

## PART II.

# Natural Resource Programs

The Branch of Natural Resources helps preserve and increase knowledge of Yellowstone's resources in these areas:

- Air, Land, and Water
- Aquatic Resources
- Geology
- Vegetation
- Wildlife



Travis Wyman and Tyler Coleman during the spring carcass survey.

## Air, Land, and Water

### Air Resources

**GYA Clean Air Partnership.** YCR hosted the partnership's 9<sup>th</sup> annual meeting in October. Mary Hektner, who continued to serve as Yellowstone's representative, provided an update on the park's air quality monitoring and "greening" initiatives and co-authored a major update of the 1999 GYA Air Quality Assessment. Other discussion topics at the meeting included snow chemistry monitoring in the GYA, Yellowstone's Greening Program, air quality issues related to oil and gas development activities in southwest Wyoming, Wyoming's air resource management update, regional NO<sub>2</sub> Increment Modeling Analysis and Existing & Planned Monitoring, and the Environmental Protection Agency's Regional Haze Regulations and Guidelines for Best Available Control Technology (BART) Determinations.

The partnership serves as an advisory group to the Greater Yellowstone Coordinating Committee and a forum to facilitate air program coordination and the implementation of consistent air quality management strategies. It includes Yellowstone and Grand Teton national parks, Gallatin, Custer, Beaverhead, Shoshone, Bridger-Teton, and Targhee national forests, Red Rock Lakes National Wildlife Refuge, the Idaho National Environmental and Energy Laboratory (INEEL), the Bureau of Land Management, and the Montana, Idaho, and Wyoming Departments of Environmental Quality.

**Air Quality Monitoring.** Yellowstone participates in a nationwide interagency air quality monitoring network designed to determine levels of air pollutants, trends in air quality, and compliance with National Ambient Air Quality Standards. Atmospheric deposition and wet (acid rain) and dry atmospheric deposition are monitored at Tower Ranger Station. Visibility (fine particulates, PM<sub>2.5</sub>) and gaseous pollutants (ozone and sulfur dioxides) are monitored at the Lake Water Tank. Carbon monoxide and fine particulates are monitored at Old Faithful and at the West Entrance. Ranger staffs at Tower, Lake, Old Faithful, and West Entrance operate the stations; the samples and raw data are sent to various national programs for analysis.

The NPS Air Quality Division's 2005 Annual Performance and Progress Report noted that no measured Clean Air standards have been exceeded in Yellowstone and the park's air quality, including visibility, is generally considered excellent. However, four (ozone, and sulfate, nitrate, and ammonium in precipitation) of six measures of air quality showed a statistically significant decline in Yellowstone from 1995 to 2004. Visibility on clear days significantly improved during that period and visibility on the haziest days improved slightly, but the trend in declining air quality is of concern. The National Park Service has no control over external sources of air pollution, such as oil and gas development or coal-fired power plants, but continues to work with the Environmental Protection Agency and with state air quality agencies to deal with the external sources.

The NPS report is available on the web at [www2.nature.nps.gov/air/](http://www2.nature.nps.gov/air/).

Most of Yellowstone's efforts in regard to air quality concern winter use monitoring at the West Entrance and Old Faithful. Data for the winter of 2004–2005 showed a direct correlation between the decrease in total oversnow traffic and a decrease in air pollutants. Data analysis is still underway by the Air Quality Division.

### **Snow Survey**

More than 75% of the surface water supply in the West is derived from snowmelt in the region's higher mountainous areas. Conditions from year to year and region to region can range from extreme drought to severe flooding, putting hundreds of millions of dollars at risk annually in agriculture, hydropower, dam operation, flood control, drought mitigation, and recreation. To help manage this resource for public safety, health, and economic viability, the Natural Resource Conservation Service (NRCS), under the federally mandated Snow Survey & Water Supply Forecasting Program, maintains an extensive monitoring system to collect snow pack and related climate information. As the headwater areas for two major river systems—the Yellowstone River east of the Continental Divide that feeds into the Mississippi River system, and the Snake River on the west that flows into the Columbia River—Yellowstone has 10 NRCS SNOTEL stations and 5 manual snow course sites.

In addition to the long-term snow water equivalent, precipitation, and temperature data that has been collected, NRCS has been adding snow depth sensors at the SNOTEL stations over the past three years. This information will provide a more accurate assessment of hydrologic and climate conditions relating to water supply conditions. The data is used to assess avalanche potentials and winter severity and range conditions for wildlife. Plans call for adding soil moisture and soil temperature sensors to the SNOTEL network over the next few years to better forecast both the quantity and timing of spring and summer stream flows.

### **Fens Study**

Fens are wetland habitats in which a constant supply of surface or ground water maintains permanently saturated soils and, over thousands of years,

causes thick layers of partially decomposed organic matter to accumulate. This organic soil, called peat, is common in far northern climates. In Yellowstone National Park, although fens occupy little land area, they include a diverse range of fens occupied by plant and animal species that rely on permanently moist environments, and they serve as examples of how complex fen ecosystems function in a pristine state. Many of the major wildlife species of the park spend at least some of their time in fens, which provide both forage and a cool, moist place to go in the heat of the summer. Until recently, little was known about the park's fens. Through a grant from Canon U.S.A., researchers from Colorado State University led by Dr. David Cooper have spent the past two summers mapping and describing fens throughout the park.

Sampling during 2004 focused on 65 sites located along the road network for easy access. In 2005, the field team sampled more than 100 fens in more remote areas such as Mirror Plateau, Shoshone Lake, Heart Lake, the South Arm of Yellowstone Lake, the Gallatin Mountains, and the Bechler area. Perhaps the most unique type found in Yellowstone has been the acid fen complexes located where the chemistry of the waters feeding the fens is influenced by geothermal activity. Although the waters are not necessarily hot, they are strongly acidic, sometimes less than 3.0 pH, and contain high sulfur content. *Carex aquatilis* (water sedge) is the most common vascular plant at these sites, but a thick mat of mosses and liverworts that can survive in such acidic waters is often present at the edges.

Searching for fens at higher elevations, the field team found several sites close to 9,000 feet in the Gallatin Mountains. These sites contain a set of species typically found in the subalpine, such as *Carex illota* (sheep sedge) and *Caltha leptosepala* (white marsh marigold), along with highly diverse forested fens.

Bechler Meadows is the wettest area in the park and filled with peatlands. To sample the floating mats located in lakes there, the field team waded out into the lake and climbed on top of the mat. The peat soil that forms the mats is often much deeper than the eight-foot sampling probe, which indicates that dead plant matter has been accumulating for thousands and thousands of years. Several rare plant species grow on the floating mat at Robinson

Lake, including *Dulichium arundinaceum* (three-way sedge), *Lycopodium inundatum* (marsh club-moss), *Scheuchzeria palustris* (rannoch-rush), and *Schoenoplectus subterminalis* (swaying bulrush).

In the Heart Lake area, the team found the rare dwarf shrub *Rubus acaulis* (dwarf raspberry) in several new locations. The team also found two samples of the moss *Meesia triquetrum*, one near the Continental Divide in the southern half of the park and the other in the Bechler area.

The two-year study has produced species lists with absolute cover of each species for 518 distinct stands of vegetation from 169 different fens. The data will be analyzed to look for recurring patterns that can be considered vegetation communities. Variables such as soil and water chemistry, elevation, annual precipitation, bedrock geology, and proximity to geothermal features will be examined to determine why certain types of vegetation communities occur in certain locations. The project's final report is expected to be completed within a year.

## Restoration Projects

***Gardiner Basin Restoration Workshop.*** In 1926, Congress added several thousand acres to the northern part of the park to "provide the winter range and winter feed facilities indispensable for the adequate and proper protection, preservation, and propagation of the elk, antelope, and other game animals of Yellowstone National Park" (Game Ranch Addition Act of May 26, 1926). Although this area, known as the Boundary Line or Gardiner Basin area, is dominated by exotic vegetation introduced through homesteading, railroading, and gravel mining activities, it is still a crucial feeding ground, especially for Yellowstone's dwindling pronghorn population. Yellowstone's previous experiments to reestablish native vegetation to improve winter forage have been largely unsuccessful, partly because of the staff's limited experience with the semi-desert environment found in the rain shadow of the Gardiner Basin.

Funding was therefore obtained from Canon U.S.A., Inc., through the Yellowstone Park Foundation; Greater Yellowstone Coordinating Committee; and Rocky Mountains Cooperative Ecosystem Studies Unit to convene a workshop on arid lands reclamation. Ten invited arid land restoration specialists and 20 park and Gallatin National

Forest staff participated in the facilitated meeting held in Gardiner on April 19–21. A summary report was produced that gives recommendations applicable to both agencies and also site specific recommendations. Staff have begun the next steps of NEPA compliance and are seeking funding for a 50-acre pilot project that could begin in 2008.

Information about the workshop and resulting recommendations were presented in talks at the George Wright Society Biennial Conference on Parks, Protected Areas, and Cultural Sites, (Philadelphia, PA), and the 8th Biennial Scientific Conference on the Greater Yellowstone Ecosystem (Mammoth Hot Springs, WY), and in a poster at the World Conference on Ecological Restoration (Zaragoza, Spain).

***Turbid Lake Road Restoration.*** Restoration work from Turbid Lake to Pelican Creek began in 1997 as compensatory mitigation for wetland impacts incurred in the reconstruction of the Dunraven road. As required by the terms of the park's permits for the Dunraven and East Entrance Segment C road reconstruction, the hydrophytic vegetative cover must be restored before road reconstruction is completed.

The heavy equipment phase of the restoration project was completed this year with gratifying results. To document conditions at wetland restoration sites, groundwater monitoring wells were installed, checked, and repaired as necessary at 27 sites, 36 revegetation plots were set up, and more than 240 existing plots were checked and photographed.

***Mining Impacts.*** Park staff continued to monitor proposed and ongoing reclamation projects associated with three mining sites outside the park: the New World Mining District, the McLaren Mill mine tailings, and the Great Republic Smelter. Environmental cleanup of historical mining impacts in the New World Mining District adjacent to the park's Northeast Entrance is proceeding. The U.S. Forest Service continues to identify sources of pollution and conduct site investigations to refine cleanup activities.

Significant progress was made on the cleanup of the McLaren Mill and tailings sites and the Republic Smelter site, all of which are located upstream and just outside the park's northeast boundary. The U.S. Forest Service (USFS) and Environmental

Protection Agency joined forces to completely clean up the Republic site, and the USFS reclaimed the portion of the McLaren Mill site that was on USFS property. All of the contaminated soils were placed in the Forest Service’s New World waste repository near Cooke City and the sites were recontoured and revegetated.

For the McLaren tailings site, the Montana Department of Environmental Quality received funding from the NPS Water Resources Division to install three groundwater monitoring wells to determine whether there is adequate separation between the groundwater and the bottom of the proposed repository—one of the criteria necessary to determine whether the site is suitable.

## Aquatic Resources

Yellowstone National Park is home to the most ecologically and economically important inland cutthroat trout fisheries remaining in North America. However, over the past decade, these resources and the ecosystems that they support have become seriously threatened by introductions of non-native and exotic species. Aquatics Section activities are almost entirely aimed at reducing these threats and improving the overall condition of native aquatic communities in the park, with a primary focus on activities that support

- preservation of Yellowstone Lake cutthroat trout, the largest remaining concentration of genetically pure inland cutthroat trout in the world;
- restoration of fluvial populations of native trout,

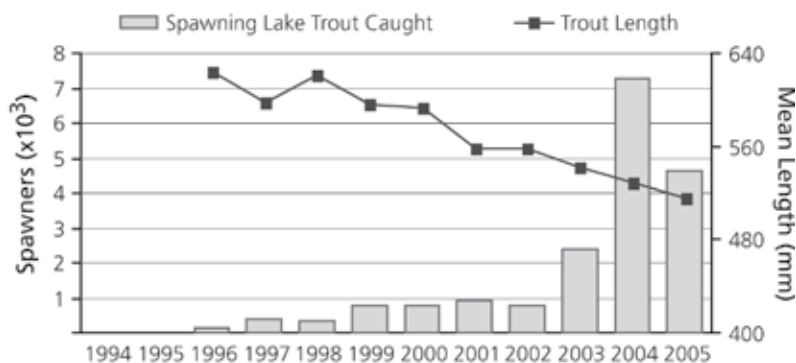
many of which have been lost due to introductions of non-native species.

### Yellowstone Cutthroat Trout Preservation

**Lake Trout Suppression.** Preservation of Yellowstone Lake cutthroat trout continued to be a top priority in 2005, as a total of 36,426 non-native lake trout were killed, bringing the overall total killed to more than 136,000 during 1994–2005. Because each lake trout is capable of consuming at least 41 cutthroat trout each year, the gillnetting effort has saved a tremendous number of cutthroat trout. The result is a lake trout population that is beginning to show signs of suppression. Catch per unit of effort for lake trout remains low, and the average length of spawning adult lake trout continued to decline (Fig. 1). However, the cutthroat trout population has yet to demonstrate a significant positive response. Because no means of completely eliminating lake trout from Yellowstone Lake is currently feasible, the labor-intensive removal program will be necessary for the foreseeable future

**Population Monitoring.** The number of upstream-migrating Yellowstone cutthroat trout (*Onchorhynchus clarki bouvieri*, YCT) counted at Clear Creek, one of the cutthroats’ largest spawning tributaries, was only 917 during 2005 (having declined from 6,613 in 2002), the lowest since annual counts began at Clear Creek in 1945 (Fig. 2). However, the fall netting assessment in Yellowstone Lake during 2003–2005 has provided some of the first indications that the cutthroat trout may be responding positively to efforts to remove lake trout,

Figure 1. Number and mean length of mature lake trout removed near spawning locations on Yellowstone Lake during late August–early October, 1996–2005.



as suggested by a modest increase in the abundance of smaller, juvenile fish. An average of 7.4, 7.9, and 7.4 fish were caught per net in 2003, 2004, and 2005, respectively, whereas previously the catch had declined 11% per year on average since 1994. Critical to the cutthroat now will be the ability of these juvenile fish to recruit to the spawning population and appear within the spawning tributaries of Yellowstone Lake; that is the only means by which the population can be expected to rebound and return to the higher densities seen in the past.

**Whirling Disease.** Understanding the factors that affect whirling disease (WD) infections and YCT population declines requires knowledge of the spatial variation in *Myxobolus cerebralis* (*Mc*), the parasite that causes WD, in the upper reaches of the Pelican Creek watershed. In 2005, the park continued its partnership with Montana State University's Department of Ecology in the Pelican Creek backcountry. Goals included quantifying *Mc* infection risk in Pelican Creek using *Tubifex tubifex* worms (which serve as a host for *Mc*), comparing results to those obtained by sentinel fish exposures, and measuring variation among tubificids and habitat.

In 2005, a uniform (100%) infection prevalence and similar, high grades of infection severity were found in sentinel fish among six sites where fry were exposed. In contrast, patchy patterns of *Mc* infection were observed in tubificids at the 25 sites examined for worms in the watershed. The highly variable patterns of infected tubificid abundance

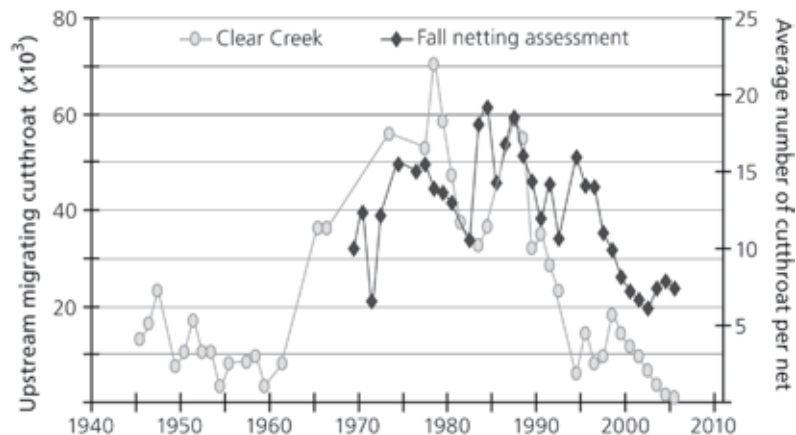
relative to habitat type warrants investigation. The next steps will be to monitor uninfected sites for colonization by the parasite, examine variation in the relative abundances of worm species, and evaluate any potential vectors of dissemination.

**Native Trout Restoration**

**Westslope Cutthroat Trout.** NPS mandates require that the park ensure the persistence of native species and restore them when appropriate. The westslope cutthroat trout (*O. c. lewisi*, WCT) has substantially declined in the park and elsewhere within its range in the upper Missouri River drainage. Losses within the park are primarily due to interbreeding (hybridization) with other trout, particularly introduced YCT and non-native rainbow trout. With generous support by the Yellowstone Park Foundation and its Fisheries Initiative that was developed in 2005, restoration of fluvial populations of native trout in the park is moving forward.

Although introgression of the North Fork Fan Creek westslope cutthroat trout was reported, a pure population of more than 700 westslope cutthroat was found in an unnamed tributary to Grayling Creek in June. Aquatics Section staff documented the population's extent during July and August and state of Idaho geneticists determined that they are the only pure westslope cutthroat trout known in the park, and one of only three populations remaining in the Gallatin and Madison river drainages of southwest Montana.

Figure 2. Upstream-migrating cutthroat trout counted at Clear Creek spawning trap (1945–2005), and mean number collected per net on Yellowstone Lake during the fall (1969–2005).



The Aquatics Section is proposing to restore westslope cutthroat to the East Fork Specimen Creek watershed by restocking it with genetically pure WCT from the few other, remaining native WCT populations within the Madison and Gallatin drainages. National Environmental Policy Act (NEPA) compliance was initiated in July for this purpose.

**Yellowstone Cutthroat Trout.** Work was completed to prioritize watersheds in the park's northern range based on probability of success for YCT stream restoration. Reese Creek, Rose Creek, the Elk Creek complex of streams, and Blacktail Deer Creek all provide excellent opportunities for re-establishment of genetically pure YCT populations. Rose Creek, given its proximity to the Lamar Buffalo Ranch, would provide opportunities for public education regarding native trout issues in the park.

### Aquatic Invasive Species

Yellowstone's fisheries are threatened by aquatic invasive species (AIS) that displace native fish and the macroinvertebrates upon which they depend for survival. AIS may also impact trout consumers such as eagles, ospreys, and grizzly bears. Exotic AIS that are present in park waters include the New Zealand mud snail (*Potamopyrgus antipodarum*) and *M. cerebralis*, which causes whirling disease in trout. Once established in park waters, AIS are virtually impossible to get rid of. These measures have been taken to prevent additional AIS introductions in the park:



Jeff Arnold sampling macroinvertebrates at Mammoth Crystal Spring.

- A brochure has been developed to provide information on how to conduct boat inspections and clean angling gear (available online at [www.nps.gov/yell/planvisit/todo/fishing/exotics.htm](http://www.nps.gov/yell/planvisit/todo/fishing/exotics.htm)).
- Signs have been developed and installed at Yellowstone Lake and Lewis Lake boat ramps.
- Anyone purchasing a boating permit in the park is now informed about AIS and how to conduct boat inspections.
- Collaboration with partner agencies and non-governmental organizations, and development of an Aquatic Nuisance Species Management Plan for the Greater Yellowstone Area.

Yellowstone National Park also participates in the "Stop Aquatic Hitchhikers" campaign sponsored by the U.S. Fish and Wildlife Service and U.S. Coast Guard.

### Fish Monitoring

Monitoring of fish communities occurred in many front- and backcountry streams during 2005, including research on the status and life history strategies of Yellowstone cutthroat trout in the Yellowstone River and its tributaries upstream of Yellowstone Lake. An inventory of fishes in the remote reaches of the Snake River and its tributaries also continued. These are among the first surveys of fishes in these regions of the park, even though fisheries investigations have been occurring in Yellowstone since the late 1800s. The waters of the upper Yellowstone River support significant numbers of spawning cutthroat trout from Yellowstone Lake. It is unknown to what extent the Snake River supports migrating cutthroat trout. Results will help managers understand the status and dynamics of cutthroat trout in these wilderness areas and the contribution of these systems to the overall cutthroat trout populations in the Greater Yellowstone Ecosystem.

The ecological health of the park's aquatic systems continues to be monitored intensively:

- The quality of surface waters is monitored biweekly at 12 fixed sites located near the confluences of major streams and rivers.
- The physical and chemical characteristics of Yellowstone Lake are monitored seasonally to assist in eliminating lake trout.
- Macroinvertebrates are sampled using regionally standardized methods to allow for data compari-

son among agencies. Results are being used in the development of NPS Vital Signs Monitoring protocols for the Greater Yellowstone Network.

- A study was completed on the effects of road operations at Sylvan Pass on the water quality and macroinvertebrate communities of Mammoth Crystal Spring.

### Angler Participation

Anglers caught an estimated 520,218 fish in the park during the 2005 fishing season. Native cutthroat trout remained the most caught fish species, comprising 52% of the total catch, followed distantly by rainbow trout (20%), brown trout (13%), brook trout (6%), lake trout (4%), grayling (3%), and mountain whitefish (2%). Overall, native species comprised 57% of the total catch.

Yellowstone Lake remained the most popular destination for anglers; an estimated 10,271 anglers fished the lake this year, representing one-quarter of all fishing effort in the park. Anglers fishing Yellowstone Lake reported catching 0.70 cutthroat trout per hour of fishing. This catch rate continues a six-year downward trend following a record high catch rate in 1998. The angler-reported catch rate for lake trout in Yellowstone Lake decreased for the second consecutive year, to 0.05 fish per hour. This is a positive sign that lake trout suppression efforts are having some effect. The park encourages anglers to fish for lake trout on Yellowstone Lake and killing them is required by law; an estimated 5,530 lake trout were removed by anglers from Yellowstone Lake during the 2005 angling season.

### Changes in Fishing Regulations

Public scoping took place for proposed changes in fishing regulations, including a possible requirement to use barbless hooks as a way to reduce fish injuries in catch-and-release fishing, especially in heavily fished waters such as the Yellowstone River and Soda Butte Creek. Five public meetings were held in gateway communities and a period for written public comments remained open for more than five months. Of the 506 correspondence records received, 352 (70%) were in favor of the proposed changes and 18 (4%) were opposed. A slightly higher percentage (74%) favored a parkwide requirement for barbless hooks and 2% were opposed.

Given the strong public support for the proposed

changes, the park plans to implement them in 2006. The framework for the new policy is based on the presence or absence of native sport fish species in different park waters. Most of the park will be designated a "Native Trout Conservation Area," where catch-and-release applies to native species but non-native fish may be taken within certain limits. The west-central part of the park will be considered a "Wild Trout Enhancement Area," where catch-and-release applies to rainbow trout and most brown trout as well as to all native species. Pelican Creek and part of the Yellowstone River drainage above the Upper Falls is closed to fishing because of the presence of whirling disease.

### Assistance and Support

Aquatics Section staff continued to provide a variety of short-term educational programs with an emphasis on native fish conservation for visiting schools and other interested groups. The staff also provided American Red Cross certification in First Aid and CPR for employees of Yellowstone National Park as well as other agencies.

### Public Involvement and Volunteer Support

Public involvement with the Aquatics Section increased, primarily through the assistance of many volunteers. The Yellowstone Volunteer Flyfishing Program, in which anglers from across the United States participated in specific fisheries projects in the park, was a highlight again this year. Information provided by volunteers is being used to assess the status of fisheries in many waters of Yellowstone.



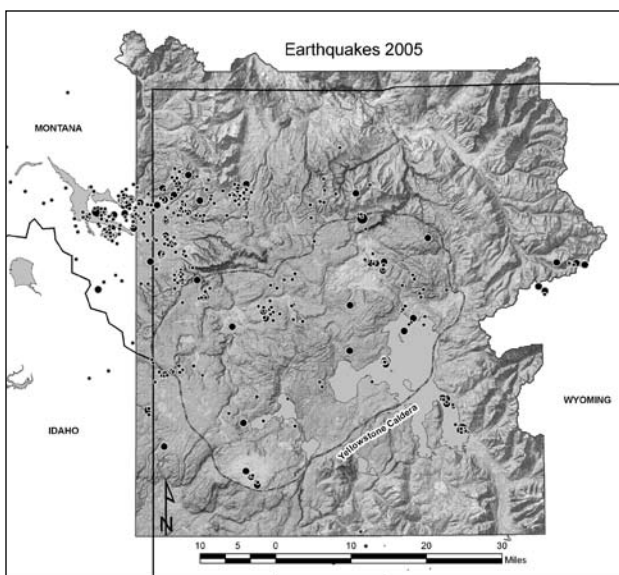
Non-lethal sampling of fin tissue for genetic analysis.

## Geology

Yellowstone's geologic resources include its thermal features, landscape, rocks, minerals, and fossils as well as the geologic processes that continually form these resources and affect road projects, water sources for developed areas, boardwalks, visitors, and the distribution of plants and animals. Yellowstone became the world's first national park because of the many spectacular hydrothermal features, and their protection was a primary goal of the park's enabling legislation. The Geothermal Steam Act of 1970, as amended in 1988, also requires that the park's geothermal features be protected.

The primary mission of Yellowstone's geology program is to provide park managers with the information needed to protect the park's geologic resources from human activities and to protect the public from the dangers posed by geothermal activity. To carry out this mission, the park geologists collaborate with outside groups to ensure that the park's geologic resources are scientifically inventoried and monitored, and they work with other park divisions to help staff understand geologic processes and their impact on the park's geologic resources.

Protection and monitoring of the park's geothermal features is accomplished by the geologists in conjunction with the Montana Water Rights Compact and partner scientists from other government agen-



The seismic network detected 872 earthquakes in the Yellowstone area during 2005, the fewest since 1994.

cies and academic institutions. The Yellowstone Volcano Observatory (YVO, the park's partnership with the USGS and the University of Utah), monitors volcano and earthquake hazards within the park using a network of seismic and GPS leveling stations. The Montana Water Rights Compact, which YNP established in 1994 with the state of Montana, protects geothermal features by limiting groundwater withdrawal in a designated area north of the park. This Controlled Groundwater Area was intended to be monitored by the state of Montana with funding provided by the federal government. During 2005, the geology staff worked with the NPS Water Resources Division of the National Park Service to review groundwater use applications for the Controlled Groundwater Area.

### Geothermal Monitoring Program

In March 2003, Yellowstone staff and partner scientists prepared a proposal for a comprehensive geothermal monitoring program that would include groundwater, surface water, chloride flux, geochemical monitoring, and remote sensing of thermal features for a total annual cost of \$989,000. The YVO and the Technical Oversight Committee for the Montana Water Rights Compact have peer reviewed and support the proposed program as a critical component of monitoring the Controlled Groundwater Area, volcanic and seismic hazards, and protecting Yellowstone's irreplaceable geothermal features.

As a result of successful lobbying by the Montana Water Rights Compact Technical Oversight Committee to implement a comprehensive geothermal monitoring plan for the park, in 2005 YNP received a \$646,000 base increase from Congress of which \$141,000 is to be paid annually to the Montana Bureau of Mines for monitoring the Controlled Groundwater Area, and \$250,000 will be used to relieve park budget shortfalls. The remaining \$255,000 a year is to be applied toward geothermal monitoring in the park, of which \$145,000 will fund three Cooperative Ecosystem Studies Unit (CESU) agreements for the use of remote sensing techniques to monitor the park's geothermal features:

- Montana State University—Drs. Steve Custer (Earth Sciences) and Rick Lawrence (Land Resources) will use current and historical satellite imagery to map active thermal features in the park.



- University of Montana National Center for Landscape Fire Analysis—Dr. Lloyd Queen, Dr. Carl Seielstad, and Josh Rodriguez worked with the USDA Forest Service Rocky Mountain Research Station Fire Sciences Lab (Dr. Colin Hardy and Jim Reardon), a Minnesota flight crew, and the park geologists to acquire day- and nighttime thermal infrared images over Norris Geyser Basin in October 2005, with the goal of generating a thermal map that shows changes in active thermal features since the last airborne data was collected in October 2002.
- Utah State University—graduate students (Deepak Lal, Miguel Augel Moreno Hidalgo, Sarvanan Sivarajan, and Raghuvier Vinukollu) from Dr. Christopher Neale’s Irrigation Engineering–Remote Sensing Services Lab acquired day- and nighttime images over the Upper, Midway, and Lower geyser basins.

### Yellowstone Volcano Observatory

Scientists improved the YVO monitoring network by installing a new seismic station at Parker Peak and five new GPS stations for continuous data collection at the Northeast Entrance, Slough Creek, the Promontory, Madison Junction, and Canyon. These network enhancements increase the YVO’s ability to monitor seismic and volcanic hazards with a total of 27 seismic and 11 GPS leveling stations in the park. The network makes it possible to provide real-time data over the Internet, including live seismograms, an earthquake catalog of the Yellowstone area, GPS station velocities, stream discharge and temperature at Tantalus Creek, stream flow for several major rivers in Yellowstone, and temperature logs for Steamboat Geyser.

In November 2005, the geologists met in Salt Lake City with scientists from all five U.S. volcano observatories to discuss a 10-year plan for volcano and earthquake monitoring for YVO.

The park’s geologists and other scientists associated with the YVO provided technical information for the British Broadcasting Company’s production of “Supervolcano,” a two-hour docudrama about a catastrophic eruption of the Yellowstone volcano and its regional and worldwide impacts. Accompanying the drama was a one-hour documentary, “The Science Behind the Supervolcano Story” for which geology personnel were interviewed.

### Monitoring at Sylvan Pass

Nearly one third of the geologists’ time during 2005 was taken up by intensive study and monitoring at Sylvan Pass in order to determine the possible impact of the East Entrance Road reconstruction on the hydrology of the area. The analysis began in August 2004 after a plume of milky turbidity was observed in 8 km of Middle Creek below Sylvan Pass. To investigate how the water flows underground, in June 2005, the geology staff worked with USGS scientists to inject fluorescein dye on the west side of the pass where a stream disappears into the talus. Activated charcoal samplers were deployed on both sides of the pass, and an auto sampler was set up at Mammoth Crystal Spring about 1.5 km east of the pass. About 22½ hours after the injection, dye was observed 2.25 km away in Mammoth Crystal Spring. Geology staff prepared four internal reports concerning the geohydrology of Sylvan Pass, including data on water flow, turbidity, pre-



Steamboat Geyser, the tallest in the world, erupted in 2000 for the first time in nine years, five times in 2002 and 2003, and once in 2005.

precipitation, and temperature that park managers are using to determine what changes the U.S. Federal Highways Program needs to make in how the road work is done.

### **Boreholes on the Mammoth Terraces**

On a bitterly cold January day, park geologists logged three boreholes at the planned site of the Justice Center on the Mammoth Terraces and measured gases and temperatures within the boreholes. All three boreholes exposed decomposed, altered, porous travertine and produced temperatures near 8°C in moist, gray-brown, clay-rich layers. In borehole 1, explosive levels and concentrations of carbon dioxide and carbon monoxide gases were greater than those measured in boreholes 2 and 3. This information was used by the engineers of the Justice Center to make changes in its design.

### **Thermal Areas at Canary Spring**

Three times during 2005, rapidly advancing deposits of travertine and flowing thermal water at Canary Spring prompted Yellowstone's boardwalk crew to remove segments of boardwalk. Law enforcement ranger Joe Bueter assisted the geology staff in each effort to restore the thermal areas affected by these removals.

### **Assistance and Support**

The geology staff assisted other park divisions by providing information and conducting on-site investigations followed up by written reports (see Appendix II). For the Division of Interpretation, the geology staff edited publications and electronic field trips for scientific accuracy and provided a scientific review of exhibits for the Canyon Visitor Education Center and the Old Faithful Visitor Education Center.

During 2005, eight volunteers contributed 2,964 hours (370 eight-hour days) to clean thermal features, manage temperature loggers, and assist with protection and restoration of thermal resources. Patrice Barlow, a geology student at Stephen F. Austin State University, contributed 400 hours developing a geologic database for thermal features as a GeoCorps America volunteer paid by the Geological Society of America.

## **Vegetation**

The vegetation found in Yellowstone reflects the physical environment—climate, geology, soils, elevation, and aspect—as influenced by natural disturbances and human activities. Preserving native vegetation communities and associated processes while minimizing human influences has great value for wildlife habitat, wilderness, cultural landscapes, and scientific research. However, there are situations, such as in the case of hazard trees or fire, in which park visitors and staff must be protected from hazards associated with the natural processes operating on vegetation communities.

YCR's vegetation group has diverse responsibilities and functions related to the protection, perpetuation, or restoration of vegetation communities, management of threatened or endangered species, safety and enjoyment of the public, mitigation of human-induced effects, assessing threats from external sources, and general management and compliance needs.

### **Plant Inventories**

The park's vascular plant list includes more than 1,370 taxa. Yellowstone has met the goal of the servicewide inventory and monitoring initiative that requires documenting at least 90% of the vascular plant species in each park and incorporating the information in the NPSpecies biodiversity database. During 2005, Yellowstone's database was updated with new records, synonymy, park status, abundance, residency, nativity, and cultivation data, and several hundred specimens were labeled and mounted for addition to the herbarium.

*Native Species.* The vegetation zone believed most likely to have species not yet in Yellowstone's database is the alpine zone, especially in the Gallatin Mountains. Field work for the Gallatin Mountains alpine plant survey, which began in 2003, was completed in 2005, including surveys of limestone areas in the vicinity of Fawn Pass and revisits of the Quadrant, north cirque of Bannock Peak, and the slopes of Gray Peak with the help of corral operations. As a result of this fieldwork, the presence of grayish draba (*Draba cana* Rydb.) in the park was confirmed, and an unusual mustard was located that may be a new *Draba* species, pending verification at regional herbaria. Additional searches of the

Yellowstone portion of Cutoff resulted in the location of a population of dwarf buttercup (*Ranunculus pygmaeus* Wahlenb.) in the park that was previously reported erroneously in the annual report for 2001. The visit also located a site of one-head pussytoes (*Antennaria monocephala* DC.), a new record for the park. Three additional native species were found last summer for the first time in the park: scarlet gaura or butterfly-weed (*Gaura coccinea* [Nutt.] Pursh); rush-like skeletonweed (*Lygodesmia juncea* [Pursh] D. Don ex Hook.); and cup-shaped western stickseed (*Lappula redowskii* [Hornem.] Greene var. *cupulata* [Gray] Jones).

**Non-native Species.** Four additional non-native species were documented for the first time in 2005:

- The NPS Mountain Exotic Plant Management Team located spotted cats-ear (*Hypochaeris radicata* L.), also known as hairy cats-ear or gosmore, at the entrance to the Norris Geyser Basin. Although the infestation was small and completely dug up and eradicated, seed is probably present in the soil and the area will have to be monitored for several years.
- During wetland inventory in the Old Faithful development, the delineation team located common velvetgrass or Yorkshire-fog (*Holcus lanatus* L.), a highly invasive grass that is common on the West Coast. Eradication will be difficult because the species has apparently been present in the park for years and spread into wetlands on the edge of the Firehole River.
- An infestation of water speedwell or water pimpernel (*Veronica anagallis-aquatica* L.) along the spring within the NPS corrals at Tower could be eradicated through aggressive management over the next few years, but other introductions are possible since this species is well-established in areas adjacent to the park, such as Jackson Hole.
- Lamb's quarter or goosefoot (*Chenopodium strictum* Roth var. *glaucophyllum* [Allen] Wahl) is present in Gardiner, so its discovery in front of the HRC building was not unexpected. The solitary individual was eradicated, but it was late enough in the summer that some seed may have matured and dispersed.

**Rare Plant Surveys.** To prevent inadvertent negative impacts to rare plant populations in the park, surveys are conducted prior to construction proj-

ects, trail re-routes, and other disturbance activities. One benefit of these required compliance activities is the data gathered: the summer field season resulted in documenting 27 additional sites for the GIS layer of "species of special concern" or rare plants in the park.

Summer fieldwork for Federal Highways projects took place primarily in the Old Faithful area and at the Lamar River bridge. Rare plant sites that were potentially vulnerable were visited when advantageous or necessary during various stages of road construction. Staff worked with the park's landscape architects to coordinate salvage soil activities necessary as a result of impacts to the annual hairgrass (*Deschampsia danthonioides*) site on the East Entrance road. The revegetation plan that the landscape architects are developing for the section of the Gibbon Canyon where the Grand Loop Road will be removed from the river corridor will include specific recommendations for species of special concern such as warm springs spikerush (*Eleocharis flavescens* [Poiret] Urban var. *thermalis* [Rydb.] Cronq).

Front country construction sites that were investigated for wetlands or rare plants include the waterline for the expansion/upgrade of the Madison wastewater treatment plant, the Norris developed area for the Wildland-Urban Interface (WUI) project of the fire cache, the Tower Junction area and Yancey's, and the water system at Lake in the vicinity of the spring boxes. Surveys were also initiated for ground-disturbing activities resulting from the re-route of the Winter Creek trail, the expansion of the seismograph and GPS base station sites at Parker Peak, Slough Creek, Northeast Entrance, Canyon, Grant Village, the Promontory, and Madison Junction, and the Nez Perce event by the Nez Perce picnic area.

## Yellowstone Herbarium

The Yellowstone National Park Herbarium houses approximately 9,000 specimens that have been curated and entered into a database. The specimens are used by NPS personnel and outside researchers to identify vascular plant taxa as well as the bryophytes, fungi, and lichens that occur in the park, and to document the presence, variation, and distribution of native species, and the arrival and spread of exotic species.

With the new herbarium facility at the HRC, staff finally have the space needed to process specimens.

During the fall and winter of 2005, strides were made in organizing all of the unmounted specimens and establishing protocols for identifying, mounting, and entering the specimens into the NPS museum catalog database (ANCS+). Labels were generated for some of the backlog collections, and these specimens are being added to the collection.

During the 2005 field season, 166 vascular plant specimens were collected and will eventually be mounted and catalogued into the herbarium. These new specimens were needed to document the native flora in under-collected portions of Yellowstone, and the arrival and spread of exotic species.

The oldest specimens in the collection are four specimens of western groundsel (*Senecio integerrimus*) and woolly groundsel (*Senecio canus*) that were collected in the park in 1899 and donated by the Booth Herbarium at Montana State University (MSU) in Bozeman in 2005.

### **Browse History of Aspen**

Although aspen occupy a very small proportion of the northern Yellowstone landscape, the species has been the source of controversy regarding the cause of its decline over the past century, with some researchers attributing the decline largely or entirely to elk browsing. To look for evidence of browsing while the trees were seedlings and saplings, staff have examined 279 overstory trees that had died and fallen or were protected from browsing by range exclosures. Paired cross sections were obtained from each tree at 0.2 and 1.5 m above ground level for age estimation to determine whether previous browsing influenced growth rates. Most of the trees in the sample originated between 1850 and 1900. The terminal stem of 85% of the trees were browsed from 1 to 7 times. The trees reached breast height after an average of 6.8 years (range = 1 to 17 years). The median time it took to achieve breast height increased with the frequency of browsing. A subset of trees ( $n = 28$ ) with a known death year showed that browsing on these aspen trees took place from the early 1860s through 1900. Data are being prepared for publication in a scientific journal.

### **Forest Insect Infestations**

Aerial detection surveys conducted during 2005 showed that the insect-caused mortality of overstory trees that erupted early in the decade continues.

Although the number of infected acres for some tree species declined somewhat from previous years, mountain pine beetle activity increased in lodgepole pine and, more alarmingly, in whitebark pine. Small, isolated pockets of lodgepole pine infestation remain in the center of the park, and new areas were mapped in the Thorofare/Two Ocean region and in the northwest corner along U.S. Highway 191 between Dailey and Fan creeks. Epidemic levels of whitebark pine infestation persist in all high-elevation mountain ranges except on the Pitchstone Plateau. Large tracts of beetle-killed whitebark pine can be found in the Gallatin, Washburn, and Absaroka ranges. Mortality of up to 80 trees per acre has been reported on the slopes of Avalanche Peak. An estimated 365,000 whitebark pine trees died in the park during 2005, and the adjacent Gallatin National Forest has also experienced substantial losses.

Most of the insects responsible for the mortality are small (1/8" long) native bark beetles in the Scolytidae family. They are often referred to as "primary" beetles because through sheer numbers their feeding activity can girdle a tree and be directly responsible for its death. A tree attacked during the summer will have a red crown the following summer, and the red needles usually drop within the next year, leaving a bare, standing dead tree. Secondary beetles, like the native wood-boring and longhorn beetles, are larger (3/4" or more) and attack trees that are already dying or dead.

Landscape-scale drought and the availability of suitable host trees are the primary forces in the initiation and persistence of insect outbreaks. Healthy trees can successfully defend themselves from beetle attack by "pitching out" adult females as they try to bore their way into the tree. Climate is also a driving force in diminishing insect outbreaks, as when extreme winter temperatures kill off overwintering broods, or wet, rainy summer weather impedes the insects from invading additional trees. Insect activity also decreases as the older, more preferred and susceptible trees are killed off. All of these insects remain active in local areas between outbreaks, but the resulting tree mortality is negligible.

The recent surge in mountain pine beetle, western balsam bark beetle, and spruce budworm activity seems to coincide with recent drought conditions. The Douglas-fir beetle activity that began in the early 1990s and the Engelmann spruce beetle activity that

dates from the mid-1990s may be tapering off.

## Vegetation Management

**Fire Management.** Management of fire activity in 2005 was limited to aerial reconnaissance, mapping, and fire behavior forecasting of the Chickadee and Elk Tongue fires. The YCR management specialist continued to serve on the YNP Fire Management Strategy Team to discuss logistics and implementation of hazard fuels reductions in the wildland-urban interface, revision of the fire management plan (completed), and prescribed burning to meet fuel reduction targets. Other interagency fire planning efforts involved participation in: 1) the Fire Program Analysis process, which is part of a national directive to optimize resources, personnel, and budget; 2) a three-day fire management workshop in Bozeman, Montana, to discuss landscape-level fuel treatments for units throughout the GYA; 3) a four-day vegetation modeling workshop in Missoula, Montana, to help The Nature Conservancy meet contractual obligations with the federal government to produce the nationwide LANDFIRE wildland fuels mapping database and delineate Fire Regime Condition Class for vegetation types specific to the GYA.

**Hazard Tree Management.** To protect people and property, it is necessary to identify, and remove potentially hazardous trees in areas of high visitor and employee use. Representatives from YCR, Resource Management Operations, and the fire cache met at the U.S. Attorney's Office in Cheyenne, Wyoming, with lawyers from the NPS Solicitors Office in Denver, Colorado, to review a draft of the park's Hazard Tree Management Plan. Comments were incorporated into a final version that was signed by Superintendent Lewis.

To assist field personnel in implementing the plan, the management specialist evaluated the condition of a culturally-significant hazard tree at the Artist Point Overlook and suggested mitigation alternatives to the Canyon District Ranger. The management specialist also evaluated hazard trees in the Mammoth Historic District with resource management and fire cache personnel and landscape architects, and identified five trees for removal.

## Vegetation Education

Training provided by the vegetation staff during 2005 included: weed identification for the Northern

Rocky Mountain Exotic Plant Management Team, Yellowstone resource management personnel, and Bighorn Basin Master Gardeners; identification seminars in difficult groups, such as willows, primarily for outside researchers; plant and vegetation overviews for the Division of Interpretation and Xanterra bus drivers. Two courses on Yellowstone wildflowers were taught through the Yellowstone Association Institute. Staff also identified unknown plant species for all divisions of the park, outside researchers, and the public on request.

**Bryophyte Workshop.** Although bryophytes (mosses and liverworts) are increasingly included on regional rare plant lists, relatively little research has been done on these plants in the park. Funding from Canon U.S.A. through the Yellowstone Park Foundation made possible a three-day workshop on bryophyte identification for interested NPS personnel, outside researchers, and other federal agency personnel. The workshop was presented by Judy Harpel, a USFS bryologist, and Wilf Schofield, curator of bryophytes at the University of British



Visiting bryophyte expert Dr. Judy Harpel (left) and park botanist Jennifer Whipple (right).

Columbia Herbarium. In addition to identifying several new liverwort species and relocating the type locality for an endemic moss, the workshop led to an even more ambitious project wherein Canon has agreed to fund a complete inventory of the park's bryophytes that will result in an annotated checklist.

## Wildlife

In YCR wildlife programs, staff with expertise in wildlife biology work individually and in small groups to apply National Park Service policy in the management, research, and monitoring of individual species and groups of species and their encounters with people.

### Endangered Species Consultation

The National Park Service is committed to promoting the recovery of federally listed species. Section 7 of the 1973 Endangered Species Act requires federal agencies to consult with the U.S. Fish and Wildlife Service whenever agency projects (e.g., road improvements and fire management) may affect listed species or their habitats. The Canada lynx, grizzly bear, gray wolf, and bald eagle are federally protected as threatened in Yellowstone; the Arctic grayling is a candidate species.

YCR biologists consulted with the Division of Planning, Compliance, and Landscape Architecture on improvement of a wastewater treatment plant at Madison Junction and a modification of the East Entrance road improvement project. YCR biologists serve as resource experts on the effects of park projects on listed species during consultations with the U.S. Fish and Wildlife Service. They also attend Level One Streamlining meetings that technically review and expedite projects proposed by federal land management agencies in northwest Wyoming.

### Road-killed Wildlife

A database of wildlife killed on the park roads is maintained by the Bear Management Office. In 2005, a total of 90 large mammals (those that can attain weights of >30 pounds) are known to have been hit and killed by vehicles. This is less than the average of 103 for the period 1989–2004. Variations in annual numbers of road-killed wildlife are related to wildlife population numbers, park visitation,

weather conditions, and other factors.

The species most often killed in 2005 were elk (29) and mule deer (26). Other large mammals killed by vehicles included 14 bison, 14 coyotes, 2 moose, 2 pronghorn, 2 bighorn sheep, 1 black bear, and 1 beaver. The highest kill rate was on U.S. Highway 191 (1.5 road-kills per mile of road), which has a 55 mph posted speed limit, compared to no more than 45 mph on other roads in YNP. Highway 191 comprises approximately 7% of the primary roads in YNP, but accounted for 32% of the road-killed large mammals in the park in 2005.

### Integrated Pest Management

During 2005, YCR's management specialist Roy Renkin responded to complaints involving insects (7), small mammals (5), spiders (3), and birds (1). He worked with park concessions staff to determine the source of each problem and ways to minimize or eliminate it according to IPM protocols. He also participated in an inspection of concessions facilities with the NPS Chief of Business Management, NPS Sanitarian, and managers from Xanterra for sanitation/food storage issues at the Lake Hotel, Old Faithful Inn, and Mammoth Hotel that resulted in specific exclusion/removal efforts being undertaken by concessions employees and long-term recommendations in a report submitted by the sanitarian.

As the park's IPM Coordinator, the management specialist maintains Commercial Pesticide Applicator certification, submits Pesticide Use Requests to the Washington Office for approval to use specific pesticides in the park, and completes Pesticide Use Logs that detail the amount of pesticides used each year.



## Bears

The grizzly bear was added to the list of threatened species protected under the Endangered Species Act in 1975 as a result of high human-caused bear mortality. Since then, the GYE grizzly bear population has increased from an estimated 136 bears to more than 600 bears. The area occupied by grizzly bears has increased by more than 48% in the last two decades. Less is known about the number and area used by black bears.

In addition to being part of the GYE-wide effort to maintain the grizzly bear, Yellowstone’s Bear Management Office works to prevent bear–human conflicts in the park through public education and the appropriate management of individual bears when necessary.

### Grizzly Bear Recovery Status

On November 17, 2005, the USFWS published a proposal in the Federal Register to remove grizzly bears in the GYE from the list of threatened species. After reviewing public comments, the USFWS will likely publish its decision by the end of 2006. The states of Montana, Idaho, and Wyoming have all completed state management plans and a multi-agency team has completed a *Final Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area*, outlining how grizzlies will be managed if they are delisted. This plan will protect the core of the population in a designated primary conservation area (PCA), while state plans will provide man-

agement direction outside the PCA. Delisting will not significantly affect grizzly bear management in Yellowstone. Staff will continue to protect bear habitat and emphasize prevention of bear-caused property damages, bear-inflicted human injuries, and human-caused bear mortalities through public education, sanitation, storage of human foods and garbage in a bear-proof manner, and enforcement of bear management storage regulations.

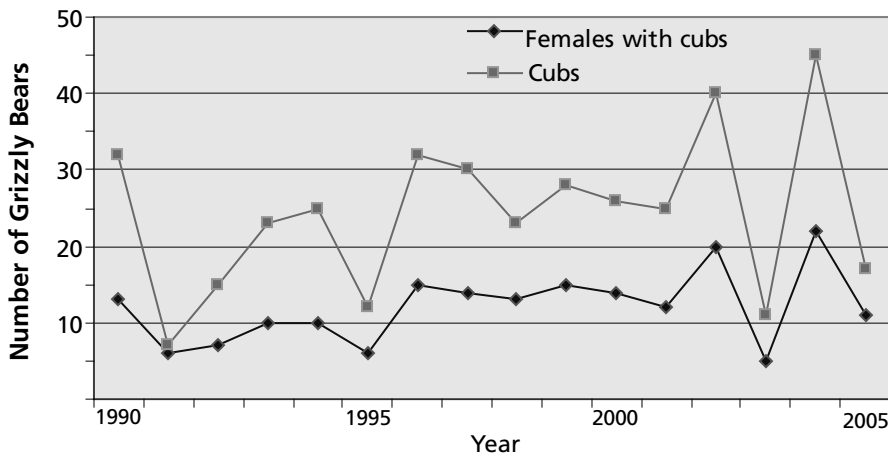
At least 11 grizzly females whose home ranges are wholly or partially within the park produced litters in 2005: 5 one-cub litters and 6 two-cub litters for a total of at least 17 cubs (Fig. 1). The grizzly bear’s low reproductive rate and vulnerability to human-caused mortality make it important to keep mortalities at a sustainable level. In recent years the number of grizzly bear cubs produced in the park has exceeded the number of known human-caused grizzly bear mortalities in the park. No human-caused mortalities or natural grizzly bear mortalities were detected in the park in 2005.

### Bear Foods Monitoring

**Summary of Seasonal Bear Foods.** Based on data collected along 29 routes in the park, the availability of ungulate carcasses in both thermally influenced ungulate winter ranges and on the northern ungulate winter range was below average in 2005. From den emergence until mid-May, staff observed bears scavenging wolf-killed ungulates and digging up pocket gophers and their food caches in localized areas where they were abundant.

During the season that bears are in estrus (May 16–July 15), the numbers of spawning cutthroat trout observed in tributary streams of Yellowstone Lake were very low in 2005; the predominant activities observed were predation on newborn elk calves, scavenging wolf-killed ungulates, digging biscuit root, and activities associated with reproduction (travel, leisure, and

Figure 1. Female grizzly bears with cubs and total cubs counted in Yellowstone National Park, 1990–2005.



play). Wet conditions during the spring and summer resulted in abundant vegetal foods for bears during estrus and early hyperphagia (July 16–August 31). Grazing clover, digging yampa roots, and scavenging the remains of wolf-killed ungulates were the predominant activities observed during this period. Whitebark pine seeds were abundant during late hyperphagia (September 1 until den entrance). The abundance of whitebark pine seeds kept bears at high elevations away from human activities during the fall, and likely contributed to the low numbers of bear–human conflicts that occurred in the park.

**Winter-killed Ungulate Carcasses.** Twenty-nine routes in ungulate winter range were surveyed to monitor the relative abundance of winter-killed ungulate carcasses available for bears to scavenge after den emergence in spring. A total of 11 bison and 9 elk carcasses were documented along the 258.2 km of survey routes for an average of 0.08 carcasses/km surveyed.

Thirteen routes totaling 137.5 km were surveyed on the Northern Winter Range. Four bison and nine elk carcasses were observed for an average of 0.10 ungulate carcasses per km of survey route. Grizzly bear sign was observed on 6 of the 13 routes. Black bear sign was observed on 2 of the 13 routes. Bear sign that could not be identified to species was observed on 7 of the 12 surveyed routes.

Eight routes totaling 81.4 km were surveyed in the Firehole River area. Seven bison carcasses were observed for an average of 0.09 carcasses per km. No elk carcasses were observed. Grizzly bear sign was observed along six of the eight routes. No black bear sign was observed on the Firehole area transects. Bear sign that could not be identified to species was observed along one of the routes surveyed in the Firehole area.

Four routes totaling 19.4 km were surveyed in the Norris Geyser Basin. No carcasses were found. Grizzly bear sign was observed on all four routes. No sign from

black bears or unidentified species of bear was found.

Three routes totaling 16.0 km were surveyed in the Heart Lake area. No carcasses were found. Grizzly bear activity was observed on all three survey routes. No black bear activity was observed. Sign from an unidentified species of bear was observed on two of the three survey routes.

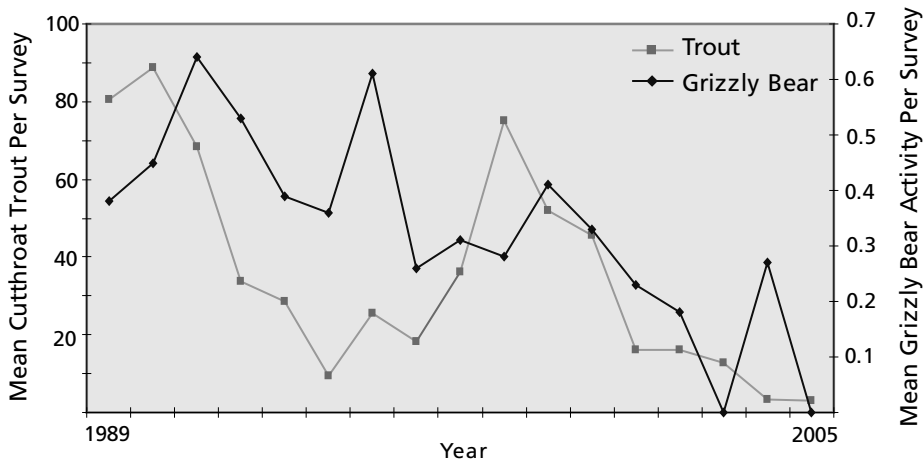
One route totaling 3.9 km was surveyed in the Mud Volcano area. No carcasses were found. Grizzly bear sign was observed on the survey route.

**Spawning Cutthroat Trout.** To monitor the timing and relative magnitude of cutthroat trout spawning runs and associated bear activity, park staff conduct surveys along eight streams within or near the Lake developed area and four streams within or near the Grant Village developed area. The survey data are used to set the opening dates for recreational facilities in these areas and to manage visitor use so as to prevent conflicts with bear use.

The spawning cutthroat trout count in the North Shore and West Thumb streams has decreased noticeably since 1989 (Fig. 2). This data is consistent with the decline in spawning cutthroat trout documented at fish traps operated on Clear and Bridge creeks (see the “Aquatic Resources” section).

Spawning surveys are also conducted on the Trout Lake inlet to determine the potential of this stream for fishing activity by bears. In 2005, the first movement of spawning cutthroat was observed on June 22 and the last on July 13. The average count per weekly visit was 46, well below the high of 131

Figure 2. Mean number of spawning cutthroat trout and activity by grizzly bears observed during weekly surveys of 12 streams tributary to Yellowstone Lake, 1989–2005.







Lisa Coleman and Kerry Gunther doing whitebark cone counts.

observed in 1999. No evidence of grizzly or black bear fishing or activity was observed along the inlet creek during the surveys.

**Whitebark Pine Seeds.** Whitebark pine seeds are an important fall food for bears due to their high fat content and their potential abundance as a pre-hibernation food source. As part of an ecosystem-wide whitebark pine survey conducted by the Interagency Grizzly Bear Study Team, cone counts are conducted at 19 whitebark pine transects within the GYE, 10 of them in YNP. Cone counts at the YNP transects averaged 14.6 (SD = 27.4) cones per tree in 2005, close to the 1987–2004 average of 14.4 (SD = 32.8). The abundance of whitebark pine seeds available to bears during late hyperphagia likely contributed to the low number of bear–human conflicts that occurred in the park during the fall.

A high level of mountain pine beetle-caused tree mortality has been observed in the YNP transects in recent years. Of the 100 transect trees that were alive in 2002, 42 were dead by 2005.

## Confrontations and Conflicts With Humans

Bear–human conflicts are defined as incidents in which bears damage property, obtain anthropogenic foods, or injure people. Most property damage occurs when bears are trying to obtain human foods or garbage. Two of the 11 conflicts reported in 2005 resulted in human injury, both by a grizzly bear.

Confrontations are defined as incidents in which bears approach or follow people, bluff charge or otherwise act aggressively toward people, or enter front country developments or occupied backcountry campsites without inflicting injury. Of the 99 confrontations reported in 2005, 66 involved bears in developed areas and 19 involved a bluff charge or other aggressive behavior by a bear.

## Bear Management Actions

In 2005, management action was taken in 658 bear-related incidents, including

- 581 in which park personnel responded to roadside bear-jams to provide traffic control, answer visitors' questions, and ensure that visitors did not approach or throw food to bears;
- 40 in which bears were hazed away from developed areas or roadsides for the safety of visitors;
- 22 in which trails, campsites, or other areas were closed to the public because of bear activity;
- 12 in which bear warnings were posted because of bear activity;
- 1 in which two grizzly bears on Stevenson Island were relocated to the mainland to increase their chances of survival.

The decrease in the number of bear-jams from 2004 to 2005 (Fig. 3) was likely related to the increased abundance of whitebark pine seeds, which drew bears to high elevation whitebark pine sites not visible from park roads.

**Grizzly Bear Captures.** On June 4, staff received a report that an adult grizzly bear with two yearlings had been observed on Stevenson Island, which covers approximately 105 acres. The next day staff investigated the shore around the island and found tracks of an adult grizzly bear and at least two yearlings. The numerous bear tracks and scats indicated that the bears had been feeding on the island's vegetation and had likely been there since before the ice broke up on Yellowstone Lake on May 23, 2005.

The island was closed to the public and on June

6, staff placed a bait station on the island. The tracks of two yearlings but no adults were found there the next day, suggesting that the adult bear, presumably the yearlings' mother, may have swum to the mainland. (The nearest shore is 1.4 miles away at the Gull Point/Sand Point area.) Although the island provided the bears with plenty of succulent vegetation, the types and quantity of late summer and fall bear foods were rather scarce, and the bears seemed likely to starve if they remained on the island. In 1984, a female grizzly bear with three cubs-of-the-year was found starving on Frank Island. One of the cubs died of malnutrition, the adult female and remaining two cubs were captured and relocated to the mainland. In 2001, a yearling grizzly was found on Dot Island and evidence indicated that the yearling's mother had swum to the mainland. The yearling was captured and relocated to the mainland. In 2005, the NPS again chose not to "let nature take its course" because of the grizzly bear's status as a threatened species. The yearlings' chances for survival were thought to be higher if the bears were captured and returned to the mainland.

With help from Lake Maintenance staff and the NPS Landing Craft, three aluminum culvert traps were placed on the island on June 8. The traps were baited and opened but not set, so that the bears could become accustomed to feeding in the traps and to increase the likelihood that all bears would be caught at once. If the yearlings' mother was still present, catching them without her would create a significant risk for personnel checking the traps.

To obtain evidence as to how many bears were on the island, staff placed digital remote sensor cameras in several locations. On June 25, these cameras confirmed the presence of two yearlings. The re-baited and set traps captured the yearlings that evening. The trap with the bears in it was moved to a secure, well-shaded location

on the island and left for another night, surrounded by cameras. The periodic bawling of the yearlings was certain to attract their mother if she was on the island, but she did not appear. Interagency Grizzly Bear Study Team members helped immobilize the yearlings, weigh them, and fit them with ear tag transmitters to monitor their survival. The bears, both females, were underweight (71 lbs. and 76 lbs.) for their age, but otherwise healthy. After recovering from the immobilizing drug, the bears were transported to the south arm of Yellowstone Lake for release. They were last seen grazing together just above the beach. They were monitored by telemetry flights for the rest of the summer and are believed to have survived the summer and fall.

**Bear-Human Conflict Prevention.** To reduce the likelihood that obtaining anthropogenic food would result in bears damaging property or injuring people, in 2005 staff installed 30-cubic-foot bear-proof storage boxes at the Pebble Creek, Indian Creek, and Norris campgrounds, and at the Elk Tongue patrol cabin to store horse grain. In May 2005, a grizzly bear broke into the steel reinforced wooden grain shed that had previously been used at the cabin.

The long-term survival of bears in the GYE also depends on park visitors and surrounding communities understanding bear management practices. As part of this education effort, staff presented 33 bear-related talks, fieldtrips, and slide shows to various groups in 2005.

Figure 3. Number of grizzly bear and black bear-jams reported in Yellowstone National Park, 1984–2005.

