National Park Service
U.S. Department of the Interior
Yellowstone National Park

Yellowstone National Park

Superintendent's 2008 Report on Natural Resource Vital Signs

Yellowstone National Park
National Park Service
Mammoth Hot Springs, Wyoming

YCR-2009-04

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Photos courtesy of the National Park Service.

List of Acronyms

GYCC: Greater Yellowstone Coordinating Committee
GRYN: National Park Service, Greater Yellowstone Inventory and Monitoring Network
IGBST: Interagency Grizzly Bear Study Team (U.S. Geological Survey–Biological Resources Division, National Park Service, U.S. Forest Service, and the states of Idaho, Montana, and Wyoming)
NPS-ARD: National Park Service–Air Resources Division
NYCWWG: Northern Yellowstone Cooperative Wildlife Working Group (Montana Department of Fish, Wildlife and Parks; Yellowstone National Park; Gallatin National Forest; and U.S. Geological Survey–Northern Rocky Mountain Science Center)
YNP: National Park Service, Yellowstone National Park
YVO: Yellowstone Volcano Observatory (U.S. Geological Survey, Yellowstone National Park, and University of Utah)

Natural resource vital signs are key indicators for assessing the health of an ecosystem. They were selected for Yellowstone National Park (YNP) in collaboration with the National Park Service Greater Yellowstone Inventory and Monitoring Network (GRYN), which includes Grand Teton National Park, the John D. Rockefeller, Jr. Memorial Parkway, and Bighorn Canyon National Recreation Area. More than 400 scientists and managers participated in identifying and prioritizing these vital signs. They are monitored by park staff, GRYN staff, cooperators from other federal and state agencies, and university scientists. Monitoring data for many of these vital signs are too short-term to indicate trends or establish an appropriate standard or reference condition against which to compare the current condition, but enough is known about twenty-seven of the vital signs to complete this first Superintendent's 2008 Report on Natural Resource Vital Signs. The park's managers need to track these vital signs so that this information can be integrated into their understanding of long-term changes in the park's natural resources.

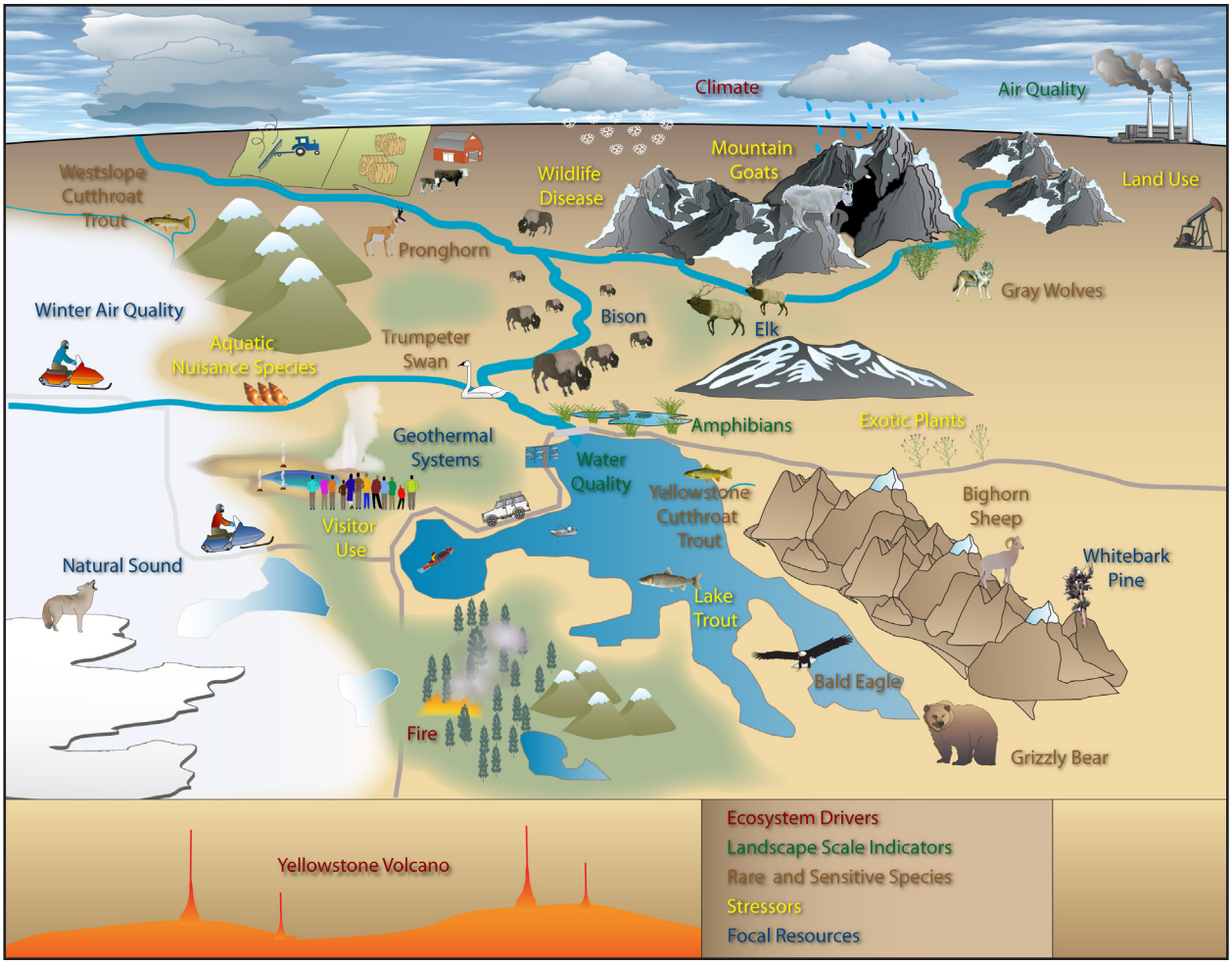
2008 Summary

Yellowstone's climate was characterized by near average (1971–2000) precipitation and snowpack, making 2008 one of the wettest winters the area has experienced in the last nine years. The Yellowstone volcano ended the year with a swarm of almost 900 quakes in 11 days, most of them deep under Yellowstone Lake, reaching a magnitude 3.9. The only known swarm since 1973 that was more intense occurred in 1985.

The Yellowstone wolf population declined 27% during 2008, to 124 wolves in 12 packs. However, the U.S. Fish and Wildlife Service (USFWS) goal of 30 breeding pairs in the Northern Rocky Mountain recovery area has been met and the gray wolf is expected to be removed from the endangered species list in Idaho and Montana in 2009; the USFWS has not yet accepted the wolf management plan proposed by the state of Wyoming. Since 1975, when the grizzly bear was listed as a threatened species, its population in the Greater Yellowstone Ecosystem has grown to approximately 600. The USFWS removed the grizzly bear from threatened species status in 2007 but a suit was filed to relist it. As of year end 2008, the court had not issued a ruling. The park's resident trumpeter swan count has declined to 6 compared to counts of more than 60 in the 1960s.

Biologists have removed almost 350,000 lake trout since they were first documented in Yellowstone Lake in 1994. Although the removal program has altered the size and age structure of the lake trout population and slowed the rate of increase, the Yellowstone cutthroat trout population continues to decline. A panel of fisheries scientists convened in August 2008 concluded that the current program is insufficient to alleviate the lake trout threat and recommended a significant increase in removal effort for the next five field seasons, through 2014.

During the 2007–08 winter, 1,728 bison were removed from the population, including 166 that were taken by hunters outside the park and 112 calves that were sent to a quarantine feasibility project underway by the state of Montana and the U.S. Department of Agriculture. The bison population numbered approximately 3,000 in August 2008.



This conceptual diagram of Yellowstone's natural resource vital signs begins to tell the stories of how these resources interact on the landscape.

Yellowstone's vital signs fall into five categories according to the role they play in the larger Greater Yellowstone Ecosystem (GYE).

Ecosystem Drivers: As the major forces that create and modify our parks, ecosystem drivers operate at regional, continental, or even global scales. Changes caused by these forces are likely to have cascading effects on virtually all park resources.

Landscape-scale Indicators: Landscape-scale indicators are monitored because changes they exhibit tell us something about the ecosystem or the landscape beyond their individual status or trends.

Rare and Sensitive Species: Rare and sensitive species are monitored not only because they are of high concern to both management and the public, but also because preserving native flora and fauna is core to the park's mission.

Stressors: Like ecosystem drivers, stressors are agents of change. Stressors, such as exotic species, tend to reduce biodiversity and ecological integrity, and destabilize ecosystems.

Focal Resources: These are resources that are of particular interest to management either because of concerns for that resource or because of how they might influence other resources.

The table on the following page summarizes information on selected vital signs, including the criteria used to assess them, their current condition, and a reference condition that can be used to evaluate the current condition. Several types of reference conditions are used depending on the information available (sources are listed on page 4); they are not necessarily desired future conditions.

They may be based on:

- recovery plans for endangered or recently recovered species (e.g., grizzly bears), a Record of Decision resulting from an Environmental Impact Statement (e.g., bison), or federal and state standards (e.g., water quality);
- recommendations derived from scientific literature and empirical data (e.g., Yellowstone cutthroat trout); or
- a comparison of the current condition to that of prior years (e.g., fire).

In other cases, park managers have not yet been determined a reference condition for the vital sign (e.g., mountain goats).

Each reference condition serves to inform park managers about whether a resource has changed since previous years or is approaching a threshold which indicates that more management time, energy, and effort may need to be directed toward that resource.

Resource Category	Vital Sign	Indicators	Current Condition (most recent data as of 2008)	Reference Condition (see next page for sources)	Within Reference Condition?
Ecosystem Drivers	Climate	Precipitation Temperature Growing season (N.E. Ent. 1997–2008) Snowpack Streamflow Drought	average near average longer than previous decade near average above average near average	30-yr. av. (1971–2000) 30-yr. av. (1971–2000) 1985–1996 30-yr. av. (1971–2000) period of record period of record percentile	yes
	Fire	Acres burned per year	10,363	1–28,849 (1990–2005)	yes
	Yellowstone Volcano	Uplift/Subsidence Earthquakes	118 cm uplift (1996–2005) 2,317 (2008)	TBD 872–3,172 (range 1995–2007)	yes
Landscape-scale Indicators	Air Quality	Visibility Ozone (W126) Nitrogen in precipitation Sulfur in precipitation	3.42 deciviews (2003–07 av.) 10.13 ppm-hr (2003–07 av.) 2.28 kg/ha/yr (2003–07 av.) 0.97 kg/ha/yr (2003–07 av.)	<2 deciviews < 7 ppm-hr <1.4 kg/ha/yr <1 kg/ha/yr	no
	Amphibians	5-year analysis of # of sites with breeding habitat and % occupancy	TBD	TBD	TBD
	Water Quality	Temperature, dissolved oxygen, pH, specific conductance, turbidity, and total suspended solids	no exceedances	no exceedances of state standards attributed to human causes within the park	yes
Rare and Sensitive	Bald Eagles	Nesting pairs Fledglings	34 (2007 count) 26 (2007 count)	≥25 ≥15	yes
	Bighorn Sheep	Northern range winter count Lambs/100 ewes	353 34	300–500 22 (1992–2008 average)	yes
	Gray Wolves	Year-end wolf count in WY Year-end breeding pairs in WY	302 21	≥150 in WY ≥15 in WY	yes
	Grizzly Bears	Estimated GYE bear population >2-year-old female mortality	596 3.3% (2007), 9.5% (2008)	≥500 not to exceed 9% for 2 yrs	yes
	Pronghorn	Northern range spring count	290	300–600	no
	Trumpeter Swan	Resident adults summer count Nesting pairs count Fledglings count	6 2 2	≥20 (2000 baseline) ≥7 (2000 baseline) ≥2 (2000 baseline)	no
	Arctic Grayling (stream)	km of occupied historical habitat	0 km	TBD	TBD
	Westslope Cutthroat Trout (stream)	km of occupied historical habitat	<1% of 1,031 km	TBD	TBD
	Yellowstone Cutthroat Trout (lake)	Spawner count at Clear Creek	538 (2007 count)	20,000–30,000	no
Stressors	Aquatic Nuisance Species	TBD	TBD	TBD	TBD
	Invasive Plants	TBD	TBD	TBD	TBD
	Lake Trout in Yellowstone Lake	Catch per unit effort	4.63	0.5–1.0	no
	Land Use	TBD	TBD	TBD	TBD
	Mountain Goats	Estimated pop. in and near YNP	175–225	TBD	TBD
	Visitor Use	TBD	TBD	TBD	TBD
	Wildlife Diseases	TBD	TBD	TBD	TBD
Focal Resources	Bison	Estimated summer population	3,000	2,500–4,500	yes
	Elk (northern range)	Winter count	6,279	4,000–15,000	yes
	Effects of Oversnow Vehicles • air quality • soundscapes • wildlife	• West Entrance carbon monoxide; Old Faithful $PM_{2.5}$ • % time OSVs are audible, 8AM–4PM • Movement response to OSVs	• ≤6.1 ppm; ≤9.5 $PM_{2.5}$ (µg/m³) • 68% at Old Faithful, 53% at Madison Junction • 5 monitored species ≤23%	TBD	TBD
	Geothermal Systems	TBD	TBD	TBD	TBD
	Whitebark Pine	Blister rust infection (% of trees) Pine beetle infestation (acres)	20% (in the GYE) 29,805 (in the park)	TBD 0–36,837 (range 1983–2007)	TBD

Background color denotes the basis for the reference condition, see pg. 2. *federal and state standards or NEPA process* *scientific opinion* *range or average* *to be determined*

Sources for Reference Conditions

Indicator	Source
Climate	Gray, S. T., C. M. Nicholson, and M. D. Ogden. 2009. Greater Yellowstone Network: Climate of 2008. Natural Resource Report NPS/GRYN/NRR—2009. DRAFT. National Park Service, Fort Collins, Colorado.
Fire	Yellowstone National Park website, http://www.nps.gov/yell/parkmgmt/firemanagement.htm.
Yellowstone Volcano	Yellowstone Volcano Observatory website, http://volcanoes.usgs.gov/yvo.
Air Quality	Thresholds set by the NPS Air Resources Division, i.e., 2008 Annual Performance & Progress Report: Air Quality in National Parks, October 2007 and "Air Quality Condition Interpolation Values 2003–2007." See also Inferring Critical Nitrogen Deposition Loads to Alpine Lakes of Western National Parks with Diatom Fossil Records. 2009. Saros, J. Final Report for the NPS Air Resources Division.
Amphibians	TBD
Water Quality	Montana Department of Environmental Quality. 2008. Circular DEQ-7: Montana Numeric Water Quality Standards. Helena, (MT): Montana Department of Environmental Quality. February 2008. Wyoming Department of Environmental Quality (WYDEQ). 2007. Water Quality Rules and Regulations, Chapter 1, Wyoming Surface Water Quality Standards. Arnold, J., C. Bromley, S. Carrithers, S.E. O'Ney, D. Schmitz and H. Sessoms. 2009. DRAFT Greater Yellowstone Network Water Quality Monitoring Report: January 2007–December 2008. National Park Service, Greater Yellowstone Network, Bozeman, MT.
Bald Eagles	Baril, L.M., and Smith, D.W. 2009. Yellowstone bird monitoring report – 2008. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming.
Bighorn Sheep	Bighorn sheep demography following wolf restoration. 2007. White, P. J., T. O. Lemke, D. B. Tyers, and J. A. Fuller. *Wildlife Biology* 14:138–146.
Gray Wolves	Federal Register 73(2008):10520. Final Rule Designating the Northern Rocky Mountain Population of Gray Wolf as a Distinct Population Segment.
Grizzly Bears	Federal Register 70 (2005):69854. Proposed Rule Removing the Yellowstone Distinct Population Segment of Grizzly Bears From the Federal List of Endangered and Threatened Wildlife. U.S. Fish and Wildlife Service. 2007. Final Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area, U.S. Fish and Wildlife Service, Missoula, Montana, USA.
Pronghorn	Irruptive population dynamics in Yellowstone pronghorn. 2007. White, P. J., J. E. Bruggeman, and R. A. Garrott. *Ecological Applications* 17:1598–1606.
Trumpeter Swan	National Park Service. 2000. Strategic Plan, FY 2001–2005. Yellowstone National Park, Mammoth, Wyoming, USA. Yellowstone National Park Trumpeter Swan Conservation Assessment, prepared by the Rocky Mountain Cooperative Ecosystem Studies Unit, December 2008.
Arctic Grayling (stream)	TBD
Westslope Cutthroat Trout (stream)	TBD
Yellowstone Cutthroat Trout (lake)	Koel, T. M., J. L. Arnold, P. E. Bigelow, P. D. Doepke, B. D. Ertel, and M. E. Ruhl. 2008. Yellowstone Fisheries & Aquatic Sciences: Annual Report, 2007. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming, YCR-2008-02.
Aquatic Nuisance Species	TBD
Invasive Plants	TBD
Lake Trout in Yellowstone Lake	Koel, T. M., J. L. Arnold, P. E. Bigelow, P. D. Doepke, B. D. Ertel, and M. E. Ruhl. 2008. Yellowstone Fisheries & Aquatic Sciences: Annual Report, 2007. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming, YCR-2008-02.
Land Use	TBD
Mountain Goats	TBD. See Schullery, P., and L. Whittlesey. 2001. Mountain goats in the Greater Yellowstone Ecosystem: a prehistoric and historical context. *Western North American Naturalist* 61:289–307.
Visitor Use	TBD
Wildlife Diseases	TBD; may incorporate data, goals, or standards from ID/MT/WY state agencies, the USGS National Wildlife Health Center, the GYCC Interagency Brucellosis Committee, the GYCC Northern Yellowstone Cooperative Wildlife Working Group, and the Yellowstone Wildlife Health Program strategic plan.
Bison	U.S. Department of the Interior, National Park Service and U.S. Department of Agriculture, Forest Service, Animal and Plant Health Inspection Service. 2000. Record of Decision for Final Environmental Impact Statement and Bison Management Plan for the State of Montana and Yellowstone National Park. Washington, D.C.
Elk (northern range)	Survival and cause-specific elk calf mortality following wolf restoration to Yellowstone National Park. 2008. Barber-Meyer, S. M., L. D. Mech, and P. J. White. Wildlife Monographs 169.
Effects of Oversnow Vehicles • air quality • soundscapes • wildlife	TBD; may be based on Winter Use Technical Documents (http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm), e.g., Ray, J. D. 2008. Winter air quality in Yellowstone National Park: 2007–2008. Natural Resource Technical Report NPS/NRPC/ARD/NRTR—2008/139. National Park Service, Fort Collins, Colorado. McClure, C., and T. Davis. 2008. Wildlife Responses to Motorized Winter Recreation in Yellowstone." Report to the National Park Service. Burson, S. 2008. Natural Soundscape Monitoring in Yellowstone National Park, December 2007–March 2008. Report to the National Park Service.
Geothermal Systems	TBD
Whitebark Pine	TBD. See Greater Yellowstone Whitebark Pine Monitoring Working Group. 2009. Monitoring Whitebark Pine in the Greater Yellowstone Ecosystem: 2008 Annual Report. Pages 62–68 *in* C.C. Schwartz, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2008. U.S. Geological Survey, Bozeman, Montana, USA. Mountain Pine Beetle Conditions in Whitebark Pine Stands in the Greater Yellowstone Ecosystem. 2006. Missoula, MT: USDA Forest Service, Forest Health Protection Report 06–03. 6 pages. Unpublished Data, USDA Forest Service, Missoula, MT.

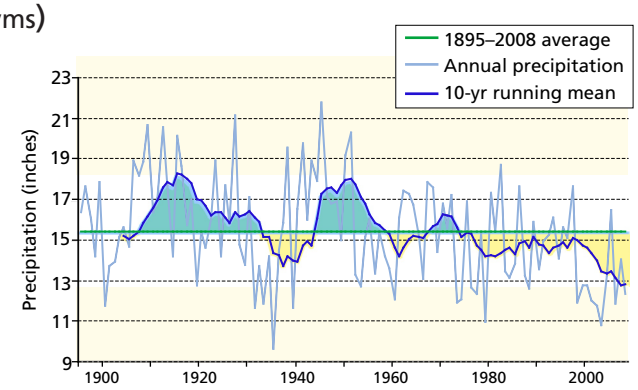
ECOSYSTEM DRIVERS

Climate (monitored by GRYN, see pg. ii for acronyms)

Within Reference Condition

Yellowstone began 2008 in a moderate drought. Although precipitation was at or above the 30-year average (1971–2000) during winter and spring, and the snowpack was near average, precipitation was at or below average during summer and early fall. Parts of Yellowstone received less than 25% of average precipitation in July. Residual moisture from late May storms combined with average to relatively cool spring temperatures and a long-lasting snowpack prevented a severe drought late in the growing season. Annual runoff at the Yellowstone River gauges was 115–120% of average, and the timing of peak runoff was near average.

Most of the year was relatively cool in Yellowstone, with maximum daily temperatures near or slightly below average. However, July and August maximums were 2–4°F warmer than average. Data collected at the park's northeast entrance indicate that the growing season (daily temperature minimums >32°F) has lengthened from an average of 88 days (1985–1996) to 115 days (1997–2008); it was 107 days in 2008. The onset of the 2008–09 winter did not occur until the latter half of December.

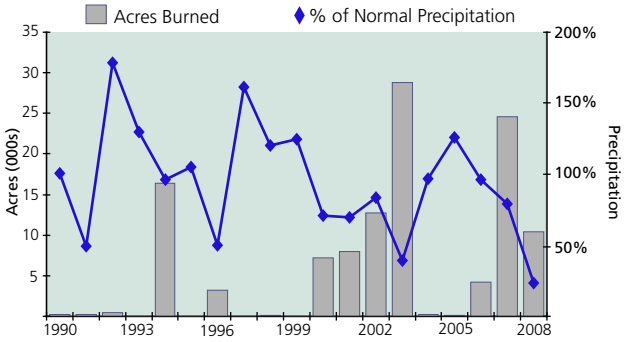


Upper Yellowstone River Basin precipitation, 1985–2008 (data from the Western Regional Climate Center, WY Climate Division 1).

Fire (YNP)

Within Reference Condition

Since 1988, fire activity has fluctuated from less than one acre per year to nearly 29,000 acres in 2003. Fires caused by human activity have been responsible for less than 2% of the burned acreage since 1990. In 2008, a total of 10,363 acres burned in Yellowstone. There were eight known wildland fire starts, of which seven were considered human-caused, including one downed power line. Three of these fires were fully suppressed and one partially suppressed, and four were managed under Appropriate Management Response and allowed to burn themselves out. A total of 165 acres were treated for hazard fuels; 30 acres through burning piles and the rest through mechanical removal.



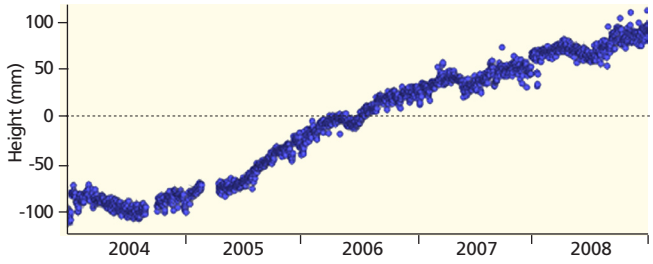
Acres burned in Yellowstone compared to summer precipitation as a percentage of the 1970–2000 average.

Yellowstone Volcano (YVO)

Within Reference Condition

The Yellowstone Volcano Observatory detected 2,317 earthquakes in the park in 2008, compared to a range of 872–3,172 per year during 1995–2007. Most earthquakes in the park are less than magnitude 3. (Earthquakes with magnitudes less than 3.4 are generally not felt by people.) From late December to early January, the northern portion of Yellowstone Lake experienced a swarm of almost 900 earthquakes with magnitudes up to 3.9. This swarm is well above typical activity in the park but not unprecedented in the last 40 years of monitoring. Earthquake swarms typically occur within the Yellowstone caldera. During a 1985 swarm on the northwest rim of the caldera that lasted for three months, more than 3,000 events were recorded with magnitudes up to 4.9.

Data from Global Positioning System (GPS) ground stations and the European Space Agency's Envisat satellite indicate that parts of the Yellowstone caldera rose as much as 7 cm per year from 2004 to 2006. The largest uplift has been recorded at the White Lake GPS station, inside the caldera's eastern rim, where the total uplift from 2004 to October 2007 was about 17 cm. Given the area's geologic history, YVO scientists think that the current period of uplift will likely cease and be followed by another cycle of subsidence. Norris Geyser Basin, which uplifted 12 cm from 1996 to 2004, has subsided 6 cm since 2004.



Vertical uplift at the White Lake GPS station, 2004–08.

LANDSCAPE-SCALE INDICATORS

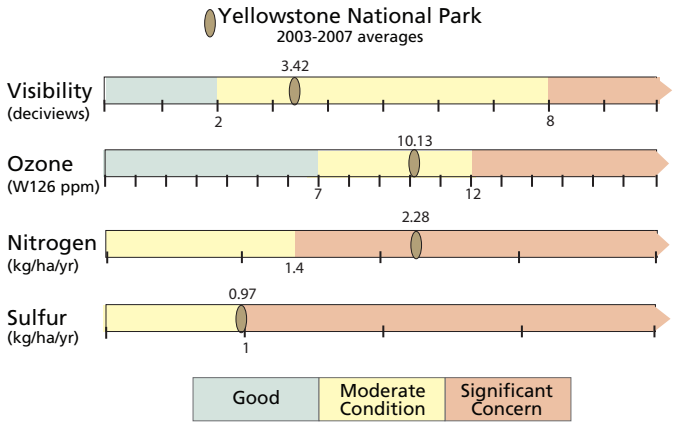
Air Quality (NPS-ARD)

Not Within Reference Condition

Yellowstone is in compliance with federal air quality standards for human health in regard to ozone, sulfur dioxide, and particulate matter. However, data from the park's monitoring program has raised concerns about how air quality trends may be affecting other aspects of the ecosystem. For example, nitrogen in precipitation has increased in recent years at many Western monitoring sites as a result of ammonium ion concentrations associated with fertilizer use and feedlots. By stimulating plant growth, nitrogen can alter the structure and diversity of plant communities. An analysis of sediment cores from Heart Lake in the park and Island Lake in the Beartooth Mountains (northeast of the park) found that when their algal composition began changing in about 1980, nitrogen loading had reached a critical threshold (1.4 kg/ha/year) that can alter the ecology of alpine lakes; the average nitrogen load in the two lakes from 1993–2006 had increased to 1.8 kg/ha/year.

Unlike ozone in the stratosphere which protects Earth from radiation, ground-level ozone can be harmful. It is produced by the reaction of UV radiation with nitrogen oxides and volatile organic compounds that are emitted by fossil fuel combustion, wildfire plumes, and other sources, and it can travel hundreds of miles on air currents. Ozone concentrations in Yellowstone typically peak in spring rather than summer, indicating that human influences are less significant than changes in atmospheric circulation and lengthening daylight. Nonetheless, data on ozone levels during the growing season (the W126 exposure index) may be high enough to cause biomass loss in sensitive species such as aspen.

The sources of most air pollution in the park are outside its boundaries. Like most of the United States, the air quality in Yellowstone is sometimes impaired because of vehicle, power plant, and other industrial source emissions that may travel for hundreds of miles. To remedy and prevent human-caused impairment of visibility in Yellowstone and other Class I areas as required by the Clean Air Act, states participating in the Western Regional Air Partnership have adopted and are continuing to develop programs to reduce emissions of pollutants.

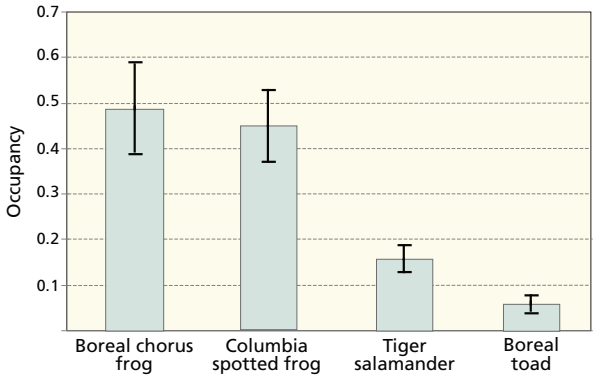


The average 2003–07 values in Yellowstone relative to categories set by the NPS Air Resources Division for four air quality measures. A threshold for "good" condition has not been determined for nitrogen and sulfur wet deposition in Yellowstone. Total natural background wet deposition in the West has been estimated at 0.13 kg/ha/yr.

Amphibians (GRYN)

Reference Condition TBD

Annual surveys since 2002 have found the same four native amphibian species in Yellowstone: the Columbia spotted frog, boreal chorus frog, tiger salamander, and boreal toad. As part of the monitoring program, 334 potential sites in 32 catchments were visited in the park in 2008; 281 sites with sufficient water for amphibian breeding habitat were surveyed. Hydrological fluctuations change the extent and location of wetland sites, resulting in considerable year-to-year variation in amphibian reproduction. Longer-term data on these sites will therefore be needed to identify any significant trends. However, population data collected since 1992 appear to be within the range of natural variability and suggest that these species are resilient to at least short periods of drought. Reports from the 1950s suggest that the boreal toad was more widespread and common then, but it continues to be found at most of the major breeding sites that have been identified since the early 1990s.



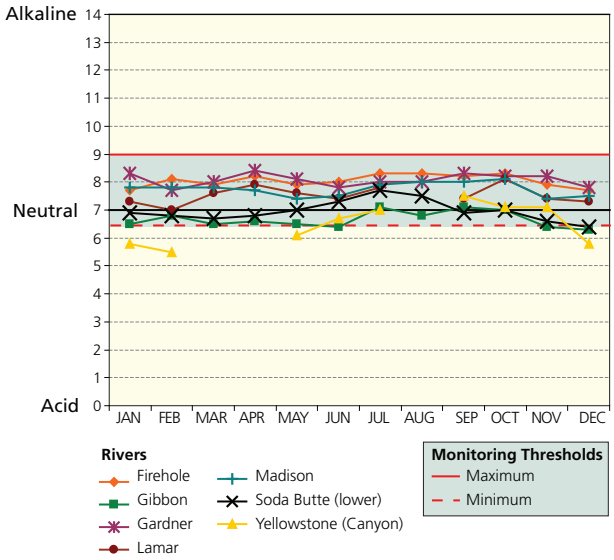
Amphibian occupancy estimates for Yellowstone and Grand Teton national parks based on data collected at 40 catchments in 2008. Occupancy refers to the proportion of catchments occupied by each breeding species, adjusted for the probability that the species may be present but not detected.

Water Quality (GRYN)

Within Reference Condition

In 2008, 6 of the 11 monitored stream sites did not meet EPA and/or state standards for pH, turbidity, or temperature in at least one monthly sampling. However, most of these exceedances are likely the result of natural rather than anthropogenic factors. Many stream sites have upstream thermal inputs that affect pH and water temperature. Analysis of water quality data is underway to better understand the natural variation of Yellowstone's surface waters and increase our ability to detect changes caused by anthropogenic sources.

As a result of elevated metal concentrations from previous mining activity upstream of the park, dissolved and total metals (arsenic, copper, iron, and selenium) in the water and sediment of Soda Butte Creek are measured at the park boundary during its annual high and low flow periods. Although the metal concentrations appear negligible, the water is at risk from upstream contamination during an extreme flood event. The site at Soda Butte Creek exceeded state standards for dissolved iron when a water sample collected in September 2008 was tested. State and federal agencies are participating in a long-term plan to remove the mine tailings from the streambed. In 2009 park staff will increase water sampling at the creek to better monitor possible impacts of the removal process.

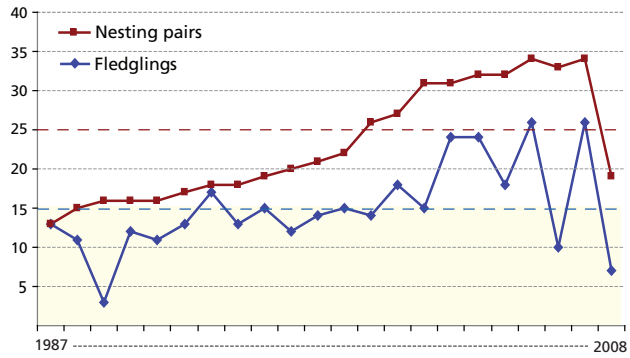


Water quality monitoring data for pH in 2008. The EPA has determined that pH levels from 6.5 to 9.0 are optimum for freshwater aquatic life. Yellowstone waters are sometimes more acidic, especially the Gibbon River, because of geothermal influences.

Bald Eagles (YNP)

Within Reference Condition

Bald eagles, which usually mate for life and may reuse the same nest year after year, occupy territories near major rivers and lakes in Yellowstone and Grand Teton national parks. Juveniles may migrate to warmer habitat in the fall but many adults stay in the parks year-round. Winter numbers are increased by the arrival of bald eagles that breed farther north. New territories in Grand Teton indicate population expansion in recent years. In 2005 and 2007, a record number of nesting pairs was counted in both Yellowstone (34) and Grand Teton (14). Only 19 nesting pairs were counted in Yellowstone in 2008; however, this was considered an incomplete count. Although a pair produces an average of two eggs once a year, the number of eaglets that successfully fledge depends partly on weather. For example, the number of fledglings dropped to 10 in 2006 because of many nest failures that were attributed primarily to wet weather and strong winds.

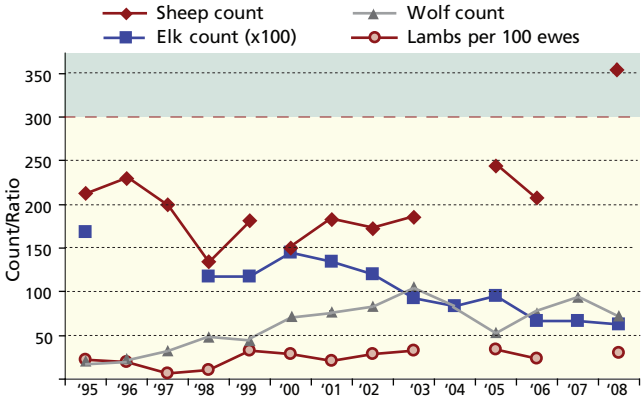


Counts of bald eagle nesting pairs and fledglings in Yellowstone National Park, 1987–2008, compared to reference conditions (above dashed lines).

Bighorn Sheep (GYCC NYCWWG)

Within Reference Condition

From the 1890s to the mid-1960s, the bighorn sheep population fluctuated between 100 and 400. The count had reached a high of 487 in 1981, but a pinkeye epidemic caused by Chlamydia reduced the population by 60% the following winter. Counts did not increase significantly during the next 15 years and reached a low of 134 sheep following the severe winter of 1996–97. Since then, the overall trend has been upward to 353 sheep in 2008. Recruitment dropped to 7–11 lambs per 100 ewes during the winters of 1996–97 and 1997–98, but since then has fluctuated between 21 and 34 lambs per 100 ewes.

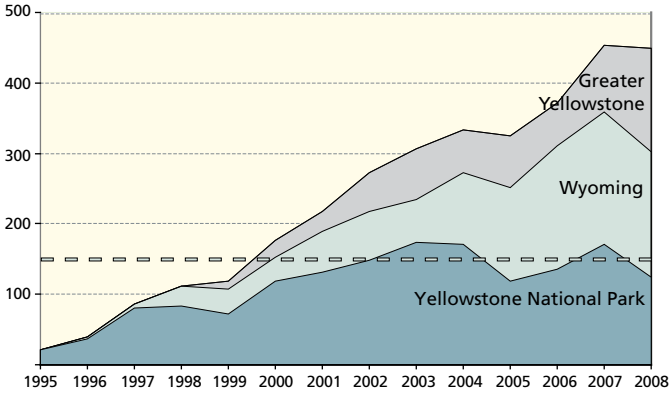


Counts of bighorn sheep, lambs, elk, and wolves on the northern range, 1995–2008, with reference condition for sheep (above dashed line).

Gray Wolves (YNP)

Within Reference Condition

In the first years after restoration, the wolf population grew up to 70% annually as the newly formed packs spread out to establish territories with sufficient prey, primarily elk. Official counts in 2008 identified 124 wolves in 12 packs residing in Yellowstone. This 27% decrease from 2007 was likely caused by mange, distemper, and inter-pack fighting. It mirrors similar population declines in 1999 and 2005. The increasing mortalities from conflicts between and within packs and the instability of some packs may be evidence that the park is reaching its ecological carrying capacity for wolves.

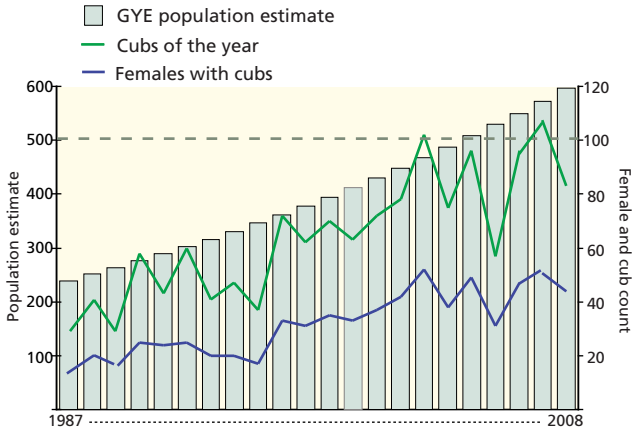


Wolf counts for Greater Yellowstone, Wyoming, and Yellowstone National Park, with reference condition for Wyoming (above dashed line),

Grizzly Bears (IGBST)

Within Reference Condition

The estimated GYE grizzly bear population increased from 136 in 1975 to 596 in 2008, and the bears have gradually expanded their occupied habitat by more than 50%. Of the 44 grizzly mortalities known to have occurred in the GYE in 2008, 14 were hunting-related (mistaken for black bear or in self-defense); other deaths were in defense of life or property (13), from natural causes (7), malicious killings (2), capture-related (2), a road accident (1), and undetermined causes (5). For female grizzly bears ≥2 years old, the 2008 mortality rate exceeded the recovery goal. There were no human-caused grizzly mortalities in Yellowstone in 2008. Ten conflicts with grizzly bears occurred in the park in 2008, compared to an average of 7.1 a year during 1994–2007. In 5 of the incidents, property damage occurred, and in 3 incidents, human food was obtained. The other two incidents resulted in minor injuries to a firefighter and an electric utility employee.

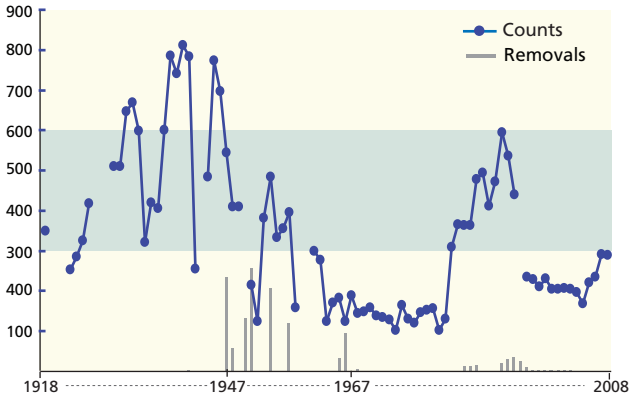


Counts of females and cubs based on sightings of unique bears, and estimated total population with reference condition (above dashed line)..

Pronghorn (GYCC NYCWWG)

Not Within Reference Condition

An estimated 1,000–1,500 pronghorn were widely distributed in the upper Yellowstone drainage in the 1800s, but increasing development north of the park and efforts to keep them in the park with fences and winter feeding reduced their abundance and eliminated their migration beyond the park by 1920. The removal of approximately 1,200 pronghorn during 1947–67 because of concerns about sagebrush degradation may have resulted in the abandonment of several summering areas. Culling ended in 1969 when the population was estimated at less than 200. Since then, pronghorn numbers have exhibited periods of relative stability punctuated by relatively rapid, dramatic fluctuations. A decrease in counts from 536 to 235 pronghorn during 1992–95 caused serious concerns about the population's long-term viability. The current population is approximately 300, but fawn survival remains low due to coyote predation, and development of private lands outside the park has reduced available winter range.

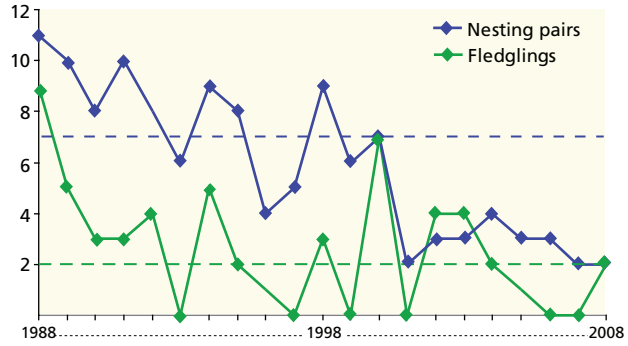


Pronghorn removals and spring counts in Yellowstone National Park and adjacent areas of Montana, 1918–2008, with reference condition (shaded area).

Trumpeter Swan (YNP/GYCC)

Not Within Reference Condition

The park's resident trumpeter swan population was increasing when counts began in 1931, peaked at 69 in 1961, and then gradually declined to 6 in 2008. Nearly all of the Rocky Mountain population, which includes several thousand swans that migrate from Canada, winters in GYE locations where waters are kept ice-free by springs, geothermal activity, or outflow from dams. But only a small portion of these swans remain in the GYE during the summer to build their nests. In Yellowstone, where an average of 13.1 cygnets fledged a year in the 1950s and nest attempts peaked at 17 in 1978, no cygnets fledged in 2006 or 2007 and only two in 2008.

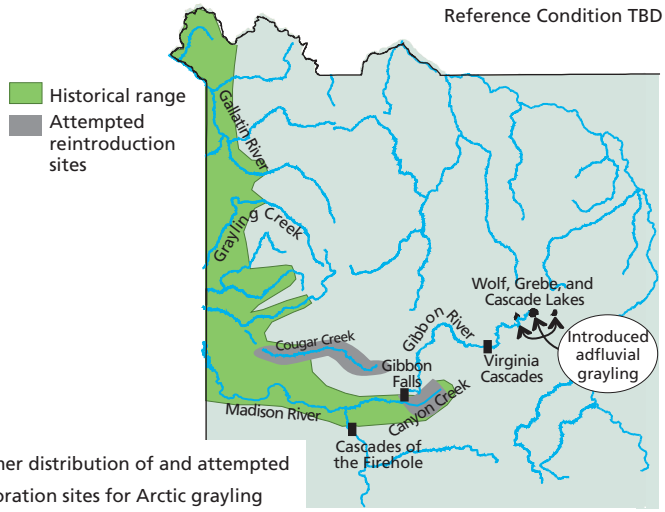


Count of trumpeter swan nest attempts and fledglings in Yellowstone National Park, 1988–2008, with reference conditions (dashed lines).

Arctic Grayling (YNP)

Reference Condition TBD

One of 11 fish species native to Yellowstone, fluvial (entirely stream-dwelling) Arctic grayling were historically common within the Madison, Gibbon, Firehole and Gallatin rivers. The only known grayling populations that remain in the park are adfluvial (lake-dwelling). Adfluvial grayling fry were first stocked in Grebe Lake in 1921, and this lake-dwelling population has populated Wolf Lake as well. Cascade Lake was also stocked and supports a viable population. Efforts to restore fluvial Arctic grayling began in 1975 in Canyon Creek and continued in 1993 in Cougar Creek; however, these efforts ultimately failed. In 2005 and 2006, the U.S. Geological Survey's (USGS) Montana Cooperative Fishery Research Unit and Yellowstone staff began to extensively assess the status of grayling in streams. Molecular methods confirmed Grebe and Wolf lakes as the source of fish within the river.

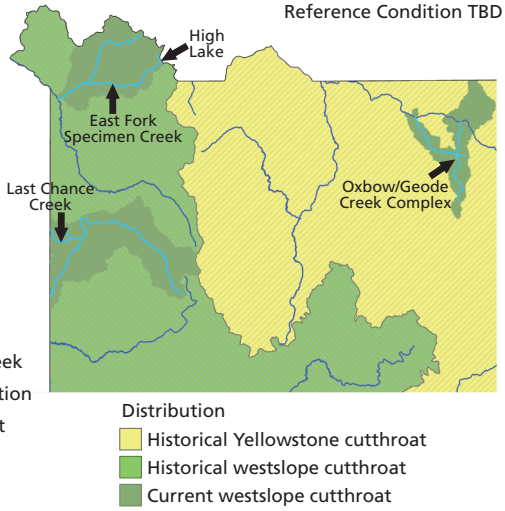


Former distribution of and attempted restoration sites for Arctic grayling within Yellowstone National Park.

Westslope Cutthroat Trout (YNP)

Reference Condition TBD

Although approximately 641 stream miles within the park originally supported genetically pure westslope cutthroat trout (WCT), the species has been extirpated from an estimated 36% (231) of stream miles and exists in a hybridized form in most of the remaining habitat. One of two known genetically pure WCT populations in the park is in a tributary to Grayling Creek in the Madison River drainage, where an estimated 700 WCT reside. It is one of only three known genetically pure WCT populations remaining in the Gallatin and Madison drainages of southwest Montana. Another pure population resides in the Oxbow/Geode creek complex, tributaries to the Yellowstone River in the park. These WCT are not within the native range and were likely introduced between 1922–24.

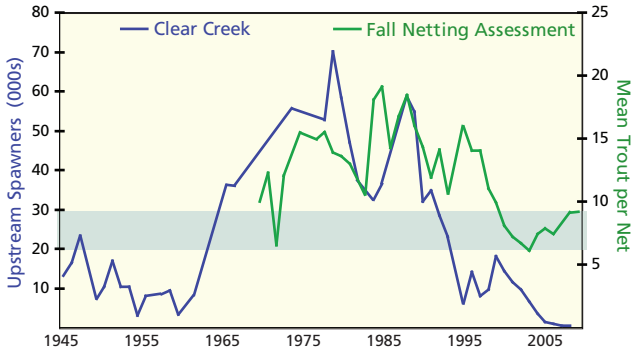


East Fork Specimen Creek was chosen as the location for westslope cutthroat trout restoration.

Yellowstone Cutthroat Trout (YNP)

Not Within Reference Condition

The fall monitoring program on Yellowstone Lake, aimed at detecting trends rather than estimating population size, indicates that the Yellowstone cutthroat trout population has declined significantly since 1994. Catch per net was 9.2 in 2008, compared to 6.1 in 2002, 15.9 in 1994, and 19.1 in 1984. The number of YCT spawning at Clear Creek, which have been counted most years since 1945, was 538 in 2007. This was an increase from the 489 counted during 2006, which was the lowest Clear Creek spawn since counting began and compares to 70,105 fish at the peak spawn in 1978. Within the park outside of the lake system, of the approximately 3,132 km of stream originally supporting resident (fluvial) Yellowstone cutthroat trout, 65% (2,025 km) continue to support genetically pure fish. The rest is home to fish characterized by hybridization with nonnative rainbow trout.



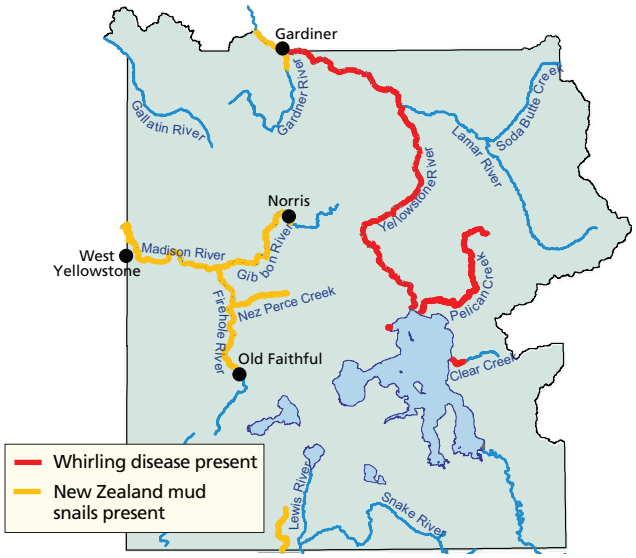
Number of upstream-migrating cutthroat trout counted at Clear Creek (1945–2007) and the fall netting assessment (1969–2008).

Aquatic Nuisance Species (YNP/GRYN/GYCC)

Reference Condition TBD

In Yellowstone, three ANS are having a significant detrimental effect:

- **Lake trout,** illegally introduced in Yellowstone Lake where they feed on the native Yellowstone cutthroat trout. The gillnetting of almost 350,000 lake trout since 1994 has saved many more cutthroat trout and slowed the lake trout population growth, but whether this effort will keep the lake trout population suppressed remains uncertain.
- Confirmed in the park in 1998, *Myxobolus cerebralis,* a parasite that causes **whirling disease** in cutthroat trout and other species, appears most concentrated in the Yellowstone Lake watershed, where it has reduced the cutthroat trout in Pelican Creek. Whirling disease has also been found in the Firehole and Yellowstone rivers.
- First detected in the park in 1994, **New Zealand mud snails,** which form dense colonies and compete with native species, are now in all of the major watersheds.



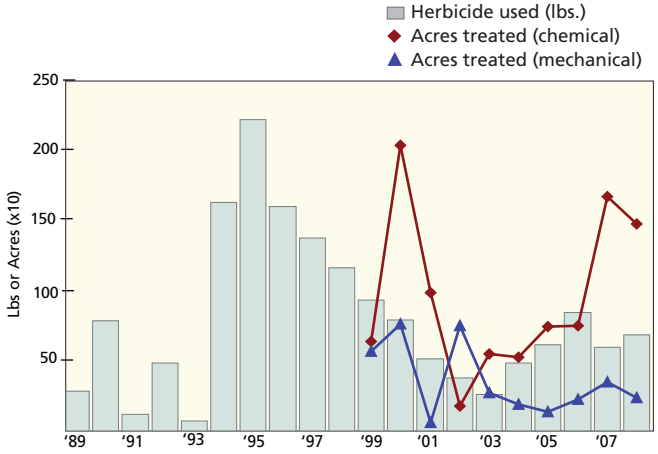
Locations known to have whirling disease or New Zealand mud snails.

Invasive Plants (YNP/GRYN/GYCC)

Reference Condition TBD

The full extent of nonnative plants in Yellowstone is not known, but the number of species that has been documented in the park has increased from 105 to 218 since 1986. (Yellowstone also has about 1,300 native plant species.) The increase in documented nonnative species is primarily a result of ongoing survey efforts, but it includes an unknown number of species that have arrived in the park during the last two decades.

Nonnative plant species in the park are prioritized according to the threat they pose to park resources and the prospects for successful treatment. Most of the 38 species targeted for treatment in 2008 (on about 1,700 acres) are listed by the states of Idaho, Montana, and/or Wyoming as "noxious weeds," which means that they are considered detrimental to agriculture, aquatic navigation, fish and wildlife, or public health. The 2008 priority list includes 10 species such as leafy spurge that infested less than one acre and can be eliminated if treated when the outbreak is still small. Some of the other targeted species such as spotted knapweed appear so frequently that stopping them from spreading is the primary goal. This strategy has helped prevent high priority invasive species from moving into backcountry areas where control is more difficult.

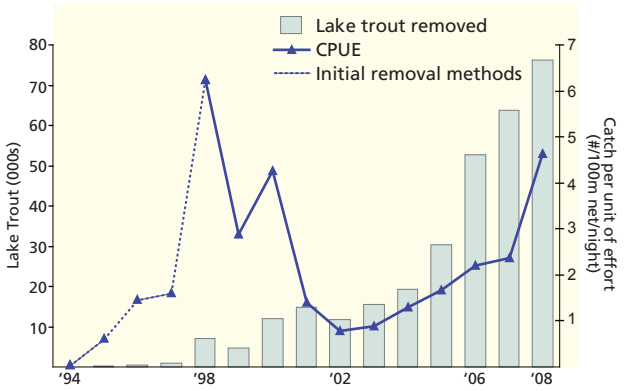


Pounds of herbicide used to treat exotic plants and acres of gross infested area receiving chemical and mechanical treatment. (Comparable data for acres treated before 1999 is not available.)

Lake Trout in Yellowstone Lake (YNP)

Not Within Reference Condition

Almost 350,000 lake trout have been removed from Yellowstone Lake since their presence was confirmed in 1994, including more than 76,000 in 2008. The largest lake trout to be caught in Yellowstone (24.3 pounds) was removed in 2008, but the average size and age of the fish netted near spawning areas has continued to decrease. Because the amount of effort put into gillnetting as well as the lake trout's abundance affects the number removed, "catch per unit of effort" (CPUE) is also monitored, i.e., the number of lake trout caught per 100 meters of net in one night. CPUE has been rising in the last five years, and is near the 1998 peak. Although these data suggest that the removal effort has reduced the lake trout population, whether current techniques will collapse the population to an insignificant level remains uncertain. Lake trout appear insusceptible to the whirling disease that has severely reduced cutthroat trout abundance in Pelican Creek, a tributary to Yellowstone Lake.

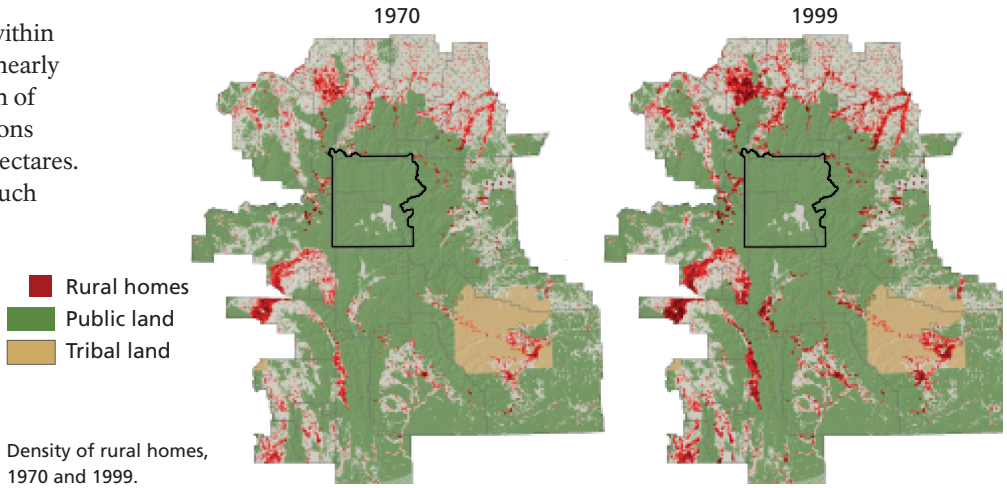


Number of lake trout removed by control nets and catch per unit of effort (CPUE) on Yellowstone Lake, 1994–2008.

Land Use (GRYN)

Reference Condition TBD

From 1970 to 1999, the population within the 20 counties of the GYE grew by nearly 60% to over 370,000 residents. Much of that growth is occurring in subdivisions with more than one home per 16.2 hectares. The area of rural lands taken up by such subdivisions increased by 350%.

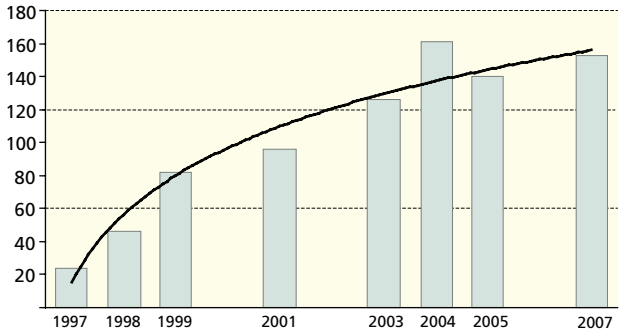


Density of rural homes, 1970 and 1999.

Mountain Goats (GYCC, NYCWWG)

Reference Condition TBD

Investigations of paleontological, archeological, and historical records have not found evidence that mountain goats are native to the GYE. However, descendants of mountain goats introduced into Montana during the 1940s and 1950s established a breeding population in the park in the 1990s and have reached a relatively high abundance in the northeastern and northwestern portions. This colonization has raised concerns about adverse effects on alpine habitats. Surveys in 2002 and 2003 suggest that ridgetop vegetation cover is lower, and barren areas along alpine ridges are more prevalent in areas with relatively high goat use. Competition with high densities of mountain goats could also negatively affect bighorn sheep, whose range overlaps with mountain goats. The number of goats in and adjacent to the park is estimated to be 175–225.



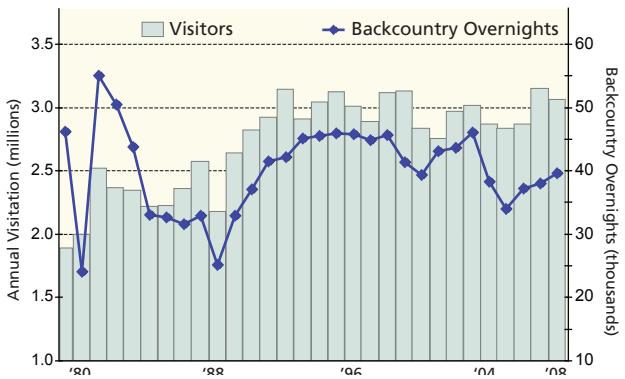
Counts of mountain goats in Yellowstone National Park and adjacent areas of Montana and Wyoming, 1997–2007.

Visitor Use (YNP)

Reference Condition TBD

Annual visitation at Yellowstone passed 3 million people for the first time in 1992; since then, it has remained relatively stable, ranging from 2.8 to 3.1 million. Most visitation occurs during the summer; use typically peaks from the last week of July through the second week of August. Although there are no day use quotas, the park only accommodates 14,341 visitors per night during the peak summer season. Fall visitation began to increase in the 1990s and now comprises 20% of annual use. Winter visitation has never been more than 5% of the annual count.

Similar to trends at other western parks, overnight backcountry use in Yellowstone peaked in 1977 at more than 55,000 "people use nights" (the total number of nights spent in the backcountry). Since 1990, people use nights have fluctuated between 34,000 and 46,000 with an overall downward trend. In 2008 it was 39,603.



Annual number of Yellowstone visitors and number of backcountry overnights, 1979–2008.

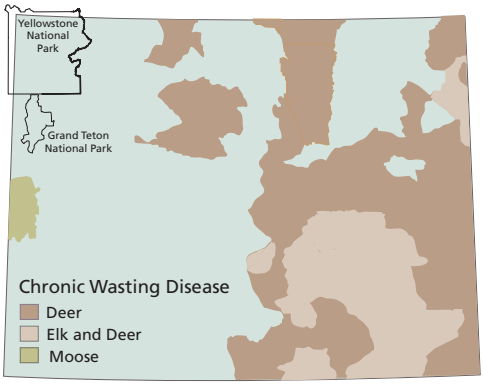
Wildlife Diseases (YNP)

Reference Condition TBD

Significant diseases present in Yellowstone wildlife:

- **Brucellosis.** Many bison and elk in the GYE have been exposed to the bacterium that causes brucellosis, which originated in domestic livestock. It does not appear to have had substantial population-level impacts in wildlife, but infected females may abort their first calf, and the disease can be transmitted to livestock through contact with infected birth materials.
- **Canine diseases**. Parvovirus, distemper, mange, and hepatitis are believed to have been a major factor in wolf population declines in Yellowstone in 1999, 2005, and 2008; these diseases also appear to have affected coyotes, foxes, and possibly cougars and other smaller carnivores.
- **Chytridiomycosis.** This amphibian disease, caused by a fungus of uncertain origin, has contributed to the worldwide decline in frogs. In 2007, mass mortality and abnormalities were documented in Columbia spotted frogs at Lodge Creek. The pathology of six specimens attributed the death to ranavirus but the frogs also had mild chytrid infections and parasites.

Hantavirus, considered native in origin, has been found in some Yellowstone voles and deer mice, but transmission to humans in the park is not known to have occurred. Wildlife diseases that could potentially appear in Yellowstone include chronic wasting disease (deer, elk, and moose) and West Nile virus (birds).



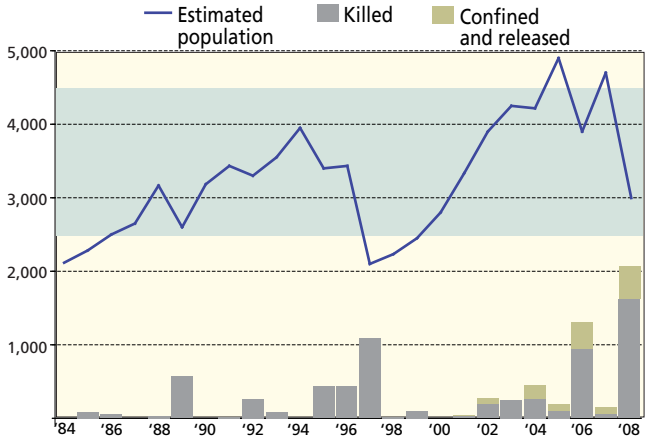
Areas in which the Wyoming Game and Fish Department has identified deer, elk and moose with CWD through December 30, 2008.

FOCAL RESOURCES

Bison (YNP)

Within Reference Condition

Although poaching reduced the park's bison population to less than 50 at the turn of the 20th century, it grew to more than 2,000 by the 1980s and began expanding its use of lower elevation winter range. The northern sub-population expanded westward along the Yellowstone River into the Gardiner Basin, the interior sub-population expanded into the upper Madison River Valley westward to Hebgen Lake, and part of it began migrating to the northern range. The number of mortalities that occur as part of boundary control operations near Gardiner and West Yellowstone, Montana, reflects annual fluctuations in winter bison movements out of the park. When the estimated 2007 summer population of 4,700 bison encountered a winter of heavy snowfall, hazing efforts along the north boundary became ineffective because of the large groups making repeated attempts to cross it. A total of 1,728 bison were removed from the population, including 166 that were taken by hunters outside the park and 112 calves that were sent to a quarantine project being carried out by the state of Montana and the U.S. Department of Agriculture. The bison population has fluctuated between 2,000 and 5,000 since 1980 and is currently around 3,000 animals divided evenly between the northern and central ranges of the park.

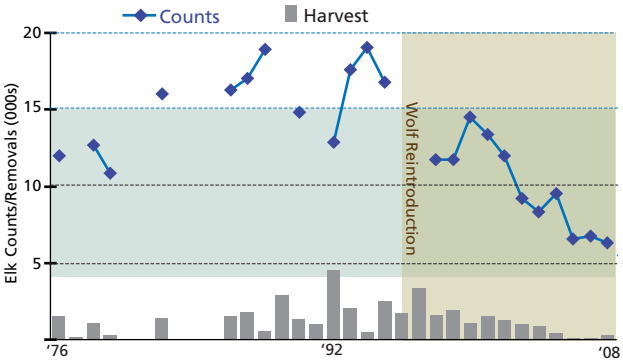


Estimated early winter bison population and boundary control operations, 1984–2008.

Elk on the Northern Range (GYCC, NYCWWG)

Within Reference Condition

Yellowstone's largest elk herd winters on range along and north of the park's Montana boundary. After decades of debate over whether this range was overgrazed by too many elk, public concern has shifted to whether wolf predation will leave too few elk. The winter elk count for the northern range, which was approximately 17,000 when wolf reintroduction began in 1995, decreased to 11,000–12,000 in 1998 following a substantial winter-kill and harvest of >3,300 elk the preceding winter. Counts varied between 11,500 and 14,500 elk during 1999–2001, and have been <10,000 since 2003. Predation by wolves and bears as well as hunting were the primary factors in the recent decline, though drought-related effects on pregnancy and survival contributed to an unknown extent during 1998–2004. Predictions about elk numbers range from maintenance at relatively low densities (i.e., <6,000–7,000 elk) to fluctuations around a mean of 10,000 elk with long-term oscillations.

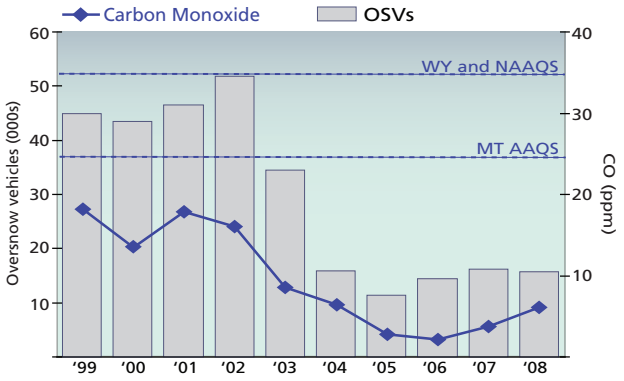


Annual winter counts and hunting harvests of the northern elk herd in Yellowstone National Park and adjacent areas of Montana, 1976–2008, with reference condition (shaded horizontal band). Counts were not adjusted for sightability.

Effects of Oversnow Vehicles on Resources (YNP)

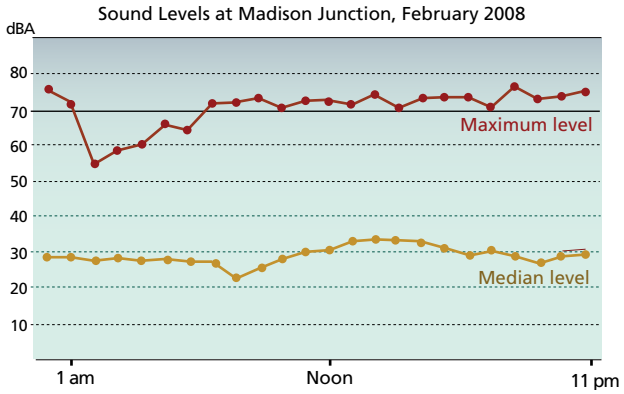
Reference Condition TBD

Winter Air Quality. CO and $PM_{2.5}$ have not exceeded federal or state air quality standards (AAQS) at the West Entrance or at Old Faithful, where oversnow vehicles (OSVs) are most concentrated. The levels of these pollutants have declined in recent years because of fewer snowmobiles in the park and because they are required to have "Best Available Technology" (BAT) and be accompanied by a licensed guide. The highest CO level at the West Entrance in the winter of 2007–08 was 6.1 parts per million (ppm), compared to a typical summer maximum of 0.8 ppm. Winter inversion layers, which impede dispersion of pollutants by trapping the cooler surface air, are a major factor in the difference between summer and winter air quality. However, for the last few years $PM_{2.5}$ levels have been higher in summer than winter, primarily because of smoke from wildland fires.



Although the decline in snowmobile numbers was partially offset by an increase in snowcoach use, CO levels dropped at the West Entrance as BAT was implemented and overall OSV numbers declined.

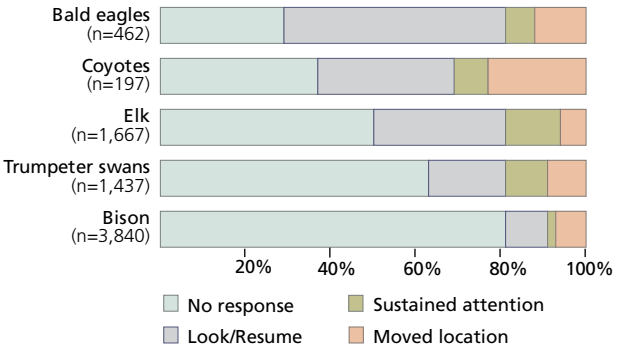
Winter Soundscapes. Lower snowmobile numbers and regulations on BAT, lower speed limits, and use of commercial guides also reduced sound levels and the percent of time that snowmobiles are audible. Snowmobile access is now limited to vehicles that produce no more than 73 dBA measured at 50 feet, which is roughly equivalent to 67 dBA at 100 feet. (An increase of 10 dBA represents a perceived doubling of loudness.) Maximum sound levels often exceed 70 dBA at 100 feet from the groomed roads; however, nearly all of the daytime exceedances are caused by snowcoaches, the nighttime exceedances by road groomers. OSVs have often been audible for slightly more than half of the 8 a.m. to 4 p.m. period along the busiest corridor (West Yellowstone to Old Faithful). An estimated 22–29% of OSV traffic is from administrative rather than visitor use.



The average and median sound level 100 feet from the road at Madison Junction remained well below the 70 dBA threshold, but the maximum sound level frequently spiked above 70 dBA; 93% of the spikes were from snowcoaches.

Winter Recreation Effects on Wildlife. Research indicates that disturbance by winter visitors is not a primary influence on the distribution, movements, or vital rates of bison, trumpeter swans, elk, coyotes, and bald eagles. Monitoring of OSV use in Yellowstone has found that nearly all OSV users remain on groomed roads and behave appropriately toward wildlife, rarely approaching unless animals are on or adjacent to the road. In most of 7,603 encounters observed between people on OSVs and wildlife, the animals either had no apparent response or looked and then resumed what they were previously doing: bison 91% of the encounters; swans, elk, and bald eagles, 81%; and coyotes, 74%.

The possibility that road grooming increases bison migration out of the park where they may be killed has not been borne out by research. Data on bison road use and off-road travel collected from 1997 to 2005 found bison on the road less often from December to April when the roads were groomed than during the rest of the year, and no evidence that bison preferentially used groomed roads during winter.



Reactions of five species to visitors on OSVs during the winters of 2003–08, as a percentage of the total number of animals of that species observed. Statistically, movement responses were higher for snowcoaches than snowmobiles. Average daily OSV traffic levels ranged from 156 to 593 during the monitoring period.

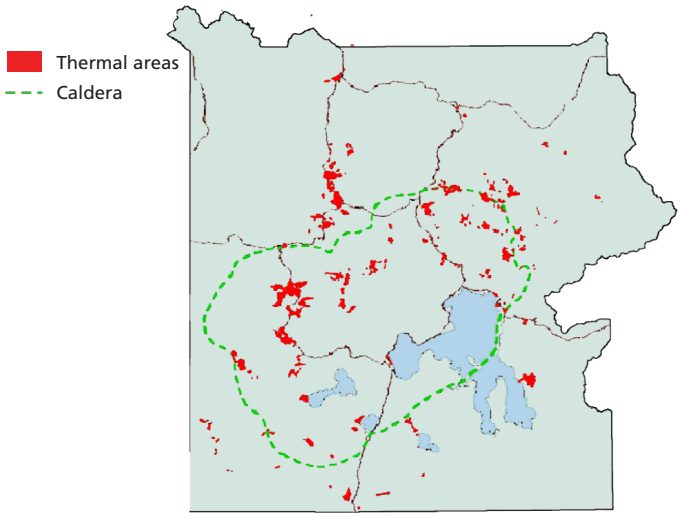
Geothermal System (YNP)

Reference Condition TBD

The geothermal system of Yellowstone is the visible expression of the immense Yellowstone volcano. In 2008, no geyser-basin scale changes were noted in Yellowstone's geothermal system. The Old Faithful eruption interval remained at 90 to 91 minutes and Steamboat Geyser did not have a major eruption. Hydrothermal explosions occurred at three places: Biscuit Basin, Ferris Fork Hot Springs and the Mushpots in Pelican Valley.

Work continues on Yellowstone's Geothermal Monitoring Program. Progress is being made in documenting the status and trends of the park's geothermal system by measuring the total amount of thermal water and the total heat output for selected geyser basins.

Oil, gas, and groundwater development outside the park and drilling in "Known Geothermal Resources Areas" identified by the USGS in Island Park, Idaho, and Corwin Springs, Montana, could alter the natural functioning of geothermal systems in the park. Research on heat-resistant microbes in the park's thermal areas has led to medical, forensic, and commercial uses.



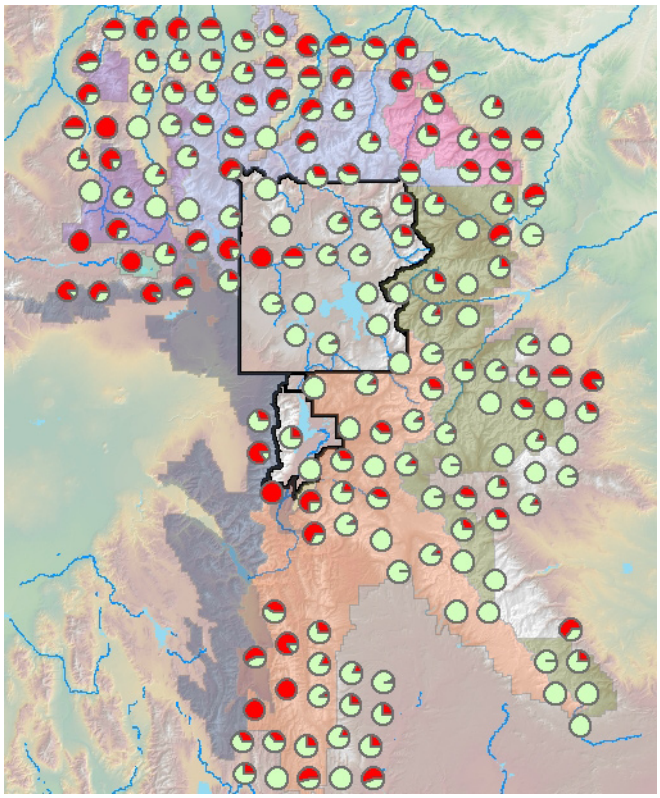
Whitebark Pine (GRYN/GYCC)

Reference Condition TBD

Based on 4,774 live whitebark pine trees that were examined in 176 transects from 2004 to 2007, preliminary estimates suggest that 20% of the whitebark pine in the GYE are infected with white pine blister rust; 2% of the trees showed evidence of mountain beetle activity. Approximately 86% of the blister rust cankers detected were on branches rather than on the main bole of the tree, where cankers are generally more detrimental to the tree's survival. Of the 744 trees that were examined in 2004, 29 (4%) had died by 2007; evidence of mountain beetle activity was found on only 9 of the dead trees.

Aerial surveys by the U.S. Forest Service since 2008 show increasing levels of whitebark pine mortality in the GYE as a result of mountain pine beetle activity, although the infested area within the park declined from 36,837 acres in 2007 to 29,805 in 2008. The currently affected area is comparable to the peak seen during the last outbreak, in 1983. Aerial surveys conducted through 2005 indicated that approximately 16% of whitebark pine dominated forest stands in the GYE had some level of mountain pine beetle mortality.

Whitebark pine seeds are dispersed almost exclusively by Clark's nutcrackers; the decline in tree density could make an area less attractive to the birds, resulting in a downward spiral for both the whitebark pine and the nutcracker.



Ratio (in red) of infected trees at each monitoring site where white pine blister rust was recorded during ground surveys, 2004–07 (provisional data). Due to map scale, symbols may not be placed at the actual survey location. The number of trees sampled per site ranged from 1 to 220. Blister rust infection does not necessarily result in tree mortality.

Conclusion

The concept of monitoring and reporting on the park's vital signs—the key natural resources that indicate the ecosystem's health—was initiated in 1999 as a part of the National Park Service's Natural Resource Challenge. This report is intended to be an annual document that will evolve based on user feedback and evaluation as our monitoring program continues to develop. As a first generation product, it is useful for transparency and communication, and it brings into sharp focus several trends in the condition of the park's natural resources. First, species that have received the time, effort, and funding of Yellowstone National Park and many other federal and state partners as part of recovery plans under the Endangered Species Act—grizzly bears, bald eagles, and gray wolves—have recovered to sustainable population levels.

Some issues, notably bison management and oversnow vehicle use in winter, remain controversial as the park's partners, the public, and the federal courts debate conflicting priorities. Despite bison removals at the park boundary as a result of the Interagency Bison Management Plan adopted in 2000, the bison population remains robust. Resource monitoring of oversnow vehicle use has shown improved winter air quality and natural soundscapes since reductions in snowmobile numbers, requirements for cleaner, quieter machines, and requirements for guided trips went into effect in 2003. Regardless of the resource conditions, the future of these issues—and the values associated with them—will continue to be hotly debated.

Finally, the effects of three overriding ecological stressors—invasive species, land use change, and climate change—are beginning to be seen on the landscape. The Yellowstone pronghorn population, which dropped from over 600 animals in 1993 to just under 300 today, can no longer migrate north of the park due to land use change, and its winter range in the park has been taken over by several nonnative invasive weed species. The restoration of native grasslands in the Gardiner Basin, currently underway, is in part intended to improve pronghorn habitat on the herd's winter range.

Although Yellowstone's air quality continues to meet federal standards for human health, it may be damaging the park's ecological health because of pollution from sources outside its boundary. Yellowstone is an active partner in the Western Regional Air Partnership to reduce the emissions of pollutants that are degrading the park's air quality.

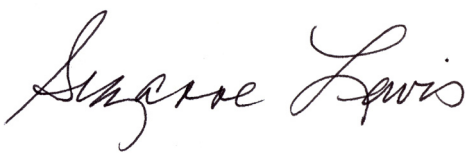
Although the evidence available from paleontological, archeological, and historical records indicates that mountain goats are not native to the GYE, the species has established a breeding population estimated to number about 200 in and adjacent to Yellowstone. Management of nonnative mountain goats has generated controversy in other National Park Service units. Determining an appropriate threshold for mountain goats and how to limit the population to that threshold will need to be debated among park staff, partners, and the public.

The GYE's whitebark pine forests remain of concern. White pine blister rust, the pathogen responsible for infecting 90% of the whitebark pine in the Northern Continental Divide Ecosystem, persists in about 20% of the GYE's whitebark pine. Of greater immediate concern, mountain pine beetle activity is comparable to levels last seen in 1983, though the area infested declined in 2008 from that of 2007. Research has suggested that mountain pine beetle infestations may persist longer and at higher rates than in the past due to climate change.

The future of the resident, non-migratory population of trumpeter swans is also of grave concern. This population, which has ranged from almost 60 individuals in 1968 to only 6 today, has declined due to changes in land use and trumpeter swan management outside Yellowstone National Park, annual variation in environmental conditions, and the long-term desiccation of ponds that provide nesting habitat. This population may now act as a biological sink to surrounding populations. Through the Greater Yellowstone Area Trumpeter Swan working group, park staff are collaborating with surrounding agencies in managing trumpeter swans throughout the tri-state region where more productive habitats may exist.

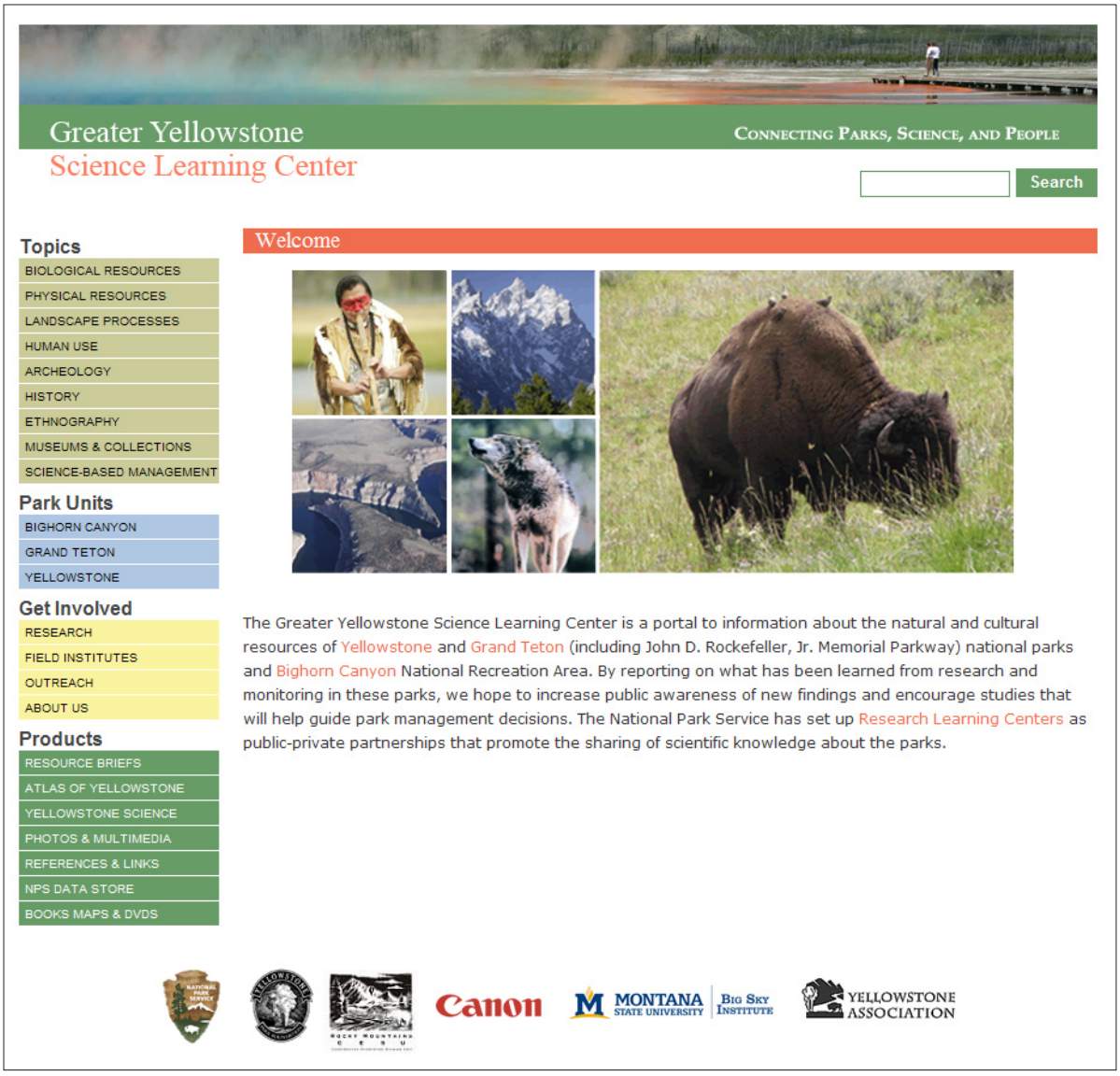
Yellowstone cutthroat trout are in serious trouble. Invasive lake trout are the proximate reason, but other invasive species, hybridization with nonnative fish, past management actions, and the effects of climate change contribute to the decline. Based on the results of an August 2008 workshop led by USGS researcher Dr. Robert Gresswell, additional efforts to increase lake trout removal, monitoring of the lake trout population, research on better lake trout control methods, and restoration of Yellowstone cutthroat trout in historical stream habitat are coming none too soon.

Long-term, scientific monitoring is the key to documenting and understanding resource conditions and ecological health. Several vital signs show that Yellowstone's ecological system is being stressed by forces acting at larger scales than the boundary of the park. Partnerships between park staff, and other federal, state, and private partners have been a successful model for addressing several issues at this scale. Existing partnerships need to be strengthened, and new partnerships formed, to address current issues and form the basis for effective stewardship of Yellowstone's resources.



Thank you for reading this report. Please send comments to Superintendent Suzanne Lewis, PO Box 168, Yellowstone National Park, Wyoming 82190.

For more information on any of the vital signs in this report,
please visit the Greater Yellowstone Science Learning Center website.



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