Park Issues

During the late 1880s when the Army administered Yellowstone National Park, the U.S. Fish Commission (a predecessor of today's U.S. Fish and Wildlife Service) stocked non-native fish in some park waters. These stockings comprise the first known, deliberate introductions of non-native fish to Yellowstone. Four trout species were widely introduced—brook, brown, lake, and rainbow. Rainbow trout hybridize with native cutthroat trout, thus diluting genetic diversity. All four compete with and prey upon native fish.

Other invasive aquatic species—New Zealand mud snail and the microorganism causing whirling disease—probably arrived via unaware boaters and anglers carrying the organisms from other fishing locations around the country.

Angler and boater introduction of aquatic invasive species remains a serious threat to Yellowstone's aquatic ecosystem because exotic aquatic species occur in waters all across the United States. We may never know exactly how whirling disease or mud snails were introduced to the park's waters, but anglers can help prevent other species from arriving.

For this reason, Yellowstone is publicizing this issue through a brochure and other information available to anglers and boaters in the park. The park's efforts join those of other agencies around the country working to protect the nation's aquatic ecosystems.

Mud Snails

About one-quarter inch long *(photo at right)*, the New Zealand mud snail forms dense colonies on aquatic vegetation and rocks along streambeds. The snails crowd out native aquatic insect communities, which are a primary food for fish. They also consume a majority of algae growth in park streams, which is a primary food for native aquatic invertebrates. Strategies for dealing with this invader are being developed.

The Issue

Aquatic invaders can irreversibly damage the park's ecosystems.

Current Status

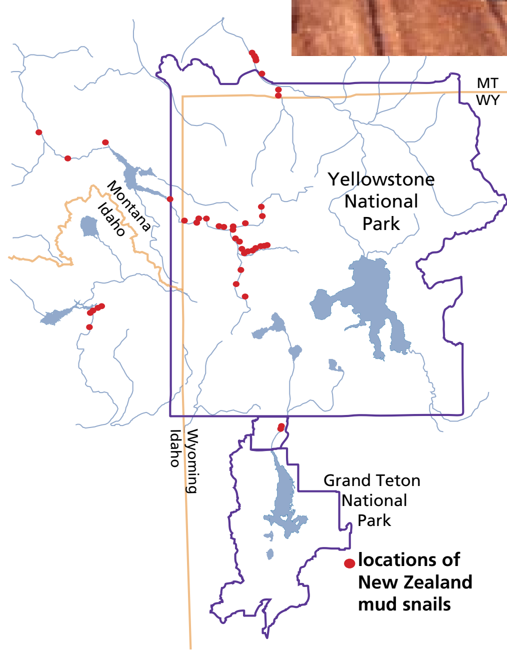
- In the U.S. currently, more than 250 exotic (from another continent) aquatic species and more than 450 non-native (moved outside their natural range) aquatic species exist.
- At least 6 invasive aquatic species exist in Yellowstone's waters:
  1 mollusk
  4 fish
  1 exotic disease-causing microorganism (whirling)
- Park staff continues to educate visitors about preventing the spread of aquatic invasive species.

Clean Your Boat! Clean Your Gear!

- Remove all plants, animals, mud, sand, and other debris from your boat and equipment.
- Rinse your boat, trailer, and equipment with high-pressure hot water.
- Drain lake and river water from your boat bilge area, livewell, and other hidden compartments, away from park waters.
- Dispose of all bait before entering the park. Otherwise, seal bait in plastic bags and place in park trash containers.
- Dry all equipment in the sun for 5 days or treat equipment with a 10 percent bleach solution.

Repeat all of the above before you leave Yellowstone National Park.

New Zealand mud snails



8

Aquatic Invaders: Lake Trout

Lake Trout

Non-native lake trout have been found in Yellowstone Lake and threaten the survival of native Yellowstone cutthroat trout and other species that depend on the native trout.

History/Background

- During the time the park stocked fish, lake trout were introduced to Lewis and Shoshone lakes.
- In 1994, an angler caught the first verified lake trout in Yellowstone Lake.
- No one knows how lake trout were introduced into Yellowstone Lake, but it probably occurred several decades ago.
- One mature lake trout can eat approximately 41 cutthroat trout per year.
- If no action is taken, the cutthroat trout population in Yellowstone Lake will likely fall to 10% of historic highs.
- Many wildlife species, including the grizzly bear and bald eagle, may depend on the cutthroat trout for a portion of their diet.
- Most predators can't catch lake trout because they live at greater depths than cutthroat trout, spawn in the lake instead of shallow tributaries, and are too large for many predators.

Current Status

- The fisheries staff is removing lake trout by gill-netting: almost 350,000 lake trout have been removed this way since the mid-1990s.
- Regulations encourage anglers to catch lake trout; approximately 9,000 per year are caught.
- Biologists are researching the abundance and distribution of lake trout in Yellowstone Lake.
- With continued aggressive control efforts, lake trout numbers can be reduced and the impacts to cutthroat trout lessened.

The lake trout is a large and aggressive predatory fish that has decimated cutthroat trout in other western waters. If its population is not controlled in Yellowstone Lake, the impacts will reach far beyond the cutthroat trout population. It has the potential to be an ecological disaster.

Controlling Lake Trout

Lake trout gill-netting begins as ice is leaving the lake and continues into October. Since the mid-1990s, almost 350,000 lake trout have been caught. Gill net operations also provide valuable population data — numbers, age structure, maturity, and potential new spawning areas—leading to more effective control. For example, during 1996, a lake trout spawning area was discovered in the West Thumb of Yellowstone Lake at Carrington Island. Since then, scientists found other spawning areas in West Thumb and Flat Mountain Arm.

Hydroacoustic work (using sonar-based fish finders) confirmed lake trout concentrations in the western portion of Yellowstone Lake. These surveys also revealed medium-sized (12–16 inches) lake trout tended to reside in deeper water (greater than 130 feet) than Yellowstone cutthroat. Now biologists can more easily target lake trout without harming cutthroat trout. Hydroacoustic data also provides minimum abundance estimates of both cutthroat and lake trout, which is invaluable information for long-term evaluation of control efforts.

Anglers are an important component in the lake trout management program. They have had the most success in catching lake trout between 15 and 24 inches long. These fish are found in shallow, near-shore waters in June and early July. Anglers have taken approximately 30 percent of the lake trout removed from Yellowstone Lake. Fishing regulations require anglers to kill all lake trout caught in Yellowstone Lake and its tributaries.

Cutthroat trout comprise about 80 percent of a mature lake trout's diet. Based on lake trout predation studies in Yellowstone Lake, fisheries biologists estimate that approximately 41 cutthroat trout are saved each year for every mature lake trout caught.

Lake trout probably can't be eliminated from Yellowstone Lake. However, ongoing management of the problem can control lake trout population growth and maintain the cutthroat trout population, which is a critical ecological link between Yellowstone Lake and its surrounding landscape.

8

Aquatic Invaders: Whirling Disease

The Madison River, which begins in Yellowstone National Park and flows through western Montana, used to be a stable, world-class trout fishery. However, beginning in 1991, studies in a section of the river outside Yellowstone National Park indicated this was changing. The population of rainbow trout in the study section was declining dramatically. Testing completed in late 1994 confirmed the presence of whirling disease, which scientists believe is one of the factors in the decline. In 1998, the disease was detected in Yellowstone's cutthroat trout.

Whirling disease is caused by a non-native microscopic parasite that can infect trout and salmon; it does not infect humans. The parasite attacks the developing cartilage of fish between 1–6 months old and causes deformities of the bony structures. An infected fish may have a deformed head and tail, blackened areas of the tail, and whirling swimming behavior. It may be unable to feed normally and is vulnerable to predation.

Whirling Disease

Whirling disease is caused by a parasite attacking the developing cartilage of young fish, resulting in skeletal deformities and sometimes whirling behavior. Affected fish cannot feed normally and are vulnerable to predation.

History/Background

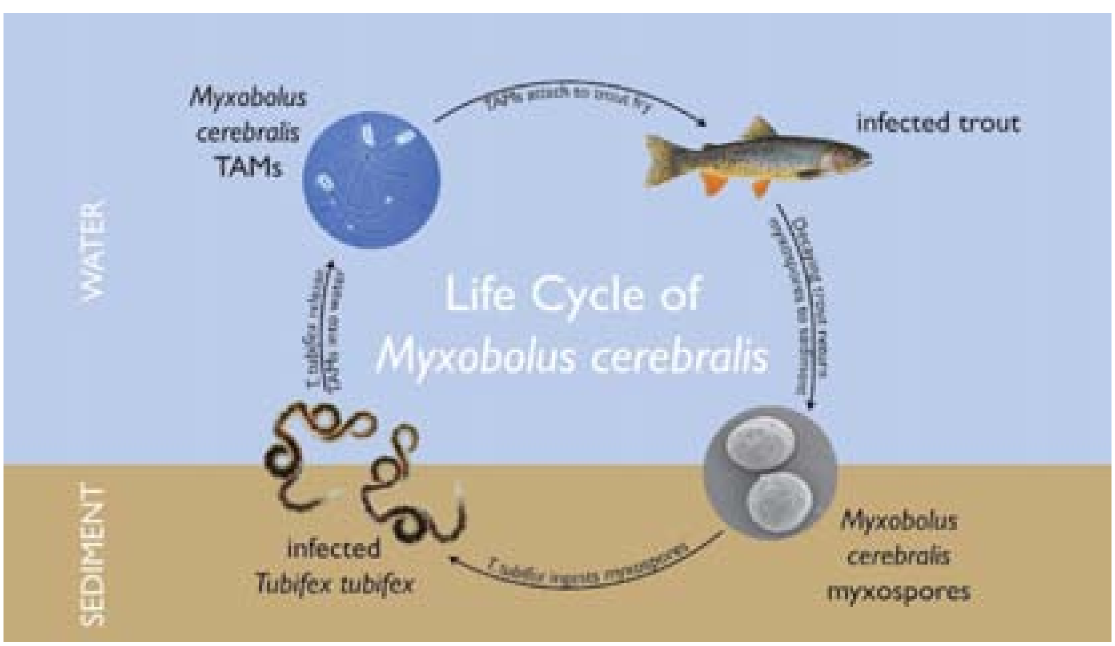
- The disease was first described in Europe more than 100 years ago. It was detected in the U.S. in the mid-1950s, and in Yellowstone in 1998.
- It most likely came to the U.S. in frozen fish products.
- Whirling disease has been confirmed in 26 states and appears to be rapidly spreading throughout the western United States.
- Recent laboratory tests suggest cutthroat trout are highly susceptible. Lake trout and grayling appear immune to the disease, and brown trout are resistant, but can be infected and can carry the parasite.
- There is no treatment.

Current Status

- Testing for whirling disease continues throughout the park.
- Pelican Creek's migratory cutthroat trout population is gone.

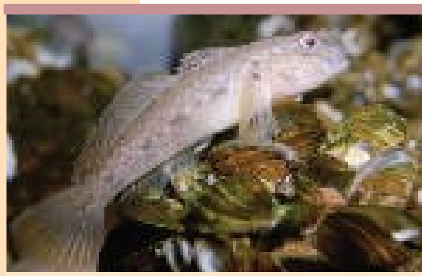
Studying the Disease

Yellowstone National Park's cutthroat trout spawning streams, which vary widely in thermal, hydrological, and geological characteristics, provide an exceptional opportunity to study whirling disease in native trout. Park staff have been working with Montana State University's Department of Ecology to measure how the infection rate



might vary in different stream conditions. They are also investigating if certain fish-eating birds help to disperse the parasite. Research has shown that the parasite can pass through the gastrointestinal tract of some birds, such as great blue herons, and remain alive.

No effective treatment exists for wild trout infected with this disease or for the waters containing infected fish. Therefore, people participating in water-related activities—including anglers, boaters, or swimmers—are encouraged to take steps to help prevent the spread of the disease. This includes thoroughly cleaning mud and aquatic vegetation from all equipment and inspecting footwear before moving to another drainage. *(See page 155.)* Anglers should not transport fish between drainages and should clean fish in the body of water where they were caught.



Round goby

Bighead carp

Zebra mussels clog water intakes, crowd out bottom invertebrates, and reduce lake productivity.

Not shown: three zooplankton species that can displace native zooplankton that are important food for cutthroat trout. These exotic zooplankton have long spines, which make them difficult for young fish to eat.

More Invaders on Their Way

Several exotic aquatic species are spreading through the United States, among them the species shown here. Fisheries biologists believe they are moving toward Yellowstone. Their arrival might be delayed if anglers remember:

- It is illegal to use any fish as bait in Yellowstone National Park.
- It is illegal to transport fish among any waters in the Yellowstone region.
- It is illegal to introduce any species to Yellowstone waters.
- To clean all of their gear properly. *(See page 155.)*

Eurasian water-milfoil

Eurasian water-milfoil *(below)* has spread to 46 of the 48 contiguous United States. In 2007, it was found in Montana. Wyoming and Maine are the only states still free of this aquatic invader.

This exotic aquatic plant lives in calm waters such as lakes, ponds, and calm areas of rivers and streams. It grows especially well in water that experiences sewage spills or abundant motorboat use, such as Bridge Bay.

Eurasian water-milfoil colonizes via stem fragments carried on boating equipment, which is another reason why boats should be thoroughly cleaned, rinsed, and inspected before entering Yellowstone National Park.

8

Issues: Bear Management

Revised

During its first century, Yellowstone National Park was known as the place to see and interact with bears. Hundreds of people gathered nightly to watch bears feed on garbage in the park's dumps. Enthusiastic visitors fed bears along the roads and behaved recklessly to take photographs.

Beginning in 1931, park managers recorded an average of 48 bear-inflicted human injuries and more than 100 incidents of property damage each year in Yellowstone.

In 1960, the park implemented a bear management program—directed primarily at black bears—designed to reduce the number of bear-caused human injuries and property damages and to re-establish bears in a natural state. The plan included expanding visitor education about bear behavior and the proper way to store food and other bear attractants; using bear-proof garbage cans; strictly prohibiting feeding of bears; and removing potentially dangerous bears, habituated bears, and bears that damaged property in search of food.

After 10 years of this program, the number of bear-caused human injuries decreased only slightly, to an average of 45 each year. Consequently, in 1970, Yellowstone initiated a more intensive program that included eliminating open-pit garbage dumps inside the park. The long-term goal was to wean bears off human food and back to a natural diet of plant and animal foods.

Drs. John and Frank Craighead, who were brothers that had studied grizzly bear ecology since 1959, predicted bears would range more widely and come into more conflict with humans. This indeed occurred in the first three years when an annual average of 38 grizzly bears and 23 black bears were moved to backcountry areas, and an annual average of 12 grizzly bears and 6 black bears were removed from the population. After 1972, though, the number of bear-human conflicts decreased to an annual average of 10 each year. Bear removals also decreased.

In 1983, the park implemented a new grizzly bear management program that emphasized habitat protection in backcountry areas. The park established "bear management areas" that restricted recreational use where grizzly bears were known to concentrate. The goals were to minimize bear-human interactions that might lead to habituation of bears to people, to prevent human-caused displacement of bears from prime food sources, and to decrease the risk of bear-caused human injury in areas with high levels of bear activity. This program continues today.

Bear Management

Feeding Bears

- Late 1880s: Bears begin gathering at night to feed on garbage behind park hotels.
- 1910: First incidents of bears seeking human food along park roads.
- 1916: First confirmed bear-caused human fatality.

Early Management

- 1931: Park begins keeping detailed records of bear-inflicted human injuries, property damage, and bear control actions.
- 1931–1969: average of 48 bear-inflicted human injuries and more than 100 incidents of property damage occurr annually in Yellowstone.

Changes in Management

- 1970: Yellowstone implements a new bear management program to restore bears to subsistence on natural foods and to reduce property damage and human injuries.
- Strictly enforcing regulations prohibiting the feeding of bears and requiring proper storage of human food and garbage.
- All garbage cans in the park convert to a bear-proof design.
- Garbage dumps close within and adjacent to the park.

Current Status

- Decrease in human injuries from 45 injuries per year in the 1960s to 1 injury per year in the 2000s.
- Decrease in property damage claims from 219 per year in the 1960s to an average of 15 per year in the 2000s.
- Decrease in number of bears that must be killed or removed from the park from 33 black bears and 4 grizzlies per year in the 1960s to an average of 0.34 black bear and 0.2 grizzly bear per year in the 2000s.
- Decrease in bear relocations away from the front country from more than 100 black bears and 50 grizzlies per year in the 1960s to an average of 0.4 black bear and 0.6 grizzly bear per year in the 2000s.

For details about grizzly bear management, see the next page.

8

Bear Management: Grizzly

Grizzly Bear Management

The grizzly bear was listed as a threatened species in 1975, which required recovering the species to a self-sustaining population.

Background

1993: A recovery plan is implemented with three specific recovery goals that have to be met for six straight years.

2000: A team of biologists and managers from the USFS, NPS, USFWS and the states of Idaho, Wyoming, and Montana complete the Draft Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Ecosystem.

2000–2002: Public comment periods included meetings held in Montana, Wyoming, and Idaho; total number of comments: 16,794.

2002: The Conservation Strategy is approved and implemented.

2003: The recovery goals are met for the sixth year in a row.

2005: The USFWS proposes removing the grizzly bear from the list of threatened species.

2006: The Grizzly Bear Recovery Plan is modified to update methods of estimating population size and sustainable mortality.

2007: The grizzly bear population in the Greater Yellowstone Ecosystem is removed from the federal threatened species list.

Conservation Strategy Highlights

1. Establish population and habitat triggers that initiate a biological review of the species if the population or habitat fall below certain thresholds.
2. Protect habitat.
3. Monitor changes in genetic diversity, major food sources, predation of livestock, private land development inside the recovery area, hunter-related bear deaths, and cub production, mortality, and distribution.

Current Status

The Conservation Strategy remains in place and scientists will continue monitoring grizzly bear populations. If Population Objective 1 *(see chart next page)* is exceeded in again in 2009, the grizzly will be reconsidered for the federal threatened species list.

On July 28, 1975, under the authority of the Endangered Species Act (ESA), the U.S. Fish and Wildlife Service (USFWS) listed the grizzly bear in the lower 48 states as threatened under the Endangered Species Act, in part, because the species was reduced to only about two percent of its former range south of Canada. Five or six small populations were thought to remain, totaling 800 to 1,000 bears. The southernmost—and most isolated—of those populations was in greater Yellowstone, where 136 grizzly bears were thought to live in the mid-1970s. The goal of ESA listing is to recover a species to self-sustaining, viable populations that no longer need protection.

To achieve this goal, federal and state agencies:

- Stopped the grizzly hunting seasons in the Greater Yellowstone Ecosystem.
- Established the Yellowstone grizzly bear recovery area (Yellowstone National Park, John D. Rockefeller, Jr. Memorial Parkway, portions of Grand Teton National Park and national forests surrounding Yellowstone, Bureau of Land Management lands, and state and private lands in Idaho, Montana, and Wyoming).
- Began the Interagency Grizzly Bear Study Team (IGBST) to coordinate bear management among the federal agencies and state wildlife managers; the team monitors bear populations and studies grizzly bear food habits and behavior.
- Established the Interagency Grizzly Bear Committee (IGBC) to increase communication and cooperation among managers in all recovery areas, and to supervise public education programs, sanitation initiatives, and research studies.
- Developed and implemented a Grizzly Bear Recovery Plan and a Conservation Strategy.

The Grizzly Conservation Strategy

The conservation strategy is the long-term guide for managing and monitoring the grizzly bear population and assuring sufficient habitat to maintain recovery. It emphasizes coordination and cooperative working relationships among management agencies, landowners, and the public to ensure public support, continue application of best scientific principles, and maintain effective actions to benefit the coexistence of grizzlies and humans. It incorporates existing laws, regulations, policies, and goals.

Flexibility in the Strategy

- Grizzly/human conflict management and bear habitat management are high priorities in the recovery zone, which is known as the Primary Conservation Area (PCA). Bears are favored when grizzly habitat and

Grizzly Bear Recovery Plan: New Population Monitoring Criteria

Population Objectives	01	02	03	04	05	06	07	08
1 Estimated percent of total mortality of independent aged females not to exceed 9%.	✔	✔	✔	✔	✔	✔	✔	✘
2 Estimated percent of total mortality of independent aged males not to exceed 15%.	✔	✔	✔	✔	✘	✔	✔	✘
3 Estimated percent mortality from human causes for dependent young not to exceed 9%.	✔	✔	✔	✔	✔	✔	✔	✔
4 Demographic objective of 48 females producing cubs annually.	✔	✔	✔	✔	✔	✔	✔	✔

Was the objective achieved?

other land uses are incompatible; grizzly bears are actively discouraged and controlled in developed areas.

- State wildlife agencies have primary responsibility to manage grizzly bears outside of national parks, including bears on national forests; national parks manage bears and habitat within their jurisdictions.
- Sustain a grizzly bear population at or above 500 bears in the Greater Yellowstone Ecosystem.
- Monitor the grizzly population and habitat conditions using the most feasible and accepted techniques, such as maintaining a radio-collared sample of bears and scientifically assessing habitat conditions and changes on a broad geographic scale.
- Remove nuisance bears conservatively and within mortality limits outlined above, and with minimal removal of females; emphasize removing the human cause of conflict rather than removing a bear.
- Increase flexibility to manage nuisance grizzlies, particularly male bears; relocate as many times as judged prudent.
- Eliminate bear management areas; base decisions affecting grizzly bears and their habitat on existing and future management plans with input from biologists, other professional land managers, and the public living in those areas.
- Outside the PCA, states develop management plans, with input from affected groups and individuals, that define where grizzly bears are acceptable.
- State and federal managers will share information, coordinate management actions, collect data, and identify research and financial needs.

Outlook

Scientists and managers believe the grizzly population has experienced robust growth since 1986. Cub production and survival have been high and bears are raising cubs in nearly all portions of the recovery area. They are also dispersing into new habitat. Of the 596 grizzly bears estimated to live in the area, approximately 175 have home ranges wholly or partially in Yellowstone National Park. The ranges of other bears extend south into the Wind River Range, north throughout the Gallatin Range, and east of the Absarokas onto the plains.

Scientists will continue to monitor the long-term recovery goals for grizzly bears as outlined above. A review of the bears' status is automatically begun if one of these three conditions are met:

- Female mortality is exceeded for two consecutive years.
- Male mortality is exceeded for three consecutive years.
- Dependent young mortality is exceeded for three consecutive years.

The chart above shows the conditions as of January 2009. If the first condition is exceeded again in 2009, USFWS will begin a status review to determine if the Yellowstone grizzly bear population needs to be relisted under the Endangered Species Act. Any organization or individual can also petition for a status review.

8

Issues: Bioprospecting & Benefits-sharing

The Issue

Should researchers who study material obtained under a Yellowstone National Park research permit be required to enter into benefits-sharing agreements with the National Park Service before using their research results for any commercial purpose?

Definitions

Bioprospecting is the search for useful scientific information from genetic or biochemical resources. It does not require large-scale resource consumption typical of extractive industries associated with the term "prospecting," such as logging and mining.

Benefits-sharing is an agreement between researchers, their institutions, and the National Park Service that returns benefits to the parks when results of research have potential for commercial development.

History

1966: The microorganism *Thermus aquaticus* was discovered in a Yellowstone hot spring.

1985: An enzyme from *T. aquaticus,* which is synthetically reproduced, contributed to the DNA fingerprinting process that has earned hundreds of millions of dollars for the patent holder.

1997: The park signed a benefits-sharing agreement with Diversa Corporation, ensuring a portion of their future profits from research in Yellowstone National Park will go toward park resource preservation.

1999: A legal challenge put on hold implementation of this agreement until an environmental analysis (EA or EIS) is completed.

2006: Draft EIS released.

Current Status

- The final EIS is being prepared.
- Each year, approximately 40 research permits are granted to scientists to study microbes in Yellowstone. Research permits are only granted for projects that meet stringent park protection standards.
- Research microbiologists continue to find microorganisms in Yellowstone that provide insights into evolution, aid in the search for life on other planets, and reveal how elements are cycled through ecosystems.

See Chapter 4, "Life in Extreme Heat."

Yellowstone's hydrothermal microbes (called thermophiles) have been the subject of scientific research and discovery for more than 100 years. One of these discoveries—of the uses for *Thermus aquaticus*—has led to scientific and economic benefits far beyond what anyone could have imagined. Today, several dozen scientific research projects—sponsored by universities, NASA, and corporations—are underway in the park to investigate thermophiles. *(See Chapter 4 for more information on these life forms.)* Some of their discoveries have been used for commercial purposes, which is the heart of the benefits-sharing issue.

History

Careful scientific study of these curious life forms began in earnest in 1966, when Dr. Thomas Brock discovered a way to grow one of the microorganisms living in the extraordinarily hot waters (more than 158°F/70°C) of Mushroom Pool in the Lower Geyser Basin. This bacterium, *T. aquaticus,* proved essential to one of the most exciting discoveries in the 20th century.

Until the 1980s, our ability to study DNA was limited. Things we take for granted today such as DNA fingerprinting to identify criminals, DNA medical diagnoses, DNA-based studies of nature, and genetic engineering were unimaginable. But in 1985, the polymerase chain reaction (PCR) was invented. PCR is an artificial way to do something that living things do every day—replicate DNA. PCR is the rocket ship of replication, because it allows scientists to make billions of copies of a piece of DNA in a few hours. Without PCR, scientists could not make enough copies of DNA quickly enough to perform their analyses. An enzyme discovered in *T. aquaticus*—called Taq polymerase—made PCR practical. Because it came from a thermophile, Taq polymerase can withstand the heat of the PCR process without breaking down like ordinary polymerase enzymes. A laboratory version of this enzyme is now used and has

Dr. Thomas Brock

allowed DNA studies to be practical and affordable.

Many other species of microbes have been found in Yellowstone since 1966. Each of these thermophiles produces thousands of uncommon, heat-stable proteins, some useful to scientists. Researchers estimate more than 99 percent of the species actually present in Yellowstone's hydrothermal features have yet to be identified.

Science

Because much of modern biotechnology is based on the use of enzymes in biochemical reactions—including genetic engineering, fermentation, and bioproduction of antibiotics—heat-stable catalytic proteins that allow reactions to occur faster are increasingly important in the advancement of science, medicine, and industry. In addition, genetic studies using knowledge developed from the study of microbes is increasingly important to medical and agricultural research. Yellowstone's geology provides a wide variety of high-temperature physical and chemical habitats that support one of the planet's greatest concentrations of thermophilic biodiversity. Research on these thermophiles can contribute to further advances.

Ongoing Research

Approximately 40 research studies are being conducted in Yellowstone on the ecological roles and community dynamics of microorganisms, and how to search for traces of similar life forms in the inhospitable environments of other planets. Research on park microbes also has proved useful in producing ethanol, treating agricultural food waste, bioremediating chlorinated hydrocarbons, recovering oil, biobleaching paper pulp, improving animal feed, increasing juice yield from fruits, improving detergents, and a host of other processes.

Controversy

Along with this exciting new dimension in understanding park resources through research, questions have been raised about whether or not bioprospecting should be allowed. Bioprospecting is biological research associated with the development of commercial products. Bioprospecting does not require the sort of grand-scale resource consumption required by the kinds of extractive industries typically associated with the term "prospecting," such as logging and mining. In this case, the "prospecting" is for new knowledge. As required by law, research is encouraged in Yellowstone if it does not adversely impact park resources and visitor use and enjoyment. Importantly, only research results, i.e. information and insight gained during research on park specimens, may be commercialized—not the specimens themselves. Nonetheless, some people question the appropriateness of allowing scientists to perform research in a national park if they are bioprospectors.

The most famous commercial application for Yellowstone-related research was the invention of the polymerase chain reaction (PCR), discussed above. PCR generated

8

Bioprospecting & Benefits-sharing

T. aquaticus as seen through a scanning electron microscope

significant profits for Cetus Corporation, which had patented the processes. In 1991, Hoffman-La Roche, a Swiss pharmaceutical company, purchased the U.S. patents for a reported $300 million. Ten years later, annual sales of Taq polymerase reportedly were $100 million. Yellowstone National Park and the United States public have received no direct benefits even though this commercial product was developed from the study of a Yellowstone microbe. Hoffman-La Roche and the researchers acted lawfully throughout the development and sales of Taq polymerase. At issue is whether or not the National Park Service (NPS) should require researchers who study material obtained under a research permit to enter into benefits-sharing agreements with NPS before using their research results for any commercial purpose.

Benefits-Sharing

Federal legislation authorizes the National Park Service to negotiate benefits-sharing agreements that provide parks a reasonable share of profits when park-based research yields something of commercial value. Similar agreements are used by other countries to allow the host nation to benefit from commercial discoveries that depended on its natural heritage. In 1997, Yellowstone National Park became the first U.S. national park to enter into a benefits-sharing agreement with a commercial research firm. The Yellowstone–Diversa Cooperative Research and Development Agreement (CRADA) provided that Diversa Corp. would pay Yellowstone $100,000 over five years (even if research resulted in no commercially valuable discoveries) and included provisions of no-cost scientific analyses and laboratory equipment, plus a royalty based on any sales revenues related to results from research in the park. The CRADA did not authorize Diversa to collect specimens or conduct research in the park. Permission to conduct research can only be acquired by applying for a research permit. In Yellowstone, an interdisciplinary team requires research permit applicants to abide by strict resource protection standards. Diversa, which had research sites around the world, was collecting DNA samples directly from nature and screening the genes for the ability to produce useful compounds. In its labs, scientists spliced the most useful genes into microbial "livestock," and these microbes then produced the compound or enzyme. (Diversa no longer exists; it merged with another corporation.) As with all NPS research specimens, the Yellowstone microbes and DNA collected in the park remain in federal ownership and are never sold.

The 2000 court decision is available at www.nature.nps.gov/benefitssharing

Into Court

Shortly after the Yellowstone-Diversa CRADA was signed, opponents sued NPS in federal court arguing that the policy put into play a new commercial activity and was illegal and inappropriate in parks. In 1999, the judge ordered NPS to prepare an environmental analysis of the potential impacts of benefits-sharing agreements and suspended the CRADA pending completion of the analysis. In 2000, the court dismissed the remainder of the case, ruling:
1) the CRADA was consistent with the NPS mission of resource conservation; 2) bioprospecting did not constitute a consumptive use; 3) bioprospecting did not represent a "sale or commercial use" of park resources; and 4) Yellowstone fell within the definition of a federal laboratory and appropriately implemented the CRADA.

Outlook

In September 2006, NPS released the draft environmental impact statement (EIS). Approximately 9,600 individuals and organizations commented on this draft. The final EIS is being prepared now. When it is released, it will be available on the web *(see at left)*. Following release of this final EIS, NPS will decide whether benefit-sharing should be implemented in national parks nationwide.

The final EIS will be available at parkplanning.nps.gov: select "Washington Office" from the menu and follow the links.

The study of natural resources has long been a source of knowledge that benefits humanity. For example, more than half of the pharmaceuticals used in the United States contain at least one major active compound derived from or patterned after natural compounds. As global biodiversity declines, national parks and other preserves become increasingly important as sources of genetic diversity for scientific study to discover knowledge to develop new solutions to the problems faced by humanity.

8

Issues: Bison Management

Revised

About Brucellosis

Brucellosis, caused by the bacterium *Brucella abortus*, can cause pregnant cattle, elk, and bison to abort their calves. It is transmitted primarily when uninfected, susceptible animals come into direct contact with infected birth material. No cure exists for brucellosis in wild animals. All cattle that use overlapping ranges with bison are vaccinated for brucellosis when calves, as are bison calves and yearlings released after capture.

Although rare in the United States, humans can contract brucellosis by consuming unpasteurized, infected milk products or contact with infected birth tissue. It cannot be contracted by eating cooked meat from an infected animal. In humans, the disease is called undulant fever. Since the advent of milk pasteurization, people in developed countries have virtually no risk of contracting the disease. And if they do, they can be treated with antibiotics.

Brucellosis was discovered in Yellowstone bison in 1917. They probably contracted the disease from domestic cattle raised in the park to provide milk and meat for visitors. Now about 50 percent of the park's bison test positive for exposure to the *brucella* organism. However, testing positive for exposure (seropositive) does not mean the animal is infectious and capable of transmitting brucellosis. (For example, people who received smallpox immunization during their childhood will test positive for smallpox antibodies even though they are not infected with the disease and cannot transmit it.) Research indicates less than half of seropositive female bison are infectious at the time of testing. Male bison do not transmit the disease to other bison. (Transmission between males and females during reproduction is unlikely because of the female's protective chemistry.) Bison have a very low probability of transmitting brucellosis to cattle under natural conditions, in part because management strategies prevent bison from commingling with cattle.

Park managers face numerous uncertainties about how to best manage and preserve bison while addressing the issue of brucellosis-infected wildlife in the greater Yellowstone area. In the absence of data to describe bison-*brucella* interactions, assumptions are based on the best available information. Studies conducted on cattle and *brucella* offer clues to how the disease may function in bison. Current information shows both species exhibit very similar clinical signs of brucellosis infection and very

The Issue

About half of Yellowstone's bison test positive for exposure to brucellosis, a disease that can cause bison and domestic cattle to abort their first calf. Because Yellowstone bison migrate into Montana, their exposure to brucellosis concerns the state's cattle industry.

History/Background

(See also timeline on pages 166–167)

- Bison probably contracted brucellosis from cattle raised in the park to provide milk and meat for park visitors in the early 1900s.
- Brucellosis has little impact on the growth of the bison population.
- The disease may be contracted by contact with infected tissue and birth fluids of infectious cattle or bison that are shed at the end of pregnancy.
- The human form of the disease, called undulant fever, is no longer a public health threat in the U.S.
- A vaccine used in cattle, RB51, is being used for Yellowstone bison.
- Bison have not been known to transmit brucellosis to cattle under natural conditions although transmission has occurred in captivity.
- The state of Montana, like other states, has spent much time, effort, and money attempting to eradicate brucellosis in cattle.
- Elk in the greater Yellowstone area also carry brucellosis.

Current Status

- The bison management plan in effect since December 2000 has been revised.
- Bison are now tolerated outside the west boundary until May 15.
- A large herd of cattle on the north boundary has been removed, opening that area to a few bison in winter.
- A few tribes are conducting bison hunts north of Yellowstone according to their 1855 treaties with the United States.

Agencies Involved

National Park Service (NPS)
Animal Plant Health Inspection Service (APHIS)
U.S. Forest Service (USFS)
Montana Department of Livestock (DOL)
Montana Department of Fish, Wildlife & Parks (FWP)

- 1985 — Montana receives brucellosis-free status; begins public hunts for bison.
- 1989 — Almost 600 bison killed in public hunt.
- 1990 — Montana ends hunt due to public outcry. NPS prepares EA enabling park staff to haze and shoot bison outside the park.
- 1995 — Montana files lawsuit against NPS; settlement requires EIS preparation.
- 1996 — Interim Bison Management Plan begins.
- 1997 — Unusually severe winter. More than 1,000 bison shot or shipped to slaughter.
- 1998 — 94 bison died in management actions. Draft EIS released. Receives 67,500+ public comments.
- 1999 — No bison die in management actions. August: Almost 8,000 acres winter wildlife habitat acquired by federal government or put under easement. December: Federal agencies withdraw from agreement with Montana to produce an EIS.

similar methods for transmitting the disease to other individuals. However, a scientific review of published and unpublished data indicates bison differ from cattle in their response to vaccines and possibly to standard testing for the disease. In addition, the majority of elk in the greater Yellowstone area have a brucellosis exposure rate up to 3 percent; but elk that use feed grounds in Wyoming outside of Yellowstone National Park show exposure rates up to 35 percent. This disease reservoir may be a brucellosis transmission risk to bison. Studies are being conducted on wild bison to better understand the bison-*brucella* relationship, and to study these other questions.

Cattle–Bison Conflicts

Federal and state agencies and the livestock industry have spent much time and money to eradicate brucellosis from cattle. States accomplishing this task receive "brucellosis class-free" status and can export livestock without restrictions and costly disease testing. Brucellosis infections in two cattle herds would downgrade a state's status and adversely affect the finances of ranchers. When one cow in a cattle herd becomes infected with brucellosis, the herd is quarantined and may be slaughtered to eliminate the infection. Federal and state indemnity funds partially compensate the livestock producer for this loss.

Montana first attained class-free status in 1985, but two cattle ranches have recently become infected (one in 2007 and a second in 2008) and the state subsequently was downgraded to class-A status. Following a scientific review of the risk and extensive testing of cattle close to the infected herds, the state will petition to regain its class-free status. The U. S. Department of Agriculture will review the case and determine when to re-classify Montana as brucellosis free. There is a minimum one year time period before class-free status can be regained.

Because of concern over losing brucellosis class-free status, livestock regulatory agencies recommend an aggressive strategy for managing wildlife to achieve the goal of brucellosis eradication in the greater Yellowstone area. A National Academy of Sciences review panel suggested that brucellosis eradication is not possible in wildlife with the current technology. The panel recommended managing bison and livestock to minimize interspecies transmission risks. Keeping bison and livestock separated is a key part of the Interagency Bison Management Plan *(IBMP; described on page 168)*.

Vaccinating cattle and bison is another important component of the IBMP. RB51 is a brucellosis vaccine safe for bison calves, yearlings, and adult males. Unlike other brucellosis vaccines, animals vaccinated with RB51 will not test positive for brucellosis on the standard battery of diagnostic tests. Vaccination of some Yellowstone bison began in spring 2004; it is limited to calves and yearlings captured at the boundary and then released back into the park.

Developing a Long-term Management Plan

In 1985, the year that Montana first received brucellosis class-free status, the state began a public hunt along the north and west boundaries to keep bison out of the state. After 569 bison were killed in the winter of 1988–89, nationwide criticism over how the hunt was conducted caused the state to stop the hunt.

In 1989, the state of Montana, Yellowstone National Park, and Gallatin National Forest agreed to develop a long-term management plan to cooperatively manage bison. While they were preparing this plan, Montana needed an interim management plan to protect private property, provide for human safety, and protect the state's brucellosis class-free status. A 1990 management plan provided for limited NPS management of

2000 — *February: Federal judge orders state & federal agencies into mediation to work out differences. August: Final EIS released. December: Records of Decision signed by federal and state governments.*

2002–2005 — *During years 2–5 of the Bison Management Plan, more than 200 bison are shipped to slaughter or killed.*

2005 — *FWP & APHIS open quarantine facility; several dozen bison calves taken from Yellowstone for project. DOL & APHIS begin vaccinating captured bison.*
FWP begins bison hunt on November 15.

990 bison removed from Yellowstone through management actions, transfer to quarantine, or hunting.

2006 — *More than 2000 bison removed from Yellowstone, mostly by being shipped to slaughter.*

2008 — *August: State and federal agencies begin revising the management plan.*
December: Revisions to plan announced; more bison will be tolerated outside both boundaries in winter.

bison through hazing, monitoring, and shooting outside of park boundaries. In 1992, the partners added the federal Animal Plant Health Inspection Service (APHIS) to to the planning process. Developing the long-term management plan was a difficult process because of a wide variety of agency perspectives and missions and would take many years to resolve these differences.

Lawsuit & Interim Management Plan

In January 1995, the state of Montana sued NPS and APHIS because the federal agencies were asking the state to implement conflicting management actions. NPS wanted more tolerance for bison on winter range outside the park; APHIS threatened the state with losing its brucellosis class-free status if bison from an infected population (i.e. Yellowstone) ranged free in Montana. In the settlement, APHIS agreed not to downgrade Montana's status if bison migrated from Yellowstone into Montana as long as certain actions were taken, including completing the long-term management plan. The partners also agreed on another interim management plan.

The 1996 interim plan called for NPS to build a bison capture facility inside Yellowstone National Park at Stephens Creek, near the northern boundary. All captured bison would be tested for brucellosis; seropositive animals would be shipped to slaughter. Any bison migrating north of the park into the Eagle Creek/Bear Creek area would be monitored and not captured. The Montana Department of Livestock (which, in 1995, had been given the lead authority to manage bison in Montana) was to capture all bison migrating out of the park at West Yellowstone and test them for brucellosis. All seropositive bison and pregnant females would be sent to slaughter. Other seronegative bison would be released on public land. The state could shoot any untested bison in the West Yellowstone area that couldn't be captured.

The last public hearing on the draft EIS, held in Minneapolis, MN, was preceded by a rally organized by area tribes.

This plan began during the winter of 1996–97, the most severe winter since the 1940s. Hundreds of bison migrated across the north and west boundaries. By the end of the winter, 1,084 bison had been shot or sent to slaughter. Bison management again became the focus of nationwide debate about how to conserve this population of bison and yet tackle the percieved threat of brucellosis transmission to livestock near the park.

Ongoing Environmental Analysis

A draft EIS describing the impacts of seven alternatives for management of Yellowstone bison was released in 1998. The draft plan received more than 67,500 public comments.

While attempting to settle on the final management strategy, the agencies reached an impasse and the federal agencies withdrew from the agreement to produce a long-term management plan. The state once again sued. The judge's opinion noted that the federal agencies had the authority to complete a management plan without the state's concurrence, but recognized that the success of a long-term bison management plan required collaboration between the state and the federal agencies. The agencies subsequently agreed to use a court-appointed mediator to help find common

Bison Management Objectives

- *Maintain genetic integrity of the bison population.*
- *Maintain a wild, free-ranging bison population.*
- *Maintain and preserve the ecological function that bison provide in the Yellowstone area, such as their role as grassland grazers and as a source of food for carnivores.*
- *Lower brucellosis prevalence because it is not a native organism.*
- *Reduce risk of brucellosis transmission from bison to cattle.*

ground in managing bison. The resulting *Final Environmental Impact Statement for the Interagency Bison Management Plan for the State of Montana and Yellowstone National Park* was released in August 2000. After a public comment period and slight modifications to the plan, the federal government and the state of Montana released separate Records of Decision in December 2000 describing the negotiated settlement.

The Interagency Bison Management Plan (IBMP)

The Interagency Bison Management Plan (IBMP) identified two common goals: 1) maintain a wild, free-ranging bison population and 2) prevent transmission of brucellosis from bison to cattle surrounding Yellowstone National Park. Because so much uncertainty remained about how to achieve these goals, the IBMP uses adaptive management, which allows for modifying the plan as scientists and managers learn more about bison behavior and migration, and about brucellosis.

The IBMP allows progressively greater tolerance for bison outside Yellowstone in three phases:

Step One: Up to 100 sero-negative bison can occupy one management area outside the west boundary, November to mid-May.

Step Two: Up to 100 sero-negative bison can be outside the north boundary from November to mid-April once cattle no longer graze on the Royal Teton Ranch during the winter (initiated March 2008).

Step Three: Up to 100 untested bison can be in both of these defined management areas during winter.

During all steps, the Eagle Creek/Bear Creek area outside the north boundary provides habitat for an unlimited number of bison during all months of the year.

The IBMP also allows natural processes to occur throughout most of the bison conservation area (the interior ranges within Yellowstone National Park) and accounts for the migratory nature of bison. But as bison approach the park boundary, more intensive management actions would occur to keep bison from commingling with cattle.

The IBMP was in use without major changes until the end of winter in 2008, and remained in Step One. Managers had the authority each winter to capture and remove all bison, regardless of disease status, outside the west boundary or north boundary if the bison population was above 3,000. Removal meant capturing bison and sending most of them to slaughter.

Winter 2005–2006

At the start of winter in 2005, almost 5,000 bison lived in the park. Hundreds migrated to winter range along and outside the park's north boundary. More than 800 bison were captured and shipped to slaughter. Also, 87 calves were sent to quarantine *(see next page)*. Scientists believe that the loss of this many bison would not prevent the long-term conservation of the bison population.

Winter 2007–2008

In the autumn of 2007, more than 4,500 bison were counted in Yellowstone. They again migrated by the hundreds out of the park. More than 2,000 bison were lost, most were shipped to slaughter. By March 2008, managers realized the bison population had dropped low enough that their long-term conservation was at risk. Management actions were put on hold, and the remaining bison were allowed outside the park with minimal hazing. As in 1997, bison management came under intense national scrutiny.

Revising the Plan

In March 2008, the Government Accounting Office (GAO) released an audit of the IBMP that recommended it be revised. GAO's recommendations included:

- Clearly define measurable objectives and refine, revise, or replace the plan and procedures as needed.
- Define specific scientific and management questions to be answered and incorporating the results into the IBMP.
- Make easily accessible to the public all documents reflecting decisions made and actions taken.
- Report annually to Congress on the progress and expenditures related to the plan.

Between August and December 2008, the agencies met seven times to begin implementing these and other changes. Their adjustments to the IBMP include:

- Establish www.ibmp.info to provide bison management documents to the public.
- Provide greater tolerance for untested bison on the Horse Butte peninsula, which is outside the park beyond West

Yellowstone.

- Allow bison beyond the northern boundary in a limited area to learn how bison may use this new winter range.
- Allow adult male bison outside the west boundary, with management based on minimizing private property damage and providing public safety.
- Work with private land owners to prevent or resolve wildlife conflicts.
- Consider fencing as a tool to help create separation between cattle and bison.

Other Recent Developments

Brucellosis near Yellowstone

Wyoming, Idaho, and Montana have lost their brucellosis-free status within the past four years. Elk—not bison—were the likely source. The states have increased efforts to keep elk and cattle separate through more aggressive disease testing, fencing, and culling. Idaho and Wyoming have regained their brucellosis-free status, and Montana is expected to regain its status as early as 2010.

Vaccination

NPS is undergoing an environmental study to evaluate vaccinating bison in the field, using remote delivery methods that do not require handling individual bison. Because scientists now know more about bison movement patterns, group dynamics, and habitat distribution, they better understand where and when remote field vaccination could succeed.

Bison hunting

The state of Montana reauthorized a winter bison hunt outside Yellowstone National Park beginning in 2005. The state hopes to use the hunt to manage bison numbers on low elevation winter range and increase public support for expanding bison habitat outside the park. In addition, the Nez Perce and Confederated Salish-Kootenai Tribes are hunting bison on public lands outside the park in accordance with their 1855 treaties with the United States.

Quarantine

Montana Fish, Wildlife and Parks and APHIS are conducting a bison quarantine feasibility study. Bison calves that would otherwise be sent to slaughter are being used to develop and test a protocol to certify disease-free bison. From the first group of 36 female bison, 22 calved successfully and cleared the quarantine protocol. They and their calves and a few males are expected to depart quarantine for a bison conservation project on tribal lands during the spring of 2009. The remaining females were allowed to breed in 2008 and will move through the final steps of quarantine in 2009. If successful, quarantine could provide a way for Yellowstone bison to be a part of bison conservation in other places.

So far, research shows that bison calves pose no risk to cattle. The risk of brucellosis transmission in the wild occurs only during the time afterbirth and its residue remain on the ground. Bison consume most of these materials.

Genetics

Several studies have reported relatively high genetic variation in Yellowstone bison compared to other bison populations in North America. This population has made a significant contribution to the overall genetic diversity in publicly-owned bison populations because they were used as a source to supplement or establish many herds. In addition, Yellowstone bison are one of only three publicly managed bison populations with no evidence of cattle hybridization.

Understanding bison movement

Like most other ungulates of greater Yellowstone area, bison are migratory, as explained in Chapter 7, "Bison." Managers are studying their movements to understand when, how, and where they migrate both inside and outside of the park. This may help managers anticipate large herd movements, and to better understand how to keep bison apart from cattle once they leave Yellowstone.

Outlook

Brucellosis is not a major factor in determining herd survival for either elk or bison, but will remain a cause of concern to the livestock industry. Therefore, state and federal agencies will continue to work together using the Interagency Bison Management Plan as their primary tool to prevent bison to livestock transmission. Each agency plays a separate role in managing this population that now has approximately 80,000 acres of habitat in Montana outside Yellowstone National Park.

8

Issues: Climate Change

The Issue

The global climate is changing, and is already affecting the Greater Yellowstone Ecosystem.

History

1750: The Industrial Revolution is underway; manufacturing begins producing greenhouse gases such as carbon dioxide and methane.

1827: Jean-Baptiste Joseph Fourier, a scientist in France, describes Earth's atmosphere being like a glass box that traps heat—later termed the "greenhouse effect."

1896: Arrehnius looks at the science, and perceives a simple cause and effect: increasing greenhouse gases in the atmosphere will cause global warming.

1958: Charles David Keeling begins measuring atmospheric carbon dioxide from Mauna Loa, Hawaii.

1957–58: International Geophysical Year

1963: Keeling warns of 10.8°F temperature rise in next century.

1965: First Global Climate Models (GCM) developed.

1969: Weather satellites begin providing weather & atmospheric data.

1978: Satellites begin measuring sea ice in both the Arctic and Antarctic.

1988: The Intergovernmental Panel on Climate Change (IPCC) is established.

1995–2006: 11 of these 12 years are the warmest years on record.

1997: The Kyoto Protocol sets mandatory targets for greenhouse gas emissions for most industrialized nations.

2007: IPCC begins its 4th report, "Warming of the climate system is unequivocal."

In the Western United States

- This region will warm more than the global average.
- Summer temperatures will increase 5–7°F in 50 years.
- Precipitation will be equal or less than present day.
- Evaporation will increase, with a net decrease in moisture available to the ecosystem even if precipitation is steady or increased.
- Ecosystem changes will be affected by land forms, microclimates, and other local factors, and will occur in all directions—north, south, lower elevations, higher elevations.
- Since the mid 1970s, the wildfire season in the western United States has increased by 11 weeks, with fires lasting an average of 5 weeks.
- Snowpack is decreasing and melting 2 to 4 weeks earlier.

In the Greater Yellowstone Ecosystem

- Growing season has increased by two weeks.
- Willows are growing three times the average recorded in the 1980s, in part due to longer growing season.
- Alpine habitat will decrease, affecting almost all alpine flora and fauna.
- Grizzly bear alpine food sources (whitebark pine, army cutworm moths) will decrease.
- Wolverine may lose habitat and denning sites.
- Pika and lynx may lose their habitat in the park.
- Sagebrush-steppe conditions, such as on the northern range, will increase.

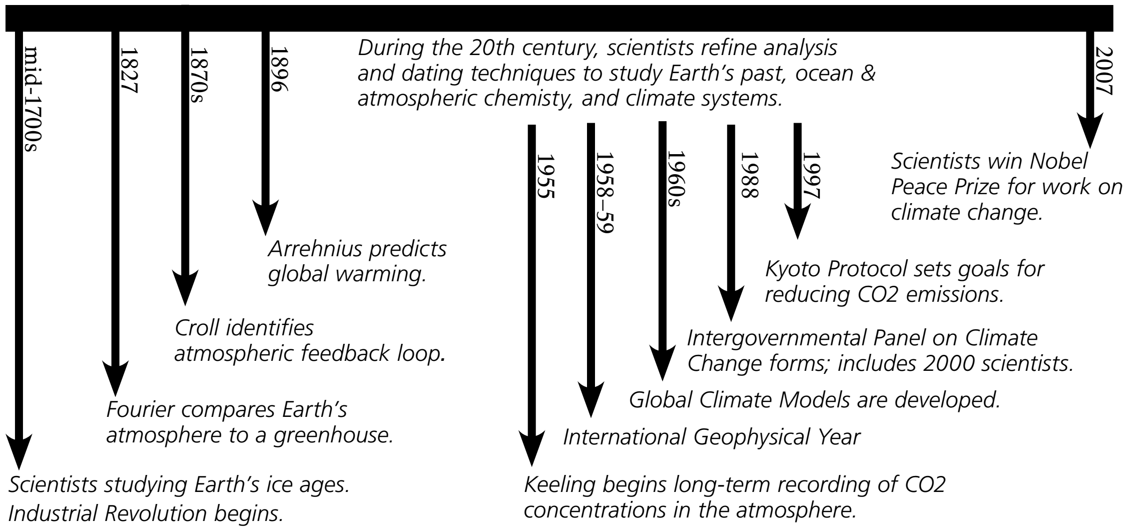
In recent years, natural events in Yellowstone associated with weather seemed to come two to three weeks early—including the peak snowmelt. Was this unusual weather or global climate change? To answer this question, you need to understand the difference between weather and climate (defined on the next page), and you need data spanning several decades, ideally centuries or even millennia. Scientists now have that data, which establish our global climate is changing rapidly and the change is unprecedented in the last several thousands of years. However, understanding global climate change dates to the 1700s.

Ironically, ice age investigations led directly to understanding global climate warming. In the 1700s, scientists began trying to understand how the ice ages had occurred. At the same time, the Industrial Revolution began, powered by fossil fuels.

Scientists studying the ice ages developed some of the first climate theories. For example, Jean-Baptiste Joseph Fourier compared Earth's atmosphere to a glass box, which allows heat in but not out—which later scientists called "the greenhouse effect." James Croll noted that ice and snow reflect heat back into the atmosphere—and if the amount of heat changed, winds would change, which would affect ocean currents, which could sustain cold temperatures—and thus create a feedback loop.

In 1896, a Swedish scientist connected climate with pollution. Savre Arrehnius wanted to know how carbon dioxide (CO_2) might have affected the ice ages. He calculated the amount of CO_2 emitted by industry, then doubled that amount and calculated it would raise global temperatures 9–11°F.

During the first 50 years of the 20th century, scientists continued to research the ice ages, developing methods and data essential to



future understanding of climate change. For example, scientists began studying pollen found in sediment layers. Based on the types of vegetation represented, the scientists could assume climate conditions in the past would resemble climate conditions where such vegetation is found today. Similarly, they developed a method to measure ancient ocean temperatures by studying shells of plankton laid down over centuries in the sea bed. By 1955, scientists had ocean temperature records going back 300,000 years.

In the 1950s, scientific attention began focusing on Earth's systems. Roger Revelle found the oceans could not absorb all the CO_2 humans were emitting. Knowing that CO_2 emissions would increase as industrialization increased, he wanted to know where the CO_2 would go. Revelle hired Charles Keeling to gather baseline data on atmospheric CO_2 from a lab on Mauna Loa, Hawaii, far from industry. Keeling saw the opportunity to begin long-term CO_2 analysis, and so began the first data set confirming atmospheric CO_2 was rising far beyond that caused by any natural mechanisms. *(See chart next page.)*

Additional research begun during the 1957–58 International Geophysical Year produced equally interesting results, and the general public began to take notice. Newspapers began reporting evidence of climate change, such as thinning of the Arctic sea ice. During the 1960s, the first Global Climate Models (GCMs) were developed and weather satellites began gathering data about the atmosphere's chemical composition.

During the ensuing decades, scientists continued to refine instruments and models, and to gather data. To assemble and review this data, the United Nations established the Intergovernmental Panel on Climate Change (IPCC) in 1988, which is comprised of 2000 scientists. Based in part upon the IPCC's work, more than 60 countries convened in 1997 to draft the Kyoto Protocol, which set mandatory targets for greenhouse gas emissions for most industrialized nations. In 2007, the IPCC shared the Nobel Peace Prize with Al Gore, and published its fourth report, which begins with this conclusion: "Warming of the climate system is unequivocal."

Climate-Change Science

The IPCC, in its 2007 report, explains: "Projecting changes in climate due to greenhouse gases 50 years from now is very different and much more easily solved problem than forecasting weather patterns just weeks from now." Weather systems are chaotic and hard to measure and predict; longer-term changes, however, can be measured and predicted because we have the necessary instruments and understanding. However, when you average weather data, "the fact that the globe is warming emerges clearly."

Two basic physical factors are at work in climate change: water expands when heated; open water and bare ground absorb thermal energy, thus warming the sea, land, and air.

Evidence

Since the end of the last glaciations, 13,000 to 14,000 years ago, Earth's snow and ice cover has remained relatively consistent. These highly reflective surfaces bounce thermal radiation back into the atmosphere, and as long as this reflection remains steady, so do world temperatures. Satellite and military data during the past few decades show Arctic ice is thinning and melting; and much evidence shows annual snow cover is diminishing worldwide, but especially in the northern hemisphere. As snow and ice

The Terms of Climate Change

Weather: *the state of the atmosphere at a given time and place, and for the next few days to a month.*

Climate: *long-term meteorological conditions that prevail in a region, with a decade as the minimum span of averages.*

Global Climate Models (aka Global Circulation Models): *GCMs use established physical laws (such as water expands as it warms) and enormous amounts of data to show how variables (such as increases in carbon dioxide) will affect climate.*

Phenology: *Relationship between periodic biological changes—like the budding of trees or arrival of migratory birds in the spring—and seasonal changes such as temperature.*

Climate changes in the past were caused, in part, by changes in the Sun's activity. Scientists have detected no such changes in the Sun during the past few decades.

coverage decrease, less thermal radiation is reflected, and more heat is absorbed by the increasing amounts of open water and bare land. This increased absorption increases surface and air temperatures.

Ocean temperature is measured every day from thousands of ships; this record combined with air temperature records provide the estimated global average temperature each month. As oceans warm, they expand and their levels rise. Data collected since the 1990s show oceans are rising 0.12 inches per year—50 percent due to water expanding from increased temperatures and 50 percent due to melting ice. This rate of change is unprecedented; the record shows global sea levels had been stable for thousands of years until the 20th century.

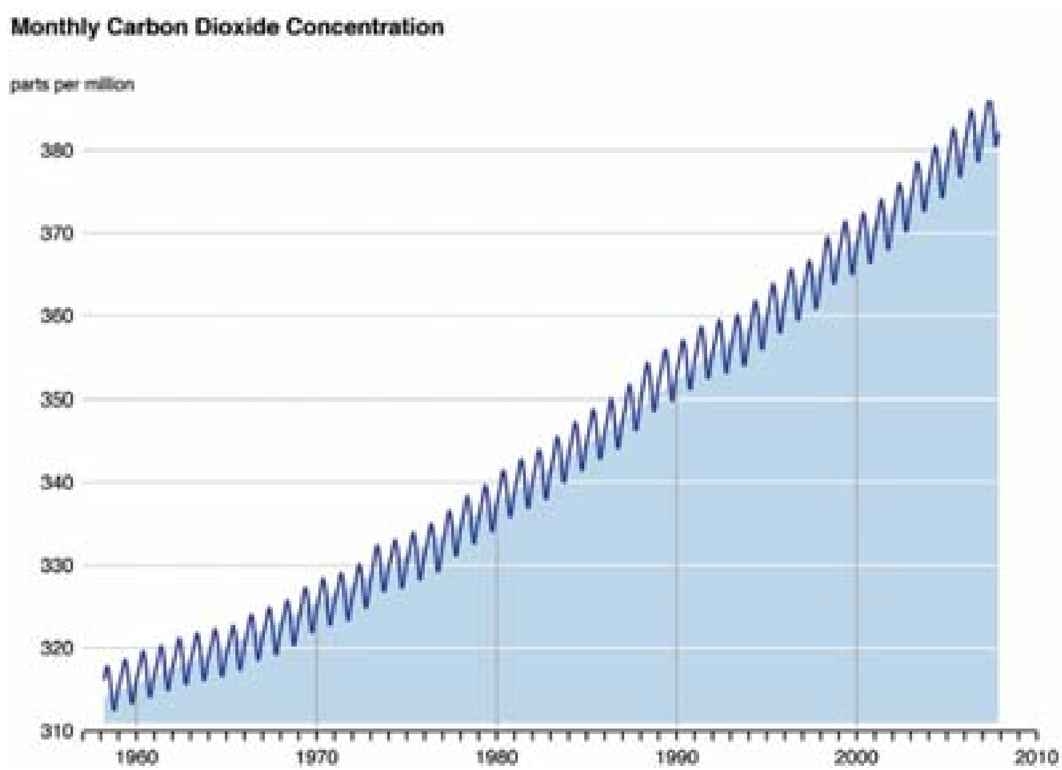
As scientists predicted in the 1800s, carbon dioxide build-up in the atmosphere is causing this extreme and rapid change in Earth's temperature. Ice core records show that after the last glacial period ended, CO_2 concentration gradually rose 80 ppm (parts per million) over 5,000 years. During the past 100 years alone, the concentration has risen 79 ppm—an unprecedented rate.

More than three-fourths of the CO_2 in the atmosphere comes from burning fossil fuels. Scientists know this because carbon atoms released during combustion are chemically distinguished from carbon released by natural causes, and thus can be measured.

Current Effects Around the World

- Since the 1950s, in most mid- to high-latitude regions, the number of very cold days and nights has decreased; the extremely hot days and nights have increased; and the length of the frost-free season has increased.
- In 2006, the average mean temperature in the United States was 55˚F—2.2˚F higher than the 20th century mean.
- The five hottest years on record were: 1998, 2002, 2003, 2004, and 2005.
- Temperatures in Alaska are rising almost twice as fast as elsewhere.
- Permafrost is melting across the Arctic regions, reducing habitat for birds, destroying buildings that used permafrost as a foundation, collapsing roads.
- Glaciers have decreased 95 percent.
- The area of melting Arctic sea ice is greater than two Montanas.
- The extent of regions affected by droughts has doubled since 1970s.
- Since 1970, category 4 & 5 hurricanes

The Mauna Loa Record, aka Keeling Curve (begun by Charles Keeling in 1958)



This version of the Keeling Curve by the CO_2 Program of the Scripps Institute of Oceanography, scrippsco2.ucsd.edu have increased by about 75 percent.

- Since 1993, worldwide sea level has risen 1.7 inches—twice the rate of the previous 30 years.

Predictions

If we continue the current rates of CO_2 emissions, scientists predict the following:

Global

- Warming oceans will increase hurricane intensity.
- By 2030, CO_2 emissions will grow 40–110 percent.
- In this century, sea level will rise 15.8–27.6 inches.
- Increased ocean acidity (from increased CO_2) may stop growth of coral reefs.
- By 2100, global surface temperatures will be from 2.5 to 10.4˚F higher .
- Heat waves and heavy precipitation will become more frequent.
- Of the species whose sensitivity to climate change has been assessed, 20–30 percent will face greater risk of extinction.

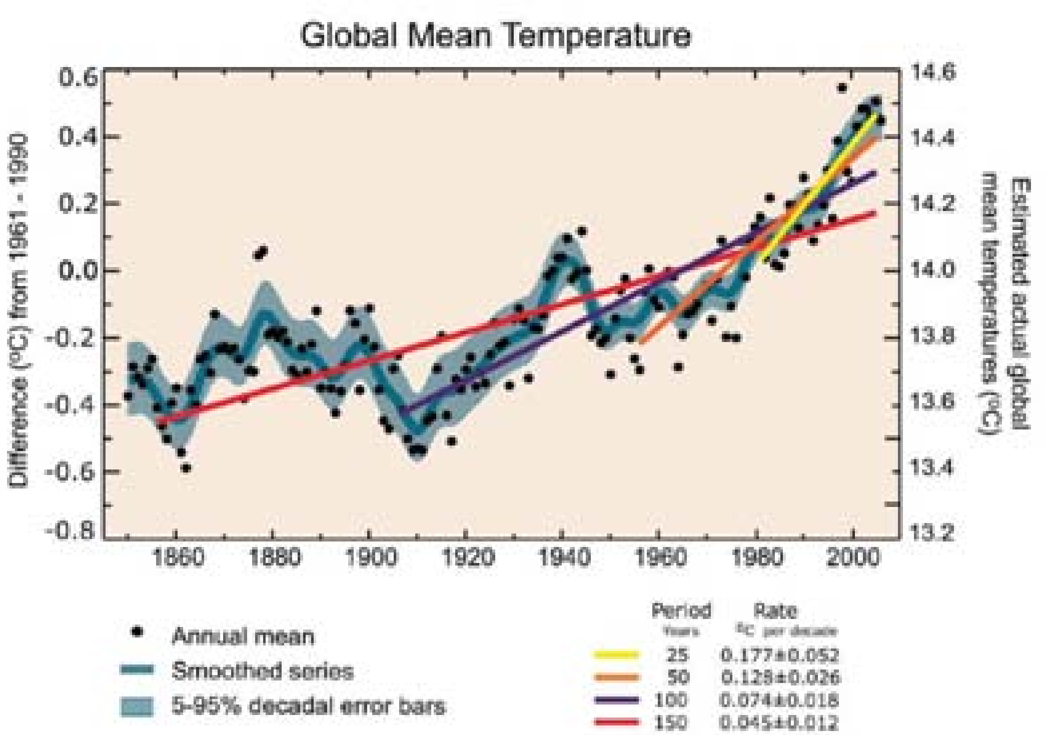
Western United States

Much of the western United States will likely become more arid according to the GCMs. Temperatures could increase 4–13˚F, with the increases higher in the mountains and greater during winter. The resulting smaller snowpacks will reduce surface and groundwater supplies, affecting all species in the region. As temperatures increase, evaporation rates increase. So even if precipitation remains the same or increases, less water will be available in the ecosystem.

Less water means wildfires will increase in frequency, intensity, and duration in most western regions. In addition, the increasing levels of CO_2 may change the atmosphere's chemistry so that lightning—a prime cause of natural wildfire—will increase and thus, begin fires more frequently.

GCMs cannot account for variations in topography—a big variable in the western United States that affects regional climate, local weather, and ecosystems. Changes here will occur north and south, east and west, from high to low elevations, and within small pockets of habitat.

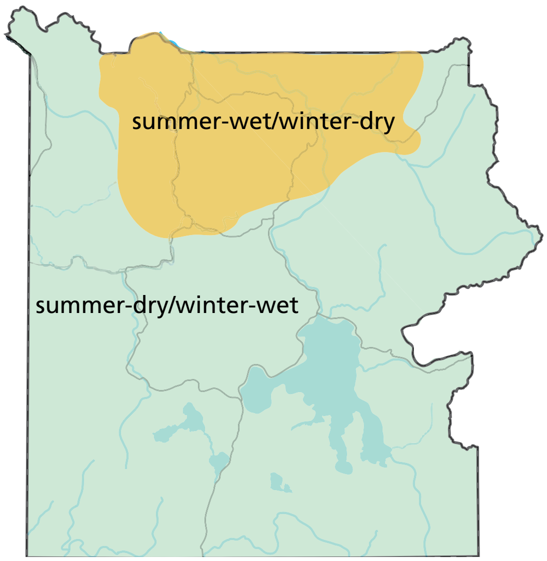
In general, plants are especially vulnerable to rapid climate changes because they change locations by generations—at best. And even then, they face landscapes



IPCC published this graph in their 2007 report. An industrialization boom after World War II contributed to cooler temperatures in the northern hemisphere. Carbon dioxide and other greenhouse gases are the main cause of warming after the mid-1970s. The steeper slope in recent decades indicates accelerated warming.

This and other graphs available at www.ipcc.ch/graphics/gr-ar4-wg1.htm.

The boundaries of Yellowstone's two climate regimes have remained stable for 14,000 years.



fragmented by humans and even more by climate change.

Plants adapted to live in cold environments, such as the Rocky Mountains, often require extreme cold temperatures. For example, young Douglas-fir must be exposed to cold for a certain length of time while they are dormant to promote maximum growth. They will face competition from trees and other plants that don't require such chilling periods.

- Spring runoff in the Intermountain West is 20 days earlier than in the 20th century.
- By 2050, the Columbia River system—including the Snake River—will lose 35 percent of its snow pack.
- In the last 30 years, the wildfire season has increased more than two months, and individual fires last five times longer.
- Coldwater fish habitat will be reduced 25–30 percent.
- Aquatic insects and other invertebrates living in streams will be reduced or wiped out.

Climate Change in Yellowstone

Yellowstone is not considered by many to be a "climate change" park that will have obvious changes in the next few decades. However, higher temperatures and changes in precipitation patterns can greatly change its ecosystems. The alpine zone, which begins at 9500 feet, will migrate higher, with important species like whitebark pine almost entirely lost to the ecosystem. Changes in snowpack and timing of spring runoff will disrupt native fish spawning and increase exotic aquatic species expansion. Changes in precipitation and temperature regimes will likely disrupt vegetation growth that in turn would seriously disrupt wildlife migrations, one of the key resources for which Yellowstone National Park is globally treasured.

Two climate regimes

Yellowstone National Park is bisected by two climate regimes that will influence how and what changes here. *(Map, left.)* These regimes—summer-wet/winter-dry and summer-dry/winter-wet—are remarkably stable, as shown by pollen records extracted from lake sediments throughout the region. By painstakingly examining and identifying pollen from these cores, scientists have determined that Yellowstone's climate regimes have retained approximately the same boundaries since the end of the last glaciation, 13,000 to 14,000 years ago. They remained steady even when temperatures increased 12,000 to 6,000 years ago. This temperature increase equals what we are experiencing now, but over millennia instead of decades.

The northern part of the park, roughly following the southern limit of the northern range *(see map)*, is in a summer-wet/winter-dry climate regime. Moisture comes in the summer via monsoon systems that move north from the gulfs of Mexico and California, wrapping around the Absarokas into the northern range; and winter storms come from the Pacific. Sagebrush-steppe and grasslands characterize the habitat within this regime. Global climate change may increase summer precipitation within this area, but this may be offset by more rapid evaporation, resulting in a net decrease in moisture available to the ecosystem.

The rest of the park is in a summer-dry/winter-wet regime, influenced by the Pacific sub-tropical high-pressure system in summer and westerly storms in winter. Higher winter moisture used to translate into high snowpack, which provided conditions suitable for forests and their inhabitants. With climate change comes warmer winters and more rain, which will alter the habitat over time.

Although the climate regime boundaries might not change, the vegetation within these regimes will change due to the speed of change and increasing disturbances such as fire and insect infestations.

Fire

The general prediction for wildfire in the western United States calls for more intense fires, similar to those of 1988. However, the charcoal in lake sediment cores is telling a different story in Yellowstone. These records extend back 17,000 years, and were taken from Cygnet Lake on the Central Plateau. Charcoal from 8,000 years ago, when temperature increases equal what we are now experiencing, shows more frequent fires than today. Fuels, along with fire weather, determine fire size and severity: the stand-replacing fires of today open up the forests where stands have been burned, limiting fuels for the next fire. As a result, areas with frequent fires also tend to have small fires. Whether this holds true for the future remains to be seen.

Insect infestations

More frequent fires join other climate-change disturbances, such as allowing conditions that increase insect infestations of trees. In the past, insect infestations were cyclical, following changes in weather. For example, trees defend themselves from pine bark beetles by exuding sap that traps or prevents them from lodging in the tree. During a drought, a tree cannot produce enough sap to defend itself, and so insects infest it. Once the drought ends, the tree resumes defending itself and the infestation eventually diminishes. In 2000, insect infestations began increasing in Yellowstone. In 2007, all four pine bark beetles and the spruce budworm were attacking trees—a circumstance never seen before. Scientists suspect climate change at work. *(See also Chapter 5.)*

Wetlands

Wetlands in Yellowstone are few and far between *(see Chapter 5)*, and include small lakes and kettle ponds, which are already drying up. Scientists don't know how much ground-water recharge they will need to recover. However, precipitation and snowpack will likely continue to decrease, which will continue to decrease surface and ground water—and thus the lakes and ponds may not recover.

As wetlands diminish, sedges, rushes, and other mesic (water-loving) plants will lose habitat. In their place, grasses and other xeric (dry-loving) plants will increase. Amphibians and birds will also lose essential habitat.

Willows, however, seem to be thriving. Their growth since 1995 has been three times the average recorded in the 1980s. In part, this is due to the changes in precipitation, snowmelt, and growing season. With a longer growing period to produce energy, willows can meet their essential needs earlier in the season and thus produce more defensive chemicals earlier. They also now have more water earlier in the year because snowmelt occurs sooner, and rain has increased in May and June. This moisture increase occurs at a time most beneficial to their growth.

Wildlife

Climate-change effects on large mammals are harder to determine than for other animals, and predictions are not easy to find. In general, scientists seem to think ungulates depending on grasslands will be able to find suitable habitat. Other species might not be so fortunate.

Grizzly bears will have less of their most valuable foods: whitebark pine nuts, army cutworm moths, and cutthroat trout.

Canada lynx will face habitat and food problems as snow cover decreases in amount and duration.

Wolverines depend on deep snow for dens where they find shelter and give birth.

Change in Other Western National Parks

Gates of the Arctic and Yukon–Charley:
Caribou ranges and population size may become less predictable, affecting the diet and culture of native Alaskans who rely on them.

Katmai:
Ocean warming may drive salmon out of southern Alaska and warmer rivers may increase parasites that make salmon unusable.

North Cascades:
Seventy to 90% of the snow pack could disappear by the end of this century, threatening winter sports and water supplies.

Olympic:
Warmer winters and more extreme precipitation events could increase winter flood risk.

Yosemite:
Warming and drought have made wildfire season longer and more damaging, and increased insect damage.

Sequoia/Kings Canyon:
Warmer temperatures will worsen smog; increasing wildfires will contribute more smoke and airborne particulates.

This information reprinted from Unnatural Disaster: Global Warming and Our National Parks *by the National Parks & Conservation Association.*

Climate-Friendly Parks

In 2002, the Park Service began a Climate-Friendly Parks Program to help parks measure and reduce their greenhouse gas emissions, evaluate their vulnerability to climate change, monitor for climate change effects, and educate visitors. Learn more at www.nps.gov/climatefriendlyparks.

8

Climate Change

An ironic twist

Yellowstone's thermophilic plants may provide clues to help scientists predict how plants will respond to global climate change. These plants are adapted to unusually high levels of CO_2. Scientists are studying these "carbon-philic" species to understand how they withstand such high amounts of carbon dioxide, and what this could mean for other plants in the future.

Today about 5.5 billion tons of carbon enter the atmosphere every year from burning fossil fuels. Carbon emissions in the United States come from industry (30%), transportation (personal and commercial, 33%), energy used to run homes and businesses (±35%), and miscellaneous.

Outlook

Data from thousands of years to the present and more than 2,000 scientists agree: the Earth's climate is warming, and 40 times faster than any other period in the planet's history. Vegetation cannot keep up with this rapid rate of change. Many animals will not be able to either. And the vast majority of humans, who live within three meters of sea level, now find their homes and livelihoods at risk in the coming decades.

Many scientists believe we have a chance to slow or stop climate change—if we stop increasing CO_2 emissions by 2017. Progress toward this goal began in 1997, with the Kyoto Protocol, which set mandatory targets for greenhouse gas emissions for industrialized nations. The technology for this change exists, as does the technology to produce climate-safe energy and power.

In Yellowstone National Park, employees and residents already are reducing their emissions contributions through landmark recycling efforts, using biodiesel and ethanol in vehicles, and other changes. For example, using alternative fuels reduced the CO_2 emissions from vehicles by 575.4 tons in 2006 alone. At the policy level, park scientists and resource managers are beginning discussions with the other National Park Service staff, scientists from the U.S. Geological Survey, and scientists from universities to develop a "science agenda" that will build a foundation for understanding how the ecological system will change as the climate changes and for developing management strategies to mitigate the effects of climate change.

Phenology—Citizen Observations Count

***Phenology** is the relationship between periodic biological changes —like the budding of trees and arrival of migratory birds in spring—and seasonal changes such as temperature. People who have been tracking such changes informally now possess valuable information that helps scientists track climate change in various regions. You can contribute to this effort.*

***The National Phenology Network** helps professionals, citizen scientists, teachers, and anyone else choose species in their area to monitor for change and contribute their data to a central website. www.uwm.edu/Dept/Geography/npn/*

***Project Budburst** provides a website where school groups and citizen scientists can contribute observations about flowering plants and other seasonal vegetation changes from their own neighborhoods. www.windows.ucar.edu/citizen_science/budburst/*

8

Issues: Northern Range

The Issue

Some people believe the park has more ungulates (hoofed mammals) than the northern range can sustain. They blame elk and bison for erosion and declines in willows, aspen, and beaver, ostensibly due to overgrazing. Other scientists have found no evidence that the park's grasslands are overgrazed.

History/Background

- For decades, the park intensively managed elk, bison, and pronghorn.
- The park discontinued wildlife reductions in the late 1960s to restore natural dynamics and minimize human intervention.
- In the 1970s and early 1980s, scientific and public concerns grew about the increasing population of ungulates on the northern range.
- In 1986, Congress mandated a major research initiative to answer these concerns. Results found that the northern range was healthy and that elk did not adversely affect the overall diversity of native animals and plants.

Current Status

- In 1998, Congress called for the National Academy of Sciences to review management of the northern range. Results were released in March 2002.
- Despite scientific conclusions to the contrary, some people continue to claim the northern range is overgrazed.
- In response to new controversy about the impact of wolves on the elk herds of the northern range, numerous researchers have been studying this elk population and the impact of wolf restoration.
- Some people are now concerned because elk counts have declined approximately 60% since 1994.

The northern range refers to the broad grassland that borders the Yellowstone and Lamar rivers in the northern quarter of the park *(map next page)*. This area sustains one of the largest and most diverse populations of free-roaming large animals seen anywhere on Earth. Many of the park's ungulates spend the winter here. Elevations are lower and the area receives less snow than elsewhere in the park. Often the ridge tops and south-facing hillsides are clear of snow, a result of wind and sun. Animals take advantage of this lack of snow, finding easy access to forage.

History

The northern range has been the focus of one of the most productive, if sometimes bitter, dialogues on the management of a wildland ecosystem. For more than 80 years this debate focused on whether there were too many elk on the northern range. Although early censuses of the elk in the park, especially on the northern range, are highly questionable, scientists and managers in the early 1930s believed that grazing and drought in the early part of the century had reduced the range's carrying capacity and that twice as many elk were on the range in 1932 as in 1914. Due to these concerns about over-grazing and overbrowsing, park managers removed ungulates—including elk, bison, and pronghorn—from the northern range by shooting or trapping from 1935 to 1968. More than 26,000 elk were culled or shipped out of the park to control their numbers and to repopulate areas where over-harvesting or poaching had eliminated elk. Hunting outside the park removed another 45,000 elk during this period. These removals reduced the elk counts from approximately 12,000 to 4,000 animals.

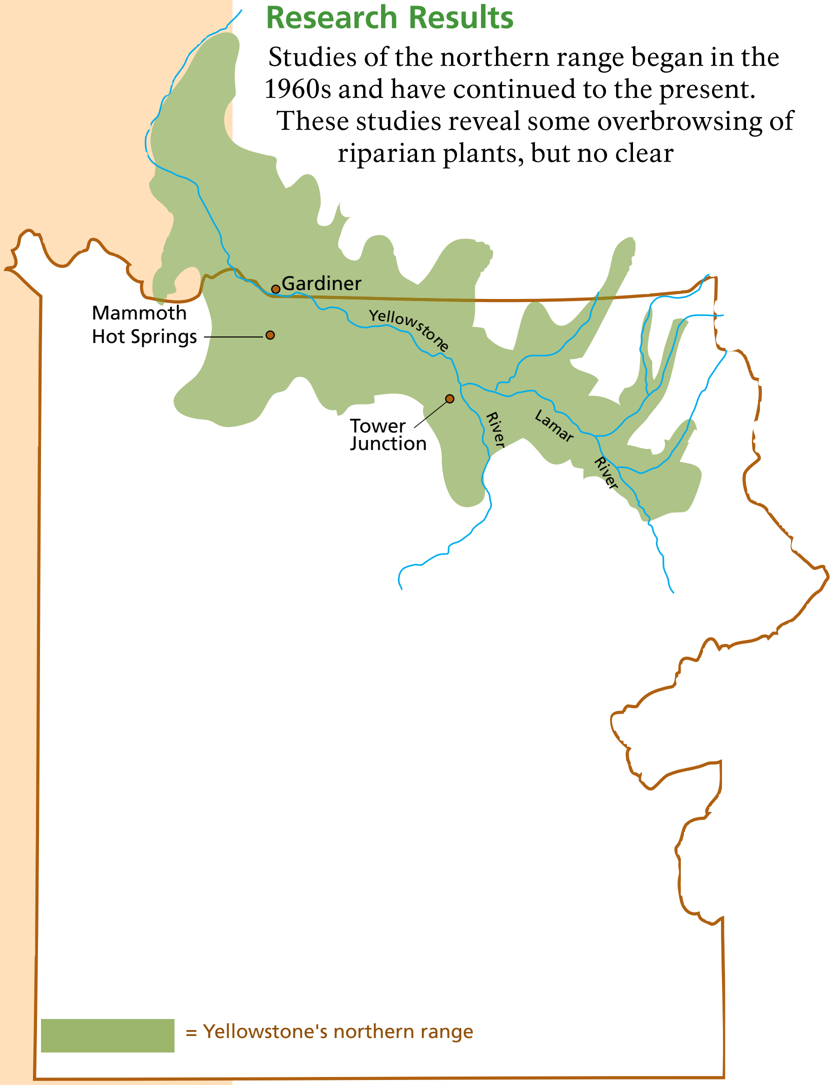
As the result of public pressure and changing NPS conservation philosophy, park managers ended elk removals in the late 1960s and let a combination of weather, predators, range conditions, and outside-the-park hunting and land uses influence elk abundance. Without any direct controls inside the park, elk counts increased to approximately 12,000 elk by the mid-1970s, 16,000 elk by 1982, and 19,000 elk by 1988. This rapid population increase accentuated the debate regarding elk grazing effects on the northern range.

The restoration of wolves into Yellowstone and their rapid increase changed the debate from concerns about "too many" elk to speculation about "too few" elk because of wolf predation. Elk are the most abundant ungulates on the northern range and comprised more than 89 percent of documented wolf kills during winters from 1997 to 2008. These data cause some people to think wolves are killing off elk, despite the fact that elk continue to populate the northern range at relatively high density compared to areas outside the park.

Another set of statistics also alarm some hunters, outfitters, and state legislators: From 2002 to 2008, elk calf survival (recruitment) and total number of the northern elk herd declined. Many factors (e.g. predators, drought, winterkill, hunting) contributed to the low recruitment and decreased elk numbers.

Research Results

Studies of the northern range began in the 1960s and have continued to the present. These studies reveal some overbrowsing of riparian plants, but no clear evidence of overgrazing. In 1986, continuing concern over the condition of the northern range prompted Congress to mandate more studies. This research initiative, one of the largest in the history of NPS, encompassed more than 40 projects by NPS biologists, university researchers, and scientists from other federal and state agencies. Results found that the northern range was healthy and elk did not adversely affect the overall diversity of native animals and plants. It was also determined that ungulate grazing actually enhances grass production in all but drought years, and grazing also enhances protein content of grasses, yearly growth of big sagebrush, and establishment of sagebrush seedlings. No reductions in root biomass or increase in dead bunchgrass clumps were observed. However, studies on aspen and willows and their relationship to ungulates on the northern range are not so clear-cut and are continuing. Despite these results, the belief that elk grazing is damaging northern range vegetation and that grazing accelerates erosion persists among many people, including some scientists.



Continuing Controversy

In 1998, Congress again intervened in the controversy, calling for the National Academy of Sciences to review management of the northern range. The results, published in *Ecological Dynamics on Yellowstone's Northern Range* (2002), concluded that "the best available scientific evidence does not indicate ungulate populations are irreversibly damaging the northern range." Studies investigating the responses of elk populations to wolf restoration continue.

In part, the controversy is likely due to the personal or scientific background of each person. Many urban dwellers live among intensively managed surroundings (community parks and personal gardens and lawns) and are not used to viewing wild, natural ecosystems. Livestock managers and range scientists tend to view the landscape in terms of maximizing the number of animals that a unit of land can sustain. Range science has developed techniques that allow intensive human manipulation of the landscape for this goal, which is often economically based. Many ecologists and wilderness managers, on the other hand, have come to believe that the ecological carrying capacity of a landscape is different from the concept of range or economic carrying capacity. They believe variability and change are the only constants in a naturally functioning wilderness ecosystem. What may look bad, in fact, may not be.

Change on the Northern Range

During the 1990s, the ecological carrying capacity of the northern range increased as elk colonized new winter ranges north of the park that had been set aside for this purpose. Summers were also wet while winters were generally mild. The fires of 1988 also had opened many forest canopies, allowing more grasses to grow.

Many scientists believe that winter is the major factor influencing elk populations. Mild winters allow many more elk to survive until spring, but severe winters result in significant levels of winter kill for many animals, not just elk. In severe winters (like the winter of 1988–89 or 1996–97), up to 25 percent of the herd can die. The northern Yellowstone elk herd demonstrates the ecological principle of density-dependence: over-winter mortality of calves, older females, and adult bulls all increase with higher elk population densities.

Elk are subject to predation by other species in the ecosystem, including bears, wolves, coyotes, and mountain lions. Also, the northern Yellowstone elk population is subject to four hunts each year. Elk that migrate out of the park may be legally hunted during an archery season, early season backcountry hunt, general autumn hunt, and the Gardiner late hunt, all of which are managed by the Montana Department of Fish, Wildlife and Parks. The primary objective of the Gardiner late hunt is to regulate the northern Yellowstone elk population that migrates outside the park during winter and limit depredation of crops on private lands. During 1996–2002, approximately 5–19 percent (mean ~11 percent) of the adult female portion of this population was harvested each year during the late hunt. However, antlerless harvest quotas have been reduced ninety-six percent in recent years due to decreased elk numbers.

The complex interdependence of these relationships results in fluctuations in the elk population—when there are lots of elk, predator numbers increase, which, in part, helps reduce elk numbers and recruitment.

Some sections of the northern range are fenced, as shown above, to study the long-term effects of grazing by fencing out large herbivores. The results were complex: Animals prune shrubs outside the fence but shrubs stay healthy. Apparently the herds are not destroying the unprotected vegetation.

Outlook

National Park Service policies protect native species and the ecological processes that occur naturally across the landscape. Whenever possible, human intervention is discouraged. While controversy continues about the northern range and NPS management practices, many research projects continue in an effort to more accurately describe what is happening on Yellowstone's northern range.

See Chapter 2 for more about wolves affecting the ecosystem; and "Climate Change" in this chapter for its effects on this area.

8

Issues: Sustainable & Greening Practices

The Issue
Yellowstone is a leader in demonstrating and promoting sound environmental stewardship through regional and national partnerships.

History:
1995: Biodiesel truck donated to park to test alternative fuel.
1997: Park celebrates 125th anniversary and "greening" efforts increase.
1998: Old Faithful wood viewing platform replaced with recycled plastic lumber; employee Ride-Share Program begins.
1999: Yellowstone National Park begins using nontoxic janitorial supplies and offers ethanol blended fuel to visitors.
2002: The park's diesel fleet converts to biodiesel; the Greater Yellowstone/Teton Clean Energy Coalition receives federal designation.
2003: Regional composting facility opens; park demonstrates the first fuel cell in a national park; park begins testing prototype alternatively fueled multi-season vehicles.
2004: Park employees begin using hybrid vehicles; Xanterra employee housing receives LEED designation.
2006: 70% of all garbage in the park is diverted away from a landfill through recycling & composting.
2007: Park completes a greenhouse gas inventory, leading to initiatives to reduce greenhouse gas emissions; interns begin gathering data for sustainability efforts; 75% of the park's waste stream is diverted from landfills.

2008 recycling in the park:
newspapers, magazines, office paper: 89 tons
aluminum/steel: 30 tons
glass: 174 tons
plastic containers: 39 tons
cardboard: 278 tons

In addition, annually in Yellowstone:
- 300 vehicles use more than 156,000 gallons of biodiesel fuel
- 350 vehicles use more than 193,000 gallons of ethanol blended fuel
- 1400 tons of food waste and other garbage are composted

In 1997, when Yellowstone National Park celebrated its 125th anniversary, one of the questions asked was what can we do to preserve and protect this national treasure for the next 125 years? The result was "The Greening of Yellowstone." Some "green" projects had already begun, such as demonstrating biodiesel fuel. Since then, the park and various partners have addressed a variety of sustainable and greening issues to increase environmental conservation in the park and surrounding communities.

Meeting to "Green" Yellowstone
Yellowstone National Park, the states of Montana and Wyoming, the U.S. Department of Energy (DOE), and private groups hosted three-day conferences in October 1996 and May 1998. Participants developed a vision for sustaining the park's values and improving environmental quality. They considered strategies such as developing a regional composting facility, operating alternatively fueled vehicles, replacing toxic solvents, using more environmentally-sound products, and modifying the energy infrastructure to make it more environmentally friendly. In 2003 and 2007, Yellowstone hosted additional greening conferences that highlighted environmental stewardship and successes in the region, and identified future initiatives.

Walking on Sustainability
Yellowstone has more than 15 miles of wood boardwalk, most of which are more than 25 years old. As these walkways age, toxic chemicals from wood preservative leach into the ground and water. To reduce this pollutant, the park is replacing wood walkways with boards made of recycled plastic. This effort began in 1998 when Lever Brothers Company donated plastic lumber for the viewing platform around Old Faithful geyser. The lumber used the equivalent of three million plastic milk jugs. Now visitors receive an educational message about recycling while waiting for the world's most famous geyser eruption.

Today the park continues to replace old boardwalks with recycled plastic lumber, which decreases toxic chemicals in the park, lengthens the life of the walkways, and saves natural resources and money.

Driving Sustainability
Yellowstone National Park offers an opportunity to demonstrate alternative fuels in an environmentally sensitive and extremely cold area. Beginning in 1995, the National Park Service, the Montana Department of Environmental Quality (DEQ), DOE, and the University of Idaho began testing a biodiesel fuel made from canola oil and ethanol from potato waste. Dodge Truck

Inc. donated a new three-quarter ton 4x4 pickup to the project. The truck has been driven more than 195,000 miles on 100 percent biodiesel. It averages about 17 miles per gallon, the same as with petroleum-based diesel fuel. Emissions tests showed reductions in smoke, hydrocarbons, nitrogen oxides, and carbon monoxide. Tests also showed bears were not attracted by the sweet odor of biodiesel exhaust, which had been a concern. In September 1998, the truck's engine was analyzed, revealing very little wear and no carbon build-up. The truck is still being used in the park.

The park also provides ample opportunity to test and use alternative fuels because its employees drive almost four million miles a year. All diesel-powered vehicles used by park employees plus many used by concession operations use a 20 percent blend of canola oil and diesel. Gasoline-powered vehicles in the park use an ethanol blend (E-10). This fuel is also available to visitors at park service stations.

In 2004, the park's hybrid fleet began with four models donated by Toyota USA. They operate with electricity generated by the gasoline engine and its braking system. They conserve gas, reduce emissions, and run quietly when using electricity. The park now operates 17 hybrid vehicles.

In 2008, Michelin North America donated $50,000 worth of tires for the Yellowstone National Park fleet to test. These tires are designed to increase fuel efficiency and to last longer than other tires.

Building Sustainability

Yellowstone's buildings present opportunities for incorporating sustainable building materials and techniques as they are maintained, remodeled, or replaced. The park and its partners have:

- drafted an architectural and landscape design standard based on national green building standards and Yellowstone Design Guidelines.
- planned the new Old Faithful Visitor Education Center to meet LEED certification requirements. *(See this and next page.)*
- retrofitted several maintenance facilities with sustainable heating systems, insulation, and high-efficiency lighting.
- encouraged concessioners to retrofit facilities and ask guests to conserve energy and water in the hotels and lodges.

"Green" Cleaning Products

In August 1998, the U.S. Environmental Protection Agency helped Yellowstone National Park assess its cleaning products. They found some products with slightly toxic ingredients and others with potentially significant health hazards. As a result, the park switched from more than 130 risky products to less than 10 safe products. The assessment expanded to include park concessioners, who also switched to safer products. This switch to safer and more environmentally sound cleaning products has expanded into many other national parks.

Renewable Energy

Yellowstone managers are testing and installing alternative renewable energy sources for various uses in the park. The Lamar Buffalo Ranch now meets 80 percent of its energy needs with a solar array. The Lewis Lake Contact Station and ranger residence also use solar energy, reducing the use of a polluting propane generator. Fuel cells, which convert hydrogen into power and don't need battery storage, have been tested as a source of electricity to the West Entrance Station. The park is also experimenting with producing biofuels from food waste. In 2007, it demonstrated a generator that produced electricity using 100 percent vegetable oil.

Recycling and Composting

In 1994, a study was done in Yellowstone National Park showing 60–75 percent of

LEED Certification

The U.S. Green Building Council (USGBC), a building industry group, developed national standards for environmentally-sound buildings. Called LEED (Leadership in Energy and Environmental Design) Green Building Rating System®, these standards have been met in the Yellowstone Park area for an employee housing project completed in 2004. The National Park Service partnered with concessioner Xanterra Parks & Resorts to build two houses following LEED certification standards. The project earned LEED certification—the first in Montana, and the first single-family residence in the country. The features include:

- *Energy efficient design standards*
- *Passive solar gain*
- *State of the art heating/cooling systems*
- *Landscaping with Yellowstone-produced compost*

Greening the new Old Faithful Visitor Education Center

The new Old Faithful Visitor Education Center will be completed in 2010. It is being built to meet "Gold LEED Certification" (see previous page).

Features include:

- *a design that reduces heated space in winter*
- *water-conserving fixtures*
- *displays and programs about sustainable practices*
- *unobtrusive, down-directed exterior lighting*

solid waste (the waste stream) could be composted. Large-scale composting becomes even more economical when compared to hauling the park's solid waste more than 150 miles to landfills.

The Southwest Montana Composting Project —a partnership among area counties, municipalities, and the National Park Service —built an industrial-grade composting facility near West Yellowstone. It began operating in July 2003 and today transforms 60 percent of park's solid waste into valuable soil conditioner.

Another regional partnership that includes Yellowstone National Park is the Headwaters Cooperative Recycling Project, which is expanding recycling in the park and surrounding communities. For example, it has placed recycling bins for glass, plastic, paper, aluminum, and cardboard throughout the park.

In 2005, Yellowstone became the first national park to recycle small propane cylinders, such as those used for lanterns and some camp stoves. Now, more than 15,000 cylinders are crushed and redeemed as steel.

Employee Ride-Share Program

In January 1998, Yellowstone National Park initiated a Ride-Share Program at the suggestion of park employees living north of the park—some more than 50 miles away. They were willing to help finance the program. Benefits of the program include:

- reducing fuel consumption and air pollution
- improving safety by decreasing traffic
- easing parking constraints in the park
- saving employees money
- improving employee morale, recruitment, and retention

Approximately 45 employees participate in the Ride-Share Program, a significant demonstration of the National Park Service commitment to public transportation.

Clean Cities Coalition

The Greater Yellowstone/Teton Clean Energy Coalition, which is part of the federal Clean Cities Coalition, promotes alternative, cleaner fuels. Its goals include:

- substantially reducing particulate matter entering the atmosphere
- educating and promoting the advancement of renewable fuels
- reducing dependency on fossil fuels
- setting an example of environmental stewardship

Projects include:

- expanding the use of renewable fuels
- developing partnerships to foster sustainable efforts
- converting all stationary applications (heating boilers, generators, etc.) to renewable fuels
- creating a tour district to promote a shuttle service within the Yellowstone region

Greening of Concessions

Yellowstone National Park's major concessioners have made corporate commitments to an environmental management system (EMS) that meets international business standards for sustainability.

Ecologix: Xanterra Parks & Resorts

Xanterra, which provides lodging and other guest services in the park, calls its

EMS “Ecologix.” It encourages employees to develop and implement sustainable practices such as:

- Replaced thousands of incandescent bulbs with efficient compact fluorescent lighting.
- Replaced two-stroke engines of rental boats and snowmobiles with cleaner burning and more efficient four-stroke engines.
- Recycle used motor oil, cooking oil, electronics, automotive batteries, antifreeze, and paint solvents.
- Use bleach-free paper products containing 100 percent post consumer content and soy-based inks for most printed materials.
- Serve organic fair-trade coffee (pesticide-free, grown and harvested in a manner supporting wildlife and bird habitats, purchased from local farmers at a fair price).
- Serve sustainable foods including pork from pigs and beef from cattle raised without hormones or antibiotics in humane facilities.
- Offer a variety of environmentally-friendly products in its retail outlets as part of its “Sustain the Earth Campaign,” including products made from recycled fabric, glass, paper, and wood.

In 2008, Xanterra began supplying guests in its lodging facilities with more sustainable toiletries, including products packaged in a corn-based biodegradable material, which annually diverts an average of 280,000 plastic bottles from the landfill.

Xanterra and NPS collaborated on building two new employee housing units to LEED standards. *(See page 181.)* The homes are constructed to reduce energy consumption (such as using R38 walls, Energy Star appliances, double pane windows, solar panels) and water consumption (two-button low-flush toilets, efficient fixtures), and to use post-consumer content materials. The solar panels produce 5 million btu in electricity annually.

GreenPath: Delaware North

Delaware North Companies, which operates twelve general stores in the park, calls its EMS “Green Path.” This EMS was the first in Yellowstone to attain ISO 14001 Registration, which means it exceeds strict environmental standards recognized internationally. Practices include:

- Purchase responsibly wherever possible. For example, using biodegradable dishware and cutlery in food service operations, which are then composted at a local facility.
- Conserve energy by bringing hybrids into its fleet of vehicles.
- Conserve water by installing low flow showerheads, kitchen sprayers, waterless urinals, and toilets.
- Eliminate the use of hazardous materials and waste where possible. For example, chemical film processing was replaced with digital photo processing, eliminating the use of many chemicals and the generation of hazardous waste.
- Operate an aggressive recycling program, annually collecting over 120 tons from over 22 different types of materials.
- Incorporate environmentally friendly materials and practices when remodeling the stores, while maintaining the integrity of historic structures.
- Partner with NPS, other concessioners, nonprofit organizations, and others to improve environmental efforts in the greater Yellowstone area.
- Train seasonal associates to carry out the program and educate visitors at each store.

The YES! Initiative

Yes!

In 2007, in concert with the Yellowstone Park Foundation, the park launched the “Yellowstone Environmental Stewardship (YES!) Initiative.” YES! is a multi-year plan to elevate the park as a worldwide leader in operational environmental stewardship. This program enables Yellowstone to build upon its sustainability successes to further reduce the ecological footprint of its operations and decrease consumption of natural resources.

YES! intends to achieve the following goals by 2016:

- reduce greenhouse gas emissions by 30%
- reduce electricity consumption by 15%
- reduce fossil fuel consumption by 18%
- reduce water consumption by 15%
- divert 100% of solid waste from landfills

8

Issues: Wilderness

A wilderness, in contrast with those areas where man and his own works dominate the landscape, is . . . an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain . . . an area of undeveloped federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural condition. . . . The Wilderness Act of 1964

The Issue

In 1972, 90% of Yellowstone National Park was recommended for federal wilderness designation. Congress has not acted on this recommendation.

History

1964: Wilderness Act becomes law.

1972: National Park Service recommends 2,016,181 acres in Yellowstone as wilderness

1994: YNP writes a draft Backcountry Management Plan (BCMP) and environmental assessment, which is never signed. The BCMP begins to provide management guidance even though not official document.

1999: Director's Order 41 (DO 41) issued to guide NPS efforts to meet the letter and spirit of the 1964 Wilderness Act. It states that recommended wilderness must be administered to protect wilderness resources and values.

2003: NPS Intermountain Region implements a Minimum Requirement Policy to evaluate proposed management actions within proposed wilderness areas.

Backcountry Statistics

- Approximately 1,000 miles of trail.
- 72 trailheads within the park; 20 trailheads on the boundary.
- 301 designated backcountry campsites.
- Approximately 13% of backcountry users travel with boats and 17% travel with stock.
- During 2007: 16,360 overnight backcountry visitors spent an average of 2.3 nights in the wilderness.

Areas of Concern for Park Wilderness

- Accommodating established amount of visitor use.
- Protecting natural and cultural resources.
- Managing administrative and scientific use.
- Monitoring & implementing Limits of Acceptable Change (LAC).
- Educating users in Leave No Trace practices.

Current Status

Yellowstone does not yet have a wilderness plan to manage wilderness within the park.

Yellowstone National Park has always managed its backcountry to protect natural and cultural resources and to provide visitors the opportunity to enjoy a pristine environment within a setting of solitude. Yet none of the park is designated as federal wilderness under the Wilderness Act of 1964.

In 1972, in accordance with that law, the Secretary of the Interior recommended 2,016,181 acres of Yellowstone's backcountry be designated as wilderness. Although Congress has not acted on this recommendation, these lands are managed so as not to preclude wilderness designation in the future. The last Yellowstone wilderness recommendation sent to Congress was for 2,032,721 acres.

Wilderness in the National Park System

Congress specifically included the National Park Service in the Wilderness Act and directed NPS to evaluate all its lands for suitability as wilderness. Lands evaluated and categorized as "designated," "recommended," "proposed," "suitable," or "study area" in the Wilderness Preservation System must be managed in such a way as 1) to not diminish their suitability as wilderness, and 2) apply the concepts of "minimum requirements" to all management decisions affecting those lands, regardless of the wilderness category.

Director's Order 41

Director's Order 41, issued in 1999, provides accountability, consistency, and continuity to the National Park Service's wilderness management program, and guides NPS efforts to meet the letter and spirit of the 1964 Wilderness Act. Instructions include:

- ". . . all categories of wilderness (designated, recommended, proposed, etc.) must be administered by NPS to protect wilderness resources and values, i.e., all areas must be managed as wilderness."
- "Park superintendents with wilderness resources will prepare and implement a wilderness management plan or equivalent integrated into an appropriate planning document. An environmental compliance document, in keeping with NEPA requirements, which provides the public with the opportunity to review and comment on the park's wilderness management program, will accompany the plan."

Minimum Requirement Analysis

The Intermountain Regional Director said "all management decisions affecting wilderness must be consistent with the minimum requirement concept." This concept allows managers to assess:

- if the proposed management action is appropriate or necessary for administering the area as wilderness and does not impact

wilderness significantly
- what techniques and type of equipment are needed to minimize wilderness impact.

Superintendents apply the minimum requirement concept to all administrative practices, proposed special uses, scientific activities, and equipment use in wilderness. They must consider potential disruption of wilderness character and resources before, and give significantly more weight than, economic efficiency and convenience. If wilderness resource or character impact is unavoidable, the only acceptable actions are those preserving wilderness character or having localized, short-term adverse impacts.

Wilderness Designation and Current Practices in Yellowstone

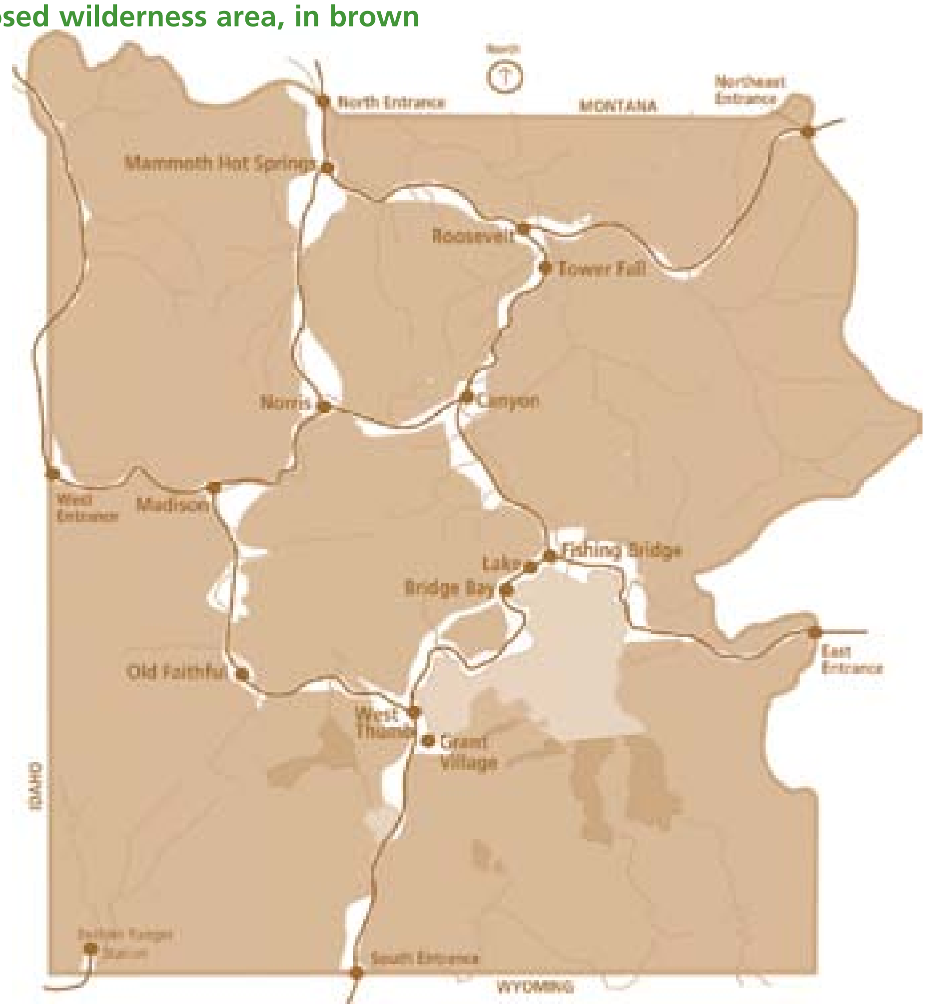
As managers develop a wilderness plan for Yellowstone, they must determine how current practices in the park will be handled within the proposed wilderness areas:

- Protecting natural and cultural resources while also maintaining the wilderness character of the park's backcountry.
- Managing administrative and scientific use to provide the greatest contribution with the minimum amount of intrusion in the wilderness.
- Monitoring Limits of Acceptable Change (LAC) to develop and enact long-range strategies to better protect wilderness resources and enhance visitor experiences.
- Minimizing visitor wilderness recreation impact by educating users in Leave No Trace outdoor skills and ethics that promotes responsible outdoor recreation.

Outlook

Yellowstone will continue to manage its backcountry to protect park resources and provide a wilderness experience to park visitors. Park managers are developing a wilderness plan to best manage and preserve the wilderness character that Yellowstone's backcountry has to offer. Yellowstone will then wait for the time when Congress will act upon the recommendation to officially designate Yellowstone's wilderness.

Proposed wilderness area, in brown



90% of the park is recommended for federally designated wilderness. Areas near roads, around major visitor areas, around backcountry ranger cabins, and in previously disturbed areas are not included.

8

Issues: Winter Use

Revised

The Issue

We have debated appropriate winter use in Yellowstone for over 75 years.

Winter Use Goals

- Provide a high quality, safe and educational winter experience.
- Provide for visitor and employee health and safety.
- Preserve pristine air quality.
- Preserve natural soundscapes.
- Mitigate impacts to wildlife.
- Minimize adverse economic impacts to gateway communities.

History: *See also timeline*

1932: First request to park managers to plow roads year-round.

1949: First visitors using motorized oversnow vehicles (snowplanes).

1955: Snowcoaches enter the park.

1963: First snowmobiles (six, total) enter the park.

1967: Congressional hearing held on plowing park roads year-round.

1968: Yellowstone managers decide to formalize over-snow use instead of plowing.

1971: Managers begin grooming roads and Yellowstone Park Co. opens Old Faithful Snowlodge.

1990: NPS issues first winter-use environmental assessment (EA) for Yellowstone and Grand Teton.

1997: NPS is sued by groups who believe bison used groomed roads to leave the park, which led to their slaughter. NPS must develop a new winter-use environmental impact statement (EIS).

1999: Draft EIS released; ±46,000 public comments received.

2000: Final EIS released, banning snowmobiles and converting to snowcoach-only transportation.

2000, December: Snowmobile group files suit challenging the ban.

2001: NPS settles with snowmobilers' group by agreeing to prepare a supplemental EIS (SEIS).

2002: Draft SEIS released; ±357,000 comments received.

2003, December 11: Final rule published in *Federal Register* to allow 950 Best Available Technology (BAT), guided snowmobiles daily.

2003–2004: Federal court decisions void previous decisions. NPS writes a new EA, allowing 750 BAT, guided snowmobiles daily; 95,000 comments received.

2004–2007: Winter use proceeds per the 2004 EA.

2007: *Winter Use Plans EIS* released, which allows 540 BAT, guided snowmobiles in the park daily; 122,000 comments received; final rule published in December.

2008, September–December: Federal court decisions cancel the new winter plan.

2008, December 15: Winter season opens with a modified version of the winter plan followed in 2004–2007, allowing 720 BAT, guided snowmobiles allowed daily.

Updates: www.nps.gov/yell/planyourvisit/winteruse.htm

Background

Winter use in Yellowstone has been the subject of debate for more than 75 years. At least twelve times since 1930, the National Park Service (NPS), its interested observers, and park users have formally debated what Yellowstone should look and be like in winter.

Beginning in the early 1930s, communities around the park began asking NPS to plow Yellowstone's roads year-round so tourist travel and associated spending in their communities would be stimulated. Each time, NPS resisted, citing non-winterized buildings, harsh weather conditions, and roads too narrow for snow storage. Meanwhile, snowbound entrepreneurs in West Yellowstone began to experiment with motorized vehicles capable of traveling over snow-covered roads. In 1949, they drove the first motorized winter visitors into Yellowstone in snowplanes, which consisted of passenger cabs set on skis and blown about (without becoming airborne) with a rear-mounted airplane propeller and engine. In 1955, they began touring the park on snowcoaches (then called snowmobiles), enclosed over-snow vehicles capable of carrying about ten people. Finally, in 1963 the first visitors on modern snowmobiles entered Yellowstone; not long after, snowmobiling became the dominant way to tour the park in winter.

Still, pressure to plow park roads persisted, and Yellowstone authorities knew that they could not accommodate both snowmobiles and automobiles. The matter culminated in a congressional hearing in Jackson, Wyoming, in 1967. By this time, park managers felt that if they plowed, the look and feel of the park's winter wilderness would be dramatically altered. Snowmobiles offered them a way to accommodate visitor use while preserving a park-like atmosphere. Consequently, managers chose to formalize their oversnow vehicle program, believing it would preserve park resources better than plowing. In 1971, they began grooming snowmobile routes to provide smoother, more comfortable touring, and also opened Old Faithful Snowlodge, so that visitors could stay overnight at the famous geyser.

Throughout the 1970s, 80s, and early 90s, visitation by snowmobile grew consistently. (Some visitors continued to take snowcoaches into the park, but not until recently did snowcoach use substantially grow.) This growth brought unanticipated problems, especially air and noise pollution, conflicts with other users, and wildlife harassment.

In 1990, recognizing that in solving one problem, others were developing, park managers completed the *Winter Use Plan Environmental Assessment* for Yellowstone and Grand Teton national parks and the John D. Rockefeller, Jr. Memorial Parkway. This plan formalized the park's existing winter use program and included a commitment to examine the issue further if winter visitation exceeded certain thresholds.

In the winter of 1992–1993, winter use exceeded the 1990 plan's projection for the year 2000 (143,000 visitors), and shortly thereafter the Continental Divide Snowmobile Trail opened through Grand Teton National Park. According to the 1990 plan, then, NPS began a Visitor Use Management analysis, which examined all types of winter recreation on all NPS and Forest Service (USFS) lands in the greater Yellowstone area. Park and forest staff utilized scientific studies, visitor surveys, and public comments to analyze the issues or problems with winter use. The final report, *Winter Use Management: A Multi-Agency Assessment,* published in 1999, made many recommendations to park and forest managers and summarized the state of knowledge regarding winter use at that time.

Unfortunately, the visitor use management analysis did not change conditions on the ground in the parks. By the late 1990s, the parks were dominated by high levels of snowmobile use, averaging 795 machines per day in Yellowstone. All were two-stroke machines, which used a mix of oil and gas for combustion, resulting in high levels of pollution. Carbon monoxide pollution was especially severe, coming close to violating the Clean Air Act's standards at the West Entrance in one event. Particulate levels were also high, as were levels of certain hydrocarbons. Two-stroke machines were also loud, making it difficult to experience natural silence in the Firehole Valley on many days. Visitors traveling by snowmobile lacked the experience necessary to pass bison and other wildlife without causing harassment. Finally, complaints about the conditions prevailing in this era were common; park managers received several hundred in the 1990s.

1992	1993	1997	1999	2000
Winter visitation exceeds threshold of 140,000 people per year, which was projected in a 1990 winter use plan.	*A Visitor Use Management process begins to evaluate winter recreation in the greater Yellowstone area.*	*Fund for Animals files lawsuit; results in NPS agreeing to develop a new winter use plan and EIS.*	*Draft EIS released. Bluewater Network and other organizations petition to prohibit trail grooming and snowmobile use in all national parks.*	*Final EIS released and Record of decision signed. Snowmobile group sues to stop this winter plan.*

Concerns Raised by the Public

overcrowding

visitor impacts on natural resources

noise & air pollution

availability of facilities and services

restricting snowmobiles, including requiring guides

restricting snowmobiles on side roads

importance of winter visitation to the local and regional economy

wildlife using groomed roads

displacing wildlife

health & human safety

A Decade of Planning & Litigation

The winter of 1996-97 was one of the three harshest winters of the 20th century, with abundant snow, cold temperatures, and a thick ice layer in the snowpack. Unable to access the forage under the ice, more than 1,000 bison left the park and were shot or shipped to slaughter amid concerns they could transmit brucellosis to cattle in Montana. *(See the section on bison management in this chapter.)* Concerned that groomed roads increased the number of bison leaving the park and being killed, the Fund for Animals and other groups filed suit in the U.S. District Court for the District of Columbia against NPS in May 1997. The groups alleged that NPS had failed to examine the environmental impacts of winter use. In 1999 Bluewater Network filed a legal petition with the NPS to ban snowmobiles from all national park units nationwide. These two actions inaugurated a decade of winter use planning and associated lawsuits, and catapulted the issue into one of the NPS's most visible and enduring environmental controversies.

The table below summarizes the series of environmental documents the NPS has produced addressing winter use since 1998, along with the decisions, the number of comments received from the public, the associated litigation, and the legal

Year	Action: Decision	Number of Public Comments	Lawsuit Brought By	Legal Outcome
1998	EA: Do not close Hayden Valley to study bison use of groomed roads	2,742	Fund for Animals (FFA)	Upheld by U.S. District Court for the District of Columbia (D.C. Court)
2000	EIS: Ban Snowmobiles in favor of snowcoaches	46,000	State of Wyoming, International Snowmobile Manufacturer's Association (ISMA), and BlueRibbon Coalition (BRC)	Vacated by U.S. District Court for the District of Wyoming (Wyoming Court)
2003	SEIS: Allow 950 Snowmobiles (all Best Available Technology [BAT]; all guided)	357,000	Greater Yellowstone Coalition (GYC) and FFA	Vacated by D.C. Court
2004	EA: Allow 720 Snowmobiles (all BAT; all commercially guided) (valid only through 2006-2007)	95,000	ISMA, State of Wyoming, Wyoming Lodging and Restaurant Association, and FFA	Upheld by Wyoming Court; not ruled upon in D.C.
2007	EIS: Allow 540 Snowmobiles (all BAT; all commercially guided)	122,000	State of Wyoming, ISMA, GYC, and National Parks Conservation Association	Vacated by D.C. Court. Wyoming court would have upheld the EIS; it did order NPS to reinstate 2004 rule to provide certainty for winter visitation in the winter of 2008-09.
2008	EA: Preferred Alternative would allow 318 snowmobiles (all BAT; all commercially guided)	27,000	None yet (no final decision as of December 2008)	Superseded by Wyoming Court's order on 11/7/08 to reinstate 2004 decision.

2001	2002	2003	2004	2007	2008
Snowmobilers lawsuit settled, which requires NPS to prepare SEIS.	*Draft SEIS released; >350,000 comments received.*	*March: Record of decision signed. Dec 11: Final rule published in Federal Register. Dec 16: Federal judge directs YNP to begin phasing out snowmobiles.*	*Feb: Another federal judge stops phase-out; requires temporary rules for rest of winter. Aug: EA for temporary winter plan released. Nov: Plan approved.*	*March: Draft FEIS released; 122,000 comments. Dec.: Final rule published in Federal Register.*	*Courts stop new winter plan. Dec. 15: Winter season opens using modified plan from 2004–2007.*

outcomes. Each document was a product of its era, reflecting the state of scientific knowledge, technological availability, and sociopolitical climate. The first draft EIS (in 1999) proposed plowing the road from West Yellowstone to Old Faithful (because the plowed road would not connect with other roads, plowing would not have altered park character in the manner feared by earlier park managers). Public comment did not favor plowing, and unmanaged snowmobile use was deemed to impair park resources. Therefore, park managers opted to ban snowmobiles and convert to snowcoaches only in the final EIS. At the time, Best Available Technology (BAT) snowmobiles were not commercially available.

Since that EIS, environmental documents have proposed addressing the historic winter-use problems using a combination of new technologies, limits on vehicle numbers, mandatory guiding, and monitoring winter-use impacts on park resources. All documents proposed to allow a combination of snowmobiles and snowcoaches, with the snowmobile numbers decreasing from plan to plan and snowcoach numbers remaining consistent. By 2002, Best Available Technology snowmobiles were commercially available; these machines used new technologies to dramatically reduce air emissions and somewhat reduce snowmobile noise. Requiring visitors to tour with snowmobile guides or in commercially guided snowcoaches reduced the conflicts with wildlife. Resource monitoring allowed NPS to gauge the effects of these actions and take further protective actions if needed. These changes largely eliminated the problems of the past.

Each of the winter use plans was litigated. The Fund for Animals sought, in several suits, to close much of Yellowstone in winter because of its concern that the plans have not addressed impacts of winter use on park wildlife (especially bison). The Greater

Yellowstone Coalition (GYC) and other environmental groups have consistently sued to ban all snowmobile use in the parks and convert to a snowcoach-only transportation system, even though more recent information suggests that snowcoaches incur wildlife and sound impacts of their own, leave substantial ruts in the snowroads, and consume as much fuel per capita as persons on snowmobiles.

The Fund for Animals, GYC, and the other environmental groups consistently sue in the U.S. District Court for the District of Columbia. The International Snowmobile Manufacturer's Association, the State of Wyoming, the BlueRibbon Coalition, and others consistently file their lawsuits in the U.S. District Court for the District of Wyoming. Litigants have found some traction in each of their courts, with varying degrees of success on any given environmental document. Certainly, the litigation is one of the factors accounting for the ongoing nature of the winter use debate. In each decision against it, NPS has responded by addressing the concerns of the courts.

Improving Conditions in the Parks

With the conversion to BAT snowmobiles, mandatory guiding, and limited numbers of snowmobiles, conditions in the parks dramatically improved. The number of snowmobiles per day averaged 296 for the winters of 2006–07 and 2007–08, while the daily average of snowcoaches increased from 15 in the late 1990s to 35 for these two winters. (Peak use those winters was 557 snowmobiles and 60 snowcoaches.) Overall, the number of oversnow visitors is still reduced over historic levels, though visitors entering the North Entrance by car have increased from an average of about 40,000 to over 50,000 each winter.

Levels of carbon monoxide (CO) and particulates fell dramatically with the conversion to BAT snowmobiles and reduced vehicle numbers. Hydrocarbon and air toxic concentrations are also no longer a concern, with the possible exception of formaldehyde levels, which are being closely monitored.

Ambient levels of CO have averaged 0.2 parts per million for the last several years, with peak levels representing less than 20% of the federal National Ambient Air Quality Standards. Particulate levels are now near background levels in winter.

Noise levels have fallen somewhat as well. Oversnow vehicles are audible 67 percent of the day at Old Faithful and 54 percent of the day at Madison Junction, on average. Administrative vehicles account for approximately one-fourth of this noise. In 2011, NPS hopes to implement BAT requirements for snowcoaches, which may bring audibility levels down even more. While there are periods of the day that oversnow vehicles are commonly heard, there are also periods of time where they are not, even in developed areas like Old Faithful and along busy corridors like the West Entrance Road. Further, winter noise levels are considerably below those of summer.

Making all visitors use a commercial guide has nearly eliminated wildlife harassment. Guides enforce proper touring behaviors, such as passing wildlife on or near roads without harassment, ensuring that wildlife do not obtain human food, and maintaining proper distances from overwintering wildlife. Commercial guiding has also resulted in a 50 percent reduction of law enforcement incidents, even when accounting for the drop in visitation. Arrests have virtually disappeared. Calls for medical assistance are the only statistic that has increased since the conversion to mandatory guiding.

Recent Visitor Survey Results

The University of Montana conducted a survey of winter visitors in 2007–2008:

- Almost 90% of those surveyed agreed that Yellowstone is a place for natural quiet and to hear natural sounds.
- 83% were somewhat or very satisfied with their experience of natural sounds.
- 71% indicated that they found the level of natural sound they desired for half or more of the time they desired it.
- 87% were “very satisfied” with their overall experience.
- The remaining 13% were “satisfied.”
- 71% considered the opportunity to view bison to be extremely important.
- 87% reported that this aspect of their Yellowstone winter experience was very satisfying.
- 99% who saw bison in winter were able to see them behaving naturally.
- 21% witnessed an encounter where the bison were hurried, took flight, or acted defensively.
- More than 72% largely considered the bison-human interactions they witnessed and the park setting as a whole as “very” appropriate and/or acceptable.

Current Situation & Outlook

In December 2008, NPS opened the parks for the winter in accordance with a November 2008 Wyoming Court order reinstating the 2004 rule (without clauses ending snowmobile and snowcoach use). This rule allows up to 720 snowmobiles per day and 78 snowcoaches per day. All snowmobiles must be BAT and commercially guided. These rules will be in place for an interim period while NPS considers its options for more long-term rules in the future.

If the past is any guide for the present, discussions (including potential litigation) about the look and appearance of the parks in winter will continue for the foreseeable future. Yellowstone is clearly cherished by much of the public, portions of which have strong opinions about appropriate park policies. As NPS looks to the future, the agency maintains its commitment to the winter use goals listed in the summary box. The parks will be open for winter use and the agency welcomes all to visit and to participate in the discussions about future winter use management.

Welcoming the wolves on January 12, 1995.

The Issue

The wolf is a major predator that had been missing from the Greater Yellowstone Ecosystem for decades until its restoration in 1995.

History

Late 1800s–early 1900s: predators, including wolves, are routinely killed in Yellowstone.

1926: The last wolf pack in Yellowstone is killed, although reports of single wolves continue.

1974: The gray wolf is listed as endangered; recovery is mandated under the Endangered Species Act.

1975: The long process to restore wolves in Yellowstone begins.

1991: Congress appropriates money for an EIS for wolf recovery.

1994: EIS completed for wolf reintroduction in Yellowstone and central Idaho. More than 160,000 public comments received—the largest number of public comments on any federal proposal at that time.

1995 and 1996: 31 gray wolves from western Canada relocated to Yellowstone.

1997: U.S. District Court judge orders the removal of the reintroduced wolves in Yellowstone, but stays his order, pending appeal.

2000: January, the decision is reversed.

1995–2003: Wolves prey on livestock outside Yellowstone much less than expected: 256 sheep, 41 cattle

2005: Wolf management transfers from the federal government to the states of Idaho and Montana.

Current Status

- As of January 2009, 400–450 wolves live in the greater Yellowstone area.
- ±124 wolves live in Yellowstone National Park.
- The leading natural cause of mortality in Yellowstone National Park is wolves killing other wolves.
- In 2008, disease killed all but 22 of the year's pups.
- Researchers are studying the impact of wolf restoration on cougars, coyotes, bears, and elk.
- In March 2008, the U.S. Fish and Wildlife Service delisted the gray wolf from the federal endangered species list in the states of Idaho, Montana, and Wyoming, and in Yellowstone and Grand Teton national parks.
- In July 2008, a judge ordered they be relisted because a genetically effective population had not developed in the GYE beyond the park, and because of problems with the Wyoming wolf management plan.

The gray wolf *(Canis lupus)* was present in Yellowstone when the park was established in 1872. Predator control, including poisoning, was practiced here in the late 1800s and early 1900s. Between 1914 and 1926, at least 136 wolves were killed in the park; by the 1940s, wolf packs were rarely reported. An intensive survey in the 1970s found no evidence of a wolf population in Yellowstone, although an occasional wolf probably wandered into the area. A wolf-like canid was filmed in Hayden Valley in August 1992, and a wolf was shot just outside the park's southern boundary in September 1992. However, no verifiable evidence of a breeding pair of wolves existed. During the 1980s, wolves began to reestablish breeding packs in northwestern Montana; 50–60 wolves inhabited Montana in 1994.

Restoration Proposed

NPS policy calls for restoring native species when: a) sufficient habitat exists to support a self-perpetuating population, b) management can prevent serious threats to outside interests, c) the restored subspecies most nearly resembles the extirpated subspecies, and d) extirpation resulted from human activities.

The U.S. Fish & Wildlife Service (USFWS) 1987 Northern Rocky Mountain Wolf Recovery Plan proposed reintroduction of an "experimental population" of wolves into Yellowstone. (An experimental population, under section 10(j) of the Endangered Species Act, is considered nonessential and allows more management flexibility.) Most scientists believed that wolves would not greatly reduce populations of mule deer, pronghorns, bighorn sheep, white-tailed deer, or bison; they might have minor effects on grizzly bears and cougars; and their presence might cause the decline of coyotes and increase of red foxes.

In 1991, Congress provided funds to the USFWS to prepare, in consultation with NPS and the U.S. Forest Service, an environmental impact statement (EIS) on restoration of wolves. In June 1994, after several years and a near-record number of public comments, the Secretary of the Interior signed the Record of Decision for the final EIS for reintroduction of gray wolves to

- **1991–94** — EIS process for wolf restoration in Yellowstone and central Idaho. More than 160,000 comments received.
- **1995–96** — 31 wolves from Canada relocated to Yellowstone.
- **1997** — Judge orders removal of the wolves in Yellowstone, but immediately stays his order, pending appeal.
- **2000** — The decision is reversed.
- **2002** — States begin process to remove wolves from the Endangered Species List.
- **2005** — Montana and Idaho wolf management plans approved; day-to-day wolf management transferred to these two states.
  Population in park drops by 1/3 due mostly to disease killing 2/3 of the pups.
- **2008** — March: removed from endangered species list.
  July: returned to the list.
  Disease kills all but 22 of the year's pups.

Released from the cage into the pen.

One of the reintroduction pens remains standing. Park managers are discussing if it should be left as a historic site or taken down to return the site to its natural condition.

Yellowstone National Park and central Idaho.

Staff from Yellowstone, the USFWS, and participating states prepared for wolf restoration to the park and central Idaho. The USFWS prepared special regulations outlining how wolves would be managed as an experimental population.

Park staff completed site planning and archeological and sensitive plant surveys for the release sites. Each site was approximately one acre enclosed with 9-gauge chain-link fence in 10 x 10 foot panels. The fences had a two-foot overhang and a four-foot skirt at the bottom to discourage climbing over or digging under the enclosure. Each pen had a small holding area attached to allow a wolf to be separated from the group if necessary (i.e., for medical treatment). Plywood boxes provided shelter if the wolves wanted isolation from each other.

Relocation & Release

In late 1994 and early 1995, and again in 1996, USFWS and Canadian wildlife biologists captured wolves in Canada and relocated and released them in both Yellowstone and central Idaho. In mid-January 1995, 14 wolves were temporarily penned in Yellowstone; the first 8 wolves on January 12 and the second 6 on January 19, 1995. Wolves from one social group were together in each release pen. On January 23, 1996, 11 more wolves were brought to Yellowstone for the second year of wolf restoration. Four days later they were joined by another 6 wolves. The wolves ranged from 72 to 130 pounds in size and from approximately nine months to five years in age. They included wolves known to have fed on bison. Groups included breeding adults and younger wolves one to two years old.

Each wolf was radio-collared as it was captured in Canada. While temporarily penned, the wolves experienced minimal human contact. Approximately twice a week, they were fed elk, deer, moose, or bison that had died in and around the park. They were guarded by law enforcement rangers who minimized how much wolves saw of humans. The pen sites and surrounding areas were closed to visitation and marked to prevent unauthorized entry. Biologists checked on the welfare of wolves twice each week, using telemetry or visual observation while placing food in the pens. Although five years of reintroductions were predicted, no transplants occurred after 1996 because of the early success of the reintroductions.

Some people expressed concern about wolves becoming habituated to humans while in captivity. However, wolves typically avoid human contact, and they seldom develop habituated behaviors such as scavenging in garbage. Captivity was also a negative experience for them and reinforced their dislike of humans.

Lawsuits

Several lawsuits were filed to stop the restoration on a variety of grounds. These suits were consolidated, and in December 1997, the judge found that the wolf reintroduction program in Yellowstone and central Idaho violated the intent of section 10(j) of the Endangered Species Act because there was a lack of geographic separation between fully protected wolves already existing in Montana and the reintroduction areas in which special rules for wolf management apply. The judge wrote that he had reached his decision "with utmost reluctance." He ordered the removal (and specifically not the killing) of reintroduced wolves and their offspring from the Yellowstone and central Idaho experimental population areas, but immediately stayed his order pending appeal. The Justice Department appealed the case, and in January 2000 the decision was reversed.

Results of the Restoration

Preliminary data from studies indicate that wolf recovery will likely lead to greater biodiversity throughout the Greater Yellowstone Ecosystem (GYE). Wolves have preyed primarily on elk and these carcasses have provided food to a wide variety of other animals, especially scavenging species. They are increasingly preying on bison, especially in late winter. Grizzly bears have usurped wolf kills almost at will, contrary to predictions and observations from other areas where the two species occur. Wolf kills, then, provide an important resource for bears in low food years. Aggression toward coyotes initially decreased the number of coyotes inside wolf territories, which may have benefited other smaller predators, rodents, and birds of prey.

So far, data suggests wolves are contributing to decreased numbers of elk calves surviving to adulthood and decreased survival of adult elk. Wolves may also be affecting where and how elk use the habitat. Some of these effects were predictable, but were based on research in relatively simple systems of one to two predator and prey species. Such is not the case in Yellowstone, where four other large predators (black and grizzly bears, coyotes, cougars) prey on elk—and people hunt the elk outside the park. Thus, interactions of wolves with elk and other ungulates has created a new degree of complexity that makes it difficult to project long-term population trends.

The effect of wolf recovery on the dynamics of northern Yellowstone elk cannot be generalized to other elk populations in the GYE. The effects depend on a complex of factors including elk densities, abundance of other predators, presence of alternative ungulate prey, winter severity, and—outside the park—land ownership, human harvest, livestock depredations, and human-caused wolf deaths. A coalition of natural resource professionals and scientists representing federal and state agencies, conservation organizations and foundations, academia, and land owners are collaborating on a comparative research program involving three additional wolf-ungulate systems in the western portion of the GYE. Results to date indicate the effects of wolf predation on elk population dynamics range from substantial to quite modest.

See Chapter 2 for more information on changes to the ecosystem.

Delisting

Delisting

The biological requirement for removing the wolf from the endangered species list has been achieved: Approximately 300 wolves and three years of 30 breeding pairs across the three recovery areas. The USFWS also has approved the wolf management plans of Idaho, Montana, and Wyoming. As a result, in 2008, the USFWS delisted the wolves in these three states, and in Yellowstone and Grand Teton national parks. Several environmental groups sued to stop the delisting. They argued that a genetically viable wolf population had not developed in the GYE beyond the national park, and that the Wyoming wolf management plan was flawed because it allowed wolves outside the GYE to be shot on sight as predators. A court decision required the wolf be listed again as an endangered species, and its status will be reviewed again in 2009.

Outlook

The wolves' future is secure. Approximately 1300 wolves live in the three-state area—well above the minimum delisting requirements. And even though Yellowstone National Park's wolf population declined in 2008, it is expected to recover quickly—as it has before.

8

For More Information

www.nps.gov/yell

www.greateryellowstone-science.org/index.html

Yellowstone Science, free from the Yellowstone Center for Resources, in the Yellowstone Research Library, or online at www.nps.gov/yell.

Yellowstone Today, distributed at entrance gates and visitor centers.

Site Bulletins, published as needed, provide more detailed information on park topics such as bioprospecting and wolf restoration. Free; available upon request from visitor centers.

Aquatic Invaders

Staff reviewer: Todd M. Koel, Supervisory Fishery Biologist

www.100thmeridian.org

nas.er.usgs.gov

www.sgnis.org

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