed. In 2017, park biologists counted and classified 1,192 elk. The total number of elk counted was almost 141 more than in 2016. Overall numbers were remarkably consistent from 2009–2014, but abruptly declined in 2015 and rebounded to near the previous level the last two years. Herd ratios and composition were 28 mature bulls, 9 spike bulls, and 43 calves per 100 cow elk. Fewer mature bulls were counted than in 2016, and bull ratios declined for a second year. Calf ratios increased significantly compared to 2016 and were the highest level observed since 2008. The calf ratio was highest in the Snake River count area south of Moose and lowest in Willow Flats.



Grand Teton mid-summer elk count and classification, 2008–2017.

Elk are ruminants, rechewing their cud to further break down plant material and aid in digestion.

The mid-winter trend count objective for the Jackson elk herd set by the Wyoming Game and Fish Department (WGF) is a three-year average of 11,000 elk ± 20%. In the trend count conducted in February 2017, WGF found 10,766 elk yielding a three-year average of 10,689. 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 2017 numbered approximately 1,307 for the Jackson elk herd. The park reduction program accounted for 18% of that total and numbered 242 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.

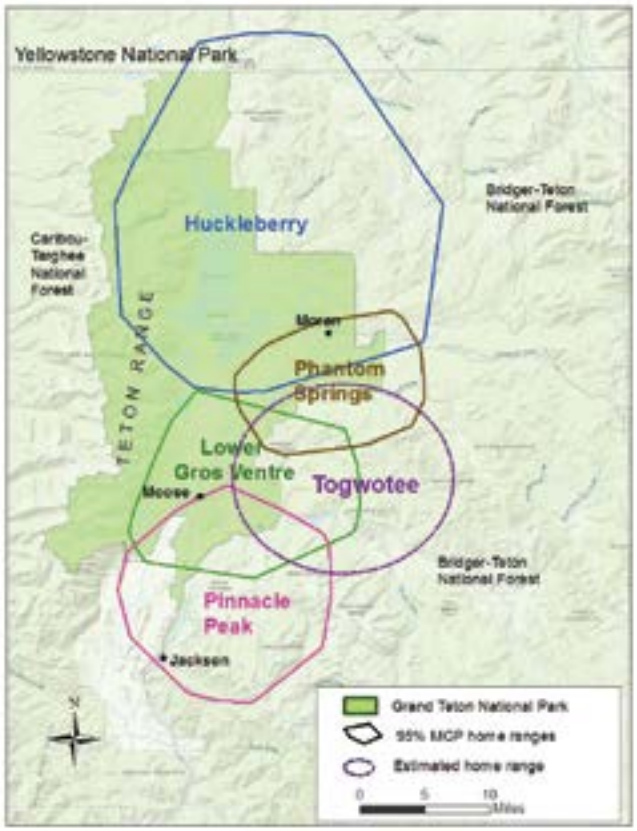
In late winter and early spring of 2017, biologists deployed automated recorders near the known nests from 2016. These recorders documented owl activity in 7 of the 8 great gray owl territories prior to nesting season. However, none of the owls in these territories initiated a nest and no owlets fledged in Grand Teton National Park, likely due to significantly harsh spring and winter weather. However, biologists continued to track owls previously outfitted with VHF transmitters. Research goals for 2018 include investigating juvenile survivorship, movements, and dispersal; and how snow and prey conditions relate to habitat use and nest success.

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 2017, a minimum of 30 wolves in 4 packs resided in the Jackson Hole area with home ranges in Grand Teton National Park. The Lower Gros Ventre (5 wolves), Togwotee (6), Huckleberry (7), and Pinnacle Peak (10) packs used the park, along with 2 lone wolves formerly of Phantom Springs. Two packs produced pups, Pinnacle Peak (5) and Togwotee (2), both outside the park. The Pacific Creek (7) and Snake River (12) packs did not use the park in 2017 and therefore are not included in the 2017 population count. The decrease from 58 to 30 wolves using the park from 2016 to 2017 can be attributed primarily to excluding these 2 packs from the area count and from relatively low pup production in 2017. To minimize human disturbance of wolves raising young, park managers implemented closures around den and rendezvous sites for the Phantom Springs pack.

The Phantom Springs pack dissolved in its 10th year of existence. This pack of 4 wolves lost 3 members: one illegally killed (yearling male), one legally harvested (adult male), and one dispersal (yearling male). The lone surviving female was killed by wolves in early 2018.

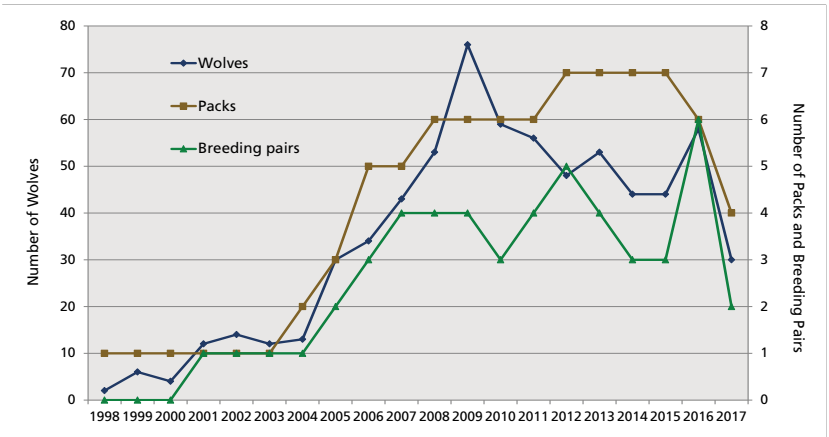


Distribution of Jackson area wolf packs, 2017. MCP (Minimum convex polygons) are home ranges based on locations of collared pack members.

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, representing 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.

Breeding male from the Phantom Springs pack just released after being fitted with a GPS collar.

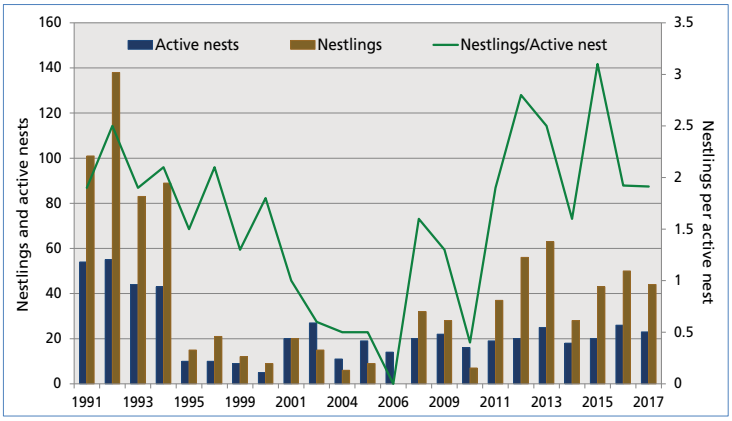


Population growth of Jackson area wolves, including those in Grand Teton, 1998-2017.

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 heronry abandonment. Heronries are also 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.

Herons have nine known historic colonies located in or adjacent to the park plus a recently established site at Sawmill Ponds, discovered in 2015. Biologists monitored the colonies at Arizona Lake, Pinto Ranch, and Sawmill Ponds in 2017. At Arizona Lake, herons produced 37 young from 17 active nests. At Pinto Ranch, there were 6 active nests which produced a total of 7 young. Biologists observed no nesting activity at the Sawmill Ponds site in 2017. The totals of 23 active nests and 44 nestlings observed in 2017 were slightly higher than the 10-year average of 20.9 nests and 38.8 nestlings. Overall numbers of active nests and nestlings remained fairly stable for the past 10 years. While heron numbers increased since their historic lows in the mid-1990s and 2000s, current numbers are still well below the historic highs in the park during the early 1990s, matching the state-wide trend of an overall slight decline since 1968.

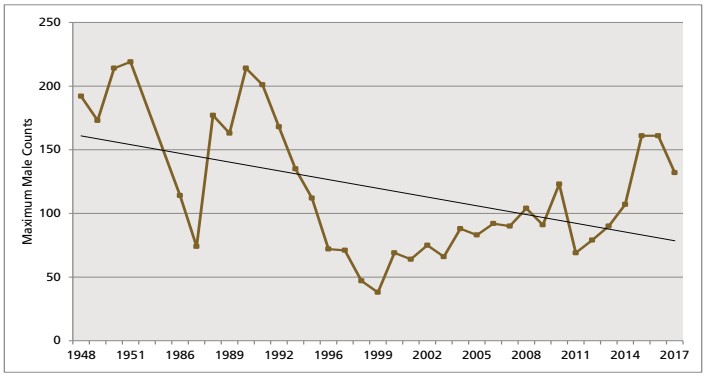


Great blue heron productivity in Grand Teton NP, 1991-2017. Arizona Lake heronry, discovered in 2007, is located just outside the park's boundary and since 2009 is included in the park's monitoring program. Monitoring of heronries was not conducted in 1996, 1997, 2002, or 2008.

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 1948-2017. No monitoring data for sage-grouse in 1952-1985 and 1993.

In 2017, of the nine historically known leks (eight in Grand Teton and one located on adjacent National Elk Refuge (NER) 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 2017 (Airport Pit and McBride).

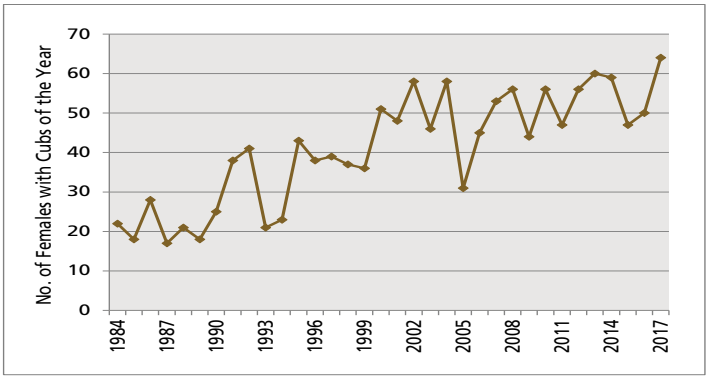
For the six active leks within Grand Teton National Park, the total maximum count of all sage-grouse was 156, and the maximum male count was 132. The total grouse count was slightly lower than the 10-year average of 164.8 while the total male count was slightly higher than the 10-year average of 111.7. Within Grand Teton, only the Moulton lek was considerably higher with 82 males and 97 total grouse in 2017 compared to 50.5 males and 63.5 total grouse for the 10-year average. All other leks were close to the 10-year averages or slightly lower. 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 2017, the GYE grizzly bear population was estimated at 718 (95% confidence interval = 640–796). 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



Estimates of grizzly bear females with cubs of the year, 1984–2017, 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.

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, when state and tribal wildlife agencies assumed management responsibilities outside national parks.

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 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.

In 2017, biologists in Grand Teton collaborated with both the Wyoming Game and Fish Department and the Biodiversity Research Institute to capture a breeding pair in the lower section of Moose Creek. The male was equipped with an implanted satellite transmitter, and the small geolocator device was removed from the leg band of the female that was first captured in 2016. In mid-August, biologists returned to conduct a survey of Berry, Owl, and Moose Creeks to locate females and their broods. They documented a minimum of 6 individual adult females without broods in Upper Moose Creek, 1 female with 4 young in Lower Moose Creek, and 1 female with 1 young in Lower Berry Creek.

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

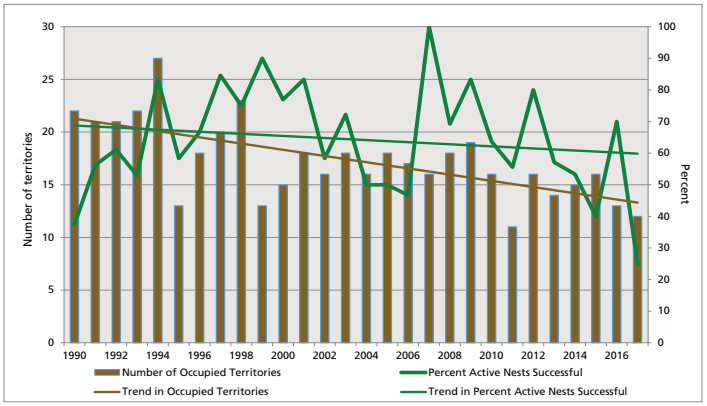
Researchers fitted two males with GPS transmitters in 2016. The transmitters recorded that the ducks roosted on Jackson Lake at night and flew back up into the streams during the day. These males left Grand Teton on 7/1 and 7/10 and arrived at their molting locations off of Vancouver Island on 7/10 and 7/13, respectively. In 2017, the tagged male left Grand Teton on 6/30 and died during migration on 7/1 in Washington, approximately 464 miles from Grand Teton.

As part of the study scientists took blood samples to determine harlequin exposure to specific toxins. Blood tests from 5 ducks captured in 2016 (3) and 2017 (2) revealed lead levels of < 0.033 parts per million which is considered background, normal exposure to lead in the environment. Test results for blood mercury levels in these ducks are expected in summer 2018.

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. In the past ten years, ospreys occupied 15 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 2017, ospreys occupied 12 (75%) of 16 monitored territories. Breeding activity occurred at 8 of these sites and 2 pairs successfully fledged a total of 3 young. This is a noticeable drop from 2016 when 10 breeding pairs fledged 15 chicks, and also lower than the 10-year average of 11.7 young fledged from 12.2 breeding pairs. 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.

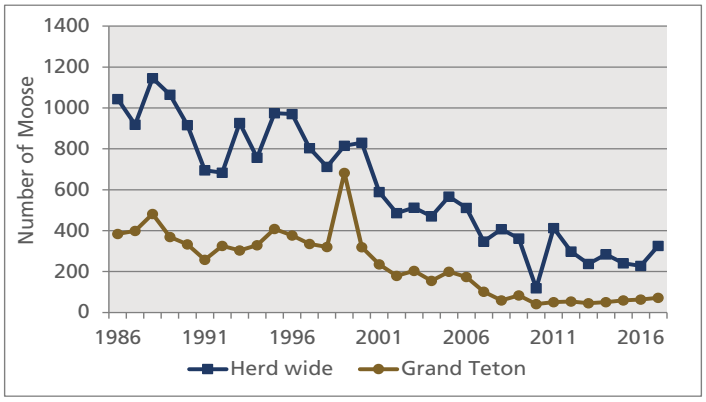


Territorial and successful osprey pairs, Grand Teton National Park, 1990-2017.

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 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 trend count of the Jackson moose herd. The count for 2017 totaled 326 moose, including 72 within Grand Teton. Ratios were estimated at 46 calves and 72 bulls per 100 cows.

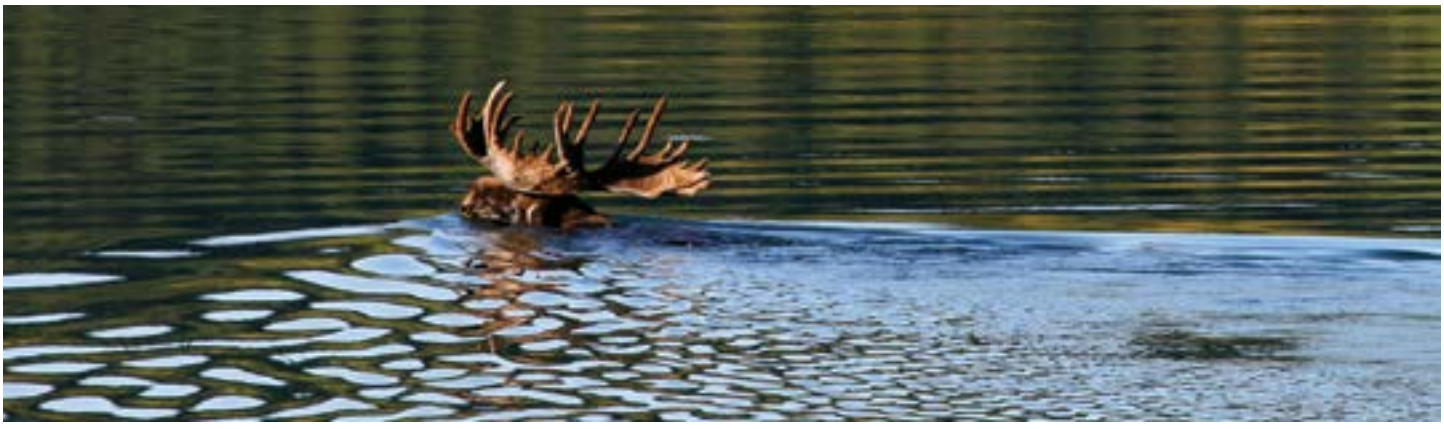
The moose herd decline likely resulted from a combination of interacting factors. The ecological landscape of today is dramatically different than the turn of the 20th century when moose populations expanded. At that time, large-scale predator reduction programs were ongoing throughout the west and wildfire suppression was widespread. Today, grizzly, cougar, 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



Jackson moose herd mid-winter counts, 1986-2017 (data from Wyoming Game and Fish Department). These counts are used to estimate overall herd size.

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 can leave moose unable to properly thermoregulate. In 2017, biologists analyzed hair loss data from 52 moose. In the southern portion of the park, mean total hair loss (broken and bare patches) for all individuals was 23.4%. Males had a 17% mean hair loss, and females had a 30% mean hair loss. In the northern portion of the park, moose exhibited a 1.2% mean hair loss, with 1.6% for males and 1.2% for females. Moose photographed in 2017 had a lower amount of total hair loss compared to 2016, but higher than all other years. 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 the nature of the link 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.



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.

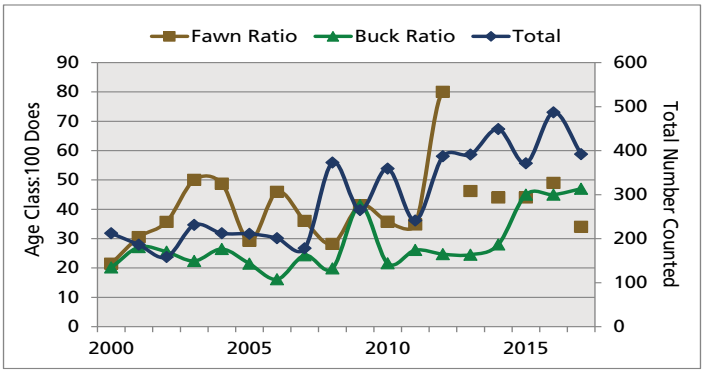
Park mule deer research provides information essential to conserving and protecting important animal migration corridors in the Greater Yellowstone Ecosystem (GYE). Park scientists are documenting the migrations of mule deer moving between summering grounds in Grand Teton National Park and the John D. Rockefeller, Jr. Memorial Parkway and crucial wintering areas throughout the ecosystem. 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, important deer stopover areas, and conservation needs; and working with partners to facilitate conservation of migration routes and important seasonal habitats.

Since the project began in 2013, park biologists collared 28 adult female mule deer from summer range throughout the park and parkway. In 2017, park biologists placed ten GPS collars on mule deer summering in the park. Six deer were captured near Colter Bay and four near the town of Moose. Park staff developed a collaborative partnership with the Idaho Department of Fish and Game (IDFG) to capture deer on eastern Idaho winter ranges where some deer that summer in the Teton Range—including deer from the sample of 28—are known to winter. Previous IDFG studies using VHF collars showed that all deer collared on these winter ranges summered in Wyoming, but did not document how the deer moved between seasonal ranges. These movements are of high conservation interest because of the large amount of private land between winter and summer ranges. To track deer movements, park biologists and partners deployed 10 GPS radio collars in late December 2017, within and near the Sand Creek Wildlife Management Area and plan to deploy an additional 20 collars along the Teton River wintering area in 2018.

Analysis of the data collected to date revealed that Grand Teton is at the center of a complex network of migration routes for mule deer. The migration patterns of deer within the park are more diverse and greater in length than previously assumed. Five of these corridors are long-distance with lengths between 43 and 130 miles. One corridor spans two states while three traverse the Continental Divide. All of the deer captured in the south end of the park in the vicinity of Moose have been short distance migrants to the town of Jackson, whereas those captured north of Moose have migrated significant distances to the east, northeast, and west.

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.



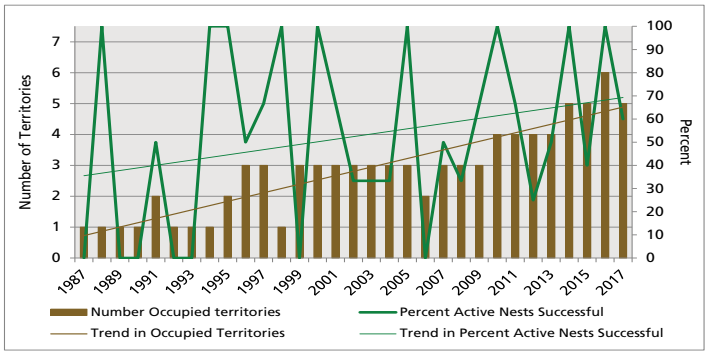
Pronghorn count and age/sex ratios during late summer classification counts, 2000-2017 (data from Wyoming Game and Fish Department).

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 2017 survey, biologists counted 268 pronghorn (in the central valley of Jackson Hole only). Based on this count, biologists estimated 602 pronghorn summer in Jackson Hole; 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 392 pronghorn were counted during the 2017 survey. Ratios were estimated at 34 fawns and 47 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.

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. Following reintroduction, 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 occupied territories in Garnet Canyon, Cascade Canyon, Webb Canyon, Blacktail Butte, Death Canyon, and Glade Creek.

In 2017, peregrines occupied five of the seven territories monitored within the park and parkway. Of those five occupied territories, peregrines successfully bred at three eyries. In total, these peregrine falcons fledged four chicks in 2017. The Steamboat and Garnet eyries were not occupied this year. A pair of adult peregrines occupied the new Death Canyon territory for a second year, but again an eyrie location was not found nor was breeding confirmed. In 2017, 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 chick had fledged.



Territorial and successful peregrine falcon pairs, Grand Teton NP, 1987-2017.

Historically the percent of successful pairs is highly variable and appears to be influenced by breeding season weather events. While all of the 2017 breeding statistics decreased from 2016 numbers, they were still on par with the ten-year averages.

Red Fox

Habituation of red foxes (*Vulpes vulpes*) to humans in national parks 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, and 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, health and safety concerns (e.g., aggression and disease transmission) for park visitors and employees, and property damage. Therefore, park resource managers aim to minimize the potential for human-fox conflicts while maintaining this valued ecological and wildlife viewing resource.

In recent years, 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 the diet of this resourceful and charismatic species. Increased ecological understanding of foxes coupled with enhanced outreach and education efforts will help staff 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 2017, 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. As of spring 2018, a total of 22 foxes were captured and sampled, with a total of 18 foxes collared. Biologists plan to continue the study and capture additional foxes in the winter of 2018–2019.

A tagged red fox successfully pounces on prey moving under the snow.

S. Daniel

Sagebrush Steppe and High Elevation Vegetation

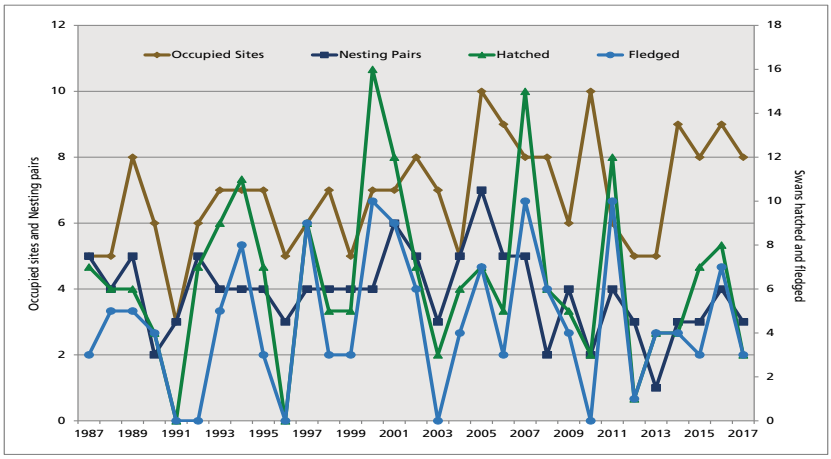
Sagebrush steppe is a sensitive vegetation type occupying much of the valley floor in Grand Teton National Park. Incredibly diverse, sagebrush steppe communities have a greater variety of plant species than any other plant community in the park except for wetlands. Home to sage-grouse, a species of concern, 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 changing climate. Approximately 15% of the park's sagebrush steppe acreage has been affected by 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 sixth 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 2017, 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 in the late 1890s and early 1900s, then abandoned when they became park lands in 1950. By fall of 2017, eight different units totaling 1,320 acres are in various stages of restoration including 1,026 acres seeded with native plant species (101 acres seeded in 2017). Monitoring efforts on sites seeded prior to 2013 show the vegetation composition to be stable over the last three years, though portions of some sites retain significant populations of nonnative species mixed in with the native grasses, forbs, and shrubs that were seeded into the sites. Monitoring data collected from restoration sites seeded in 2014 and 2015 suggests establishment of native plant seeding was successful and monitoring will continue on these sites to determine changes moving forward. In 2017 as in 2016, biologists observed sage-grouse using restoration units for the first time since treatments began.

Also in 2017, park biologists completed an initial sampling of 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.



Trumpeter swan productivity at territories in and adjacent to Grand Teton National Park, 1987-2017.

Biologists monitor 18 historic nesting territories: 13 within the park and parkway plus 5 outside but adjacent to park boundaries. In 2017, nesting territories were monitored from the air by a Wyoming Game and Fish biologist. Swan pairs exhibited breeding behavior at 3 territories: Swan Lake, Colter Bay Slough, and Pinto Pond (outside the park). Biologists observed fledglings at Pinto Pond (2) and Swan Lake Slough (1). The number of occupied swan sites, nesting pairs, and young hatched and fledged fluctuated widely over the 30 years since monitoring began.

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.

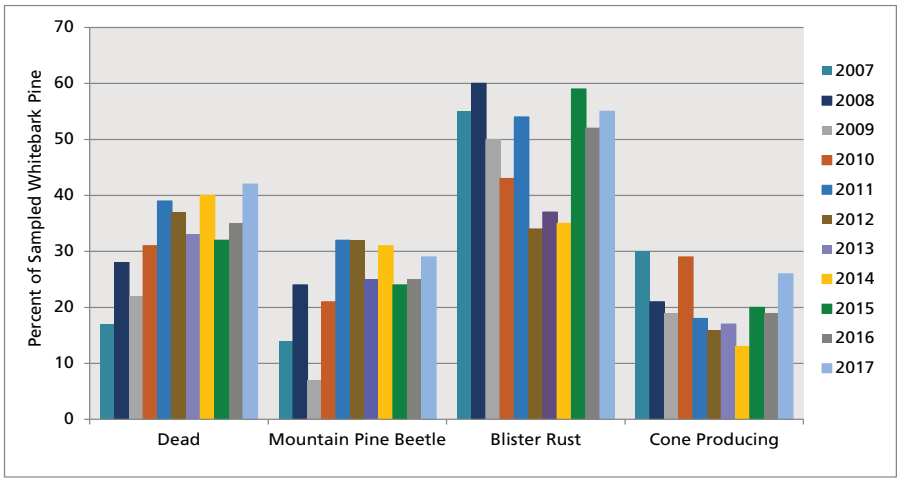
Whitebark Pine

Blister rust cankers are visible on a young whitebark. While mature trees slowly decline when infected with blister rust, it is often fatal for young trees or renders them unable to produce cones.

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. Ground surveys by park staff in 2017 indicate that there are remaining areas of mountain pine beetle activity in Grand Teton National Park and the John D. Rockefeller, Jr. Memorial Parkway. The park and parkway encompass 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 six 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 from year to year. 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 2017, 42% were dead (the highest mortality recorded to date), 29% attacked by beetles, 55% of live surveyed were infected with blister rust, and 26% 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 2007-2017.

Archeological Sites

Grand Teton National Park and the John D. Rockefeller, Jr. Memorial Parkway contain a diverse array of archeological resources that help tell the story of prehistoric and historic human occupation in the park. The 493 identified archeological sites within the park and parkway reveal stories from the prehistoric occupation of the park, which dates 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 archeological work began in 1970, cultural resource staff have surveyed approximately 4.5%, or 14,980 acres, of the 330,000 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 2017, the park completed field surveys before road repairs, river access improvement projects, bridge replacements, campground improvements, hazardous fuel treatments, 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 invites consultation with 23 traditionally associated American Indian tribes. These consultations aid collaboration and inform decision-making. In 2017, Grand Teton conducted two consultations via teleconference.

During the summer of 2017, the park hosted an archeological field school opportunity for Central Wyoming College. Over the course of the summer a park seasonal archeologist conducted several small surveys to fulfill requirements set out in Section 110 of the National Historic Preservation Act. Several student groups and volunteers worked with park archeologists during the summer. The Montana Conservation Corps, which brings in high school students from the Wind River Reservation, assisted with a pedestrian survey around Colter Bay as part of the Section 110 survey work. The Office of the Wyoming State Archeologist conducted small test units for a site within the Jenny Lake Renewal Project. The park also worked with the NPS Midwest Archeological Center to conduct geophysical survey for select areas within the Moose-Wilson Road corridor. This type of survey provides a noninvasive approach to study archeological sites.

Central Wyoming College students learning how to conduct a survey for artifacts and mark them with an orange flag, 2017.

Park Service archeologists also assess the condition of previously discovered sites. By the end of 2017, archeologists determined that 208 sites are in good condition; 124 sites are in fair condition; 77 sites are in poor condition; 8 sites have been destroyed; and a total of 84 sites are lacking data or the site condition is unknown. Of the archeological sites within Grand Teton and the parkway, 184 sites are listed in or eligible for the National Register of Historic Places, 260 sites are considered ineligible for the National Register, and 48 sites remain unevaluated.

State archeologists conducting fieldwork in the Jenny Lake Area, 2017.

Historic Structures

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 addition to identifying, evaluating, and preserving these historic resources, the park is responsible for assessing how park activities will affect historic properties. In 2017, the park finalized a Historic Properties Management Plan to guide stabilization and improvement of historic properties in Grand Teton National Park and John D. Rockefeller, Jr. Memorial Parkway. The plan provides strategic direction for the rehabilitation and re-use of historic properties that tell the park's story. The plan may be viewed at http://parkplanning.nps.gov/hpmp. The plan includes continuing current management of 32 in-use historic properties such as Jackson Lake Lodge, Murie Ranch, Cunningham Cabin, and Jenny Lake Ranger Station. Priority projects include the rehabilitation of the former Snake River Land Company Office, Beaver Creek #10, and 4 Lazy F Dude Ranch for adaptive reuse. Improved maintenance of the Luther Taylor Cabins, Lucas Homestead/Fabian Place, Hunter Hereford Ranch, and Manges Cabin will be undertaken to facilitate park uses. The plan also calls for stabilization of some historic properties, with priority given to those slated for adaptive reuse.

During 2017, the park also completed a Historic Structures Report for the Jackson Lake Lodge in partnership with the University of Pennsylvania Architectural Conservation Lab. This 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.

Volunteers continue to provide major support for park projects addressing historic structures. 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. In 2017, its second year of operation, the Hammer Corps was hugely successful in helping maintain historic resources. Over the course of eight weeks, volunteer groups worked at historic sites throughout the park, including: 4 Lazy F, Mormon Row, Lucas Fabian, Hunter Hereford, Bar BC, and Menor's Ferry. 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. Overall, Grand Teton's Hammer Corps hosted 73 residential and day group volunteers who contributed over 2,000 hours of service in 2017. The park plans to continue this program in 2018, 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 National Park Service Intermountain Region Hartzog Award for more than 20 years of volunteer service, mostly in Grand Teton.

A Bar BC cabin shown before and after the Grand Teton Hammer Corps volunteers repaired and stabilized the structure.

Park staff continue to work collaboratively with the NPS Western Center for Historic Preservation on the implementation of major projects including preservation of the Maud Noble cabin, Menor's Ferry buildings, Mormon Row homesteads, and Jenny Lake structures.

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 points 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 lacks 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. In the spring of 2017, park staff installed a new exhibit showcasing the work of many generations including historic items from the David T. Vernon collection and contemporary items from the personal collection of park ranger Laine Thom. The geometric patterns in beadwork and quillwork from the late 19th century are reimagined by contemporary Native Americans to reflect their cultural heritage with added modern flair. The exhibit shows how modern Native American art is a reflection of the past blended with elements of contemporary Native culture. A few other collections items are on exhibit outside of the park at local museums, the National Museum of Wildlife Art and the Teton Valley Museum. The park is continuing to explore options to develop appropriate facilities for the park collections. As of 2017, 85% of the one million item collection is processed and cataloged.

Grand Teton park ranger Laine Thom gives an interview about the exhibit.

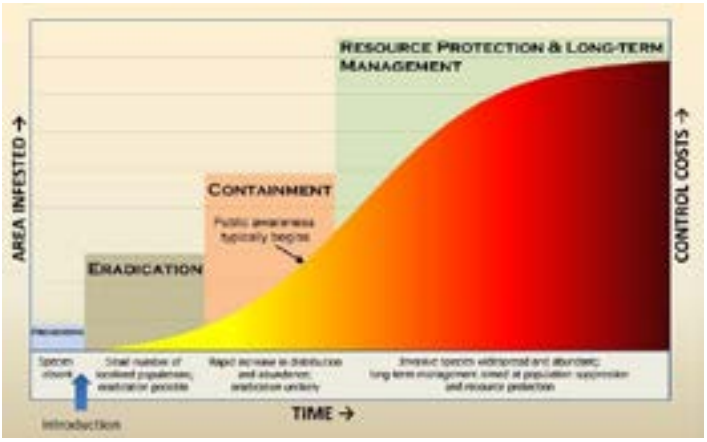
In partnership with Idaho State University's Geosciences and Geography Department, Grand Teton's museum program is working to document the history of recreational use in the park. Research in 2017 continued to focus on collecting oral histories from Jenny Lake climbing rangers in addition to park concessionaires operating river trips on the Snake River since the mid-1950s.

Contemporary pieces sitting next to historic items in preparation for the exhibit.

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) are two of the most impactful invasive species in the US and significantly expanded their range in the last 10–20 years, but have not been found in the park or parkway.

A tool called the invasion curve was developed in recent years to help illustrate the various stages of an invasion by a non-native species. Grand Teton currently sits at the base of the curve in prevention mode when it comes to most AIS. When quagga or zebra mussels are detected in a waterbody a jump to containment management is typically enacted due to the dramatic impacts they have been known to induce. Containment management often includes enacting strict regulations on accessing waterbodies, increased monitoring, an increase in the number personnel for vetting equipment and for decontaminating watercraft as they come and go from the waterbody. The cost of these are passed onto consumers and recreationalists who will often see dramatic shifts in the opportunities they previously enjoyed.



The invasion curve chart illustrates the limited time frame in which an invasive species can be prevented or contained.

The park has enacted measures to prevent the introduction of AIS, inspecting watercraft and educating boaters on practices to prevent the spread of unwanted species. In 2017, for the second year, the park had watercraft inspection stations at two locations operating daily. The stations were open nine hours a day for 116 days during prime visitation periods (May 22–September 24) and inspected 16,857 watercraft, with an additional 3,625 commercial rafts passing through the stations. In the summer of 2017, 177 boats/day came through the stations, a 13% increase from the 2016 average of 157 boats/ day. Staff preformed 36 decontaminations to reduce the risk of AIS introduction. Boaters can help prevent AIS introductions and speed inspections by ensuring they Drain, Clean and Dry their watercrafts and gear after every use.

Elk Reduction Program

The legislation that created the expanded Grand Teton National Park in 1950 included a provision for controlled reduction of elk in the park, when necessary for the proper management and protection of the elk. A long-term objective of the program is to reduce the need to harvest elk within the park. Management of elk in the park and on the National Elk Refuge (NER) is guided by the Bison and Elk Management Plan (BEMP), completed and implemented by the US Fish and Wildlife Service and the National Park Service in 2007. The plan calls for working collaboratively with Wyoming Game and Fish Department (WGF) to achieve an objective of 11,000 elk in the Jackson herd, a wintering population of 5,000 elk on the NER, and working toward bull to cow ratios in the park more reflective of an unhunted population. Also outlined is a strategy to restore previously cultivated lands in the park to improve habitat condition on elk winter and transitional range. The plan projected that roughly 1,600 elk would summer in the park given plan implementation.

The need for the Elk Reduction Program (ERP) is evaluated and determined jointly by Grand Teton and WGF biologists on an annual basis, based on plan objectives and data collected throughout the previous year during both the mid-summer classification count in the park and the mid-winter trend count that includes elk wintering outside of the park. Although mature bull ratios were above the threshold identified in the BEMP, at 39 bulls per 100 cows, the five-year running average remains below that level at 28 mature bulls per 100 cows causing biologists to recommend no bull harvest for 2017. The 2017 mid-winter trend count was 10,766 elk and the three-year running average 10,689, which the WGF considers at objective. The trend is stable. The mid-winter calf ratio, which is strongly tied to the level of population growth, was 19 calves per 100 cows. With the Jackson elk herd at objective and the trend remaining stable the antlerless harvest in 2017 was intended to slow growth of the herd. Park managers are discussing with other agency partners conditions under which an ERP would not be warranted in some years since the population has been at objective since about 2013.

Elk photographed during an aerial classification count.

Season structure and quotas changed from 2016. Specifically, no permits were offered in Hunt Area 79, although 75 Type 4 permits were validated there for four days. In addition 25 fewer permits were offered in Hunt Area 75 and overall numbers of type 4 and type 6 permits were reallocated.

The 2017 Elk Reduction Program was conducted for 43 days from October 28–December 10. Hunt Area (HA) 79 was open from October 28–October 31, while HA 75 was open for the season duration, although the Antelope Flats portion of HA 75 closed on November 30th. The reason for the short season in HA 79 was that fewer elk were observed in a portion of the hunt area during summer surveys and the productivity of these elk was reduced compared to more southern residents – a pattern similar to the northern migratory elk in the Teton Wilderness and southern Yellowstone. The reduction in hunting pressure on antlerless elk in HA 79 is generally consistent with management objectives in adjacent hunt areas 70 and 71.

A total of 242 elk were harvested in 2017 (2 in Hunt Area 79 and 240 in Hunt Area 75). The majority (86%) of elk taken were cows. Three spike bulls were also illegally harvested. Almost 60% of the harvest occurred during the last half of November. This harvest pattern is similar to that observed the last five years and is typical when a late migration occurs.

2017 Grand Teton Elk Reduction Program Quotas

Hunt Area	Permit Type	Description	Permits Authorized
75	4[1]	Antlerless. Full price.	75
75	6	Cow/calf. Reduced price.	525

[1]Also valid in HA 79 October 28–October 31.

Fish Passage

Irrigation ditches draw from several drainages in the park for agricultural purposes on inholdings or land adjacent to the park. Water drawn from perennial streams is also host to fishes who can end up these ditches, referred to by fish biologists as entrainment. Once entrained, fish have difficulty finding their way back into streams and may die prematurely. Fisheries biologists monitor fish entrainment especially in Spread Creek, the Granite Supplemental Ditch, and Ditch Creek.

Removal of a diversion dam at Spread Creek in 2011 allowed fish to access 65 miles of stream; however, the water diverted from the stream still captures some fish as they are migrating downstream. The park partnered with Wyoming Game and Fish Department (WGF), Trout Unlimited (TU), the Snake River Fund, and numerous volunteers to help return about 100–300 cutthroat trout back to the stream. Park staff and partners are researching the feasibility of a fish screen on the new diversion system.

Another irrigation system, the Granite Supplemental Ditch is drawn from the Snake River to irrigate lands in the "West Bank" region of Jackson Hole. Observations indicate this large draw of river water entrains several species of fish at varying life stages each summer. In an attempt to understand how this ditch, which crosses paths with some perennial streams, affects the fish that enter it, park personnel teamed with WGF and TU to implant transmitters in 15 cutthroat and monitor their fate. Data suggests that seven fish died after being stranded in a ditch, three fell to predation, four returned to a perennial stream where they later died, and one died early in the study possibly due to tag implantation. Quantifying the impacts on the fishery as a whole is difficult to ascertain due to the volume of water that is drawn through the ditch in the summer.

Ditch Creek flows out of the Gros Ventre Mountains east of Grand Teton, through the Antelope Flats portion of the park, and meets the Snake River about a mile north of Moose. The creek hosts several species of spawning fishes including Snake River fine spotted cutthroat trout, bluehead (categorized as extremely rare by WGF), Utah and mountain sucker; and other small non-game species.

Settlers started manipulating the stream's 9.4-square mile alluvial fan in Antelope Flats in the early 1900s, adding some 150 miles of irrigations ditches to the landscape and channelizing the stream to better facilitate agricultural pursuits. In 1957 and 1960 two bridges and culverts were installed across the stream. These culverts were not engineered for fish passage and turned out to be too long and steep for fish to negotiate in early summer when attempting to access spawning habitat upstream of these obstacles.

Fish caught in a pocket of water have no escape when the weather turns colder and die from exposure.

In 2012 and 2014, park staff installed baffles in the culverts to mitigate the situation. Unfortunately the stream also aggraded and eroded west of Mormon Row Road in 2014, effectively forestalling the efforts to restore fish passage. While aggrading and avulsing is the stream's natural tendency, the ditches and repeated channelization of the stream caused a new series of barriers to materialize.

As this is a reoccurring challenge, park personnel are exploring long term strategies. In 2017, the park with partners the Grand Teton National Park Foundation, One Fly, and Patagonia successfully raised funds to restore Ditch Creek into a fish-passable stream. 2018 will mark the first year fish from the Snake River will be able to access more than 23 miles of the stream's headwaters in nearly 6 decades.

Habitat connectivity is vital in ensuring a healthy fishery, making it more resilient to disturbances by providing access to more spawning grounds and increasing the number of life histories that can be expressed in the system. Working with water rights holders to increase the efficiency of irrigation ditches and reduce entrainment are strategies that could help keep the fishery healthy.

Roadway culverts can present impassable obstacles to fish.

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 bear habitat create a high potential for human-bear interactions.

To decrease conflicts, park staff strictly enforce food storage regulations and all park facilities have bear-resistant garbage receptacles. Bear managers emphasize "Be Bear Aware" public educational messages and provide 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, has installed 651 bear-resistant food storage lockers in park campsites and picnic areas to meet 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, or injure (or kill) humans. In 2017, park staff recorded 118 human-bear confrontations and 3 human-bear conflicts. The increase in observed confrontations in 2017 can be attributed to the presence of black bears foraging naturally within three park developed areas. Two human-bear conflicts involved black bears—one food reward and one incident in which a black bear ripped into an occupied tent. The third conflict involved an unknown bear species that chewed up a water line marker. Bear management personnel recommended removal of the black bear that ripped into the occupied tent and on June 27, 2017, the responsible animal, an approximately four-year-old female black bear, was euthanized.

Park staff recorded four motor-vehicle collisions involving bears: a black bear was hit and killed, a black bear was hit by a vehicle but ran away from the scene, and two bears (species unknown) ran away from the scene of a motor-vehicle collisions. The extent of injuries or deaths after bears run away from collisions is unknown.

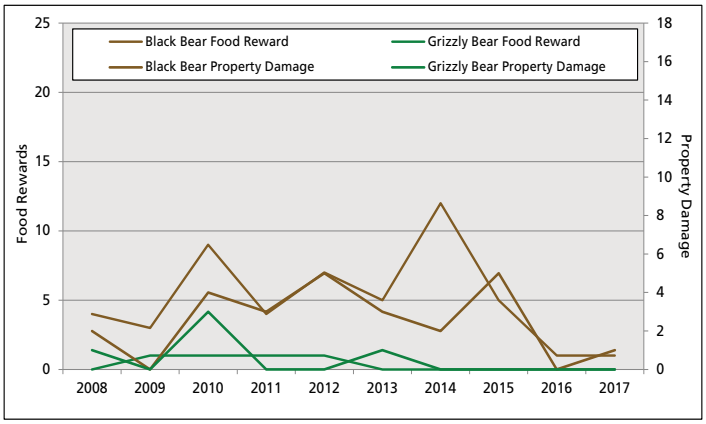
The park received seven reports of a small brown-colored black bear approaching and sniffing vehicles, putting its paws up on vehicles, and in one instance climbing on top of a vehicle along the Moose-Wilson Corridor between August 11 and October 8, 2017. Unfortunately, during one of these instances the bear was fed (see conflicts above).

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 72 times in 2017, using noise (yelling, horns, sirens), vehicle threat pressure, throwing small rocks or sticks, and in one instance a black bear was hazed with a bean bag to its left rump.

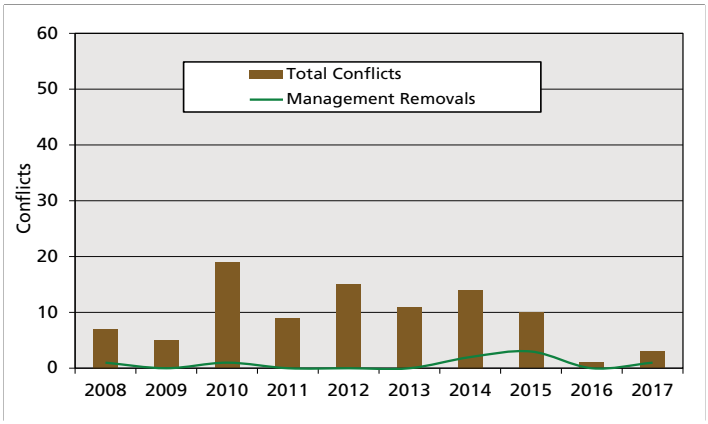
Park managers implement seasonal closures to protect bear habitat and to address human safety concerns. In 2017, bear managers enacted two annual closures (Grassy Lake Road closed to motorized use April 1–May 31 and Willow Flats closed to public entry May 15– July 15 to protect grizzly bear foraging opportunities) and one special management area closure (Moose-Wilson Road to protect fall foraging opportunities beside the narrow road), along with four temporary closures to provide for visitor safety and/or protect foraging opportunities for bears.

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 2017, they recorded 670 wildlife jams including 171 for grizzly bears, 210 for black bears, 65 for bears of unrecorded species, 162 for moose, and 62 for other species such as bison, elk, and great gray owl.

*Starting in 2017 reports will define human-bear conflicts as instances when bears damage property, obtain human foods, or injure (or kill) humans. Human-caused bear mortality will be listed separately (e.g. bear vs. motor-vehicle collisions). Please make note of this change when reading 2012-2016 human-bear interface reports.



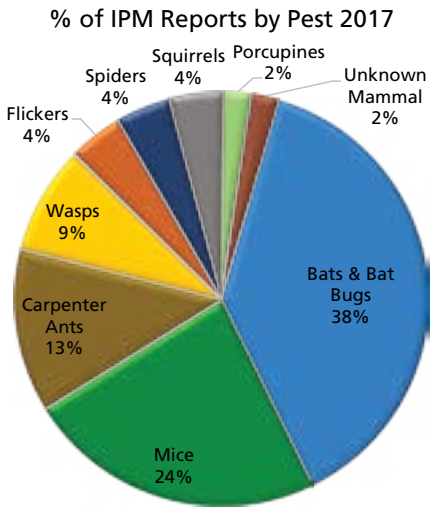
Bears receiving human-food rewards or causing property damage in Grand Teton.



Bear conflicts and removals in Grand Teton.

CHALLENGES

Integrated Pest Management



Grand Teton National Park managers remain committed to the safety, health, and well-being of park visitors and employees. That commitment includes the dedication of personnel, resources, and time to the park's Integrated Pest Management (IPM) program, tasked with prevention, response to, and mitigation of pest related issues in park visitor facilities, employee housing, and other structures. In 2017, IPM responses included intrusions in structures by bats, mice, insects, birds, and mammal species.

Currently, the park's biggest pest issue is the ingress of bats into employee quarters. At least 12 species of bats are native to Grand Teton National Park and also vital to the ecosystem as voracious consumers of insects. However, their intrusion into housing units can carry serious consequences for human inhabitants as bats are a reservoir for rabies, which, if left untreated, is nearly always fatal. In 2017, the IPM Team responded to 18 bat related incidents in park buildings, with the majority of reports coming from the Highlands seasonal housing area. In response to this, the IPM Team of Science and Resource Management and Facilities staff began a full exclusion effort in all 22 buildings located there. In spring 2018, the last two remaining cabins and the recreation center will be completed for the summer season.

In addition the IPM team participated in the response after a mass bat exposure incident at the University of Wyoming-National Park Service Research Station at the historic AMK Ranch, along with the Epi-Aid team from the US Public Health and the Center for Disease Control. As a result of this incident, park managers are now better prepared to respond quickly and efficiently to potential bat exposures. Park staff are working to raise awareness of the severity of bat exposure to employees, partners, concessioners, and visitors while encouraging appropriate reactions from the individuals.

Little Brown Myotis (*Myotis lucifugus*) are the most common bats to inhabit park buildings.

Future efforts in bat exclusion will focus on employee, partner, visitor, and concessioner education and continued exclusionary efforts in other problem housing units such as Lupine Meadows, Moran, and Colter Bay. Employees can assist by diligently reporting any pest issues in their housing units and workspaces to the park IPM Team and immediately reporting to their supervisor in the event of bat exposure.

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.

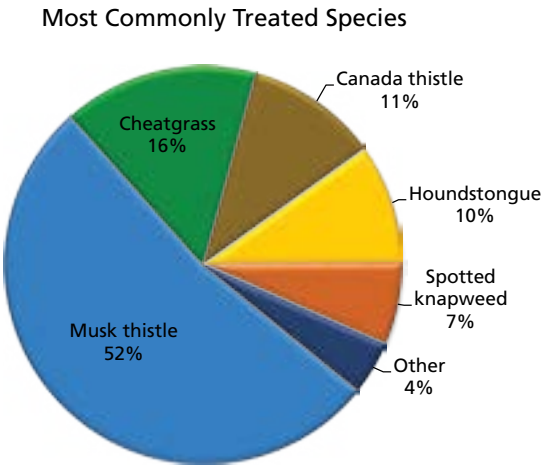
Biologists also found American bullfrogs (*Lithobates catebeianus*), another species with a wide latitudinal native range introduced for unknown reasons in the 1950s, that continue to thrive in the thermal feature and its effluent. The bullfrog is implicated in the decline of native amphibian populations 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 western 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 used by American bullfrogs. The frogs displayed more upstream movements than downstream movements with a majority of their largest movements occurring before the first cold snap of the season. The winter range was more widespread than managers had hoped leaving the species less vulnerable to mechanical removal efforts.

The Warm Ditch flows from Kelly Warm Spring.

In 2017, biologists analyzed studies of the ecology and potential threats in Kelly Warm Spring and its effluent to propose management solutions with the goal of returning the spring to a more natural state.

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 foraging opportunities for ungulates, invertebrates, and other native grazers. During the 2017 field season, vegetation staff, along with partners and contractors, actively surveyed 6,654 weed infested acres, specifically treating 1,547 acres within these areas for 27 invasive nonnative plant species.

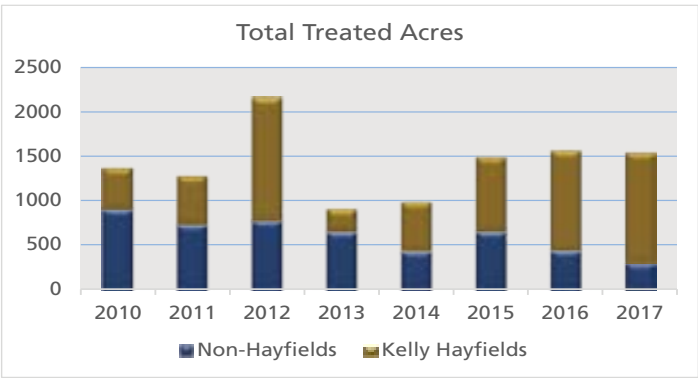
Invasive plants have multiple origins. In addition to accidental introductions from Eurasia, early homesteaders planted nonnative cultivar and ornamental plant species prior to establishment of the park, and many of these species still persist. Today, humans inadvertently transport weed seeds on their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

Collecting thistle seed heads to prevent spread.

Grand Teton biologists prioritize control efforts according to 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 common 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. 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 not found in 2017, and serves as a testament to the years of effort by park and partner organizations to the goal of eradicating the species from the local area.

Management actions in 2017 included herbicide treatments by various means, including backpack sprayers and horse-, truck-, UTV-, and tractor-mounted spray equipment. 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.

Backcountry weed surveys in 2017 focused on post-fire invasive inventory and treatment in the Berry, Owl, and Web drainages. The multi-year Snake River project continued, furthering the effort of updating invasive plant inventories and priority species treatment along the length of the river's riparian corridor within the park. Overall, in 2017, invasive plant crews surveyed 1,374 backcountry and river acres, traveling 918 miles over 55 days.



Annual comparison of acres treated.

Partnerships with Teton County Weed and Pest District, the Northern Rockies Exotic Plant Management Team, the Jackson Hole Weed Management Association, and the Greater Yellowstone Coordinating Committee are very important to successful invasive plant management. Interagency collaborations with Bridger Teton National Forest and the National Elk Refuge are equally essential. In July 2017, 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 208 acres of the Gros Ventre River corridor and near the town of Kelly.

Livestock Grazing

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. When Grand Teton 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 and heirs. 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 NPS/US Forest Service lands to the park's fenced and irrigated Elk Ranch pasture which also predates the park's establishment.

In 2017, 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.

Mountain Goats

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 pathogen transmission between the species could pose additional threats to the already stressed sheep population.

Since 2014, park biologists have captured 13 mountain goats (10 nannies, 1 subadult billy, and 2 kids) to better understand goat distribution, numbers, survival, movements, and reproduction in the Tetons. Captured animals were sexed, aged, weighed, collared with a GPS radio collar, and sampled for pneumonia pathogens before being released. Relative to surrounding mountain goat herds, few pneumonia pathogens were found. This result is unexpected because the Snake River Range population, the likely source of mountain goats in the Tetons, carries all the pathogens known to cause pneumonia.

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 (CTNF) 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.

Field crews deployed two remote camera traps from early July through mid-September 2017 in the North Fork of Cascade Canyon to aid monitoring efforts. Several cameras were also deployed at natural mineral licks on the CTNF and in the park. In addition, "Wanted" posters displayed at trailheads on the east and west slopes of the Tetons solicited mountain goat observations. Park visitors and staff submitted 46 observations of mountain goats. Observations spanned the length of the range, from Cody Peak to Ranger Peak. Most observations still occurred in the central portion of the range, but multiple observations in Death Canyon, on Prospectors Mountain, and several peaks at the north end of the Tetons suggest that goats are expanding out of their core area.

In 2017, park biologists initiated a genetics study in collaboration with several state and federal partners to confirm the source of Teton Range mountain goats. Biologists gathered genetic samples for analysis from three populations—Snake River Range (30 individuals), Teton Range (47), and the Northern Absaroka/Beartooth Range (28). Results are expected by fall 2018.

Biologists estimate that around 100 goats live in the Teton Range. The park is preparing a mountain goat management plan and environmental assessment to address options for their control.

Native Plant Restoration

Planting native seed in former agricultural fields for 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 areas to protect the integrity of the park's native plant communities and the wildlife species that depend on them. Another essential role of vegetation management is to help minimize resource damage by engaging in the design, planning and implementation process of ground-disturbing projects within the park. Revegetation seeks to rapidly establish native plant communities and initiate vegetation recovery while minimizing the establishment of invasive, nonnative species. All revegetation and restoration work conducted in Grand Teton National Park is accomplished by conserving local topsoil and using plant materials that originate within the boundaries of the park that are genetically suited to the natural ecotypes associated with a specific plant community. Research shows that using locally occurring native plant materials adapted to the local environment translates into greater success of restoration of ecosystem function.

In 2017, the revegetation crew worked on 15 separate revegetation projects seeding 17 acres of impacted areas associated with park infrastructure improvements such as waterline replacements, building construction and repairs, and road and trail construction and rehabilitation. A major focal point for revegetation efforts was the Jenny Lake Renewal which included trail removal and rehabilitation, topsoil placement, and native seeding in pristine areas of the backcountry. The revegetation program also worked to evaluate human impacts on native vegetation in heavily visited backcountry and front-country areas to help reach sensible solutions to reestablish native vegetation and prevent future impacts. In several targeted project areas, biologists salvaged native plants that could then be replanted once construction efforts were completed. The revegetation program continued to collaborate with other park work groups on several projects including stream restoration and a wildlife habitat vegetation study as well as engaging area school children with native plants at their school.

All revegetation and restoration areas are seeded with ecologically appropriate seed mixes consisting of native grass, forb, and shrub seed originating from materials hand collected within the park. In 2017, park personnel hand-collected 582 pounds of bulk plant material from 19 different species which resulted in 135 pounds of clean seed. Native seed for restoration and revegetation projects is also generated by seed increase, the process where locally hand collected seed is planted and grown in a field to generate a greater quantity of seed that can be harvested directly from 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; Bismarck, ND, and the privately owned Upper Colorado Environmental Plant Center. Additionally, vegetation management staff harvested native slender wheatgrass seed for the second consecutive year from an established restoration site that is part of the larger Kelly Hayfields restoration project.

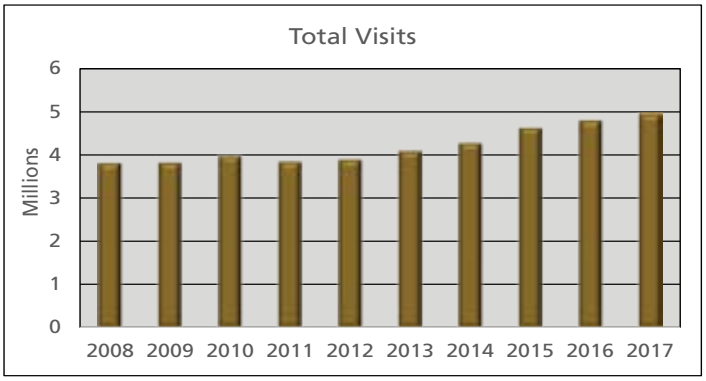
Park staff keying out native plants for seed collection.

Park vegetation crews continue the long-term effort to restore 4,500 acres of nonnative hayfields in the Antelope Flats area to native sagebrush steppe community which provides important habitat for elk, bison, antelope, sage grouse, other birds, and pollinators. Techniques for restoration of these lands include herbicide applications to remove nonnative hay crop species and invasive plants, native seed collection and seeding, monitoring, and adaptive follow-up treatments. The park's restoration team has recently embarked on an effort to create a comprehensive strategy for input from various resource experts and land managers to guide and prioritize restoration efforts for the next five years. Currently 1,320 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 the early stage of native plant establishment. Additional acres may be temporarily fenced as needed to promote successful restoration. As of November, 2017, 1,026 acres have been seeded with native vegetation and 132 acres (Aspen Ridge and Elbo West) are considered fully restored. In 2017, Grand Teton vegetation staff provided technical assistance to the Bridger-Teton National Forest in their effort to restore nonnative hayfields to native sagebrush steppe along the upper Gros Ventre River, an important restoration project in the Greater Yellowstone Ecosystem.

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 2017, 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 fourth consecutive year. In 2017, the park received more than 4.9 million visits, a 3.0% increase from last year's visitation, and a 27% increase in visitation over the past five years. Over half of visitation (53%) occurred between June and August, 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 9% and 7%, respectively, from 2016 to 2017.



Annual Grand Teton NP total visitation 2008–2017.

Visitors lined park roads waiting for totality of the Solar Eclipse, Aug. 21, 2017.

With Grand Teton National Park being in the path of totality during the solar eclipse on August 21, 2017, interesting visitor use patterns occurred. In general, there was an increase in trail use on the days before and after the eclipse, while the day of the eclipse had lower relative trail use. Additionally, use on the multi-use pathway increased on the day of the eclipse compared to other days. This is likely because many of the park visitors were focused on viewing the eclipse, rather than hiking on August 21. The park also encouraged visitors to carpool and use alternative forms of transportation (e.g. bicycles), which may have influenced more visitors to use the multi-use pathway.

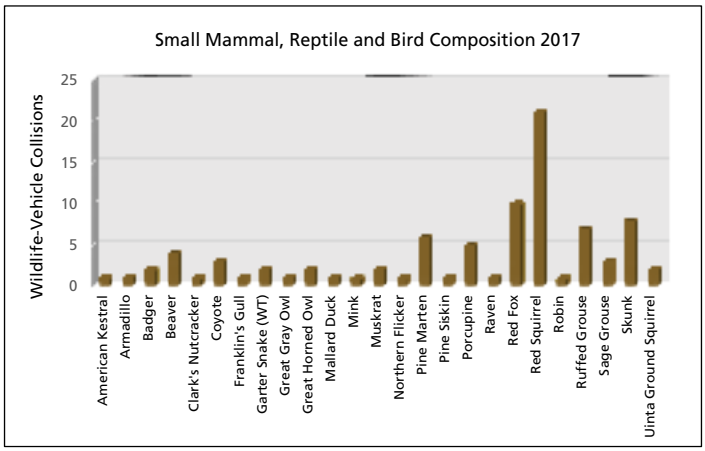
In 2017, park visitors made a total of 641,506 overnight stays. Frontcountry camping ranked first in visitor accommodations accounting for 57% of the overnight stays, followed by lodging with 36%. While almost half of the park (44%) is considered backcountry, only 6.3% of the overnight stays in 2017 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.

Wildlife-Vehicle Collisions

Wildlife casualties from motor vehicle collisions on Grand Teton National Park roads are common occurrences resulting in property damage and personal injury for humans. 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 2017, 169 WVC incidents occurred involving 173 animals were reported. Although there were fewer WVCs and animals killed in 2017 compared to 2016, the trend in WVCs has been increasing over the last two decades. The long-term increase may reflect, in part, greater effort in recent years to document 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, and decreased by almost 30% in 2017 compared to 2016. Elk WVCs were their lowest number recorded since 2001 and moose WVCs were the lowest ever recorded since 1991. The low numbers of moose WVCs may be related to declining numbers of moose in the Jackson herd. Deer WVCs dropped by 40% in 2017, which may be attributed to an extremely harsh 2016/2017 winter in which over-winter mortality was high. Almost 60% of the transmitting radio collared adult female mule deer in 2016 died over the winter. Bison collisions increased by almost 50% while pronghorn WVCs remain unchanged. In 2017, 81% 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. The majority of collisions occurred during the snow-free months (146 collisions May–October). The peak in WVCs occurred in August and while it did not coincide with peak visitation, August had the second highest visitation level in 2017.

A total of 33 species—18 mammals, 14 birds, and 1 reptile—were involved in WVCs in 2017. Large mammals made up 85 of the 173 animals involved. Ungulates comprised 46% of individuals

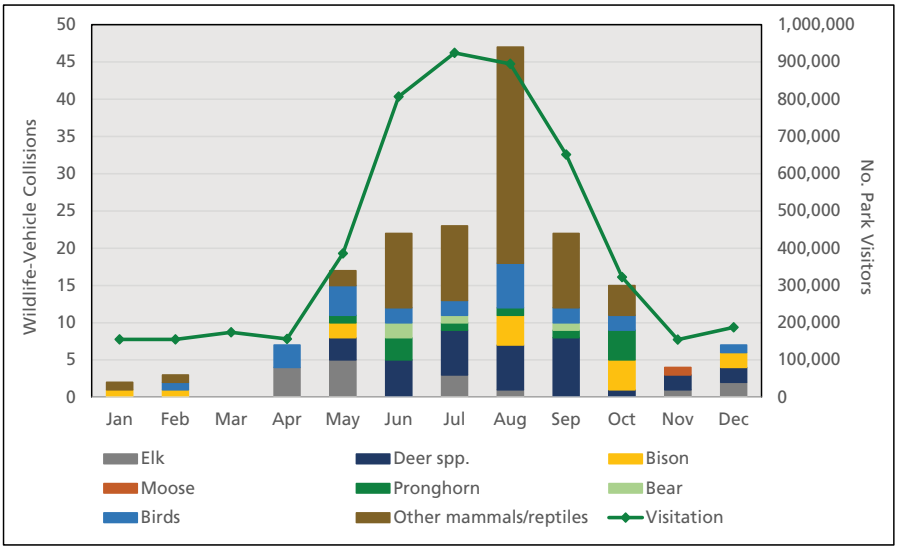


involved in WVCs, birds 13%, and small mammals 36%. Birds, small mammals, and reptiles rarely cause property damage, are less conspicuous, and are thus probably under reported.

When possible, park staff record the time of day that a wildlife-vehicle collision occurred. Of the 40% of incidents with a known time of day, 90% of collisions involving bison and 89% involving elk occurred at night. Deer and pronghorn continue to be involved in WVCs during the day, with 82% of known time deer collisions and 88% of known time pronghorn collisions occurring during daylight hours.

Park staff documented the highest number of WVCs on US Hwy. 89/191/26 (43%), followed by the North Park Road (27%), Teton Park Road (14%), Moose- Wilson Road (5%), Gros Ventre-Antelope Flats loop (2%), and other roads (5%). On US Hwy. 89/191/26, most WVCs occurred between Spread Creek and Moran Junction (27%), followed by Moose–Snake River Overlook (23%), and Moran Junction–East Boundary (11%). The majority (86%) of incidents with bison, moose, and elk occurred on US Hwy. 89/191/26. For deer, 50% of the collisions occurred on US Hwy. 89/191/26, 27% on the North Park Road, and 9% on the Teton Park Road. Pronghorn collisions were very different in 2017: 70% occurred on the Teton Park Road and only 20% on US Hwy. 89/191/26.

The park has 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 and Gros Ventre Junction; and painting wider road surface lines on park roads to delineate narrower travel lanes. In 2017, park staff installed two additional sets of permanent vehicle speed-reading signs, one donated by the Jackson Hole Wildlife Foundation. These were placed along Hwy 89/191/26 in the S-Curves near Deadman's Bar and in the Elk Ranch Flats/Spread Creek area.



Animals killed in wildlife-vehicle collisions by month during 2017, in Grand Teton NP.

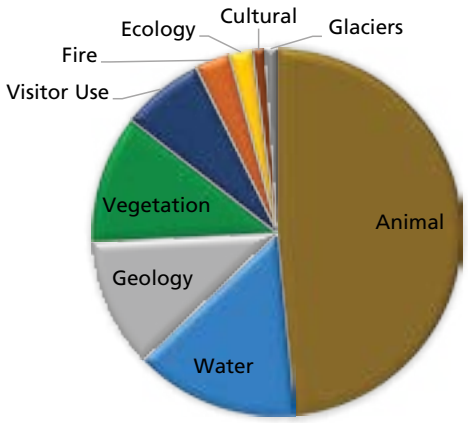
Research Permits

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 2001–2017. Since the implementation of this system, the number of permits entered into the database increased. The number of finalized permits fluctuates but generally is increasing with a new high in 2017 of 90 permits 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. The Chief of Science and Resource Management approves permits with appropriate investigations as recommended by staff.

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 2001–2017, the database lists 221 separate institutions that operated within the boundaries of Grand Teton and JDR with 1206 permits. The University of Wyoming had the most permits (162), followed closely by the US Geological Survey with 95 permits. The National Park Service had 53 research permits. Another major partner in the Greater Yellowstone Ecosystem, the Wyoming Game and Fish Department, held 29 permits during the past 15 years.

Park biologist observing a wolf den to count the pups from a distance.



Percentage of 2017 research permits for Grand Teton NP listed by subject.

The more detailed records since 2015 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). 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 2017. The park issued 16 permits for research on birds, 9 for animal communities, 10 for invertebrates, and 6 for mammals, showing a change from the more mammal dominated research of past years. Since 2001, Grand Teton finalized 414 permits for animal studies (152 mammals, 111 birds, 90 invertebrates/insects, 24 fish, 16 reptiles/amphibians, and 21 animal communities). Other leading topics for research included hydrology/water resources (118 permits), plant communities (65), geology (32), social science/visitor impacts (28), fire ecology (22), and glaciers (11).

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.