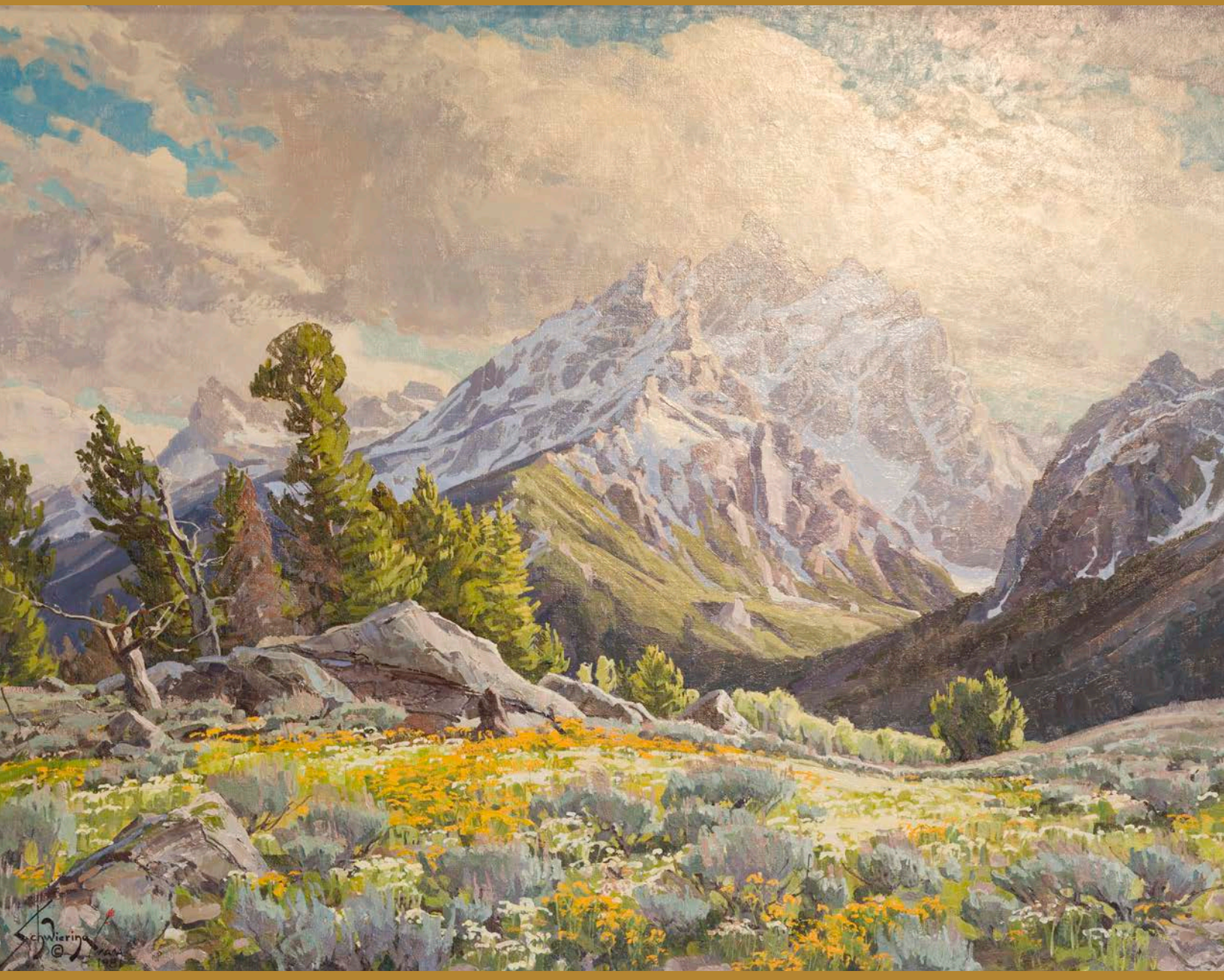
Science and Resource Management
Grand Teton National Park
& John D. Rockefeller, Jr. Memorial Parkway

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 2023

This report is made possible through generous support from Grand Teton Association. It shares natural and cultural resource data collected during the calendar year 2023 and compiled in 2024.

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& John D. Rockefeller, Jr. Memorial Parkway
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A pika poses on a rock.

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Select photos graciously provided by Greg Winston.
Where not otherwise indicated, photos in this report are courtesy of the National Park Service.

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Grand Teton resources include iconic geology and water features.

Why We Monitor the Park's Resources

The National Park Service was established in 1916 with the dual mission of protecting park resources and providing for the public enjoyment of these resources in such a manner that the resources will remain unimpaired for future generations to enjoy. While Grand Teton National Park was not created until 1929 (and expanded in 1950), the mission remains the same. To protect and manage the diverse natural and cultural resources within the park, resource management staff monitor and study individual resources and ecological processes—vital signs. This ongoing research aids park managers in decision-making by providing a clearer understanding of how resources are affected by environmental factors, human use, and management practices. Systematic monitoring is complicated by the fact that air resources, water resources, and many of the animals' seasonal migrations extend beyond the park's boundaries, where external factors can influence their condition. Within the park, plant and animal species that may affect native species have been introduced both accidentally and intentionally. Pressure from humans and human activity, both within Grand Teton National Park and outside, can directly affect the conditions of park resources. Data collected on some resources may be useful in understanding baseline conditions. 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 categories for this report. They include:

- **Climate and Environment** (air quality, climate, fire, glaciers, rivers, and water quality) are primarily the result of natural processes that operate on distinctly larger scales 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, peregrine falcon and whitebark pine).
  - have experienced declines in the park and surrounding areas or are of special concern (American goshawk, golden eagle, great blue heron, great gray owl, greater sage-grouse, moose, and trumpeter swan).
  - have relatively small populations in the park and are considered vulnerable (bighorn sheep, Columbian sharp-tailed grouse, common loon, harlequin ducks, and pronghorn).
  - 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, climate change and other human-caused factors (amphibians, cutthroat trout, osprey, red fox, and sagebrush steppe).
- **Cultural Resources** (archeological sites, historic structures, and museum collections) are significant representations of human history within the park. They are inventoried, protected, and monitored to ensure that both the resources and the information they contain are preserved for future generations.
- **Challenges & Human Factors** (nonnative plants and animals, park visitation and use, plant and habitat restoration, wildlife collisions, and the human-bear interface) are generally caused or largely influenced by human activity and are monitored to inform park management.

Comparison to Reference Conditions

The table on the following page summarizes the current status of selected resources. A reference condition is indicated 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 a government regulation or plan. The reference condition simply provides a measure for understanding the current condition.

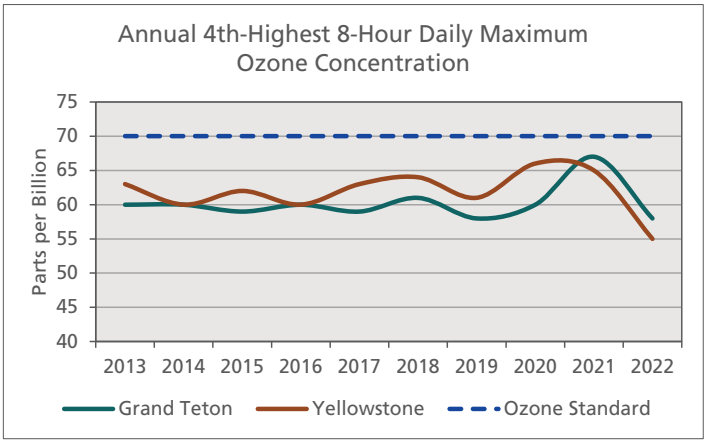
Vital Signs Summary

TBD = to be determined

Resource	Indicators	Current Condition 2023 (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)	26°F, 56°F 21.11"	22°F, 53°F (1959–2023 average) 21.83" (1959–2023 average)
Fire	Acres burned per year by wildfire	<1 acre	1–19,211 (2004–2023 range)
Glaciers	Extent of 10 named glaciers	0.8 km²	Long-term decline
Water Quality	Basic water quality parameters- 2 river sites	Iron within state standards	State water quality standards
Natural Resources			
Amphibians	% of potential sites suitable for breeding	88%	TBD
Bald Eagle	Breeding pairs	13 pairs	11.8 pairs (2014–2023 average)
Bighorn Sheep	Teton Range herd estimate	≈125 sheep	≥150–200 sheep
Bison	Jackson herd winter count (includes areas outside park)	432 bison	500 bison
Common Loon	Breeding pairs	1 pair	TBD
Elk	Jackson herd winter count (includes areas outside park) Summer count (portion of park herd)	11,064 elk ≥1169 elk	11,000 elk ≤1600
Gray Wolves	Wolves in Wyoming (outside of Yellowstone) Breeding pairs in WY (outside of Yellowstone)	352 wolves (51 in park) 24 pairs (5 in park)	≥100 wolves ≥10 pairs
Great Blue Heron	Active nests	41 nests	29.3 nests (2014–2023 average)
Greater Sage-grouse	Active lek	7 leks (6 in park)	8 occupied leks (7 in park)
Grizzly Bears	GYE population estimate Distribution of females with cubs	1002 18 bear management units	≥500 grizzly bears ≥16 bear management units of 18
Moose	Jackson herd winter count	≥297 (48 in park)	TBD
Osprey	Breeding pairs	10 pairs	10.5 pairs (2014–2023 average)
Peregrine Falcon	Breeding pairs	4 pairs	3.8 pairs (2014–2023 average)
Pronghorn	Jackson Hole/Gros Ventre herd estimate	no estimate of pronghorn	350–900 (modeled range)
Trumpeter Swans	Occupying breeding territories (includes areas outside park) Pairs producing young	4 pairs (4 in park) 1 pair (2 cygnets hatched)	14 historic territories (10 in park) TBD
Whitebark Pine	Blister rust infection (% of trees in park)	60% of trees	TBD
Cultural Resources			
Archaeological Sites	Percentage of park inventoried	8% of the park	75–100%
Historic Structures	Percentage assessed in good condition	54%	100%
Museum Collections	Percentage that has been cataloged	86%	100%
Challenges			
Aquatic Invasive Species	Presence of nonnative species	13	0 (limit spread & effects on native sp.)
Fish	Species present	12 native 9 nonnative	12 native Limit spread & effects on native sp.
Human-Bear Conflicts	Injuries, human food obtained, or property damaged	12 in park	8.2 (2014–2023 average)
Invasive Plants	Species present	30 invasive species	Limit spread & effects on native sp.
Mountain Goats	Estimated number in park	10–20 goats	0 (limit spread & effects on native sp)
Sagebrush Restoration	Restoring native plant communities in former agricultural fields (Kelly hayfields)	1440 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



Comparison of the maximum ozone levels annually on the fourth-highest day in Grand Teton and Yellowstone National Parks. The fourth-highest day of the year is identified to minimize the impact of short-term variations in weather conditions in any given year. (2023 statistics not available at publishing.)

Grand Teton National Park generally experiences good air quality; however, both distant and local sources of air pollution can affect the park. As a federally designated Class I airshed, Grand Teton is required to meet high standards for air quality. The park conducts monitoring to evaluate the potential for air pollution to affect park resources, like ecology, public health, and night sky visibility.

Air pollutants that affect ecology include sulfur and nitrogen compounds deposited by precipitation and settling out of the atmosphere. These compounds can harm surface waters, soils, and vegetation. High-elevation lakes are especially sensitive to acidification from sulfur and nitrogen deposition and excess nitrogen enrichment. Acidification may cause loss of sensitive macroinvertebrates and fish, while nutrient enrichment may alter lake diversity. Research suggests that deposition of nitrogen above 1.4 kilograms per hectare per year affected the diversity of diatoms (single-celled algae) found in high-elevation lakes in the Greater Yellowstone Ecosystem, an area that includes Grand Teton National Park. Additionally, alpine plant communities are also vulnerable to nitrogen enrichment, which may favor some species at the expense of others.

The park operates an air quality monitoring station, established in 2011, to track the deposition of these compounds in precipitation. This station is part of the National Atmospheric Deposition Program, which measures precipitation chemistry at over 200 locations across the country. The link for the real-time results from this station, including a webcam is https://www.nps.gov/subjects/air/webcams.htm?site=grte. The five-year medians (2018–2022) measured at the Grand Teton station indicate poor conditions for ecosystem health due to the estimated annual wet deposition of nitrogen (1.8 kg per hectare per year) and the estimated annual wet sulfur deposition (0.5 kg per hectare per year). Total wet sulfur concentrations in rain and snow, while still rated as poor, have improved over the past ten years.

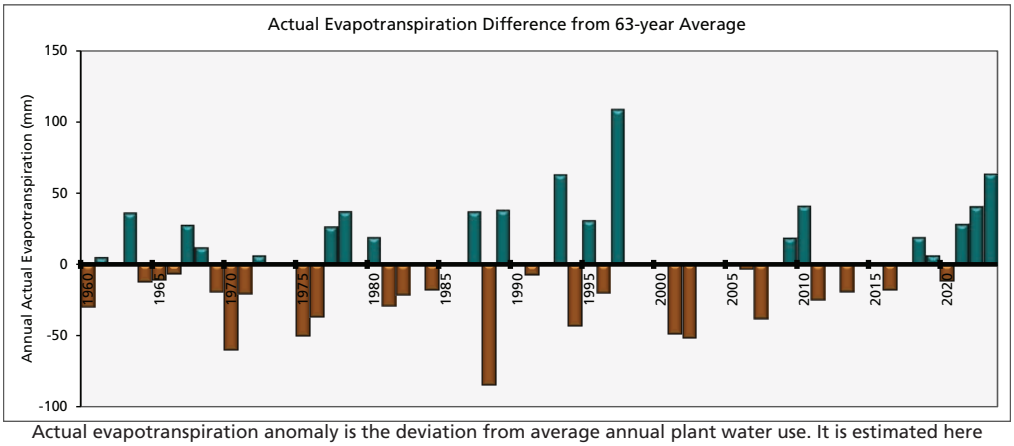
Park staff also measure ozone (O_3) concentrations and the air quality index. Ozone is harmful to human health as well as vegetation and is regulated under the Clean Air Act. The Environmental Protection Agency established a National Ambient Air Quality Standard of 70 parts per billion (ppb) for ozone based upon the three-year average of the fourth-highest daily maximum eight-hour concentration. The estimated ozone concentration five-year average (2018-2022) in Grand Teton is 60.8 ppb, rated as fair human health conditions. The air quality index (AQI) indicates how much particulates and pollutants affect air quality. In 2022, the park installed 3 PurpleAir devices to measure AQI and provide online real-time updates. The link for real-time results of the PurpleAir devices is https://map.purpleair.com/1/i/mAQI/a10/p604800/cC0#9.21/43.7973/-110.645.

The clarity of Grand Teton's night sky is an important factor for nocturnal wildlife as well as visitor experiences. Wild animals, like birds and bats, are sensitive to excess light at night. Visitors come to national parks to stargaze. Night sky visibility can be impacted by light pollution from man-made sources. To develop a baseline of night-time skies visibility, park staff worked with Wyoming Stargazing to install a TESS-W photometer. The photometer is designed to continuously measure night sky brightness for light pollution and cloudiness. The link for real-time photometer information is https://tess.dashboards.stars4all.eu/d/tess_raw/s4a-photometer-network-raw?viewPanel=2&orgId=1&orgId=1&var-Tess=stars725&refresh=1m.

Park scientists swap out the sampling bucket that is part of the National Atmospheric Deposition Program. Collected precipitation samples are sent to a lab for chemical analysis.

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. To address regional haze and visibility impairment, the National Park Service is working with the Wyoming Department of Environmental Quality- Air Quality Division to update the state's air quality protection plan.

Climate



Actual evapotranspiration anomaly is the deviation from average annual plant water use. It is estimated here from data collected at the Moose, WY weather station from 1960-2023. Brown bars indicate years when growing season plant water use was lower than the 63-year average and green bars indicate above average water use. Years without bars had more than 15 days of missing data. Since 2023 had 18 days of missing observations, the threshold for missing data was relaxed to 20 days to enable comparison with previous years. Data from Climateanalyzer.org.

Although 2023 was among the warmest years recorded since 1960 with a mean annual temperature in the 95th percentile, it was 0.9^{o} C cooler than the record high set in 2021. In 2023 the maximum spring snow water content was at the 79th percentile and summer rain and soil moisture were above the 90th percentile. Moist conditions were sustained during the growing season due to the third highest August precipitation (91 mm, 3.6 in) since 1960. The combination of warm temperature and soil moisture stimulated plant growth which resulted in plant water use (estimated by actual evapotranspiration) in the 99th percentile for the 2023 growing season. The moist August conditions resulted in low water deficit and consequently low fire hazard on the valley floor near Moose, WY.

Fire

Vegetated landscapes in Grand Teton National Park and the surrounding Greater Yellowstone Ecosystem primarily consist of sagebrush shrublands, mixed conifer forests, and lodgepole pine stands. Fire plays a natural role in each of these vegetation types and the post-fire succession can vary. Staff from Teton Interagency Fire Effects monitor recovery after prescribed fires and wildfires using a variety of protocols including multiple visits to established photo points. Monitoring fire over the past 30 years has provided a baseline for understanding post-fire recovery and allows for comparison under novel conditions, like climate change and impacts of visitor activities.

Sagebrush- Historic fire frequency varies in sagebrush vegetation. Typically, moderate severity fires occur on these landscapes every 15-200 years. During the primary growing season, lush understory vegetation contains too much moisture to carry fire. By mid to late summer, grasses dry out enabling rapid, wind-driven fire spread. Sagebrush is killed by fire, while grasses and forbs resprout from roots, providing a flush of forage for grazing herbivores post-fire. The initial grass-forb phase dominates burned areas for at least a decade following fire as sagebrush seeds slowly disperse into and sprout in burned areas. Monitoring of sagebrush burns in Grand Teton National Park reveals that canopy cover and height take at least 20 years to return to pre-burn conditions.

Immediately Post-fire | 5 Years Post-fire | 10 Years Post-fire

2011 Shadow Mountain Prescribed Burn post-fire recovery of sagebrush shown in photos taken from the same location.

Mixed Conifer- Fires in mixed conifer forests tend to be stand replacing and occur every 100-300+ years in the lower elevations forest (<8,500'). Spruce and subalpine fir torch easily with branches connecting the ground to the crown, serving as ladder fuels that support vertical fire growth. Wind-carried embers spread fire across less flammable meadows and spot fires ignite surface fuels and understory vegetation that builds up during the long fire return intervals. Higher elevation forests that include whitebark pine tend to have sparser tree density, so fires are smaller with even longer fire return intervals. Regeneration of burned areas is dependent on the distance to live, cone-bearing trees. Conifer seed dispersal is primarily driven by wind but can also be distributed by water and animals, like birds and bears. Areas that burn at high severity have lower recruitment due to increased distances to live seed trees and competition from fire-following shrubs. If aspen were in the burned area, immediate seedling "suckering" is stimulated by fire, and aspen proliferates.

Lodgepole Pine- Lodgepole pine forests typically experience stand replacing fire every 100-300 years. Exceptionally warm and dry conditions, combined with wind, provide conditions suitable for fire to move through dense overstory canopies. Homogeneous stands in flat terrain allow wind-driven crown fires to spread rapidly over vast distances. Lodgepole pines have adapted to stand-replacing fires with serotinous cones. These cones are covered in resin that prevents the cones from opening and dispersing seeds, until they are subjected to heat. Not all lodgepole pine trees have serotinous cones, especially those in areas that haven't had stand-replacing fires at regular intervals over the past 10,000 years. Stands with a high proportion of serotinous cones see rapid regeneration that is typically apparent the year following fire. With recent fires burning more frequently and at greater intensity, some sites are seeing repeat fires before the next generation of trees can reach maturity and set cones, causing a transition to a new mix of tree and shrub species.

Post-fire recovery varies based on fire severity, area affected, and time elapsed since a previous fire. Climate change is leading to hotter and drier fire seasons that are challenging the previously accepted science of post-fire recovery. Long-term monitoring that assesses conditions immediately post-fire and tracks recovery over time is crucial for understanding future vegetation dynamics and how vital habitats will be affected. This monitoring informs decisions for managing wildfires and prescribed fires and supports research and understanding of how the changing fire-climate dynamic will shape this iconic landscape.

Immediately Post-fire | 5 Years Post-fire | 10 Years Post-fire

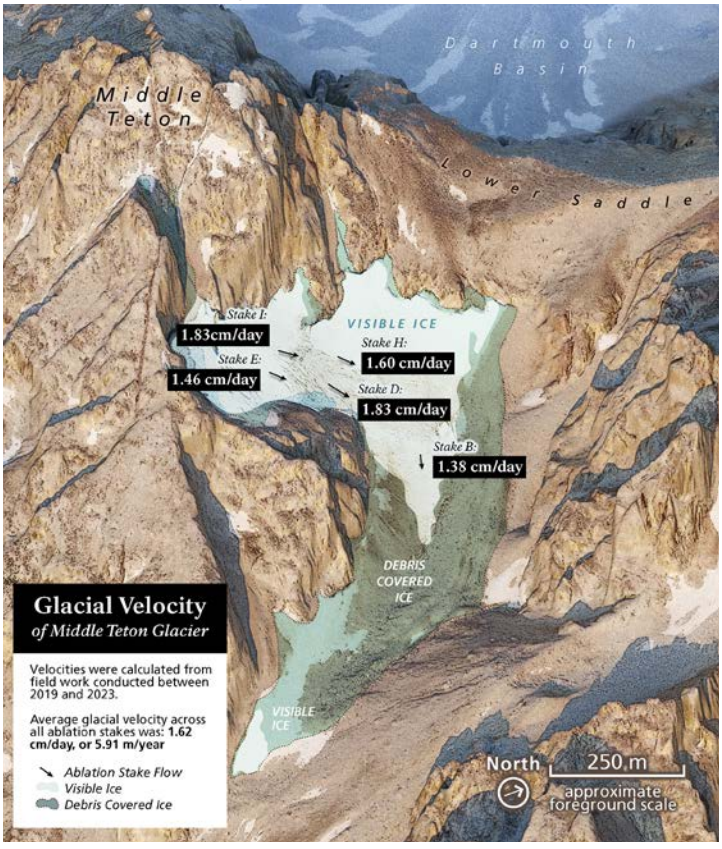
2009 Bearpaw Fire post-fire recovery of lodgepole pine shown in photos taken from the same location.

Glaciers

Grand Teton National Park has 11 known glaciers, previously thought to have formed during a short cold neoglaciation period called the Little Ice Age (1400–1850); however, recent research suggests that Teton Glacier may have been active since the last major glaciation approximately 10,000 years ago. Some of these glaciers are active, while others are considered remnant because they have lost so much volume they have stopped flowing. The Teton glaciers are iconic features of the park landscape, prompting efforts to monitor their fluctuations under current and future climate regimes.

Park staff monitor glacier movement, area and volume changes, as well as glacial influence on stream flow quantity and quality. Glaciers store water that provides critical input to land and aquatic ecosystems during the summer months. This is particularly evident in years of below-average precipitation. Researchers found summer stream temperatures can be 2–3 ºC cooler in glacier-fed streams than in adjacent glacier-less basins. In 2020 park staff installed gauges in paired glacier-fed streams and glacier-less basins to measure stream temperatures and flow levels over the next few years. With gauges currently installed in five different alpine streams, resource staff hope to use the collected data to understand the significance of glacial contributions to water volume and the influence on temperature for late-season stream flows.

Changes in glacial extent and volume are 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 Rockies are experiencing changes such as rising temperatures and earlier, more rapid snow melt than the region overall.



Late summer still of the only glacier monitored in the northern area of the park. While this glacier has no official name it is informally called Glacier Peak Glacier or Seward Webb Glacier.

In 2013, NPS staff created and tested ice surface elevation survey methods on Middle Teton and Schoolroom Glaciers—both chosen for their relative safety and accessibility. Park staff also installed air temperature sensors to provide data for a GYE-wide sensor network, as well as time-lapse cameras to provide images and monitor glacial change on glaciers too difficult or hazardous to monitor directly.

Annually since 2015, physical science staff and climbing rangers conduct GPS elevation surveys of Middle Teton Glacier in the fall—when seasonal snow has mostly melted off the glacier and measurements can be directly taken on the ice surface. Preliminary comparisons of 2022 and 2023 survey data suggest a loss of 0.7–1.6 meters of ice near the center of the glacier. These surveys show changes in glacier surface elevations and measure volume change over time.

Since 2015 park scientists have worked with experienced ski mountaineers to complete snow surveys on Middle Teton Glacier in the spring—when seasonal snow is most abundant. On June 1st, 2023, snow depths ranged from 1.6 to over 6 meters. The snow accumulation across the glacier surface is dynamic, with variability likely resulting from avalanches and wind distribution of snow from surrounding terrain in addition to direct snowfall. During this survey, the researchers drilled through the snowpack and into the glacial ice beneath to install five ablation stakes. The stakes remained through the summer to measure snow and ice melt, as well as glacier movement. At the end of the melt season, only one of stakes had any remaining snow. The total melt at each stake ranged 1.2–3.3 meters. Measurements of the movement of the ablation stakes indicate an average glacier velocity of about 1.6 centimeters a day or 5.9 meters per year. Park scientists will be able to use measurements from individual ablation stakes to project water loss and gain across the entire glacier surface, augmenting the GPS surface elevation measurements, which characterize volume (but not mass) change. These surveys illuminate patterns of seasonal snow accumulation and melt on the glacier surface.

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. Major tributaries such as Pacific Creek, Buffalo Fork, Spread Creek, and the Gros Ventre River feed into the Snake River from the east. Spring snowmelt from these high-elevation areas drives annual floods in the park. Peak flows typically occur between mid-May to mid-June, depending on snowpack and spring temperatures.

The fluvial backbone of Grand Teton, the Snake River, is managed as a Wild and Scenic River. The Wild and Scenic Rivers Act, passed by Congress on October 2, 1968, aims to preserve rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. The segment of the Snake River below Jackson Lake Dam, designated as Wild and Scenic in 2009, is one of the longest continuous, naturally-braided river systems in the contiguous United States. This dynamic system transports significant quantities of gravel and features diverse fluvial characteristics, including side channels, oxbows, logjams, and floodplains that support critical wildlife habitat. Despite being managed as a Scenic River; human activity impacts the hydrology of the Snake River.

Jackson Lake Dam, built in 1906–07 and reconstructed in 1916 to supply water for irrigation in Idaho, raised the natural lake by 38 feet. The Bureau of Reclamation (BOR) operates this dam primarily to manage water delivery for agricultural use and to a lesser extent control flows to mitigate spring flooding. Dam operations typically reduce peak flows, which would occur naturally as snow melts in the spring. By storing spring meltwater in the reservoir, it can be released later in the year when needed for irrigation. In 2023 the regulated peak flow from the dam was 3,840 cubic feet per second (cfs)—59% less and almost two months later than the estimated unregulated peak. Although two large, unregulated tributaries augment the Snake River 4.5 miles downstream from the dam, the overall flow is altered in both timing and peak flow magnitude which can impact river ecology and physical habitat.

Even after a record snowpack, the debate over flow releases from Jackson Lake Dam in the spring of 2023 sparked intense discussions, due to the unusual circumstances and proposed changes to flow

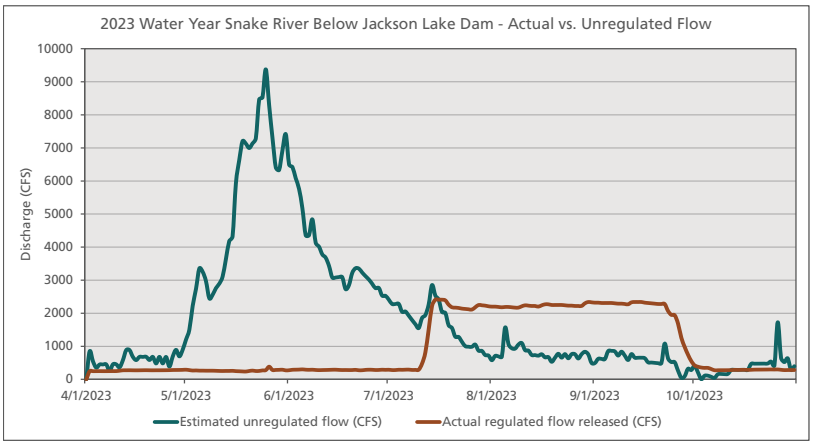


Chart comparing the Snake River's 2023 flow regulated by the dam (brown) compared to the estimated unregulated flow (green).

The dam on Jackson Lake increased the natural lake by 38 vertical feet and provides water storage for downstream users.

management. The BOR had announced plans to reduce Jackson Lake Dam flows to 50 cfs to avoid spillage in downstream Minidonka storage units, which were already at or near capacity. Because Jackson Lake Reservoir still had storage capacity while other units were full, the BOR sought to retain water in Jackson Lake to avoid releasing it from downstream units, a common optimization strategy employed by the BOR.

However, Jackson Hole resource managers believed the proposed reduction to be detrimental, potentially harming fish and wildlife habitat. Stakeholders, including local, state, and federal agencies, Grand Teton National Park, and environmental groups, sought to find a balance between efficient water storage, flow releases, and protection of vital resources. The Oxbow Bend section of the Snake River, located just downstream of the dam, is especially sensitive to flow fluctuations, given its critical habitat for native fish and seasonal importance for migratory birds.

This was not the first time in the dam's management that flows were reduced to extremely low levels. After it occurred in the 80s, Wyoming Game and Fish completed a 1987 study that identified a minimum flow of 280 cfs to maintain biological and habitat functions. The study outlined short-term impacts from low flows that included stranded organisms and mortality in dewatered riffles and side channels. Since this minimum flow was identified, the BOR generally maintained flows of 280 cfs from Jackson Lake Dam in winter months; although, no formal agreement was made. 2023 was the first time since the early 1980s that the BOR again proposed to drop below the minimum flow target. The situation highlights the challenges of managing Jackson Lake Dam to balance water delivery in downstream reaches with resource protection.

Ultimately, the state of Wyoming successfully resolved the issue by using a small amount of the storage water they typically reserve for augmenting fall flow releases. The 2023 crisis underscored the importance of active and enduring collaboration among all Snake River stakeholders. Staff at Grand Teton National Park are working with the Snake River Headwaters Watershed Group—a mix of government and non-goverment stakeholders—to bring water users together, fostering a collaborative process to promote dialogue and problem-solving within the local community. Additionally, park and BOR staff incorporated a collaborative process into their agency agreement on dam operations, aiming to balance water use with resource protection and better prepare for unusual circumstances before they escalate into crises.

Water Quality

Less than 10% of Grand Teton National Park is covered by surface water and all waters within the park are classified as Outstanding Natural Resource Waters. 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 drain 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 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. The State has designated the upper Snake River and all surface waters within the park as Outstanding or Class 1 waters—recognized for their exceptional quality and therefore "no further water quality degradation by point source discharges other than from dams will be allowed" (WYDEQ 2001, updated 2018). Along with these designations, 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. In 2023 discharge at the Flagg site was below the long-term average (2023: 26.4 billion cfs; average 1983–2022: 27.4 billion cfs) for most of the year. Peak flows ranked 25th in the 41-year monitoring record of the Flagg site and occurred on May 24, 2023, 2 days earlier than the average date (May 26) for this location. Snake River flows at Moose are strongly manipulated by Jackson Lake Dam and reservoir operations but were below average for that site (1995–2023). The total volume of annual flow at the Moose monitoring location was the second lowest in the 29-year record (62.3 billion cfs, with the lowest volume at 55.5 billion cfs in 2005). The date of half discharge (the day marking half the annual flow volume) occurred June 30, 2023, three days after the average date (June 27) for this location.

Greater Yellowstone Inventory & Monitoring field staff use a crane, reel, and suspension sampler to examine river water quality at Moose, WY.

G. Winston

The Snake River's braided channels wind across the valley floor.

NPS resource staff from the Greater Yellowstone Inventory and Monitoring Network also monitor Snake River water quality at the Flagg Ranch and Moose locations. Results from water quality analyses (2006–2023) confirm that concentrations of primary nutrients (nitrogen and phosphorus) remain consistently low or near detection limits at both sites. Nitrogen levels show little variation seasonally; however, total phosphorus shows significant variation and is highest during runoff. Trace metals (i.e., arsenic, copper, and selenium) are often naturally present in measurable concentrations, but typically below the State of Wyoming's aquatic life criteria.

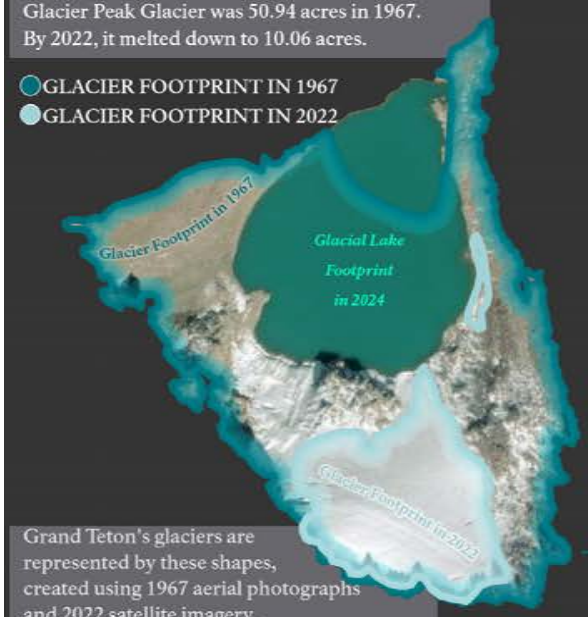
In 2023 selenium was below detection levels at both sites. Total copper and total iron concentrations were below detection or low at both sites and did not exceed Wyoming's Iron Criteria for Aquatic Life (1.0 mg/L) as they have in previous years. Total arsenic concentrations were measurable at both locations with higher concentrations found at the Flagg site; however, both sites were below the State of Wyoming's Aquatic Life Criterion (0.15 mg/L). 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 metal levels are driven by elevated discharge following snowmelt. Given the role of the Snake River in Grand Teton and downstream communities, it is important to continually monitor flow and water quality for this river system.

Shrinking Glaciers

Why are glaciers in Grand Teton important?

GLACIER PEAK GLACIER

Glacier Peak Glacier was 50.94 acres in 1967.
By 2022, it melted down to 10.06 acres.



Grand Teton's glaciers are represented by these shapes, created using 1967 aerial photographs and 2022 satellite imagery.

TETON
69.45 acres melted to 55.42

PETERSEN
68.51 acres melted to 2.47
No longer active

MIDDLE TRIPLE
56.88 acres melted to 25.96

WEST TRIPLE
54.36 acres melted to 18.76

GLACIER PEAK
50.94 acres melted to 10.06

SKILLET
47.87 acres melted to 16.04

MIDDLE TETON
45.92 acres melted to 29.02

FALLING ICE
39.79 acres melted to 34.7

ICE FLOE
31.27 acres melted to 6.15
No longer active

EAST TRIPLE
28.79 acres melted to 10.64

Grand Teton National Park's 11 known glaciers are iconic features of the park landscape, prompting efforts to monitor their fluctuations under current and future climate regimes. These glaciers may have been active since the last major glaciation approximately 10,000 years ago. Some of the Teton glaciers are active, while others have recently been considered remnant because they have lost so much volume they have stopped flowing.

Glaciers store water that provides critical input to land and aquatic ecosystems during the summer months. Changes in glacial extent and volume are significant indicators of changing climate and show rapid retreat and volume loss of glaciers.

Since 2015 Park staff have been conducting GPS elevation surveys on Middle Teton Glacier. In 2022, ice thinned across 70% of the glacier's surface, and areas with the greatest amount of thinning had 4.7 meters of ice loss, with a mean loss of 2.1 meters.

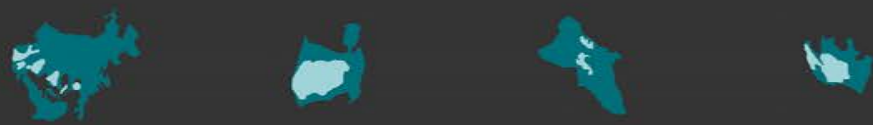
What will this rapid retreat and volume loss of glaciers mean for the Greater Yellowstone Ecosystem in the next generation?

NORTH 1
28.17 acres melted to 2.43
No longer active

NORTH 2
16.71 acres melted to 6.96
No longer active

TEEPE
15.79 acres melted to 1
No longer active

SCHOOLROOM
9.95 acres melted to 3.46



American Goshawks

American goshawks live in dense forests and hunt large prey like grouse and hares.

American goshawks (*Accipiter atricapillus*), formerly called northern goshawks until 2023, are secretive birds that inhabit mature, large-tract forests including those in Grand Teton National Park. They are classified as a species of greatest conservation need in Wyoming and as a sensitive species by the US Forest Service. In western North America, goshawks have been a species of concern for the last 20 years. Logging, insect infestations, wildfires, and climate change affect the old, mature forests and have a direct impact on the success of this species.

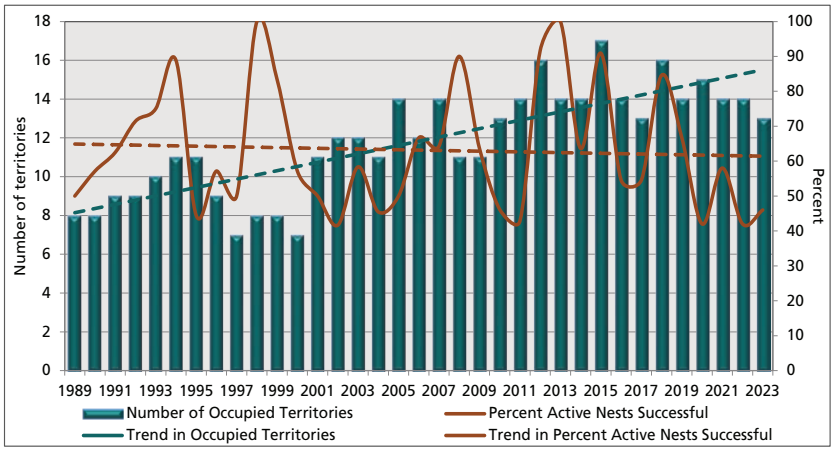
Since 2020 park biologists have partnered with the Teton Raptor Center (TRC) to study the movement, distribution, and abundance of goshawks in Grand Teton National Park. In 2023 TRC biologists deployed automated recording units near eight of the nine known territories to determine occupancy during the goshawk's courtship period. Goshawk calls were detected in five territories and three of those territories were determined to be occupied. Biologists only located one nest which produced 2 chicks. The adult female had been previously tagged and TRC biologists banded both chicks in 2023. Parent goshawks are very protective and known to attack humans in close proximity to their nests. To mitigate this hazard and minimize disturbance to the nesting birds, the area around the active nest (including a nearby trail) was closed for the duration of the nesting period. Once the goshawks fledged and left the area, biologists removed the closure.

Area scientists have limited knowledge of goshawk population trends, habitat needs, and sensitivity to disturbance in northwestern Wyoming due to the secretive nature of these birds and the denseness of the forests they inhabit. Continued investigation is needed to understand the status of American goshawks in Grand Teton. Park biologists plan to continue collaborating with TRC biologists to gain more knowledge of this species in the Greater Yellowstone Ecosystem.

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.

Once listed as endangered under the Endangered Species Act, bald eagles were delisted in 2007 due to their dramatic population recovery throughout the US. The number of territorial pairs in Grand Teton almost doubled over the past 30 years. In accordance with the Greater Yellowstone Bald Eagle Management Plan (1995) and National Bald Eagle Management Guidelines (2007), park managers implement temporary closures around active bald eagle nest sites to minimize disturbances. In 2023, closures were established at nest sites along the Snake River and Jackson Lake.



The number of territorial and successful bald eagle pairs in Grand Teton National Park.

Of the 31 bald eagle territories monitored in 2023, 13 were occupied and all 13 pairs initiated nesting. Six pairs hatched and successfully fledged eight eaglets. The 2023 numbers of occupied territories (13), nesting pairs with fledglings (6), and eaglets fledged (8) were slightly below the 10-year averages (14.5, 7.1, and 11.6). The total number of eaglets fledged in 2023 was below the 10-year average but is an increase from 2022 (6). The number of fledglings per nest in 2023 (1.3) was on trend with the 10-year average (1.3) and the 30-year average (1.4). The percent of successful active nests this year (46%) was higher than 2022 (42%) but is still lower than the 10-year average (60%).

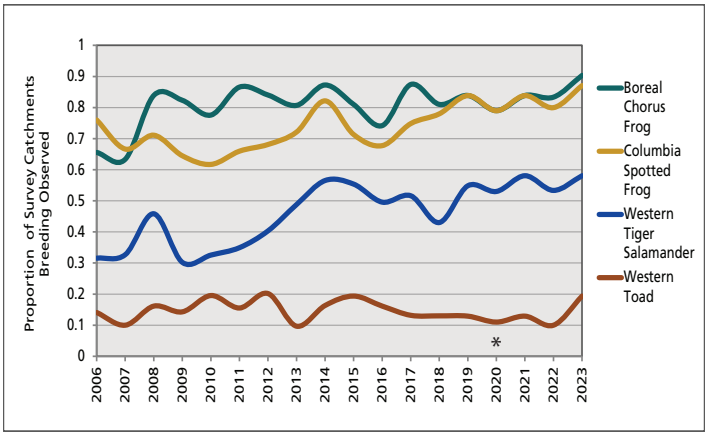
The increase in the percentage of successful active nests from 2022 may in part be due to the water level of Jackson Lake. Heavy snowfall and spring rains allowed the reservoir to fill for the 2023 nesting season after two years of historic low levels. In 2023 territories along Jackson Lake produced two fledglings, an increase from none in the 2022 nesting season. The full lake level may also have encouraged the establishment of new territories along Jackson Lake and the Snake River in 2023. Overall data collected in 2023 indicates a stable trend in the breeding bald eagle population of Grand Teton National Park.

Amphibians

Each year the National Park Service collaborates with the Northern Rockies Conservation Cooperative, US Geological Survey, and university scientists to monitor amphibians in Grand Teton and Yellowstone National Parks. Biologists identified four species of native amphibians: western tiger salamander (*Ambystoma mavortium*), boreal chorus frog (*Pseudacris maculata*), western toad (*Anaxyrus boreas*), and Columbia spotted frog (*Rana luteiventris*) to monitor. The boreal chorus frog and the Columbia spotted frog are the most widely distributed species each year, usually found at 40–50% of the visited wetlands. The western tiger salamander and western toad appear to be less widespread. The northern leopard frog was historically documented in Grand Teton National Park, but only one confirmed sighting occurred 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.

Annually since 2006 biologists have monitored and documented amphibian breeding activity in 31 catchments in the two parks. Encompassing about 500 acres each, these catchments or watersheds are defined by topography and vary in amounts of seasonal and permanent water. Biologists document 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).

In 2023 field crews were able to visit all 31 of the long-term wetlands including seven in Grand Teton. With help from park partners and other agencies, the large field crew was also able to visit a record of 26 additional catchments. Four of the long-term catchments contained breeding evidence of all four species, but none of these wetlands were within Grand Teton. However, 9 of the 57 catchments contained all 4 species (not necessarily breeding), 3 of these were in Grand Teton. These three catchments were all extensively modified by beaver activity. Wetlands that support breeding of all four native amphibians are relatively rare and are referred to as amphibian "hot spots". Finding 4 hot spots is slightly higher than usual but consistent with long-term monitoring data. For comparison, in 2016 no catchments contained breeding evidence of all 4 species, and in 2022 only 2 long-term catchments were hot spots. In 2023, 20 catchments had evidence of breeding for three species, 18 catchments had two species breeding, 9 catchments had 1 species breeding, and 6 catchments didn't have any evidence of amphibian breeding. These results illustrate the breeding variability that takes place even in protected areas.



Proportion of the surveyed wetlands where researchers observed amphibian breeding. The asterisk indicates the restricted 2020 field season due to COVID-19 precautions.

Dedicated field crews spend soggy days searching wetlands for evidence of amphibian breeding.

In 2023 researchers visited a record of 534 individual wetland sites spread across the 57 catchments and surveyed the 468 sites with standing water present. Researchers found approximately 53% of the sites were occupied by at least one species of breeding amphibian, compared to 60% out of 263 surveyed sites in 2022, 70% out of 230 surveyed sites in 2021, and 56% out of 281 surveyed sites in 2019.

Annual variations in breeding is likely 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 2023 researchers estimated 88% of the wetland sites were flooded. A handful of sites not surveyed since 2006 due to the lack of water had enough standing water to be surveyed in 2023.

All amphibians in Grand Teton and Yellowstone National Parks 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). The four surveyed species employ diverse strategies to survive the winter requiring both aquatic (unfrozen, oxygenated waters) and terrestrial (digging underground, using logs, trees, rocks, snow layers, and even burrows of other animals) habitat. Suitable overwintering habitat may be near breeding wetlands or may involve significant travel, increasing risks. The predicted warming temperatures and changes in snowpack driven runoff for this region could alter wetland habitats and influence amphibian breeding. These expected impacts will disproportionately affect amphibians because they rely on shallow wetlands and sometimes ephemeral waterbodies.

Bighorn Sheep

Bighorn sheep (*Ovis canadensis*) were once widely distributed throughout the mountains and foothills of the Rocky Mountain west. Today, they persist in small, fragmented populations that are at risk of further decline and extirpation due to disease, human development, and habitat degradation. The Teton Range population is one of Wyoming's smallest and most isolated native sheep herds. Due to loss of migration routes and winter range over the past century, the population 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. Bighorns in this population endure harsh winter weather in windblown areas above 9,500 feet. This remnant population faces an elevated risk of extinction due to its small size and isolation. Specific concerns include loss of genetic diversity; respiratory disease; habitat loss; and competition and disease transmission from nonnative mountain goats. Biologists are working to protect bighorn habitat and minimize other threats.

Traditionally biologists have estimated the size of this population using visual counts from winter helicopter surveys. In April 2023 Wyoming Game and Fish Department personnel counted a total of 71 bighorn sheep (34 in the south end of the range and 37 in the north). Only five lambs were counted during the survey. This represents a decrease from 2020–2022 counts, which ranged from 90 to 104. The winter of 2022/2023 was severe with record breaking snowfall and a snowpack that persisted at all elevations well into the spring. In response to high variability in the 2015–2019 aerial survey counts, park biologists began to evaluate the effectiveness of two non-traditional count methods that take advantage of bighorns' affinity for mineral licks during the summer months: analysis using remote cameras and genetic analysis based on fecal DNA. Beginning in 2018, park biologists placed motion-triggered cameras at mineral licks in the Teton Range. To date, biologists have analyzed more than 162,000 photos of bighorn sheep and documented groups making over 2,900 visits to the licks. The cameras allow biologists to document use of different mineral licks across years, lamb production, and observed health of the animals. Additionally, from 2019 to 2022, biologists collected fecal pellets near mineral licks and sent them to collaborators with expertise in DNA analysis. The DNA obtained from the fecal material identified individual bighorn sheep and other important population attributes like genetic diversity, inbreeding depression (the reduced survival and fertility of offspring of related individuals), and interbreeding between subpopulations. Of the 2,166 fecal samples collected over the course of the study, 1,523 were submitted to the genetics lab, and 1,097 of these were successfully sequenced and genotyped by the lab. The lab expanded genotyping in 2023 to identify unique individuals and provide more information on the population's genetic health. Ultimately, the lab identified 86 unique bighorn sheep (52 females; 31 males, 3 unknown sex) in 2019, 98 (55 females, 41 males, 2 unknown sex) in 2020, 93 (55 females, 38 males) in 2021, and 109 (58 females, 42 males, 9 unknown sex) in 2022. Biologists will conduct analyses to estimate population size and genetic health in 2024.

G. Winston

Bighorn have hooves adapted to their rugged mountain habitat. The outside of the hoof has a hard rim used for digging into the ground or cutting into snow or ice while the inside is soft and spongy to aid in traction. They have split hooves which aid in balance allowing them to pinch and hold onto rocks.

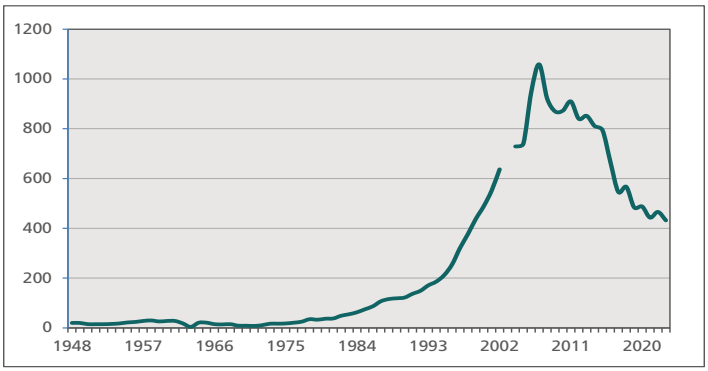
Historical accounts suggest that the Teton Range once hosted a larger population of bighorn sheep than are currently present. To understand how many bighorn sheep the Teton Range can support, park biologists began a study in collaboration with University of Idaho scientists in 2023 to estimate the nutritional carrying capacity for bighorn sheep. Nutritional carrying capacity refers to the number of animals a landscape can support as determined by the availability and quality of forage, the movement patterns and landscape use of animals, and their dietary choices.

In 2023 University of Idaho and park staff sampled 69 vegetation transects between July 1st and October 6th, collecting over 3,000 samples from 247 plant species. Researchers will use data from these surveys to calibrate an existing remote sensing model that predicts forage quality and quantity. In late November 2023, biologists captured and radio-collared 14 female bighorn sheep in the Teton Range (7 from the south and 7 from the north). Biologists took body fat measurements during the capture and found that, overall Teton Range bighorn sheep entered the 2023/2024 winter with high fat reserves—a positive sign for the population. However, given the high-elevation wintering strategy of these animals, it is not clear how their fat levels should be interpreted since Teton Range bighorns experience more severe winter conditions than most populations.

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 reoccupy the valley. Present-day Jackson bison are descendants of those bison and subsequent migrants from Yellowstone. During the winter of 1980, bison moved onto the National Elk Refuge (NER) and began using supplemental feed intended for elk. This altered the herd's natural population dynamics, as they returned annually to feed on this easily obtainable food source.

Bison summer primarily in Grand Teton National Park. Depending on winter severity and native forage availability, most of the herd now 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. The joint Bison and Elk Management Plan, approved in 2007 for the park and NER identified a population objective of 500 bison for the herd. The Wyoming Game and Fish Department adopted this objective. With unusually low winter mortality, supplemental winter feed, and no significant predation, the herd grew steadily since the 1980s, reaching more than 1,000 by the winter of 2007. More recently bison hunting, allowed on the NER and the Bridger-Teton National Forest, has reduced bison numbers to slightly below the objective of 500 animals.



Population size of the Jackson bison herd, 1948-2023. (No data for 2003.)

Bison are adapted to survive long winters but it is important for them to conserve energy and not be needlessly disturbed by humans.

In mid-February 2023, biologists counted 432 bison with about 83% of the herd (360 individuals) found on the NER and 72 bison on native winter range scattered throughout the central portion of the park. This marked the third winter in the last four years that the majority of the bison population moved to the NER and used the supplemental feed. Bison recruitment (as indexed by the late-winter calf ratio) in 2023 was 46 calves per 100 cows. This represents an increased recruitment rate compared to 2022 (28 calves per 100 cows).

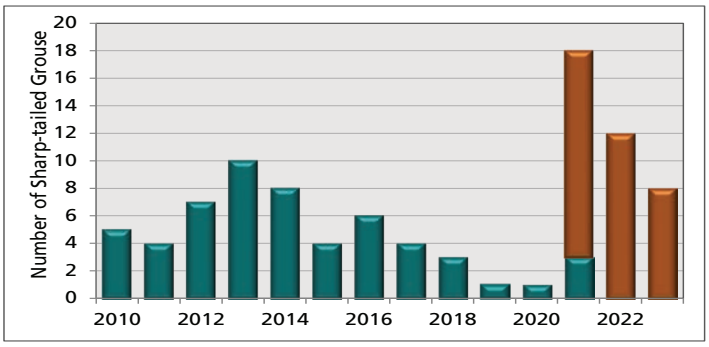
Winter 2022/2023 was colder and snowier than normal, and the snowpack persisted later into the spring than in a typical year. Overwinter mortality is typically higher in severe winters compared to milder ones and this year was no exception. NER personnel documented five bison mortalities including two adults and three orphaned bison calves. In a normal year the NER documents zero to one mortality. Three bison-vehicle collisions were reported in 2023 resulting in at least one confirmed bison death. Two bison left the scene of accidents but may have been injured and died later away from the road. The Shoshone Bannock tribe harvested five bull bison on the NER in April 2023, and hunters harvested another 19 bison outside of the park.

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 population declines and range reduction. Sharp-tailed grouse are considered a species of greatest conservation need in Wyoming. The Columbian is the rarest subspecies and has experienced the largest decline of all sharp-tailed species.

Similar to greater sage-grouse, sharp-tailed 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 sharp-tailed grouse subspecies. Little is known about the sharp-tailed grouse population in Jackson Hole. Recently, incidental observations of small groups of sharp-tailed grouse were recorded in Grand Teton but no leks were found prior to 2010, and the nearest known lek was in Idaho on the western slope of the Tetons.

In the spring of 2010, biologists observed five sharp-tailed grouse displaying on a lek, Elbow West, near the southeast boundary of the park. In the spring of 2021, a University of Wyoming graduate student conducting survey transects found a second lek in the park, Warm Ditch with 15 males. Grand Teton



Counts of male Columbian sharp-tailed grouse are in green for the Elbow West lek and in brown for the Warm Ditch lek.

transect locations were determined by modeling preferred lek habitat for sharp-tailed grouse in other parts of Wyoming. Transect surveys in future years based on this habitat modeling may lead to the discovery of more leks.

In the spring of 2023, park biologists surveyed both known leks. This year, no grouse were observed at the Elbow West lek. Biologists counted 12 sharp-tailed grouse on the Warm Ditch lek with a high of 8 males (4 fewer than last year). Biologists observed a high count of 4 females on the Warm Ditch lek—the highest count of sharp-tailed females at a lek site in the park to date. This was the first year since the discovery of the Warm Ditch lek that birds were easily visible on the lek due to the heavy snowpack that remained on the valley floor during early season observations.

Common Loons

The common loon (*Gavia immer*) is a long-lived waterbird that feeds mostly on fish and prefers to nest on shorelines of lakes and ponds. Common loons that breed within the Greater Yellowstone Ecosystem (GYE) are the rarest breeding bird in Wyoming with only approximately 20 breeding pairs. The GYE population of loons is geographically isolated south of the species' core breeding range. Small, isolated breeding populations are vulnerable to local extinction from genetic bottlenecks, habitat loss, and mass mortality events.

Grand Teton National Park has over 150 reports of common loons dating back to 1934. Loons commonly use the Oxbow Bend portion of the Snake River as they stage, waiting for higher-elevation lakes to melt. Loons also forage on Jackson Lake in the spring and fall. Additionally, there are nine other lakes in the park where loons have been observed. Breeding has only been confirmed twice in the park, at Emma Matilda Lake in 2007 and 2013; one chick was produced each time. There are also two unconfirmed reports of loons with young, on Leigh Lake in 2009 and on Jackson Lake in 2016. Overall, the park has suitable habitat for nesting, staging, and migratory stopovers; however, due to loon fidelity to their birthplaces dispersers are infrequent.

In the early spring of 2023, Biodiversity Research Institute biologists placed automated recorders in two historical breeding areas. Biologists confirmed one territorial pair at Emma Matilda Lake that initiated nesting. A closure was put in place on the west

If loons detect a threat, they squeeze air out of the spaces between their feathers, allowing them to sink low in the water and appear inconspicuous.

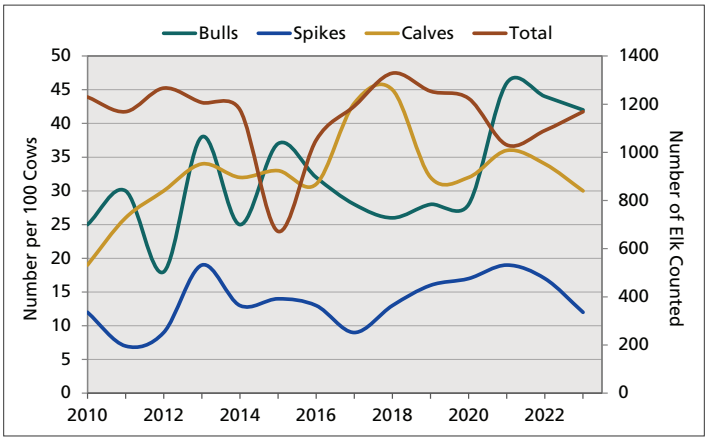
side of the lake to minimize human disturbance during the critical and sensitive nesting period. The closure was removed when biologists found that the nest had failed. Although the 2023 nesting attempt was unsuccessful, this is the first known nesting attempt by common loons in Grand Teton National Park since 2013. Additional observations of unpaired loons were documented on both Jackson and Leigh Lakes during 2023.

Common loons found throughout the GYE are known to be sensitive to human disturbances. Increased recreation on lakes is suspected to decrease the likelihood for loon breeding. Nesting habitat on Jackson Lake may also be limited by fluctuations in the water level due to dam management. Low water levels expose broad areas of lakebed decreasing the quality of loon foraging and nesting habitat. In 2023 after several years of historic low lake levels, Jackson Lake reservoir was full. When full, Jackson Lake has numerous bays that provide refuge and offer excellent foraging and nesting habitat for loons.

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 park lands 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 and other localized areas. Other portions of the herd migrate through the park and 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 affects plant communities and, as prey and carrion, elk provide sustenance to carnivores and scavengers. They are also popular with park visitors for viewing and photographing.

The mid-winter trend count objective for the Jackson elk herd set by the Wyoming Game and Fish Department is a three-year average of 11,000 elk ± 20%. During the 2023 classification count, biologists counted 10,064 elk yielding a three-year average of 10,618, meeting the objective. Estimated at above 19,000 during the early-mid 1990s, the Jackson herd has been intentionally 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).



Grand Teton mid-summer elk count and classification, 2010–2023.

An elk calf is born weighing about 35 lbs and grows very fast sustained by drinking almost a gallon of its mother's milk daily. By the time winter arrives the calf weighs about 175 lbs.

Non-harvest mortality (e.g., from winterkill) averages an unusually low 1–2% of the herd. However, winter 2022/2023 was severe with significant snowfall—43% of the days between November and March were below 0° F and the snowpack persisted late into the spring. Winter mortality on the National Elk Refuge was well above average, but likely much lower than on surrounding native winter range. During the 2023 park reduction program a total of 10 elk were harvested.

Each 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 park elk but provides a minimum count of elk within the area surveyed. In 2023, park biologists counted and classified 1,169 elk. The total number of elk counted was slightly higher than in 2022. For a third year in a row few elk were counted along the Snake River south of Moose. Often, several hundred elk are counted in this area, but radio collar data indicated the elk were outside of the park on the day of the count. Herd ratios were 42 mature bulls, 12 spike bulls, and 30 calves per 100 cows. All herd ratios were slightly lower than in 2022. Calf ratios were 25 per 100 cows in the central valley and 19 calves per 100 cows in the Willow Flats. Biologists also surveyed elk along northeast and west sides of Jackson Lake and counted 34 additional elk with relatively high calf ratios at 40 calves per 100 cows, but the overall number of elk counted in this area was low.

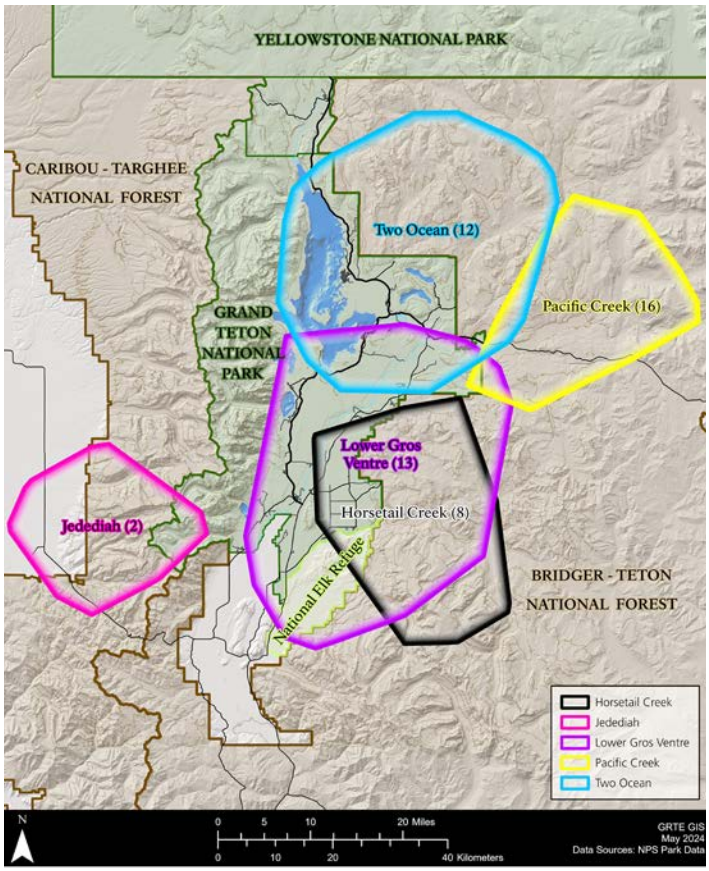
Gray Wolves

After the US Fish and Wildlife Service and National Park Service reintroduced gray wolves (*Canis lupus*) into Yellowstone National Park in 1995–96, wolves quickly 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.

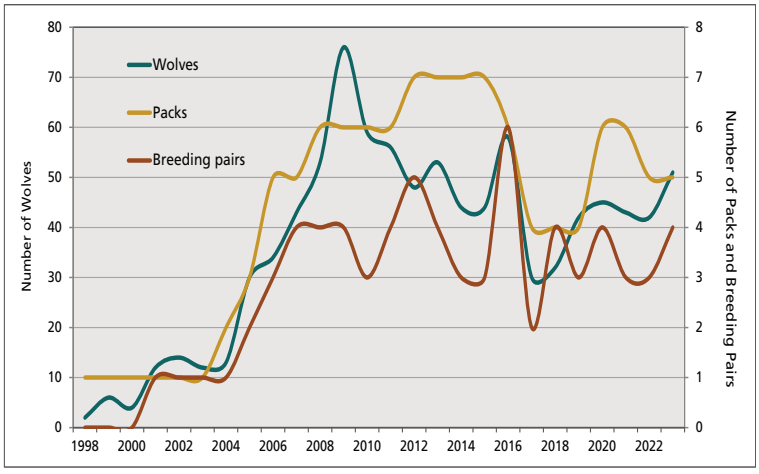
At the end of 2023, a minimum of 51 wolves in 5 packs resided in the Jackson Hole area with home ranges in Grand Teton National Park. The Jedediah (2 wolves), Lower Gros Ventre (13), Two Ocean (12), Horsetail Creek (8), and Pacific Creek (16) packs all had home ranges that included the park. The Two Ocean pack denned in the park and the Lower Gros Ventre pack had its rendezvous site in the park in 2023. There were no known wolf mortalities in the park in 2023. Biologists captured nine wolves in 2023 and fitted them with five GPS and four VHF collars.

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. Inside the park, there is no record of wolf depredation on livestock since their return to the area. Northern Rocky Mountain gray wolves including those in Wyoming were officially removed from the federal list of threatened and endangered species on April 25, 2017. Wyoming Game and Fish manages a trophy wolf hunt in the trophy game management area of northwest Wyoming outside national parks, the parkway, national wildlife refuges, and the Wind River Indian Reservation. Wolves traveling outside of the park and other protected areas are subject to the regulations governing that area.



Distribution of Jackson Hole area wolf packs. 2023 MCP (minimum convex polygons) home ranges are based on collared pack members.



Population of Jackson area wolves, including those in Grand Teton, 1998-2023.

Area wolves are split fairly evenly between black or gray coat colors, but black-colored wolves have a genetic advantage of being more resistant to canine distemper—a virus that can have devastating effects on the population.

Golden Eagles

Golden eagles (*Aquila chrysaetos*) are large aerial predators well suited to the Teton Range, with abundant cliff faces for nest sites and diverse 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 population. Concerns about golden eagle populations throughout the western US have arisen recently, primarily because of habitat loss and alteration. Like many raptors, golden eagles are sensitive to disturbance around their nest sites.

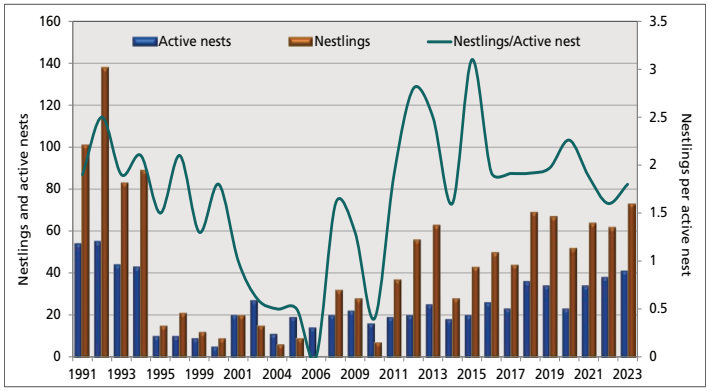
In 2023 park biologists conducted surveys for golden eagle and their nesting activity in four of the eight known territories in the park. Avalanche and Cascade Canyons were unoccupied and the status of the territory in Granite Canyon was unknown. The Uhl Hill territory was occupied by adult eagles. Biologists observed courtship behavior but did not observe nesting or young at the site.

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 occupancy, disrupt nesting behaviors, change foraging behavior, increase predation, or lead to abandonment. Heronries are also vulnerable to predation. Monitored since 1987 in Grand Teton National Park, heron occupancy and site fidelity has changed over the years with several historically productive heronries, including two along the Buffalo Fork, being abandoned in the last two decades. In 2018, biologists discovered two new heronries in the Oxbow Bend and Moran Junction areas that are geographically separate from historic heron colonies. These heronries have remained active since their discovery. In 2021, biologists on an aerial survey located a new heronry near Swan Lake.

During the 2023 breeding season, park staff monitored six heron colonies. Breeding pairs occupied five of the six colonies.

Great blue herons are mostly silent except at breeding colonies and when disturbed on foraging grounds.



Great blue heron productivity in Grand Teton NP, 1991-2023. Arizona Lake heronry, discovered just outside the park's boundary, is included in the park's monitoring program since 2009. Monitoring of heronries was not conducted in 1996, 1997, 2002, or 2008.

The Sawmill Ponds heronry was unoccupied, and the one historic nest structure observed in 2022 is no longer standing. The Arizona Lake heronry was the most productive during the 2023 nesting season with 11 active nests producing 25 young. Other successful colonies were the Pinto Ranch with 8 active nests (19 nestlings), Oxbow Bend with 9 nests (18), Moran Junction with 3 nests (8), and Swan Lake with 9 nests (3). The Swan Lake heronry may have been more productive, but observations were limited and occurred early in the nesting season.

In 2023 the total number of active nests (41) and nestlings (73) were well above the ten-year averages (29.3 and 55.2, respectively) and the number of nestlings per active nest (1.8) was near the ten-year average (1.7). Overall numbers of active nests and nestlings remained generally stable or slightly increasing over the last ten years. While heron numbers increased since their historic lows of 1995-2006, current numbers are still well below the historic highs of the early 1990s.

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 trends. 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 (TRC) to collect baseline data on territorial occupancy, demographics, nest success, prey use, and year-round habitat use of the great gray owl population in the park. This data will aid area land managers in developing conservation plans and strategies.

During the great gray owl courtship period of 2023 (mid-February through April), TRC biologists deployed automated recorders near all known nests to determine occupancy. These recorders documented three occupied territories prior to nesting. All three great gray owl pairs initiated nesting and successfully fledged a total of six owlets. Biologists had not documented any fledglings since 2019. Nest initiation and success varied considerably over the past several years. This marks the highest success rate since 2016 when biologists recorded 17 owlets fledged from 8 park nests.

Great gray owls do not build nests. They seek out cavities in trees or use abandoned nests of other large forest birds.

Biologists continue to track owls previously outfitted with VHF transmitters to evaluate habitat selection and movement patterns. Additional research includes continued surveys of pocket gophers to assess prey availability and measuring monthly snow depths at several owl territories throughout the valley and park.

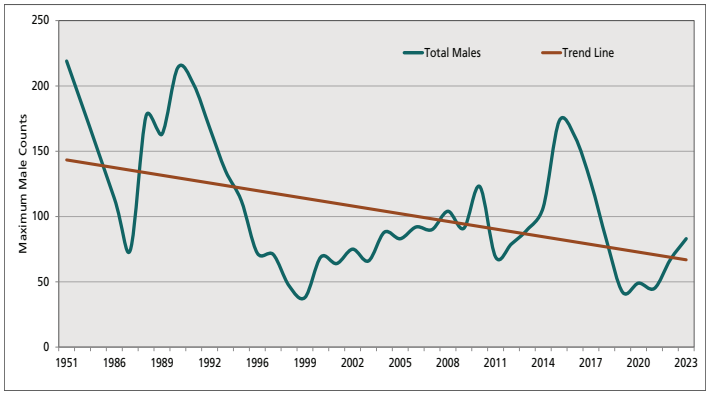
Greater Sage-grouse

Historically, greater sage-grouse (*Centrocercus urophasianus*) occurred in sagebrush habitats across much of Wyoming and the American West. Sage-grouse populations declined up to 80% throughout their range over 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 surrounded by sagebrush. 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.

Male sage-grouse make an impressive display in their strutting courtship ritual.

In the spring of 2023, eight leks were monitored weekly [seven in the park and one 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). The Airport Pit (last active in 2014) was not active in 2023. The Bark Corral lek was occupied for the first time since 2020.



Counts of male sage-grouse (with a brown trend line) on Grand Teton NP leks 1986-2023. No monitoring data for sage-grouse in 1993.

For the six active leks within Grand Teton, the total count of all sage-grouse was 105 and the maximum male count was 86, below the 10-year averages of 130 birds and 93 males. Biologists made the highest recent counts in 2015 with 243 total birds and 173 males. Despite the 2023 increase in maximum male count (86) over the 2022 count (67), sage-grouse numbers remain at historic lows.

Biologists attribute these historic lows to limited winter habitat. For five of the past seven winters, Grand Teton experienced well-above average snowfall that decreased the amount of exposed sagebrush which is critical cover and food for sage-grouse.

Grizzly Bears

Predator eradication programs eliminated grizzly bears (*Ursus arctos*) from most of the western US 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. During this period, grizzly bears were allowed to scavenge for food at garbage dumps throughout the region. To return bears to a diet of natural foods, garbage dumps in the GYE were closed in the 1960s and 1970s. After the closure of the dumps, human-caused mortality rates rose, leading to a significant decline in the grizzly bear population. This decline prompted their federal designation as a threatened species in 1975.

Intensive conservation efforts over the next four decades allowed grizzly bears to make a remarkable recovery. As a result, the US Fish and Wildlife Service delisted the species in the GYE twice—first in 2007 and again in 2017. However, both delistings were overturned due to litigation, and grizzly bears continue to be classified as a threatened species in the lower 48 states.

Scientists with the Interagency Grizzly Bear Study Team (IGBST) use the best available science for population monitoring and research. To estimate the GYE grizzly bear population size, the IGBST uses a statistical method to estimate the number of unique females with cubs, forming the basis for estimating the total population. In 2021, the IGBST revised this method by redefining what constitutes a unique female. Previously, scientists classified females with cubs as unique only if they were sighted at least 30 km apart, which provided a conservative statistical model capable of detecting small population changes during a time of low numbers. However, as the GYE grizzly bear population increased, this method began to underestimate the actual number of females with cubs. To correct this bias, the IGBST adjusted the criteria to distinguish unique females with cubs if they are sighted at least 16 km apart. The refined 16-km threshold provides a more accurate population estimate reflecting the true population size in the ecosystem.

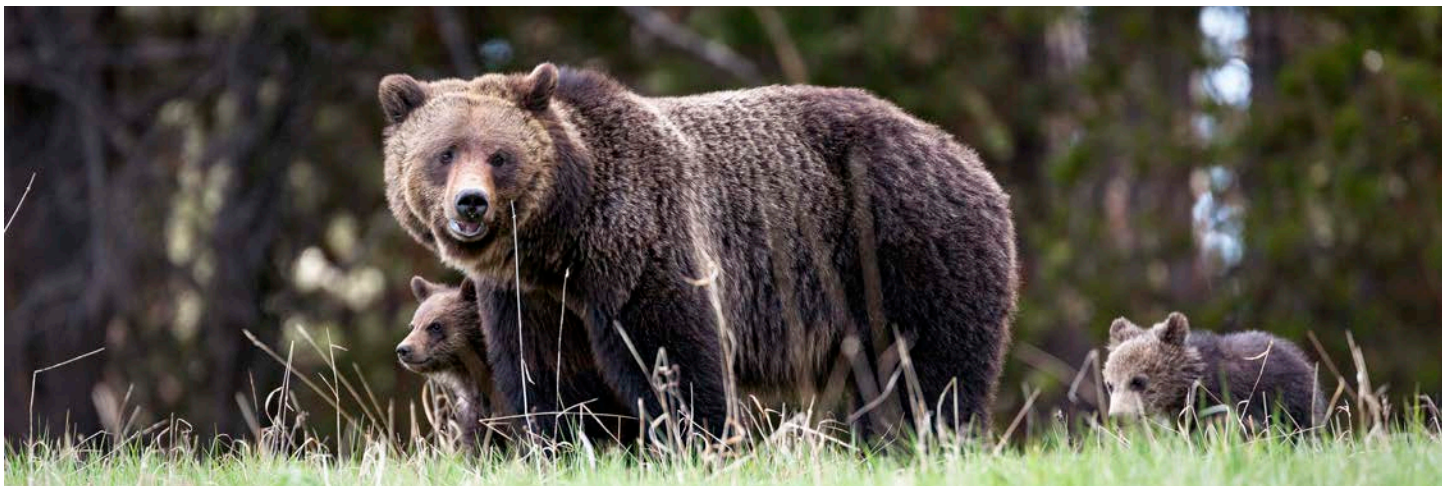
In addition to refinements in estimating unique females with cubs, the IGBST transitioned to an integrated population model (IPM) in 2022. This newer modeling approach is increasingly used world-wide to estimate populations of species. It uses advancements in statistical methods to integrate data from multiple sources in a single inferential framework. Additionally, the IPM equips IGBST scientists with new tools to monitor vital population rates and to project the impacts of different management scenarios on the grizzly bear population.

G. Winston

Grizzly bear claws can grow up to 4 inches long and are essential for digging up roots, catching small prey, and excavating their winter dens.

For 2023, the GYE grizzly bear population was estimated at 1,002 (95% credible interval = 852–1,201) using the IPM approach. It is important to note that the overall population trend has been increasing since the grizzly bear was listed as a threatened species. However, the rate of population growth has slowed in recent years as grizzly bears begin to reach carrying capacity across much of the GYE.

There are more grizzly bears today, occupying a larger area (27,066 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 grizzly bears foraging on native foods in roadside meadows makes Grand Teton a popular bear viewing destination. Management of grizzly bears and their habitat continues to be a high priority in the park and parkway.



G. Winston

Harlequin Ducks

The harlequin duck *(Histrionicus histrionicus)* is a relatively small sea duck that breeds in northern boreal regions of eastern Canada, the Pacific Northwest of the US and Canada, Alaska, and the Rocky Mountains. The population status for North American harlequin ducks is regionally variable; however, in the Rocky Mountain region they are considered a sensitive species and Wyoming 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. Limited information is available on survivorship, migration movements, winter habitat, and general breeding ecology. Better understanding of these factors is needed for effective conservation in Wyoming.

Biologists captured and tagged harlequin ducks with satellite transmitters and geolocators from 2014-2019. Biologists are planning future tagging studies to learn more about this population's migration patterns between the mountains and the sea.

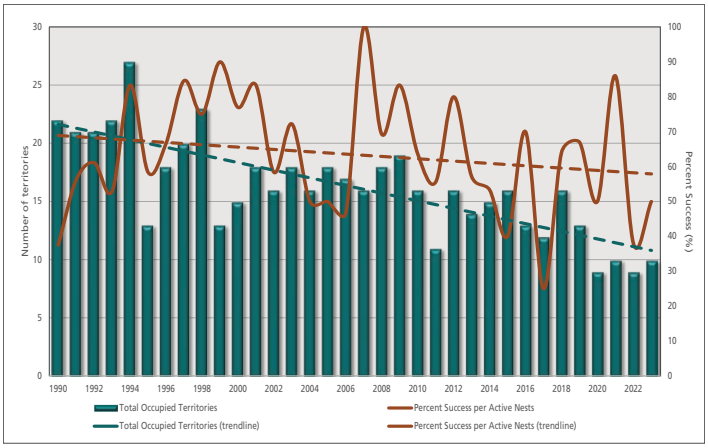
Harlequins drakes are notable for their striking plumage patterns while the more subtle colors of the hen camouflage her against shoreline vegetation.

In the spring of 2023, biologists surveyed the lower stretch of Moose Creek for breeding pairs, but none were located. In mid-August, biologists conducted more extensive surveys along Moose Creek. They located one hen with five ducklings and two solitary hens matching 2022's survey total of 8 individuals. Harlequin surveys of Owl and Berry Creeks were not made in 2023.

Ospreys

Osprey (*Pandion haliaetus*) are impressively widespread raptors, found across every continent except Antarctica. In Grand Teton National Park, osprey are often observed flying over lakes, rivers, and waterways in search of fish. With a diet consisting primarily of fish, osprey nest near low-elevation lakes and along the Snake, Gros Ventre, and Buffalo Fork Rivers and their tributaries. Park staff started monitoring osprey nest occupancy and success in 1972 and later standardized the surveys in 1990. While only 6–8 nests were occupied annually 1972–1981, more recently ospreys occupy approximately 12 territories (10-year average 12.3).

In 2023, ospreys occupied 10 of 19 monitored territories in the park. Five pairs successfully fledged 11 young—a notable increase over the 4 fledged in 2022. In 2023 park ospreys averaged 2.2 fledglings per nest, higher than the 10-year averages of 1.6. The total number of fledglings in 2023 (11) was the highest since 2019 when 16 were counted. With a 50% nesting success rate in 2023, park ospreys were close to the 10-year average of 54%.



Osprey territory occupancy and nest success with trend lines.

Osprey build large stick nests up to six feet wide on elevated locations like tree tops. They return to the same nest for multiple years expanding the structure.

G. Winston

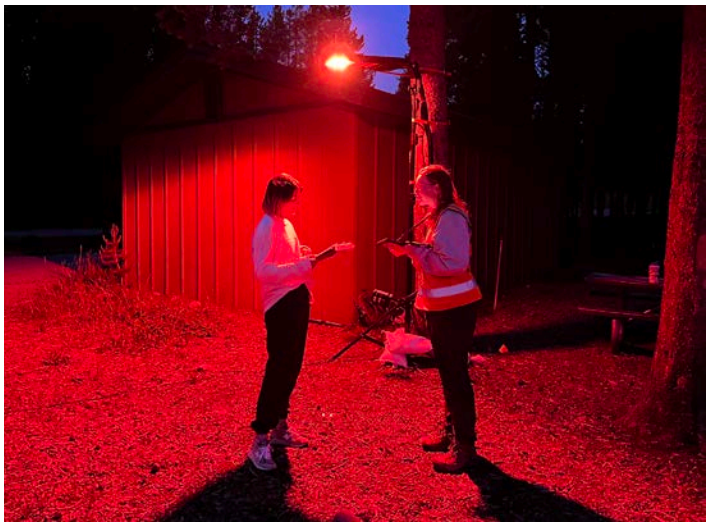
It is important to note that in 2023 Jackson Lake Reservoir returned to full after two years of historically large drawdowns. This may have contributed to the osprey nest success rate as more foraging habitat was available. There was one successful nest along Jackson Lake—it may take more years of full lake levels to see a return to all the old territories along the lakeshore.

Nesting success is generally stable to slightly declining for park ospreys. There is a more obvious decline in the total number of osprey occupied territories in the park. This decline coincides with an increase in the number of territorial bald eagles. Compared to bald eagles, osprey populations recovered more quickly following the banning of DDT in 1972. With bald eagles regaining prevalence on the landscape, osprey populations may be responding by stabilizing at a lower number.

Studying Night Skies

The park social science group is gathering information that helps Grand Teton's managers understand current and desired conditions. One focus is the night skies study at Colter Bay. Under the direction of the park's social scientist, two interns surveyed park visitors. Sponsored jointly by the University of Wyoming and the National Park Service (UW-NPS), the study was designed to better understand perceptions and preferences park visitors have about lighting including impacts lighting can have on wildlife, night sky viewing, and other night recreation activities. This study will advise park managers on the type of park lights visitors prefer, visitor acceptance levels of potential management actions, and how visitors use nighttime lights. This project builds on the 2019 study of the human dimensions of park lighting, specifically preferences between red light and white light. That study found visitors accepted red lights which are known to be more wildlife friendly. This result influenced the change to red streetlights in Colter Bay. For the current study, the social science team explored more than just colors but also the effect of light intensity on visitor experiences at night. Surveys were conducted using a specialized sample lights that emitted four different LED light hues—PC Amber, Clear Light Red, Clear Light Amber, and White—with ten intensities for each. This project is in partnership with biologists from Boise State University, focusing on the impact of lighting hues and intensities on bats and insects at Colter Bay. The research is investigating whether light intensity has a greater impact than the hue of the light itself.

During the summer months of June, July, and August, the interns collected data from visitors at two sites within Colter Bay, outside the general store and outside the amphitheater. Because it was necessary to be fully dark during the survey, active surveying didn't start until around 9 pm. The UW-NPS interns intercepted Colter Bay visitors and asked them to participate in a visitor survey to help inform park management decisions. Willing respondents were given a physical copy of the survey questions to read, and their answers were recorded by survey administrators. For each night of sampling, the light sources were set to a predetermined condition of hue and intensity indicated in the study's sampling plan. The set intensity ranged from high



The night sky survey recorded visitory perceptions of different lighting options.

(intensity 9), medium (intensity 5), and low (intensity 2). With the sample light set to the selected hue and intensity to provide a visual example, survey participants answered a series of questions based on their thoughts of the predetermined light condition, their ability to see in unlit areas of Colter Bay (views of the night sky), their ability to perform nighttime activities with this lighting condition, and their opinions of the lighting condition as "inappropriately dark" or "inappropriately bright". In addition to working on the lighting survey, the 2023 UW-NPS interns assisted social science projects by surveying traffic conditions at the main Colter Bay intersection, calibrating trail counters, mapping user made "social" trails, and monitoring watercraft for aquatic invasive species prevention.

The interns conducting this survey are just one example of how the UW-NPS partnership adds to park capacity. Each summer, two research interns are selected through the University of Wyoming internship program to work with park staff on a range of projects including vegetation management, wildlife studies, and science communication.

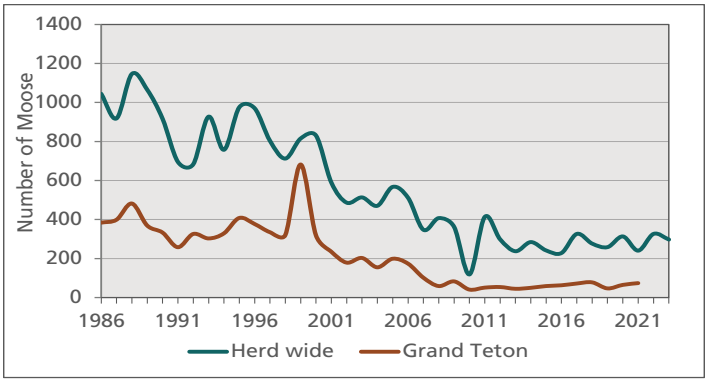
Sophia Palcic and Bianca Walder
2023 UW-NPS Interns

NASA/B. Dunford

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 more than 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 2023 totaled 297 moose, roughly 29 fewer than counted in 2022, including 48 individuals in 31 groups within Grand Teton (23 cows, 17 bulls, and 8 calves). Ratios were 37 calves and 97 bulls per 100 cows.

The moose herd decline likely resulted from a combination of interacting factors. The ecological landscape of today is different than the early 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 bear, cougar, and wolf populations have recovered. Also, large-scale wildfires affected portions of the herd unit in 1988, 2000, and 2010. Studies suggest that nutritional quality of moose forage in areas burned in 1988 is significantly lower than in unburned areas. Individuals summering in these areas have lower pregnancy and calf survival rates. In contrast, 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 have not reestablished following large-scale wildfires. Additionally, warmer ambient air temperatures associated with changing climate may be affecting moose by altering their feeding and other activities, potentially affecting caloric intake, and providing favorable conditions for parasites.



Jackson moose herd mid-winter counts, 1986-2023 (data from Wyoming Game and Fish Department). These counts are used to estimate overall herd size.

G. Winston

Moose browse primarily on woody material in the winter. Their metabolism lowers during the colder months when food is of lower quality.

Biologists continue to assess hair loss in moose presumed to be caused by winter tick loads. Winter ticks are a small, ectoparasites that feed on mammal blood with infestations most commonly found on moose. In fall, the ticks amass on vegetation and transfer onto moose. In mid-winter to early spring, adult ticks irritate the moose causing moose to groom excessively which results in loss of insulating hair, blood loss, and changes in foraging behavior. In 2023 biologists made visual observations of 45 moose and assigned each to a hair loss rating category (1=no loss [0-5%], 2=slight loss [5-20%], 3=moderate loss [20-40%], 4=severe loss [40-80%], and 5=ghost [80-100%]) for 116 moose. Slight hair-loss was the most frequently assigned category with 3 moose in the north and 17 in the south. No moose were categorized as ghost moose. Biologists continue to study the relationship between weather indices (e.g. fall/spring temperatures and amount of snow-on-the-ground) and hair loss in moose as these variables may influence tick survival. Studies in other regions found that severe winter tick infestations can reduce moose calf survival, and that tick reproductive success is positively influenced by earlier springs and milder winters. Ongoing research seeks to better understand the ecology of winter ticks and their impacts on the local moose population.

Mule Deer

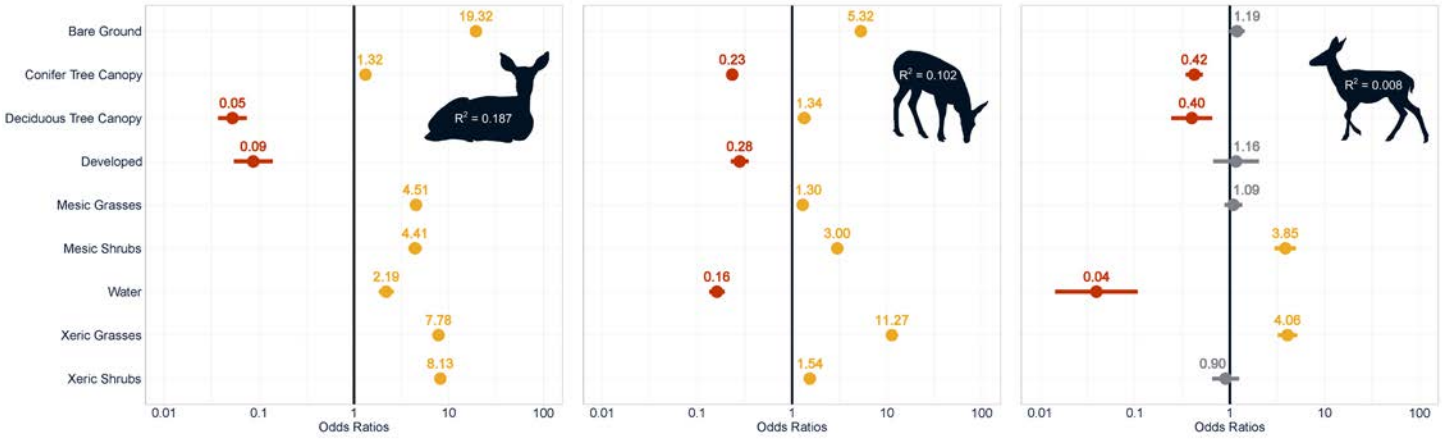
Mule deer (*Odocoileus hemionus*) that summer in the park, migrate to distant wintering areas throughout the Greater Yellowstone Ecosystem (GYE) to meet their biological needs. Their travels link the park with remote areas of western Wyoming and Idaho, highlighting the importance of understanding wildlife behavior and habitat needs for long-term conservation efforts. After nearly a decade of research, park biologists are now focused on sharing their findings with the public, emphasizing the significance of mule deer migrations and the partnerships necessary for their long-term conservation.

Park staff collaborated with the Wyoming Migration Initiative (WMI) to create a documentary film, *Animal Trails: Rediscovering Grand Teton Migrations*. This film, showcased in the park's visitor centers, raises public awareness of these migrations. It also is available online (www.vimeo.com/migrationinitiative/AnimalTrails or www.youtube.com/watch?v=HNXBiOyw7Cs). Further collaboration with WMI led to the development of the "Grand Migrations: Wildlife on the Move" exhibit at the Craig Thomas Discovery and Visitor Center that further educates visitors on the spectacular phenomenon of animal migrations.

Wildlife staff also completed an evaluation of mule deer habitat selection by behavioral state in the predominantly agricultural landscape of eastern Idaho. By analyzing GPS collar data, biologists characterized deer behavior as resting, foraging, and traveling based on movement patterns. Biologists also compared the landcover types deer used to other available locations in evaluating whether mule deer land cover preferences were dictated by behaviors. The findings revealed a strong preference for native land cover types across all behaviors, underscoring the importance of preserving diverse habitats to support mule deer during winter. Resting deer showed the strongest preference for rocky areas (specifically the rocky sides of the Teton River Canyon), while foraging and traveling deer preferred dry grasslands over agricultural land. The results provided land managers with an understanding of the importance of native vegetation as well as the need for diverse land cover types to meet the biological needs of wintering mule deer. Park staff are working with partners outside the park to identify and conserve critical mule deer habitat as a means of protecting the mule deer that live in the park during the spring, summer, and fall.

G. Winston

Migration presents many challenges for mule deer as they cross physical and jurisdictional boundaries encountering people, vehicles, and domestic animals while still needing to find forage and resting spots.



This graph divides mule deer activity into three movement patterns—resting, foraging and traveling. The ratios show what land cover types were preferred for those activities with red numbers identifying nonnative land cover and yellow numbers indicating native land cover.

Peregrine Falcons

Peregrine falcons (*Falco peregrinus*) are found globally and primarily feed on birds captured in flight. The lower elevations of the major Teton Range canyons provide peregrine with excellent cliff-nesting and diverse foraging opportunities. Decimated by the insecticide DDT used in the US until the 1970s, peregrine falcon disappeared from the Greater Yellowstone Ecosystem by the 1960s. From 1980 to 1986, biologists released 52 fledgling falcons in Grand Teton National Park and the John D. Rockefeller, Jr. Memorial Parkway. Following reintroduction, park staff have monitored the local peregrine population since 1987. The first nesting attempt was at Glade Creek that year and young successfully fledged the next year. Peregrines, once listed as threatened under the Endangered Species Act, were delisted in 1999. To date peregrine occupy territories in Garnet, Death, Cascade, and Webb Canyons; Blacktail Butte; Glade Creek; Steamboat Mountain; and near the Gros Ventre River in Kelly.

In 2023, peregrines occupied four of the eight territories monitored within the park and parkway. Of those occupied territories, three breeding pairs successfully fledged a total of three chicks, one each at the Garnet Canyon, Webb Canyon, and Kelly eyries. Peregrines occupied the Baxter's Pinnacle territory throughout the season and initiated nesting but failed to produce young. Park managers established a temporary closure in the Baxter's Pinnacle climbing area of Cascade Canyon to limit human disturbance to that eyrie. The area reopened when biologists determined the nest had no young. The Blacktail Butte, Death Canyon, Glade Creek, and Steamboat territories were not occupied. In addition to the territories monitored within the park, biologists monitored Davis Hill, adjacent to the park boundary, where a peregrine pair successfully fledged three nestlings in 2023.

Breeding statistics for park peregrine territories monitored in 2023 were below the ten-year averages for territorial pairs 4 (ten-year average 4.8) and chicks fledged 3 (4.9). While fledglings per occupied territory 0.8 (ten-year average 1) and pairs with young 3 (2.8) were at the ten-year averages. Historically the percent of successful pairs is highly variable. In 2023 75% of the territorial pairs were successful compared to the ten-year average of 56%.

Overall, the peregrine falcon population in Grand Teton is stable and the trend in occupied territories and successful nests has increased gradually over time. There is potential for peregrines to occupy territories outside of the current survey areas. Sightings of peregrines in Granite Canyon occurred during the 2022 and 2023 breeding seasons, but further surveys are needed to confirm if this is a newly established territory.

Snake River Fine-spotted Cutthroat Trout

Grand Teton National Park is home to 12 species of native fish along with 9 nonnative fish (4 trout and 5 warm or tropical species). Two distinct looking but genetically undifferentiated cutthroat trout (*Oncorhynchus clarkii*), the Snake River fine-spotted and Yellowstone cutthroat, are native to the park. Historically the Wyoming Game and Fish Department stocked area lakes and streams, including several park locations, with game fish including nonnative species: lake, brook, brown, and rainbow trout. With strong support from the park, the nonnative fish stocking program in the park ended in 2006. The state manages the recreational fishing licenses and catch limits of both native and nonnative fish within the park, with input from the National Park Service. The potential impacts of nonnative trout species on native trout in Grand Teton National Park continues to be a concern.

In 2019 Grand Teton National Park fisheries staff developed a new tool to census cutthroat trout in the park with the support of the Grand Teton National Park Foundation and the One Fly Foundation. To assess the population status of the Snake River fine-spotted cutthroat trout, they constructed a video weir and installed it at Upper Bar BC Spring, one of the primary spawning springs in the park and the location for decades of cutthroat recruitment studies. Fisheries personnel fabricated the aluminum weir to funnel fish through a chute past a video camera that records footage 24 hours a day. The lights, video camera, and recorder are powered by a solar array. The recorder uses security software to highlight time periods when movement is detected, allowing staff to quickly review footage and count the number of fish passing through the chute. This video weir is the first one constructed in Wyoming. It allows biologists to make accurate counts of fish without handling them, causing minimal stress and disruptions to fish activities. As the tool is used on other springs and streams, it will provide more accurate park cutthroat surveys. Understanding the number of fish moving through spawning springs and streams helps park managers improve their knowledge of park cutthroat populations.

In May 2023 park biologists set up the video weir at Blacktail Spring recording fish using the spring between mid-May and mid-July. The peak day was July 9th when 196 cutthroat were in the spring. To increase efficiency this tool requires further refinement, and biologists are working to improve the system.

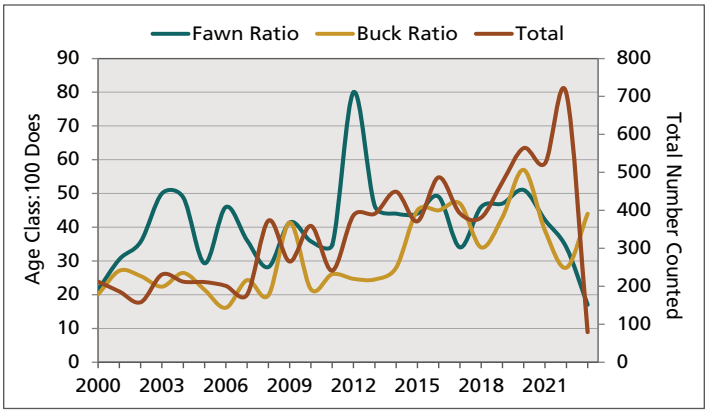
Snake River fine-spotted cutthroat are genetically indistinguishable from the and Yellowstone cutthroat, but have visibly smaller spots.

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 suggest animals may have been using this narrow pathway for 6,000 years. This migratory route of the pronghorn herd is threatened by development (residential and energy) which is occurring along the southern portion of the route and in their winter range.

Park biologists track the number of pronghorn summering in the Jackson Hole and the Gros Ventre River drainage by conducting two annual surveys—an aerial line transect survey in June and a ground classification survey in late summer. The aerial survey is timed to occur before or early in the fawning period when pronghorn are widely dispersed in many, small groups and typically fawns are not included in the counts. This survey technique corrects for groups missed and provides an estimate of pronghorn abundance with a level of precision. The late summer classification occurs after fawning and the neonatal period and is intended to provide information on fawn productivity through late summer and ratios of males to females.

In June 2023 an aerial line transect survey revealed a significant decline in pronghorn populations, with only nine pronghorn observed in five groups within the distance bands and an additional eleven pronghorn in three groups beyond those bands. The low count of just 20 total pronghorn was markedly lower than the average of around 200 animals counted in previous years. Due to the decrease in sightings, biologists could not estimate the population size because a minimum of 50 groups within the distance bands is necessary for the modeled population estimate.



Pronghorn count and age/sex ratios during late summer classification counts, 2000-2023 (data from Wyoming Game and Fish Department).

G. Winston

Pronghorns males have scent gland in their black cheek patches. They rub these glands on vegetation to mark their territory.

Grand Teton, National Elk Refuge, and Wyoming Game and Fish Department personnel conducted the ground classification count in late August. A total of 79 pronghorn were counted during the 2023 survey. Ratios were estimated at 17 fawns and 44 bucks per 100 does. In 2022, a total of 708 pronghorn were counted. The low count in the late summer survey mirrors the significant population decline documented in the early season aerial survey. Both fawn and buck ratios were lower than in 2022. It is not unusual to see low fawn counts following a severe winter which was well documented this year. In general, a ratio of 25 bucks per 100 does will maintain good recruitment for the population.

Pronghorn populations in western Wyoming suffered significant mortality in winter 2022/2023, with thousands of animals succumbing to starvation and an outbreak of *Mycoplasma bovis*. Given the high rate of winter mortality, biologists were uncertain if any animals in the Jackson Hole summering segment survived. The good news is that not only did some animals survive, but some were healthy enough to complete the migration and gave birth to fawns. The 2023 rainy spring and summer weather produced abundant forage that provided these animals with a good opportunity to put on weight. If these fawns survive, it will be another generation that makes the migration and begins rebuilding the population.

G. Winston

Red Fox

Red fox (*Vulpes vulpes*) live year-round in Grand Teton National Park. Increased visitation and an observed increase of foxes has led to more frequent human-fox interactions in the park. Red fox can often be seen in highly visited park areas, possibly attracted by the availability of human food sources. These attractants include the purposeful feeding of individual foxes by park visitors, ingestion of fish remains left by anglers, and opportunistically acquiring unsecured food in developed areas.

A red fox that has learned, through prior food reward, to associate people including their activities and areas of use or food/trash containers as sources of anthropogenic foods is food conditioned. Once a wild animal is food conditioned, human safety can become a concern. Food-conditioned behavior can cause numerous problems for humans and wildlife alike. These issues include harm to wildlife by ingesting processed foods, increased traffic hazards as wildlife are drawn to road corridors and developed areas, and safety concerns (e.g., aggression and disease transmission) for park visitors and employees. Food-conditioned behaviors may lead to the animal having to be destroyed. Therefore, park resource managers work to minimize the potential for human-fox conflicts while maintaining this valued ecological and wildlife viewing resource.

In 2023 park biologists monitored three successful fox dens. Biologists installed remote cameras to capture data about denning chronology, kit survival, and den attendance by the adult foxes. Park managers implement closures to protect adult fox and kits at dens near trails, roads, or human development. In 2023 one closure was put in place to protect denning foxes in Lupine Meadows.

G. Winston

Fox are opportunistic feeders, open to finding new sources of food. Habituation to humans brings foxes into close contact with people and food conditioning can result in the need to euthanize especially bold individuals.

To minimize human-wildlife conflicts, park biologists occasionally trap and relocate animals due to concerns for both human and wildlife safety. In 2023 park biologists used box traps to live-capture three foxes at the Jackson Hole Airport. Biologists measured and collected vital information on each captured fox including samples of blood and hair for diet and disease analyses. All foxes were individually marked with ear tags, and then released. Throughout the year, biologists also collect data from fox mortality events like roadkill. In 2023 biologists collected blood, hair, and muscle samples from three deceased foxes to aid in understanding disease presence and diet of Grand Teton National Park's fox population.

2023 Field Notes

Park staff share some of their more interesting field adventures.

Ben Landolt: "…all this science, I don't understand; it's just my job 5 days a week…" Sir Elton John's immortal lyrics had lodged themselves firmly in my mind as I unpacked a motley assortment of gear onto the shoulder of the Teton Park Road (TPR), somewhere in the vicinity of the Potholes Turnout. Tripod? Check. Global Navigation Satellite System (GNSS) unit? Check. Measuring tape? Check. Notebook….? Thankfully, check. I ran through my usual checklist of supplies as the back of my mind pondered whether I could adequately describe "geodetic datums" and "spatial reference systems" should any passers-by take an interest in my work that morning. I decided the answer was a solid "maybe" as I set off to locate my target, a small metal disk stamped into a short concrete post about 10 meters off the road. Some of these survey benchmarks are fairly easy to find, if you know what to look for. However, finding them can quickly turn into a real scavenger hunt (perhaps the most niche form of geocaching?) when their only available description is 50+ years old and references roads, bridges, and/or turnouts that may not exist anymore… Searching for these benchmarks has led to a few goose chases.

Prepped for field work, Ben Landolt carries all the handheld GPS devices for his team.

While the adventurous among us may recognize survey benchmarks from mountain peaks, they are frequently placed along roads as well, collectively forming a vital component of land surveying infrastructure. At the risk of getting into the weeds (an all-too-easy path when discussing the field of geodesy), by re-surveying these benchmark locations with modern high-accuracy GPS equipment and submitting their positions to the National Geodetic Survey, we are contributing to a nationwide initiative aimed at improving the accuracy of future position measurements particularly those involving elevation. It's sort of a "rising tide lifts all boats" situation. Since the physical science team at Grand Teton frequently relies on this type of data for precise positioning in our work, this is a worthwhile endeavor!

A National Geodetic Survey marker on the park's valley floor.

Ben uses satillite positioning tools and precise measurements to update survey benchmark information.

Anyway, back to the TPR. I found my benchmark, spent a few minutes fumbling with the tripod as I centered and leveled it over the mark, precisely measured the height distance between the mark and the base of my GNSS receiver (a distinctly UFO-shaped device), and hit "go" on my Bluetooth-connected data collection tablet (after exhaustively documenting the process and quadruple checking everything, of course). Thanks to some excellent weather and stellar satellite visibility, I was quickly logging positions with an accuracy of +/- 2 centimeters. Not too shabby. Now for the fun part: letting the machine run continuously for at least 15,000 seconds… (technically that's overshooting the requirements by a few minutes, it's just such a nice round number!).

Approximately 4 ½ hours after I began, it was time to turn everything off, take down the tripod, and head back to the office. Oh, and I never did get any questions while I was out there, just a few inquisitive looks and friendly waves from park visitors. It was a productive afternoon gathering foundational data that will be useful in our work for years to come.

Tyler J. Brasington: I am frequently asked, "What is it like working with and managing bears?" The answer is simple. Managing the human-bear interface within Grand Teton is more about people management than managing the bears. The bears will always care for themselves, whether foraging, fighting, or protecting their cubs. We do not actually "manage" the bears. Instead we focus on managing the thousands of visitors who come to Grand Teton each year to view the bears. By managing our visitors, we ensure that bears can remain wild and undisturbed by humans activity.

Driving through the park, I am constantly scanning my surroundings. Sometimes, we discover roadside bear jams, where people congregate near the road to observe bears. It is my responsibility to ensure people observe wildlife safely, meaning safe for the public and safe for the bears. Those who live in the

community and visit the park regularly have seen bears countless times. However, for most visitors this is their once-in-a-lifetime opportunity to observe a bear in its natural habitat. It is truly extraordinary to share these experiences with them. I often must remind myself of the significance of having grizzly bears on the landscape–not only from the lens of a biologist reflecting on their conservation success but also what they represent. The grizzly bear is the epitome of wildness in the diminishing natural environment and has deep cultural significance to many throughout the Mountain West.

Each day I experience something different. That is something I like the most about this type of work: you never know what each day will bring. Bear jams are unique, dynamic, and sometimes chaotic. When you combine hundreds of people at the roadside with a wild grizzly bear making its own decisions, our priority is to protect both the bear and the public, while also facilitating a phenomenal viewing experience for park visitors.

Safely managing roadside crowds is a delicate balancing act with very dynamic elements.

Some of the more memorable wildlife jams I managed were in October 2023 when grizzly bear #793 appeared frequently at Pilgrim Flats along with her independent daughter, grizzly bear #1063. Hundreds of people, with dozens of vehicles, would line the roadside hoping for even a brief glimpse of the bears. Emotions radiated from the visitors, their faces shone with infinite smiles and beaming eyes after spotting their first grizzly bear. It was remarkable to share this energy and experience with them.

I love to share my passion for bears and wildlife with our visitors. Sometimes, that means kneeling down to hand a young child my binoculars for a better look. Other times, it is handing visitors a "Bear Aware" sticker while explaining bear behavior or the grizzly's essential role in the Greater Yellowstone Ecosystem. Often I am answering the most popular question, "Who is this bear!" Humans long to connect with nature, and witnessing a bear in its natural habitat while visiting a national park can deepen their appreciation for the importance of wild places and the preservation of ecosystems.

J. Hadley

Tyler Brasington works to protect visitors and wildlife along the roadside.

Outreach and education along the roadside during wildlife viewing opportunities are critically important. We have a unique opportunity to convey the National Park Service's mission while educating people about bear safety, biology, and management. Grabbing someone's attention for even 20 seconds—just talking with them—can make someone's day, their trip, or even impact the course of their life. I vividly recall my first interaction with a park ranger as a child—his enthusiasm and passion still resonate with me today. That park ranger was my uncle, and that experience inspired me to become a National Park Service Ranger.

When you drive through Grand Teton and encounter a traffic jam caused by roadside wildlife, slow down for the safety of both people and animals. Remember, this might be a once-in-a-lifetime opportunity for someone in the crowd—this unique experience could inspire the next generation of wildlife professionals to continue protecting and preserving these special places.

G. Winston

Sagebrush Steppe

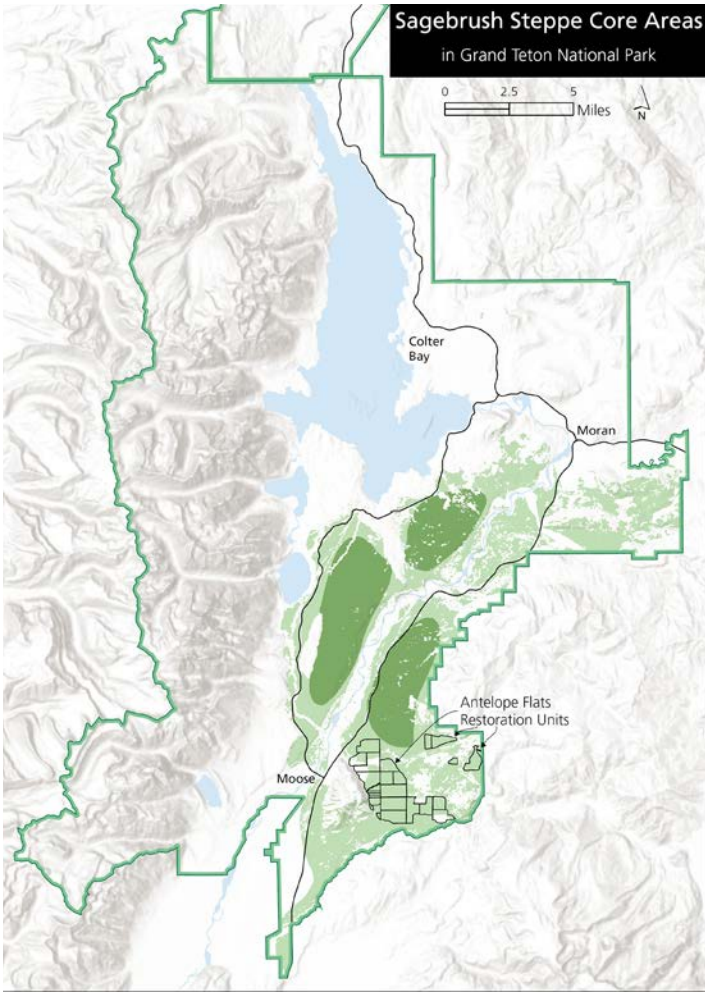
The sagebrush steppe community is one of the most widespread and diverse native plant communities in Grand Teton National Park, as well as across the greater western United States. Where intact, this ecosystem hosts a variety of native plant and animal life, including several species of concern, such as the greater sage-grouse. However, the sagebrush steppe faces numerous threats including invasion by nonnative plants, fire, destruction for human development, and climate change. Today, sagebrush steppe communities comprise less than 50% of their historic range across the west, while much of the remainder is modified or under threat.

Monitoring this resource is a priority for park staff. Starting in 2010, Grand Teton biologists partnered with NPS Inventory and Monitoring Network scientists to adopt a standardized protocol for annually tracking sagebrush plant community composition. In 2021 park staff expanded using this same protocol to monitor sagebrush restoration sites for better comparison of plant community characteristics between intact sagebrush communities and restored sites. In 2023 park staff took measurements at 500 plots in intact sagebrush communities and 275 plots in restored areas.

Generally, plant composition in intact sagebrush plots showed minimal change over the last decade. Despite droughts, climate change, and increasing competition from invasive plants, sagebrush steppe species are proving to be resilient in the park. This resiliency also benefits park wildlife that depend on sagebrush steppe habitats. Park biologists developed a management strategy that protects the core areas of intact sagebrush habitat. Dominant plant species in Grand Teton sagebrush steppe include mountain big sagebrush (*Artemisia tridentata vaseyana*), buckwheat (*Eriogonum spp*.), antelope bitterbrush (*Purshia tridentata*), and bluebunch wheatgrass (*Pseudoroegneria spicata*). The intact sites also have high cover of native forbs (wildflowers, 30%), native grasses (18%), native shrubs (27%) and minimal cover of nonnative species (1.1%). The prevalence of nonnative species is increasing slightly, but at a rate of less than one percent over the last decade.

In restored sites, native grasses are establishing well, comprising 30% cover. However, the representation of cover by native forbs (6%) and shrubs (2%) is lower than in the intact sagebrush sites. Biologists found most nonnative species in the restored sites are short-lived annuals taking advantage of open ground exposed by disturbance that will be out competed by native species and disappear as the seeded plants establish. Monitoring park restoration units is important for adaptive management; comparing differences between the intact and restoration sites allows park staff to modify their restoration strategies. For example, in response to trends noted in restoration plots, park vegetation biologists started increasing the percentage of forbs in their seed mixes and using more container plants. The sagebrush monitoring program provides concrete goals for restoration work and protecting intact ecosystems.

Biologists monitor sagebrush health and growth using transects.



Map of Grand Teton National Park identifying the areas of core sagebrush habitat (dark green) and areas for growth opportunity (light green). Data source NPD, USGS, & ESRI.

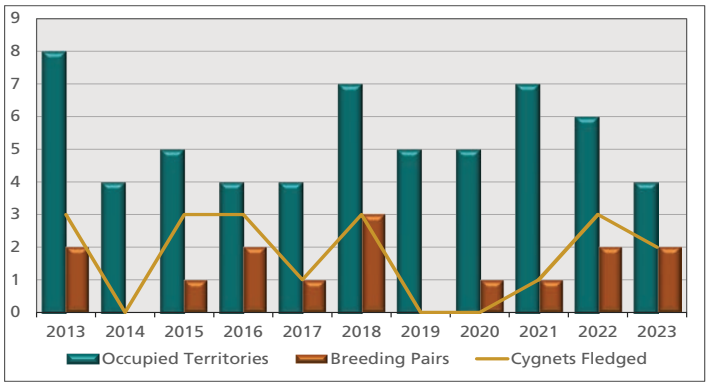
Trumpeter Swans

Nearly extirpated 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 Greater Yellowstone Ecosystem and surrounding areas in MT, ID, and WY. Many factors likely inhibit recovery, including competition with migratory swans, marginal winter range, variable reproduction rates, limited nesting habitat, and high cygnet mortality. Monitored since 1987, Grand Teton National Park provides important nesting and foraging habitat for swans. The number of occupied swan sites, nesting pairs, and young hatched and fledged has fluctuated widely since monitoring began. Swan pairs abandoned some traditional park nesting sites, which could be attributed to predation, increased human activity, or decreased water levels due to drought and hydrologic changes. Biologists primarily use spring and fall aerial surveys to monitor trumpeter swans.

During the 2023 breeding season, due to heavy snowpack and spring rains, water was plentiful, Jackson Lake Reservoir was full, and most smaller ponds had water throughout the summer. A total of four territories were occupied by swans within Grand Teton National Park and John D. Rockefeller, Jr. Memorial Parkway in 2023. Swans occupied two of the territories in the spring but did not initiate nesting: Glade Creek slough and Elk Ranch Reservoir. Swans at Hedrick Pond and Swan Lake both initiated nesting, but only the Swan Lake pair was successful, fledging two cygnets. Interestingly, two cygnets (presumably from Hedrick Pond) were found abandoned near Cunningham Cabin on July 2nd and were rescued and brought to a rehabilitation facility run by the Wyoming Wetlands Society. One of these cygnets survived and was released back into the wild in September.

Two cygnets fledging in 2023 is consistent with the ten-year average of 1.73. Over the past ten years, the number of occupied territories in the park has consistently hovered around 5.5

Trumpeter swans are the largest waterfowl in North America with a wing span that averages 8 feet. Larger males can have wingspans of 10 feet.



Trumpeter swan productivity in Grand Teton over the last ten years.

territories with 1.3 breeding pairs nesting in the park. In addition to territories monitored within the park boundary, park biologists monitor an additional territory outside of the park, Pinto Pond. Swans occupied the Pinto Pond territory and successfully produced three cygnets in 2023. Data collected from Pinto Pond is not reflected in park statistics.

At Elk Ranch Reservoir, a pair of adult swans was observed, but there was no sign of nesting activity at the provided nesting platform. The swan nesting platform was installed in 2020 through a partnership with the Wyoming Wetland's Society and Wyoming Game and Fish Department to mitigate the effects of fluctuating water levels within the reservoir on nesting swans improving chances of reproductive success. Despite maintaining the nesting platform, biologists observed no nesting activity in 2022 or 2023.

Trumpeter swans are known to be sensitive to human disturbance; these disturbances may be attributed to the abandonment of historic nesting territories. After observing nest initiation at Swan Lake in 2023, biologists placed a closure to protect those trumpeters from disturbance during the sensitive cygnet-rearing phase and lifted it once the cygnets fledged. Biologists also placed closures at Hedrick Pond and Elk Ranch Reservoir after adult swans were initially observed. Those closures were removed when no nesting activity was initiated, or the nest failed.

On late September observation flights, biologists spotted 16 swans in the park and adjacent lands. Two adult swans were still on Elk Ranch Reservoir. Both the Swan Lake and Pinto Pond pairs remained on their territories with 2 cygnets each. All other swans were observed on Jackson Lake.

	2023	10-Year Average
Occupied Territories	4	5.36
Total Adults	11	19.82
Breeding Pairs	2	1.36
Pairs with Cygnets	1	0.91
Percent Pairs Successful	25%	67%
Cygnets Fledged	2	1.73
Cygnets Fledged per Productive Pair	2	1.90

Ten-year averages for swans monitored by Grand Teton biologists.

Whitebark Pine

Whitebark pine (*Pinus albicaulis*) is a slow growing, long-lived, five-needle 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, whitebark pine plays a significantly greater ecological role disproportionate to its abundance, because it influences biodiversity, forest structure, and ecological function. These trees maintain surface and groundwater availability by trapping snow, promoting snowdrift retention, protracting snow melt, and preventing erosion of steep sites. Whitebark pine also produces seeds that are an important food source for wildlife such as Clark's nutcrackers, grizzly and black bears, squirrels, and other species.

In December of 2022, whitebark pine was listed as a threatened species under the Endangered Species Act due to declines range wide. In the past two decades, whitebark pine has experienced severe overstory mortality due to an unprecedented epidemic of native mountain pine beetle (MPB), nonnative white pine blister rust, increased wildfire, and climate change.

Grand Teton ecologists actively collaborate with the Whitebark Pine Subcommittee of the Greater Yellowstone Coordinating Committee and land managers across the Greater Yellowstone Ecosystem (GYE) to protect and restore whitebark pine. For over two decades, they have identified and promoted rust-resistant trees and safeguarded high-value individuals from MPB infestations. Their work emphasizes the critical role of ecological expertise and collaboration in conservation efforts.

In the fall of 2023, Grand Teton vegetation staff launched a new project to further whitebark pine conservation through restoration. Building on a pilot planting study conducted in the park a decade ago, this initiative marks the first step in an intensive planting effort to restore whitebark to the park. The team planted 1,334 whitebark pine seed caches across six acres, experimenting with the cache placement and recording features like rocks, trees, and logs along with age of the seeds and cache density. They plan to monitor these sites to assess germination rates and pilfering by seed predators.

Additionally, park staff contracted for 4,000 rust-resistant seedlings to be grown in a nursery for planting in 2025. Grand Teton biologists are also collaborating with American Forests staff on a direct seeding study. The park plans to perform another round of direct seeding in 2024 as well as ordering more seedlings. The direct seeding method is less conventional than planting seedlings but if successful, would benefit the restoration effort especially in remote, rugged terrain preferred by whitebark. Carrying seed and small tools is easier than transporting seedlings and their planting equipment. Digging in rocky soils can be difficult limiting seedling placement whereas a seed cache needs only to be planted one inch deep.

Vegetation biologists track and record details of their direct seeding project.

G. Winston

A healthy whitebark stand provides habitat and essential food to several iconic animal species like Clark's nutcrackers and grizzly bears.

Concurrently with restoration efforts, it is critically important that park staff continue to protect mature rust-resistant trees from beetle attack. These trees provide natural regeneration and continue to be a source of seed for ongoing restoration projects, tree improvement programs, and genetic studies. Biologists from the Northern Rockies Conservation Cooperative, a park partner, placed verbenone packets on rust-resistant trees to deter mountain pine beetle attack and began a pilot project to strip bark from brood trees (trees currently hosting an infestation of pinebark beetles) to reduce beetle spread to adjacent trees.

Grand Teton biologists collaborate with the NPS Inventory and Monitoring Program staff on monitoring whitebark condition, mortality, and regeneration in the park and across the GYE. An exciting water balance model developed by Inventory and Monitoring staff will help Grand Teton managers determine suitable planting sites in current and future climates—a critical factor in optimizing planting success.

Conserving and restoring whitebark pine is crucial to preserving the resilience, health, and the integrity of these high-elevation ecosystems. Conservation of this slow-growing, long-lived species requires protecting the precious remaining healthy trees with verbenone to deter beetle infestations, collecting seeds for replanting, promoting genetic and physiological health, and continued monitoring. Conservation and restoration of whitebark must be a priority now to protect the persistence of the species.

Historic Structures & Cultural Landscapes

Cultural landscapes are historically significant areas that reflect human interaction with the physical environment, including the natural and modified ecology of the area. These landscapes usually retain features that demonstrate human modifications due to settlement. The park seeks to identify and record cultural landscapes to comply with regulations, but also use this information to share with the public and to adequately protect these physical assets and resources. Park staff and contracted researchers develop detailed reports like Cultural Landscape Inventories, and Cultural Landscape Reports that assist park managers in making wise decisions about historic properties and cultural landscapes.

One recently completed report is the Cultural Landscape Inventory of Jenny Lake Lodge that will guide park cultural resource managers in making decisions about the property. This inventory analyzes and evaluates the property's landscape within the context of its history. The document provides a detailed timeline of property development including historic photographs to show changes over time. Landscape characteristics analyzed include natural systems and features, topography, spatial organization, land use, circulation, vegetation, buildings and structures, views and vistas, small scale features, and archeological sites. The document also discusses the condition of resources with some basic treatment recommendations.

Cultural Landscape Reports are planning documents that are usually written after an inventory is completed and include an update to inventory items as well as detailed treatment recommendations that factor in park management concerns, treatment approaches to avoid damage to the cultural landscape and both general and specific resources. In 2023 park staff contracted with outside researchers to complete the 4 Lazy F Ranch Cultural Landscape Report. This document will be used to guide park staff throughout the planned rehabilitation of the ranch to provide seasonal park housing. Using this document to guide the updates ensures that the significant resources of the ranch continue to reflect and retain the integrity of the ranch's history as a family vacation ranch throughout the project.

H. Crandall/GTLC

Expansion of the main building at Jenny Lake Lodge in 1947. It is important to keep a record of how the historic buildings in the park are modified over time.

These Cultural Landscape Inventories and Reports, as well as National Register Nominations, Historic Resource Studies, and Historic Structure Reports are generally public documents and are available for widespread use after their completion. Documents can be found through an internet search of the NPS Integrated Resource Management Applications (IRMA) website at irma.nps.gov, searching by park or by specific property.

Preserving historic buildings take continual maintenance with both large and small repairs. In 2009 the barn at 4 Lazy F required new footings and replacement of some of the lower logs. More recently in 2022, the roof was fully replaced.

Studying Animal Dens

Dens provide a critical source of cover for numerous wildlife species, including grizzly and black bears, wolves, beavers, squirrels, and chipmunks. Dens provide thermal protection during inhospitable winter conditions, protect animals from predators, and serve as a birthing chamber for offspring. Dens are constructed in various ways from excavated underground burrows to using natural rock cavities or hollow trees.

Historically, wildlife biologists analyzed den characteristics by physical measurements, such as entrance width and height, chamber width and height, and total length of the structure. Other site metrics might include the topography, vegetation, and soil type within and surrounding the den site.

In 2022 park wildlife staff began exploring the effectiveness of Light Detection and Ranging (LiDAR) technology to quantify den structure. A LiDAR sensor emits rapid laser pulses, which then bounce back to the sensor after striking the surface of an object. By calculating the time it takes for the laser pulses to return, the LiDAR sensor determines the distance traveled and uses this data to construct a point cloud of the scanned surface. The resulting point cloud is then processed to create a three-dimensional model. LiDAR technology has become widespread with applications including self-driving cars, archeology surveys, agriculture and forestry management, and landscape mapping.

J. Hadley

A scientist maps the measurements of an empty den using a LiDAR application on a portable computer.

Using the LiDAR sensor onboard an Apple iPad Pro, park biologists scanned the interior of bear and wolf dens to generate three-dimensional models of each den. These models allow researchers to calculate den measurements and volume in more efficient and consistent ways compared to physically measuring a den. The difference in measurements between LiDAR-generated models and physical measurements in the field was less than 2% with the LiDAR output providing much greater flexibility.

Many dens are temporary structures that may last only one denning season with structural integrity often compromised after an animal vacates. Using LiDAR, researchers can digitally archive three-dimensional models for future studies related to den structure. Future research using LiDAR technology may also help answer questions about thermodynamics related to den site selection and construction.

Scientists can map a den using LiDAR imaging—a laser scan that returns information in a collection of data points that represent a three-dimensional object or shape in space. This point cloud can then be used to construct a model of the den. This series shows an actual den that was scanned, the resulting point cloud, and the three-dimensional model of the den.

Aquatic Invasive Species

Aquatic invasive species (AIS) are aquatic organisms that are not native in a particular water body. These species vary in size and type and are most often, but not solely, introduced to a new watershed via watercraft or human activity. Once introduced, many species will thrive without the presence of their natural predators or competitors. This can result in major alterations to native ecosystems, and in some cases adversely affect recreation, water utilization, and the local economy. A few examples of invasive species that biologists want to prevent spreading to 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 that are increasing their range in the western US during the last 10–20 years. Fortunately, these nonnative mussels have not yet been found in the park or parkway as they are known to be particularly damaging to the water infrastructure and ecology after becoming established.

The park has enacted measures to prevent the introduction of AIS consistent with standards set by multi-agency guidance like the Western Regional Panel on AIS. Preventative actions include inspecting watercraft and educating boaters and visitors about diligence to prevent further spread. In 2023 the park had watercraft inspection stations at two locations. They operated daily during prime visitation periods. Crews inspected 21,848 watercraft passing through the stations. Staff conducted 28 decontaminations on suspect watercraft to minimize the risk of AIS introduction.

In the fall of 2023, a single adult quagga mussel was found in the Snake River near Twin Falls, Idaho. Idaho State Department of Agriculture biologists responded by treating that stretch of the river with two 96-hour chemical treatments. This response cost an estimated $3 million. State biologists will follow up with continued monitoring and subsequent treatments. Quagga mussel biological activity is reduced in cold water temperatures making detection difficult during winter months.

Boaters and owners of any type of watercraft, including paddleboards, can help prevent AIS introductions and speed inspections by ensuring they drain, clean, and dry their watercrafts and gear after every use.

Granite Supplemental Ditch

Irrigation ditches draw from several drainages in the park for agricultural purposes within or adjacent to the park. Water drawn from these streams can trap fish in the ditches which can result in their death. The Granite Supplemental Ditch draws water from the Snake River (10%–15% of the flow at the point of diversion) to irrigate lands in the "West Bank" region of Jackson Hole. This large ditch traps fish throughout the season. Additionally, this ditch intersects two perennial park streams. To understand the effects of this ditch on fish, park fisheries staff teamed with the Wyoming Game and Fish Department and Trout Unlimited to implant transmitters in 45 adult cutthroat in 2017–2018 to monitor their movement. Data analysis suggests that the mortality rate for trout is up to 73% after entering the ditch. High numbers of other fish species also get stranded in this ditch and are often less capable of escaping the high water velocities at the headgates, likely resulting in even higher mortality rates.

In 2019 and 2020, park staff worked to quantify the number of fish entering the ditch during the summer. Using nets on the downstream end of the headgate culverts, biologists identified, measured, and counted fish entering the ditch. Biologists used the data to estimate the number of fish entering the ditch throughout the irrigation season. Data showed that more than 50,000 fish enter the ditch each summer, about a third of which are cutthroat.

The Snake River's stream bed elevation has dropped since the installation of the headgate several decades ago increasing the maintenance needed to keep water flowing into the headgate. In 2018 water right holders commissioned a redesign of the headgate structure to support both water delivery and fish passage. When the new headgate is installed, resource managers plan to study fish movement and use of the structure. This information will shed light on fish population dynamics and inform further fish management options.

Biologists place nets on the Granite Ditch headgates to capture, count, and measure fish being swept into the irrigation diversion.

Chronic Wasting Disease

Chronic wasting disease (CWD) is a naturally occurring prion disease of cervids (species in the deer family). The disease attacks the brain causing animals to become emaciated, display abnormal behavior and poor coordination, and eventually die. Since the 1967 discovery of CWD in a captive mule deer herd in Colorado, the disease has spread geographically and increased in prevalence. CWD is currently found across the majority of Wyoming and continues to expand westward. The spread of CWD in elk generally lags behind deer.

CWD spreads through direct contact between free-ranging animals, through movements of captive animals between fenced facilities (and occasionally via escaped animals from captive facilities), or infrequently as a result of spontaneous protein misfolding. Animal-to-animal transmission is likely a primary means of disease transmission early in an outbreak. CWD also spreads indirectly via prions on the landscape shed in feces, urine, and saliva, as well as decomposing carcasses. Scientist have found prions in plant tissues, suggesting that plant material may serve as an environmental reservoir in addition to soils. Prions are highly resistant to decomposition in the environment and may persist and remain infectious for many years.

In November of 2018, a sample collected in the park from an adult male mule deer tested positive for CWD, marking the first detection of CWD in Grand Teton National Park and Teton County. In response, park biologists completed a CWD Action Plan to address and manage the disease including enhancing surveillance efforts, minimizing disease spread, conducting applied research, and increasing communication and outreach efforts. One action identified to limit disease spread was to hold and test deer carcasses before disposing of them. In 2020 the Grand Teton National Park Foundation aided the park by buying a freezer specifically for this use. Park staff use the walk-in freezer, to store mule deer and white-tailed deer carcasses while test results are pending. To enhance surveillance efforts, the park initiated mandatory CWD testing of all hunter-harvested elk during the Elk Reduction Program in 2019. Intensified sampling continued in 2023.

Chronic wasting disease is 100% fatal and has an extended incubation period averaging 18–24 months between infection and the onset of noticeable signs. During the incubation period animals may look and act normal, but slowly, signs of the disease may develop, including dramatic weight loss, impaired coordination, stumbling, drooling, excessive thirst or urination, and aggression.

In 2023, 54 samples were sent to the laboratory for testing: 38 from road-killed cervids, 11 from hunter harvested elk, and 5 from other mortalities. Of those samples, 33 were collected from elk, 20 from mule deer, 0 from white-tailed deer, and 1 from a moose. All samples came back negative for CWD. Jackson elk herd managers have been intensively sampling the elk herd for more than a decade. The fact that only one elk in the park has tested positive (in 2020) for the disease suggests that CWD is likely present at a low prevalence. Recent modeling suggests that CWD will probably result in a decline in elk numbers over time, particularly as disease prevalence increases.

Elk Reduction Program

In the late 1800s, elk populations across North America were being hunted to extirpation. During this time, Jackson Hole, home to one of the largest concentrations of elk on the continent, also experienced development and land use changes that reduced access for elk to native winter range. Severe winters in the valley in the late 1800s and early 1900s made foraging difficult and substantial die-offs occurred in the Jackson elk herd. In response, local conservationists acted to create a supplemental feeding program in 1910 and Congress created the National Elk Refuge (NER) in 1912 to protect remaining elk wintering grounds. These efforts allowed the Jackson elk herd to grow significantly. The unnatural concentration of elk stemming from the feeding program has consequences including impacts to other species and habitat quality as well as increased mortality rates and increased potential for disease outbreaks in elk.

The legislation that expanded Grand Teton National Park in 1950 included a provision for controlled reduction of elk in the park, when necessary, for proper management and protection of the elk herd. Management of elk in the park and on the NER is also 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 the 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 that are reflective of an unhunted population. It projected that roughly 1,600 elk would summer in the park given plan implementation. Also outlined in the BEMP is a strategy to restore previously cultivated lands in the park to improve habitat condition on elk winter and transitional range. Additionally, the plan calls for a phased transition from supplemental feeding on the NER to encourage greater reliance on natural forage and reduce the risk of disease transmission.

The need for the Elk Reduction Program (ERP) is evaluated and determined jointly by Grand Teton and WGF staff on an annual basis, based on data collected during the previous year mid-summer classification count in the park and the mid-winter trend count that includes elk wintering outside of the park. The long-term goal is to reduce the need to harvest elk in Grand Teton National Park.

The 2023 mid-winter trend count was 10,064 elk and the three-year running average 10,618, which the WGF considers at objective (± 20%). The trend is stable; however, elk wintering on the refuge number well above the 5,000 elk objective. The mid-winter calf ratio, which is strongly tied to the level of population growth, was 22 calves per 100 cows. With the trend for the Jackson elk herd stable, antlerless harvest in 2023 was intended to slow herd growth.

The winter of 2022 to 2023 was severe with record-breaking snowfall, cold temperatures, and a snowpack that persisted well into the spring. The combination of a severe winter with higher overwinter mortality than typical and fewer elk counted during the mid-winter survey resulted in biologists recommending

G. Winston

Park managers use the Elk Reduction Program to ethically manage the herd and avoid excessive winterkill caused by too many animals for the available forage.

significantly fewer permits for the 2023 ERP; 40 permits were authorized in Hunt Area (75) compared to 475 in 2022. In addition to population counts, the number of permits issued annually is based on harvest success (a running average of the percentage of elk harvested to the permits issued). Hunters that filled their permits during the 2023 ERP came from 2 different states; the majority were from Wyoming (90%) and 10% from other states. The ERP was structured similarly to the last two seasons with no permits offered in HA 79. The productivity of the northern migratory segment of the elk herd is lower compared to more southern residents. The reduction in hunting pressure on antlerless elk in HA 79 is consistent with management objectives in adjacent hunt areas 70 and 71 (Teton Wilderness).

The 2023 ERP was conducted for 23 days, November 18th–December 10th, with the Antelope Flats section of HA 75 closed all season. Elk migration to the NER was late in 2023 due to mild fall conditions and little significant snowfall. Ninety percent of the harvest occurred during the last week of the season. A total of 11 elk were harvested, a considerable decrease compared to 134 harvested in 2022. All but one elk harvested were adult cows (90%) with a single calf.

The high concentration of elk wintering on the NER increases the risk for major disease outbreaks. In recent years, the ERP in the park has provided an opportunity for monitoring disease in the Jackson elk herd. Grand Teton's Chronic Wasting Disease (CWD) Action Plan mandates that hunters must turn in harvested elk heads for surveillance testing. Retropharyngeal lymph nodes are collected for testing at a Wyoming Wildlife Health Laboratory. During the 2023 hunt, none of the 11 samples tested were positive for CWD. In the park's history, only one elk has tested positive for CWD, detected in 2020 during the ERP surveillance testing. (Since 2018, three deer in the park have tested positive for CWD; all three were found dead and tested as part of the park's targeted surveillance program.) Although the detection of CWD in the Jackson Elk herd is low, CWD is a significant management concern as prevalence is projected to increase over time.

Human-Bear Interface

Grand Teton National Park and the John D. Rockefeller, Jr. Memorial Parkway provide ideal habitat for free-ranging black and grizzly bears. Grand Teton receives more than three million recreational visitors per year. The consistently high levels of human recreation in bear habitat creates a high potential for human-bear interactions. To reduce the potential for conflicts, park staff focus on preventative education and proactive management including educating visitors on safe recreation in bear country, enforcing food storage regulations, installing bear-resistant infrastructure, and temporarily closing areas with high bear activity. A central theme in all these efforts is keeping attractants away from bears. Since 2008 the park with generous support from the Grand Teton National Park Foundation installed 1,069 modern bear-resistant food storage lockers in campgrounds and other popular areas, providing visitors with the necessary infrastructure to secure attractants.

Park staff annually monitor human-bear confrontations and conflicts to analyze trends and adapt management strategies. A confrontation occurs when a bear enters a developed area or campsite without receiving food, or approaches, follows, or charges people without inflicting injury. In contrast, human-bear conflicts involve bears obtaining human foods, damaging property, or injuring humans. In 2023, there were 152 human-black bear confrontations and 14 human-grizzly bear confrontations, primarily involving bears passing through developed areas while foraging for natural foods. In five confrontations bear spray was deployed; however, park staff have noted a concerning increase of unwarranted use of bear spray in situations where the bear posed no threat to human safety. In many of these cases, the bear was simply walking or foraging near a hiking trail without displaying aggressive behavior. Biologists advise using bear spray only as a last line of defense when a bear is actively charging. Additionally, there were twelve human-bear conflicts. All but one involved black bears: 4 obtained human foods, 6 caused property damage, and 1 consumed garbage. Many human-black bear conflicts continue to occur along lakeshores when visitors leave backpacks and other items to swim or wade. Park staff are implementing new strategies to educate lakeshore users on the importance of securing attractants and ensuring someone is always present to monitor their belongings. The sole grizzly bear conflict involved a visitor throwing an apple from a car toward a grizzly sow with three yearlings—one bear reportedly consumed the fruit. Park staff increased monitoring of the bear family, concluding that no further action was necessary.

Grand Teton staff work diligently to prevent bears from developing nuisance behaviors. When humans fail to secure their food, bears can become food-conditioned and exhibit dangerous behaviors. In 2023 trained park staff hazed bears 84 times from developed areas and roadways using tools like vehicle threat pressure, noise deterrents, and bean bag rounds. One black bear exhibiting bold behavior (e.g., investigating picnic tables, lingering in developed areas, etc.) near Jenny and String Lakes was proactively relocated to a less human-dominated area to enhance its chances for long-term survival.

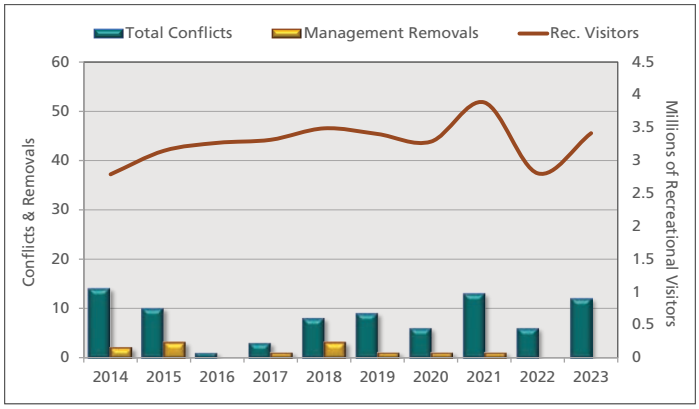
G. Winston

Park motorists can be a substantial hazard to bears accessing natural habitat.

To further minimize human-bear conflicts, park managers implement temporary area closures to protect high-use bear habitat and to ensure human safety. In addition to annual closures (motorized use of Grassy Lake Road April 1–May 31 and public entry on Willow Flats May 15–July 15), ten short-term closures were enacted to reduce disturbances around important natural foods or to protect visitor safety around ungulate carcasses.

Since 2007 the Wildlife Brigade has managed the human-wildlife interface in Grand Teton by facilitating safe wildlife viewing opportunities, patrolling developed areas for unsecured attractants, and educating visitors about bear safety. In 2023 the team was composed of a permanent bear biologist, two seasonal wildlife management rangers, and 33 volunteers. Wildlife brigade staff responded to a minimum of 790 wildlife jams: 269 for grizzly bears, 262 for black bears, 6 for bears of unknown species, 154 for moose, and 99 for other species (e.g., elk, red fox, and owls). Team volunteers collectively contributed 12,555 hours to bear conservation and wildlife management efforts.

In 2023 park staff recorded six motor vehicle collisions all involving black bears with two known mortalities and another likely. Park staff could not confirm a collision, but a grizzly bear was displaying signs of an injury near Highway 26 leading biologists to question if a collision had occurred. The bear survived. While the long-term average of bear-vehicle collisions from 1991 to 2023 is three collisions annually, 2023's count of six is close to 2016 and 2021 totals of seven. However the highest annual total occurred in 2005, when eight bears were struck on park roadways.



Bears obtaining food rewards and causing property damage in Grand Teton.

CHALLENGES

Invasive Plants

Grand Teton National Park's vegetation staff dedicates significant resources to the treatment of invasive plants which are defined as those causing ecological or economic harm. State and local governments identify aggressive plant species that threaten agriculture, waterways, fish and wildlife, and public health. These invasive plants can outcompete native plants leading to reduced biodiversity and displacement of native plants that provide crucial food and shelter for wildlife. Some invasive plants can even alter ecosystem function, like cheatgrass that is linked to increased fire potential.

In 2023 park vegetation staff and their partners treated 3,840 acres of invasive plants, primarily through chemical control. The majority of treatments focused on *Centaurea maculosa* (spotted knapweed), *Carduus nutans* (musk thistle), and *Linaria vulgaris* (Yellow toadflax) on roadsides, pathways, trails, grazing allotments, and restoration sites. Species are prioritized based on their ecological threat level, potential to spread (e.g., along trails and roads), ability to control the population, and site-specific habitat importance. Effective treatment timing is species-dependent and critical for effective control. Vegetation biologists plan treatments during the optimal phenological window.

Invasive plants are increasingly difficult to treat as their populations grow and spread. Therefore, preventing new introductions or spread along with a robust Early Detection Rapid Response program represents the most cost-effective way to manage invasive plants. In 2023 park staff welcomed a specialized canine team trained to locate high-priority invasive species, like perennial pepperweed and salt cedar, bolstering eradication efforts in the Snake River corridor.

A UTV mounted sprayer aids in invasive plant control work.

Collaboration played a key role in meeting treatment goals in 2023. Park staff worked alongside Wyoming Conservation Corps, American Conservation Experience, Utah Conservation Corps, Indigenous Grounds, Groundworks USA, and volunteers to meet the invasive plant treatment workload. Private contractors were hired to treat 1,700 acres in Antelope Flats restoration area, along roadsides, and in grazing allotments. Park concessioners (Grand Teton Lodge Company, Triangle X Ranch, and Signal Mountain Lodge) actively worked to minimize invasive plant species within their land assignments, treating 640 acres this year. Teton County Weed and Pest District and the Northern Rockies Invasive Plant Management Team also made substantial contributions in 2023, surveying and treating invasive species in Grand Teton National Park.

Sagebrush Restoration

Sagebrush steppe is a diverse plant community that covers about one-third of the park and much of the valley floor. It provides habitat for sage-grouse, bison, pronghorn, birds, insects, and many other wildlife species. Maintaining and restoring native sagebrush habitat is a high priority for park managers. Approximately 15% of the park's sagebrush steppe has been impacted by human activities over the past two hundred years. Park vegetation biologists work to restore impacted areas by surveying, mapping, and treating invasive plants; removing nonnative pasture grass; collecting and spreading native seed; and monitoring restoration effectiveness.

Vegetation staff with support from partners like the Grand Teton National Park Foundation are making progress on the long-term Antelope Flats Restoration Project aimed at restoring 4,500 acres of sagebrush steppe habitat that was converted for agricultural use at the turn of the 20th century prior to establishment of the park. Converting former hayfields from nonnative smooth brome pasture grass to native sagebrush habitat takes decades to achieve. In June 2023 vegetation staff completed the smooth brome (*Bromus inermis*) treatment across the remaining 14-acre Slough South section. Additionally, vegetation crews began restoration work on a new 26-acre unit applying a herbicide treatment to kill smooth brome. They will repeat the herbicide treatment in spring 2024 before seeding and planting in the fall. Biologists also conducted invasive plant treatments in the previously restored units to encourage native plant growth.

In the fall of 2023, vegetation staff completed seeding across 16 acres of Slough South. Vegetation crews sowed native seed using vehicle-mounted seed drills, and—with the help of youth conservation crews—hand seeded areas of difficult terrain where machinery could not be used. Recent research by the University of Wyoming and park ecologists showed that previous restoration sites had lower forb (wildflower) and shrub cover and diversity than management objectives. In response, biologists incorporated shrub and forb plantings into the restoration plan, contracting a restoration company to plant over 7,000 container-established plants in the Slough South unit in late fall.

In further research collaboration with the University of Wyoming, park ecologists will test two new seed mixes and soil tilling versus no tilling in plots at the Slough South unit. Ecologists will collect data on plant species abundance in the study plots in 2024. The University will also study soil microbial communities and test whether native soil microorganisms influence native plant growth in a greenhouse. Park vegetation managers will apply the findings to future restoration techniques and seed mixes in hopes of increasing seed germination and plant growth while promoting a healthier sagebrush ecosystem.

Kelly Warm Spring

Kelly Warm Spring is a thermal feature that has a long history of aquarium dumping leading to the proliferation of nonnative species in the spring. Nonnatives persisted throughout the warm spring effluent and in 2012 biologists found three of the nonative species in Ditch Creek, some within ten yards of the Snake River—goldfish (*Carassius auratus*), American bullfrogs (*Lithobates catebeianus*), and tadpole madtoms (*Notorus gyrinus*).

American bullfrogs possess a wide latitudinal native range and were likely introduced to the spring in the 1950s. The bullfrog is implicated in declines of native amphibian populations throughout the world due to both direct and indirect factors. In Grand Teton National Park, native amphibians are nearly absent in the bullfrog's occupied range. In recent surveys, biologists only documented a couple western toads, a native species on the decline regionally, on the periphery of bullfrog inhabited waters. A two-year NPS study of fall movements and over-wintering habitat found American bullfrogs made more upstream movements than downstream movements with 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 during this period.

After several years of environmental analysis, park resource managers moved forward with a plan to restore Kelly Warm Spring's native fish assemblage. Park staff with vital assistance from Wyoming Game and Fish Department personnel used rotenone, a chemical lethal to organisms with gills, to treat the nonnative infested spring and its effluent in 2018. The treatment successfully reduced the quantity of invasive species in the spring but failed to remove all nonnative fish present, a necessary first step in restoring a native assemblage to the spring. The control action was an important step in improving the condition of Kelly Warm Spring, but more restoration efforts will be required.

Remnant ditches that once irrigated hayfields near Kelly Warm Spring are used to limit invasive species by dewatering the spring in winter.

Since the 2018 effort, fisheries biologists have continued to develop strategies to efficiently remove invasive species while minimizing collateral impacts. In 2023 fisheries staff used an antiquated irrigation ditch near the warm spring's pond to dewater large portions of the spring's effluent in winter. This effectively reduces fish numbers without using chemicals and lowers the risk of invasive fish increasing their range. Grand Teton biologists also continued studying bullfrog life histories, beyond fall migrations to inform a bullfrog removal plan. Other national parks and agencies in the western US have successfully extirpated nonnative bullfrogs by targeting adults and egg masses. Park biologists are exploring these methods for removal of nonnatives from Kelly Warm Spring.

Restoring Ditch Creek

Ditch Creek flows out of the Gros Ventre Mountains, through Antelope Flats to meet the Snake River about a mile north of Moose. The creek is inhabited by several species of spawning fish including Snake River fine-spotted cutthroat trout, bluehead sucker (categorized as extremely rare by Wyoming Game and Fish), Utah and mountain sucker, and other small-bodied native fish species.

Settlers started manipulating the stream's 9.4-square mile alluvial fan on Antelope Flats in the early 1900s, adding 150 miles of irrigation ditches and channelizing the stream to better facilitate agriculture. In 1957 and 1960 two bridges with culverts were installed across the stream that became barriers preventing upstream access to spawning habitat. In 2012 and 2014, park staff installed baffles in the culverts to improve fish passage.

The terraced nature of the terrain combined with a snowmelt dominated hydrological regime causes both aggrading and degrading of the streambed, and results in a frequently shifting stream channel. In 2014 the stream channel moved west of the Mormon Row Road sending water into the antiquated irrigation ditches, creating a new series of obstacles incompatible with fish passage.

After analyzing the options to restore Ditch Creek's streamflow, the park partnered with Grand Teton National Park Foundation, One Fly, and Patagonia to remove the aggraded material and reconnected the primary channel for fish passage upstream. Starting in spring of 2018, fish from the Snake River could access more than 23 miles of the stream's headwaters for the first time in nearly six decades.

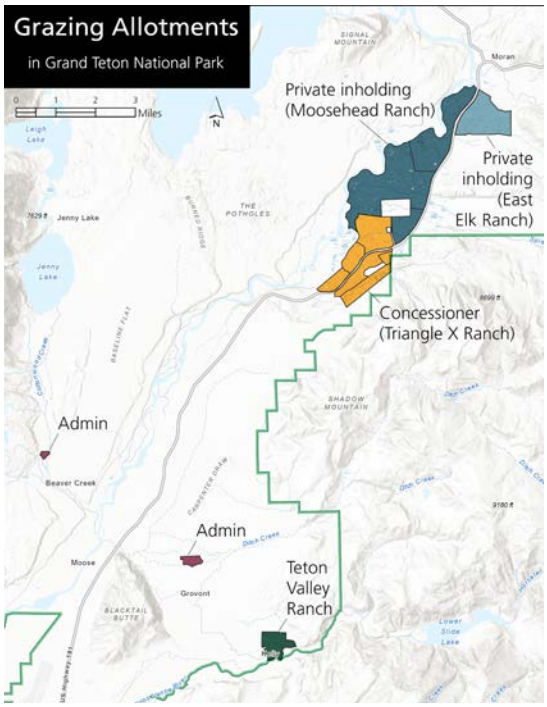
Since a similar avulsion event occurred in the same gradient inflection point in 1998 and is expected to reoccur in the future, park biologists used this reconnection to study what portions of Ditch Creek are most important to fish to inform future management decisions when the stream shifts again. To accomplish this, biologists captured and inserted Passive Integrated Transponder (PIT) tags into 192 fish (Snake River fine-spotted cutthroat trout, bluehead suckers, mountain suckers, and Utah suckers) from 2016 to 2023. Researchers installed antennas to record the tagged fish swimming past the former barriers. Biologists found that fish use the habitat upstream of the first culvert regularly and some are passing through the second culvert to use stream reaches east of the Mormon Row Road crossing.

By reconnecting upstream habitat on a tributary of the Snake River to the mainstream, fishery staff increased the resiliency of the native fishery and restored ecological function.

Livestock Grazing

Grand Teton National Park manages five active grazing allotments, including one for its backcountry pack stock. The park's expansion in 1950 included provisions in the enabling legislation to retain grazing rights, preserving the open cultural landscape and traditions of Jackson Hole. Since then, grazing allotments have dwindled through retirement and acquisition. The number of grazed acres has decreased by nearly 89%, leaving around 5,000 acres of active pasture and rangeland. Domestic stock grazing occurs mainly from June to September; native wildlife also use the abundant forage during this period and at other times of the year.

Currently active allotments are grazed by local ranching families and the park itself. Moosehead Ranch, a private 120-acre inholding operating as a dude ranch, holds a special use permit to graze 64 horses and a commercial use agreement for trail rides on park lands. Pinto Ranch, another inholding, will resume grazing 300 Angus steers on the irrigated East Elk Ranch pasture in 2024 after 4 years of non-use due to COVID and needed infrastructure repairs. Triangle X Ranch, a park concessioner, operates a historic dude ranch within the park and grazes 120 horses in accordance with their concessions contract. Teton Valley Ranch holds an agricultural lease predating park expansion and uses their allotment to graze about 34 longhorn steers. The park also grazes 19 horses and mules to support backcountry operations.



Grazing allotments are part of the Jackson Hole ranching heritage included in the park's creation.

Park staff monitor and manage for rangeland health, collecting data annually since the 1950s. Range monitoring includes measuring forage production, quality, and use; noxious weed mapping; and infrastructure condition and impacts. Using these data, park staff assess rangeland health and collaborate with operators to adjust stocking rates, periods, and to some extent locations, ensuring adequate forage for livestock while minimizing impacts on wildlife and habitat. In 2023 construction began on a new fence around the Elk Ranch pasture to secure forage availability and reduce disease transmission between bison and cattle. Fence construction will be completed in spring 2024. Additionally, staff and partners treated noxious weeds across 1,600 acres of grazing allotments, with plans for continued treatments and a technical survey to assess range health in 2024 as part of a regional NPS program.

Mountain Goats

Mountain goats (*Oreamnos americanus*) are not native to the Greater Yellowstone Ecosystem. Observations of mountain goats in the Teton Range began in 1977, less than a decade after the Idaho Department of Fish and Game introduced about a dozen individuals from central Idaho to eastern Idaho's Snake River Range. Transplanting wildlife to create populations for the benefit of hunters was a common practice at the time. Until 2005 when a breeding population of mountain goats established itself in the Teton Range, observations of goats were sporadic and thought to represent transient individuals. Genetic evidence suggests that the Teton Range mountain goat population originated from the population of mountain goats introduced to the Snake River Range.

Mountain goats in the Snake River Range have tested positive for *Mycoplasma ovipneumoniae* (*M. Ovi*) a pathogen linked to pneumonia in bighorn sheep (*Ovis canadensis*). Pneumonia in bighorn sheep causes die-offs in all age groups followed by significant lamb mortality for varying lengths of time, sometimes decades. Pneumonia in bighorn sheep involves multiple bacterial pathogens that all play a role in the disease, but *M. Ovi*, appears to be necessary for persistent population level impacts. Although limited disease testing of Teton Range mountain goats has not documented the presence of *M. Ovi*, other pathogens were detected raising concerns that resident mountain goats or dispersing Snake River Range individuals could introduce pneumonia causing pathogens to bighorn sheep with devastating consequences. Competition for space and forage between mountain goats and bighorn sheep on limited winter range is also a concern.

In the fall of 2019, the National Park Service completed a Management Plan for removing mountain goats from Grand Teton National Park using lethal and non-lethal means. The plan and the associated Environmental Assessment identified the goal of removing the mountain goats as quickly as possible to minimize impacts to native species, ecological communities, and visitors. In 2018 biologists estimated the population at over 100 mountain goats in the Teton Range, mostly within the park.

National Park Service-led removal efforts began in February 2020, when a contract helicopter crew lethally removed 36 mountain goats from Cascade, Paintbrush, and Leigh Canyons in half a day. Following concerns raised by the Wyoming Game and Fish Commission and the Wyoming Governor to the Secretary of Interior, this operation shifted to a ground-based removal program using qualified volunteers starting that fall. Volunteers could retrieve edible meat from the culled animals whenever possible—an action authorized by the John D. Dingle Conservation, Management, and Recreation Act in 2019. Concurrent with the NPS efforts, Wyoming Game and Fish Department (WGF) increased mountain goat hunting licenses for the Teton Range outside Grand Teton National Park starting in 2019. The combination of aerial efforts, ground-based volunteers in the park, and WGF licensed hunters outside the park lethally removed 134 mountain goats from the Teton Range 2019–2021. Following the conclusion of the 2021 qualified volunteer program, the park carried out lethal aerial removal efforts in February 2022 and November 2023, culling 73 mountain goats from the park in close consultation with WGF. Most of these animals were culled from rugged, trail-less areas that were not covered in the 2020 aerial removal and were challenging for volunteers to access on foot. The total number of goats removed was a substantial portion of the estimated population. After this initial wide-scale removal effort, the park shifted to a rapid response method targeting remaining scattered individuals or family groups to minimize the potential for the mountain goat population to grow and reestablish.

Biologists estimate that 10–20 non-native mountain goats may remain in the Teton Range. However, due to their low density and the rugged, remote landscape they inhabit, obtaining an exact count is challenging. Because mountain goats can continue to move into the Tetons from nearby areas, management efforts will focus on keeping the mountain goat population to a level where impacts on the native bighorn sheep are minimal until more information can be assessed. Without ongoing efforts to suppress population growth, the nonnative mountain goat population is likely to grow and reestablish in size increasing the potential for catastrophic impacts on the native bighorn sheep population.

G. Winston

Mountain goats are not native to the Teton Range, but are well adapted to extreme environments.

G. Winston

Mountain goats use the same habitat as these bighorn sheep. Life at high elevation is already a challenge without the possible introduction of disease.

Native Plant Materials

Hand collection of native seed is time consuming but aids in restoration success.

Over 1,000 species of native plants grow in Grand Teton National Park, and each one has adapted over time to the specific environmental conditions. Research shows that using native plants that are adapted to the local environment results in greater restoration success. Grand Teton National Park's vegetation staff use native plant materials (seeds and live plants) that originate within the park boundaries for ecological restoration and rehabilitation projects. The native plant materials strategy includes hand collection of wild native seed, seed increase production, nursery plant propagation, and plant salvage. This strategy has evolved in recent years to include a wider representation of native forbs and shrubs for restoration sites. Forbs are herbaceous flowering plants–or wildflowers–that provide wildlife forage. Forbs also benefit pollinators and improve overall species diversity.

Hand-collecting native seed from wild plant populations is crucial for restoration efforts, helping to ensure the long-term survival of native plant species. Seed collectors follow strict protocols to prevent overharvesting, ensuring that source populations remain sustainable over the long term. In 2023, 724 bulk pounds of seed were collected in the park from 50 native plant species. Park vegetation biologists partnered with local community members and volunteers, engaging them in nine seed collection events. Volunteers collected 10% of the total seed collected in 2023. The vegetation staff also obtains native seed by seed increase (planting hand-collected seed in an agricultural field setting, and harvesting seed produced from those plants for several consecutive years). For example, five pounds of mountain brome grass seed is planted in a one-acre field which may produce more than 1,000 pounds of seed over five years. In 2023 contractors in Colorado and Idaho harvested over 700 pounds of native seed from seed increase fields, and five new fields will be planted by a grower in Washington state to further multiply the inventory of valuable forb species. Once vegetation staff acquire seed, they store it in a walk-in cooler to ensure it stays viable until it can be used. The park currently has 13,000 lbs of seed from 87 different species in the native seed inventory that will be used for ongoing and future restoration work.

Another important aspect of using native plant materials in restoration is propagating seedlings in a greenhouse. This method complements seeding efforts and enhances restoration success by promoting rapid plant establishment. In 2023 park ecologists partnered with the Grand Teton National Park Foundation to contract the grow out of 7,140 native plant seedlings from nine different species, which were planted to restore Antelope Flats sagebrush habitat. In 2024 the contractor will grow another 9,250 seedlings for sagebrush restoration. By diversifying the methods of producing and obtaining native plant materials, park vegetation staff can sustainably meet park project needs and enhance the success of ecological restoration efforts.

Post-construction Revegetation

Grand Teton National Park and the John D. Rockefeller, Jr. Memorial Parkway's revegetation program is a nexus between the visitor experience and natural resource protection. Improving facilities and maintaining infrastructure contribute to an enjoyable visit to the park, yet it is the scenery, wildlife, and recreation that draw visitors here. The revegetation staff balances these two needs by advising park managers in minimizing impacts to vegetation resources during the planning and design stages and by implementing high-quality vegetation restoration after construction to optimize habitat functionality and aesthetic appeal.

Well before the ground is broken on a project, park vegetation biologists collaborate with facility managers on resource assessments. The biologists suggest design modifications that reduce impacts on plant communities and support the greatest chance for revegetation success. They assess the planned disturbance areas to determine the quantity of native seed and native plants needed to revegetate the impacted area; and plan how to acquire the appropriate plant materials.

Park revegetation projects begin with hand-collected native seed. Park staff, seasonal conservation corps, and volunteers spend over a thousand hours every summer collecting seed in the park for these projects. Locally collected native seed is important for maintaining the ecological connections between plants, pollinators, and herbivores and for maximizing restoration success with seeds that are adapted to Grand Teton's long winters and harsh growing conditions. Vegetation crews use the collected seeds to grow seedlings in the park nursery or in a seed mix spread on the disturbed area. Reestablishing native plants stabilizes the soil, reduces erosion, prevents the spread of nonnative plants, and provide habitat for wildlife.

Vegetation staff rake in newly scattered native plant seed in a site disturbed by construction at Jackson Lake Dam.

In 2023 vegetation crews seeded 7.5 acres of post-construction disturbance at 25 different project sites. Notable projects include seeding disturbances at the Jackson Lake Dam boat launch improvement, the staging area near the Moose Post Office, the Moran water system replacement, and the Colter Bay lift station. In addition, crews planted 20 conifer trees at the Colter Bay Lift Station rehabilitation site. Park staff and conservation corps crews salvaged over 600 plants from areas slated for future construction. Park vegetation staff will care for the salvaged plants at the park nursery until they can be replanted either in their original project area or used to supplement revegetation efforts at nearby project sites.

Spread Creek

The 2010 removal of the diversion dam built on Spread Creek in the 1960s allowed fish to access 65 miles of upstream habitat; however, while the newly installed irrigation infrastructure facilitated upstream fish passage, it still entrapped some fish as they migrated downstream. The park partnered with the Wyoming Game and Fish Department, Trout Unlimited (TU), the Snake River Fund, and volunteers to help return 21–499 fish to Spread Creek annually, including 14–310 cutthroat trout between 2012 and 2022. Other notable species saved include the rare bluehead sucker.

Fish entrainment was not the only challenge experienced at the rebuilt structure. The structure is situated in a dynamic stretch of the stream—a canyon with erosive walls is upstream of the diversion; a slow-moving landslide is adjacent to the structure; and an expansive alluvial fan is downstream. Together these features create instability and design challenges for building a water diversion structure. Rock weirs, a channel spanning series of boulders, were placed when the structure was installed; however, after a few years the weirs deteriorated causing the streambed to drop in elevation. This degradation created a need for construction of a wing dike to direct water into the headgate of the diversion structure. These manipulations further changed stream dynamics directing fish to enter the irrigation infrastructure in even greater numbers.

After analyzing alternatives to address the suite of problems, the park and its partners commissioned the design of a more persistent stream gradient stabilization structure and a fish screen. A rock ramp and several smaller details were installed to fortify the stream gradient and steer the water's energy. Completed in 2021, the rocks of the ramp are laid over an extended stretch of the stream allowing them to lock together as opposed to moving when spring freshets race through the channel.

In the summer of 2022, the irrigation infrastructure was retrofitted with a fish screen. The screen structure conveys fish entering the headgate back into Spread Creek regardless of the amount of water drawn by right holders. Because streams carry a lot of material and debris in their flow, fish screens are difficult to engineer. Without the partnership and significant support from TU this improvement would not be possible. 2023 was the first full season with the updated infrastructure. All aspects of the redesign function as intended but require continued maintenance.

Trail Use & Pathway Use

The visitor monitoring program in Grand Teton National Park, led by the park social scientist, collects information about the use of park trails and pathways. Since 2009 there is generally an increasing trend in visitor use for trails leading to the backcountry. Infrared trail counters are installed at key locations throughout the park and estimate the number of visitors entering the backcountry via the trail system during the summer months (June–September). There are also counters located further into the backcountry. Trail counters count visitors traveling in both directions, and data is aggregated by the hour. Some trail counters are validated by comparing the counter-recorded visitor use and actual counts taken by a research technician; most counters have a low error rate.

Monitoring visitor use of the trail system gives insights on park visitor experiences. Trail counters indicate an overall increase in trail use on the nine trails monitored since 2008. Use on those trails increased 56% since monitoring began and 34% in the last ten years (since 2014).

In addition to trails, park staff monitor the multiuse pathway system within Grand Teton National Park. Construction on the first section of the paved pathway, between Moose and Jenny Lake, was completed in 2009. Completion of a second section of pathway along US Highway 89 between the park's south boundary and Moose followed in 2012. Starting in 2009 researchers installed infrared counters and trail cameras at key locations to understand the timing and volume of use, including potential effects on wildlife. In the summer of 2023, five infrared counters were installed along the pathway at the same locations used since 2012: Jenny Lake, north of Taggart parking, west of Dornan's, north of the airport, and south of Gros Ventre junction (from approximately June to August).

Park trails allow visitors to easily access natural areas away from the roads.

These counters provide an approximation of use and also batch the total number of users in one-hour periods. Counters cannot determine the direction a visitor is traveling or if one user is triggering multiple counters along the pathway (which is likely). Overall, there were a total of 62,483 detections on the five pathway counters between June and August of 2023. This is a 2% decrease in use over 2022. The temperature was below average and the precipitation was above average for June 2023 which may have influences pathway use.

Analysis of trail and pathway data helps park managers to better understand visitor use (including levels of use, timing of use, and distribution of use). This in turn aids park managers in decision making to meet the objectives of providing for visitor enjoyment while protecting park resources.

Visitor Use

Use of Grand Teton National Park and the John D. Rockefeller, Jr. Memorial Parkway is both a primary reason for their establishment and a factor influencing resource condition. Increases in visitation may affect natural and cultural resources, as well as the quality of visitor experiences. Some factors that may influence visitation to parks include economic conditions, natural disasters, weather, gasoline prices, and public health. Visitation to the park has ebbed and flowed throughout the years, but the current trend is increasing.

In 2023 the National Park Service reported a total of 325.5 million recreational visits, an increase of 13 million or 4% over 2022. Recreation visits are defined as visits where the visitor entered lands or water administered by the National Park Service to use the area (alternatively, examples of a non-recreation visit include commuters, employees going to work, access to inholdings).

Grand Teton National Park had over 3.4 million recreation visits in 2023, a 22% increase over 2022. Numbers for recreation visits in 2023 were similar to those in 2019 but the timing of the visitation was different. In 2019 the peak visitation months were June, July, and August while in 2023 the peak months shifted later to July, August, and September. Although there are no day-use limits, lodging and campgrounds in the park have limited space available for overnight stays. On most July and August nights, one or more forms of accommodation are full.

G. Winston

Park visitor centers are often an important stop for new visitors.

Grand Teton staff develop studies to better understand visitor use and experiences in the park. Across many studies over multiple years, the top motivation for visiting Grand Teton is to experience the scenery. When natural resources are impacted, visitors' experiences of those resources are impacted as well. Though crowding is the most-cited issue at key destinations, other problems that were reported by visitors included visible erosion and vegetation loss. These studies guide park managers in making wise management decisions.

Wildlife-Vehicle Collisions

The roadway network within Grand Teton National Park and the John D. Rockefeller, Jr. Memorial Parkway impacts wildlife in two significant ways. First, motor vehicles frequently collide with wildlife resulting in damage to vehicles, human injuries or fatalities, and death or injuries to wildlife. Second, roads can create barriers that hinder wildlife movement and fragment habitat. Maintaining connectivity and free movement of wildlife across the landscape is vital to sustaining populations of migratory and wide-ranging species. Therefore, understanding the effects of roads on wildlife and mitigating these impacts is essential to conservation.

Since 1991, park staff have recorded information on wildlife-vehicle collisions to track trends and analyze temporal and spatial patterns. Park managers use this information to guide decisions on mitigation measures that reduce collisions and improve road safety for both humans and wildlife.

In 2023, 143 collisions occurred involving 151 animals. Of these 78% 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. Most collisions (125) occurred during the snow-free months (May–Oct.) and peaked in July, the highest visitation month for both the park and parkway. A minimum of 27 species (18 mammals and 9 birds) were involved in collisions in 2023.

Most documented wildlife-vehicle collisions involve ungulates, hooved mammals—bison, deer, elk, moose, and pronghorn. In 2023, collisions for bison, moose, and pronghorn were below the five-year average, while those with deer and elk were slightly above. Currently, on average an ungulate is involved in a wildlife-vehicle collision in the park every five days. The total number of collisions involving ungulates has increased slowly over time. Numbers have fluctuated annually, with a peak of 112 ungulate-vehicle collisions documented in 2010 and lower numbers since then (75 in 2023). Elsewhere in the state ungulate collisions have increased at a much higher rate.

Over the last 5 years (2019-2023):

Total collisions with ungulates averaged 74 per year.

- Bison-collisions averaged 4 per year (5%).
- Deer-collisions averaged 32 per year (43%).
- Elk collisions averaged 23 per year (31%).
- Moose collisions average 4.8 per year (6%).
- Pronghorn collisions averaged 9.8 per year (13%)

Total collisions with mid- to large-sized carnivores averaged 11.6 per year.

- Bear-collisions (includes both black and grizzly bears) averaged 4.4 per year (38%).
- Coyote-collisions averaged 6.2 per year (53%).
- Wolf collisions averaged 1 per year (9%).

G. Winston

Most wildlife-vehicle collisions involve ungulates, like elk, and usually result in the death of the animal.

The number of collisions in the park involving bears, 7 in 2023, was above the five-year average, but collisions with other carnivores were below the long-term average. Since 1991 the annual number of collisions involving mid- to large-sized carnivores has more than doubled.

The distribution of wildlife-vehicle collisions is frequently clustered into hotspots or places where collision risks are elevated. Similarly, the timing of these collisions tends to occur at specific times of year that are related to animal characteristics or other factors like traffic volume. Overall, the greatest number of collisions occur in the summer months when park visitation is highest. The pattern for collisions with park ungulates is different from other parts of the state where ungulate collisions tend to be highest during migratory periods, fall breeding/hunting seasons, or when animals are on winter range.

Diurnal patterns of ungulate-vehicle collisions varied by species for incidents when time of the collision was known. Most collisions involving deer and antelope occurred during daylight hours, while those with bison, elk, and moose occurred under low light conditions either at night or during twilight hours.

Park managers implemented several mitigation measures in the last decade to address wildlife-vehicle collisions, including the permanent reduction in nighttime speed limit from 55 to 45 mph on Hwy. 89/191/26; continued use of variable message signs at strategic locations to inform drivers of current wildlife activity near roads; the installation of permanent digital speed readers at Moose Alley, Elk Ranch Flats, Snake River Hill, and the Gros Ventre River; and painting wider road surface lines to delineate narrower travel lanes that indirectly encourage motorists to follow designated speed limits.

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Back cover: Grand Teton and Teton Glacier by Greg Winston.