YELLOWSTONE

CENTER FOR RESOURCES

2010 ANNUAL REPORT

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Yellowstone Center for Resources
National Park Service
Yellowstone National Park, Wyoming

YCR-2011-09

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Front cover: A young bison explores a Yellowstone meadow (NPS/Dylan Schneider); A bat is checked for potential diseases and overall health before being released (NPS/Dylan Schneider); Lisa Baril, a biological sciences technician with the park's bird program, zooms in on a winged subject for closer study (NPS/Nate Bowersock).

Inside front: A wolf investigates a remote camera used to monitor bison migration near the Mary Mountain trail.

Photographs not otherwise marked are courtesy of the National Park Service (NPS).

Contents

Introduction

Yellowstone's unique geological and biological resources inspired its creation as the world's first national park in 1872. The National Park Service (NPS) is legally responsible for preserving, unimpaired, the park's natural and cultural resources and values for the enjoyment, education, and inspiration of this and future generations. The Yellowstone Center for Resources (YCR) works to fulfill these responsibilities for the resources we are mandated to manage and protect.

This annual report highlights 2010 activities undertaken by YCR in connection with that mission. In a sense, the report serves as both mirror and frame. While the contents serve to reflect or mirror our progress over a finite 12-month period, the report's structure provides a yardstick – or frame, if you will – for measuring that progress and determining exactly how well we are meeting our continuing mission to protect and preserve.

As in past years, this year's report structure is also a direct reflection of YCR's operations. The report's first two sections address Cultural and Natural Resource initiatives. The third section, Professional Support, summarizes key programs and activities that support YCR's mission by providing financial, technical, and other essential services to work areas and staff directly engaged in cultural and natural resource programs.

Partnerships and agreements with other federal and state agencies, academia, and public organizations continue to be critical to our successes in stewardship. The YCR also continues to benefit from the hard work of many volunteers and cooperators, as evidenced by approximately 200 research permits typically issued each year to investigators from across the United States and a number of foreign countries.

For more information, readers may contact us at (307) 344-2203, visit the park's website at *www.nps.gov/yell,* or the Greater Yellowstone Science Learning Center website at *www.greateryellowstonescience.org*.

David E. Hallac
Chief, Yellowstone Center for Resources

SECTION I.

Cultural Resources

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

- Archeology
- Ethnography
- Historic Structures and Roads
- Yellowstone Heritage and Research Center

DOUGLAS MACDONALD

The MYAP Archeological Field School team, summer 2010.

Archeology

MYAP Archeological Field School

The Montana-Yellowstone Archeological Project (MYAP) Archeological Field School, which included faculty, staff, and students from the University of Montana and six other North American universities, assisted YCR staff with inventories and National Register testing through an agreement with the Rocky Mountain Cooperative Ecosystem Study Unit. Students used subsurface imaging, including magnetometry and ground-penetrating radar, to evaluate the potential for buried archeological features in landforms at Bridge Bay, Lake Lodge, and Fishing Bridge, and locate areas where hand excavations were most likely to produce results.

Shoreline surveys of Yellowstone Lake. The field school surveyed 1,040 acres on the eastern and southern shores of Yellowstone Lake between July 15 and September 15, 2010. This included almost 20 miles of the southern shore to conduct condition assessments at approximately 35 known sites and 26 previously unrecorded miles of the eastern shore along which 46 sites were identified between the Nine Mile trailhead and Trail Creek Cabin. The field crew evaluated 24 of the newly recorded sites to determine their eligibility for listing on the National Register of Historic Places and unearthed about 600 stone artifacts from shovel test pits and from 1x1-meter test units which were excavated to salvage three hearths eroding out of the lake shore near Clear and Cub creeks. The field crew also studied the geomorphology of the lake terraces in several locations along the eastern shore to determine their antiquity.

Developed area surveys. As part of the process of preparing long-range comprehensive plans for the park, all of the resources within a developed area must be identified before further development and infrastructure projects are designed and implemented. The field school surveyed and tested about 75 acres in the Bridge Bay area and 225 acres north of Lake Lodge for archeological sites, including one site at Bridge Bay and six sites at Lake Lodge that were evaluated for National Register eligibility. The sites were tested by excavating 150 shovel test pits and 26 meter-square test units, and yielded approximately 2,200 artifacts.

DOUGLAS MACDONALD

MYAP student Matt Werle excavates a hearth salvaged from a heavily eroding bank at Yellowstone Lake, summer 2010.

DOUGLAS MACDONALD

MYAP students conduct an archeological inventory prior to replacement of a buried water line.

Projects related to road reconstruction. From May 15 to September 15, 2010, the field school conducted archeological inventory for the redesign of parking areas associated with Golden Gate to Norris road reconstruction, the replacement of the Isa Lake Bridge, and the replacement of a buried water line at Fishing Bridge that is located within the boundaries of a buried precontact archeological site. The work included surveys of about 18 acres at Swan Lake Flat, 2 acres at Sheepeater Cliff, 100 acres at Fishing Bridge, and 7 acres at Isa Lake Bridge as well as identification of 19 sites in these areas, 12 of which were evaluated for National Register eligibility. The sites were tested by the excavation of 403 shovel test pits and 33 meter-square test units, and yielded approximately 2,900 artifacts.

Radiocarbon dating. Radiocarbon dates established for three hearths excavated on the Yellowstone Lake shoreline and three prehistoric features identified at a site near Lake Lodge indicate that all of these sites were occupied about 1,500 years ago during the Late Archaic period. The six prehistoric features identified behind the Fishing Bridge store dated to between 1,300 and 200 years ago, during the Late Prehistoric period. Ethnobotanical and pollen analysis of the feature contents is ongoing, as is analysis of source provenance of about 50 obsidian artifacts collected during survey and excavations along the Yellowstone Lake shoreline.

Data Recovery Near Obsidian Cliff

With preparations under way to widen a section of the Grand Loop Road that bisects five precontact sites associated with obsidian procurement near Obsidian Cliff, YCR staff have worked with the Office of the Wyoming State Archeologist (OWSA) and the Wyoming State Historic Preservation Office to develop a multi-year plan for data recovery at the area to be impacted. OWSA crews began the excavation work in 2010 with three 10-day sessions, during which 45 shovel tests and six meter-square test units were excavated to obtain information on the amount and location of buried cultural material. The site with the highest concentration of surface and subsurface cultural materials within the area of potential effect of the road project was selected to be the focus of the data recovery efforts. Fortunately, the most significant portion of this site is near Obsidian Creek, away from the road corridor, and will not be impacted by this road project.

Nineteen meter-square units were excavated to Pleistocene gravels, usually around 90 to 120 centimeters below surface. More than 10,000 chipped stone artifacts were recovered, most of which were flakes from core reduction and various stages of tool production. As expected, the majority of the

Obsidian Cliff

lithic material was obsidian, although some chert and quartzite were present. The recovered diagnostic tools indicate that the site was used from Paleoindian to Late Prehistoric periods.

The data recovery is expected to be completed in 2011; laboratory analysis of the recovered archeological data will continue through 2012 and the final report is scheduled for 2013.

The Grand Canyon of the Yellowstone

After the National Park Service was created, landscape architects, architects, and engineers were called upon to give formal articulation to the overlooks and trails at the Grand Canyon of the Yellowstone River that had developed over the years. In the 1930s a necklace of 10 overlooks, including staircases and five miles of pathways, were constructed of iron, native stone, and mortar along the precipice of the canyon. Having been subjected to decades of wear and tear by people and the elements, these structures are in need of stabilization and major repair.

Through a Rocky Mountain Cooperative Ecosystem Study Unit agreement, Rosenberg Historical Consultants, which is a partner of the Office of the Wyoming State Archeologist, conducted intense archival research to develop the historical context for evaluating the significance of the views and trails in the canyon and prepared a National Register Historic District Nomination form for seven of the extant overlooks and three trails. In 2010, the Wyoming State Historic Preservation Office concurred with the finding of park managers that the Grand Canyon of the Yellowstone Historic District is eligible for the National Register. Thomas Moran's paintings and Jackson's photographs of the Grand Canyon of the Yellowstone were instrumental in persuading Congress to establish the world's first national park, and the design of the overlooks and trails is representative of the aesthetics and design philosophy of the NPS Rustic style.

Ethnography

Park managers consulted by correspondence with 26 associated tribes on four planning projects and conducted a consultation meeting with representatives of the Shoshone-Bannock tribe at Old Faithful in July regarding the Old Faithful comprehensive planning effort. YCR staff worked with the interpretive staff to develop a new wayside exhibit on the Nez Perce National Historic Trail that was installed in 2010. A traditional use study for the Comanche tribe was completed and traditional use studies for the Salish-Kootenai and Kiowa tribe are ongoing. New website content related to the Nez Perce was developed for the Greater Yellowstone Science Learning Center website.

The Greater Yellowstone Science Learning Center website was revised in 2010 to include new content, links and information about the Nez Perce National Historic Trail (www.greateryellowstonescience.org/nezpercetrail).

Historic Structures and Roads

Cultural Resources staff is responsible for helping to ensure that any alterations to the park's more than 900 historic structures are in compliance with the National Historic Preservation Act (Section 106). Representatives from all divisions participated in a March 2010 meeting that was part of a CESU agreement to develop a historic structures strategy for the park and criteria that will be used to prioritize the work to be done on the buildings.

An intern from the List of Classified Structures (LCS) program completed condition assessments on more than 40 LCS records and updated the database during the summer of 2010. Assistance provided by park volunteers, the Montana and Wyoming state historic preservation offices (SHPOs). and through agreements with the Montana Preservation Alliance,

Roof repairs in progress at the Lake Fish Hatchery, July 2010.

the University of Montana Anthropology Heritage Resource Program, and the Rocky Mountains Cooperative Ecosystem Studies Unit, enabled park staff to address compliance issues for many projects, including those summarized below.

Preservation

Old Faithful Photo Shop. Constructed in 1927, the shop was later expanded and relocated, and has not been used since 1999. After the Snow Lodge was built nearby in 1998, it was determined that the original photo shop could be moved to a temporary location until a new site (the former location of the temporary Old Faithful visitor center) was ready.

Mission 66 structures. With a cooperative agreement under way to evaluate the park's Mission 66 era structures for National Register eligibility, the need for mold abatement and energy-efficient windows and doors compelled immediate assessment of the 40 Mission 66 era housing units in Lower Mammoth. The houses were not intended to represent NPS tenets for Mission 66, and in 2010 the WYSHPO agreed with park managers that they were not eligible for the National Register. The failing single pane, aluminum frame windows will be replaced with wooden frame windows, the exterior doors will be upgraded, and several flat roofs inappropriate for the park's snow loads will be replaced by slightly pitched roofs.

Trails documentation. Appropriate management of the park's 1,000-plus miles of backcountry trails requires an understanding of their history, design principles, and construction methods. In 2010, the NPS began to conduct archival research, draft a historic context for all types of trails in the park, and prepare a National Register document to evaluate the trails.

Rehabilitation

Yellowstone Lake Fish Hatchery. The hatchery buildings were constructed in the early 1930s for the US Fish and Wildlife Service, which used them until hatchery activities halted in 1958. Some are now used for other purposes, but the main building is currently unoccupied. The WYSHPO agreed that the proposed repairs would not adversely affect the structure's historical integrity and this work was begun in 2010. The electrical wiring, which is unsafe, will be replaced with minimal wiring until the building is assigned a permanent use.

Fox Creek patrol cabin. Located near the park boundary about 18 miles from the south entrance and accessible only by trail, the Fox Creek patrol cabin was constructed in 1915 for the Army winter patrol. With the sill logs rotted from exposure and animal gnawing, a two-year rehabilitation project was begun in 2010 to preserve the cabin and maintain its use for ranger patrols for another 20 to 30 years. The cabin was raised off the ground while concrete block piers, a concrete pad and stone facing were installed on the existing foundation. The sill logs were replaced with logs harvested near the cabin. Most of the other construction materials and supplies were brought in by pack animals, but the steel roofing that replaced the wood shingles (which had replaced the original sod roof) had to be brought in by helicopter.

Enhancements

Fire detection and alarm systems. A program to replace or install smoke and heat detectors, pull stations, horns, strobes, and in some high-use buildings, voice evacuation equipment was begun in 2010. Upgrades of existing equipment in historic structures can be done under the NPS streamlined compliance process, but the installation of new fire detection systems in some historic structures will involve consultation with the Montana or Wyoming SHPOs. Park staff worked with the WYSHPO to identify the least intrusive means to install fire suppression systems in the Norris Trailside Museum and the Fort Yellowstone Chapel.

Mammoth Hot Springs lighting and parking. The WYSHPO concurred with park managers that additional outdoor lighting to increase safety after dark and parking area alterations to decrease vehicular congestion while maintaining existing circulation patterns would not adversely affect the Fort Yellowstone National Historical Landmark or the Mammoth Hot Springs Historic District. Late in 2010, seven light fixtures were installed in parking areas at the main administration building and the communications and telecommunications building. The fixtures are the most energy efficient available, mounted on metal poles at a maximum of 15 feet above the ground, and shielded to light only the area needed. Parking space will be added behind the Aspen dormitory, the Xanterra engineering building, the Chittenden House, and east of the Justice Center, and additional striping along the esplanade islands will provide parallel parking for RVs and other larger vehicles.

The Fox Creek patrol cabin (built circa 1915) previously rested on the bare ground (top) and its log base had rotted. In 2010, workers raised the cabin off the ground and added concrete structural supports and historically compatible stone facing.

Historic Roads

Lamar River Bridge. Slightly downstream from the existing Lamar River bridge, construction began in 2010 to build a seismically stable, slightly wider bridge to replace it. The NPS has agreed with the WYSHPO to mitigate removal of the existing bridge, whose construction began in 1940, by installing an interpretive sign at the new bridge, working with the Wyoming Division of Travel and Tourism to provide interpretation of the park's bridges for their website, and completing the National Register nomination for the Northeast Entrance Road Historic District.

Sylvan Pass. The final reconstruction and roadside re-contouring of the roadway over the top of Sylvan Pass on the East Entrance Road was completed in fall 2010. Rock used in road construction had been excavated from the talus slopes on both sides of the road at Sylvan Pass for almost two decades, leaving some landforms that had to be reshaped to create natural looking contours. All quarry operations in the area have ceased and 18 inches of talus will be deposited where necessary to return the area to its prior appearance.

Tanker Curve reroute. The final phase of the 12-year project to rehabilitate the Gibbon Falls section of the Grand Loop Road was completed in fall 2010 with the construction of a new bridge over the

The HRC's 57 accessions in 2010 included natural history specimens, early park photos, and cougar skulls like this one.

Gibbon River and removal of the abandoned section of road between Tanker Curve and the new bridge, restoring the landscape to as close to the original landforms as possible.

Yellowstone Heritage and Research Center

The Yellowstone Heritage and Research Center in Gardiner, Montana, houses the park's archives and library collection and most of its museum collections—several million items that document the cultural and natural history of the park. They include some of the first photographs taken of the park by William Henry Jackson; Thomas Moran's original field sketches from the 1871 Hayden Expedition; one of the most comprehensive collections of postcards, souvenirs, and ephemera of Yellowstone; and a rare book collection. The archives collection consists of several thousand linear feet of historic records that document the history of Yellowstone since its establishment in 1872, while the library contains more than 20,000 volumes related to Yellowstone's history, past and present.

The goal of the archives and museum program is to properly preserve and document the park's cultural and natural history, and to make them available to as wide an audience as possible through on-site research, the Internet, facility tours, loans, and temporary exhibits. The archival collection is one of nine affiliates of the National Archives and Records Administration (NARA), and the only one located in a national park. This affiliation means the park retains permanent federal records on-site instead of transferring them to NARA facilities. In addition the archives include donated historical records and collections, records of park concessioners, and an extensive oral history collection.

The primary objectives of the Yellowstone Research Library are to document the history of Yellowstone National Park by preserving all relevant books and papers, and to select, organize, and make accessible books and related materials that will assist park staff in the performance of their duties. The library also makes its resources available to the general public; independent researchers; students; concessions employees; the local community in Gardiner, Montana; residents of the state of Wyoming; and park visitors through the Wyoming Library Consortium.

Accessions

In addition to cataloging almost 6,600 items from the museum collections backlog, HRC staff processed 57 new accessions in 2010, including natural history specimens, several early park photo albums, and cougar skulls. Collections added to the archives in 2010 included diaries from a father and daughter who toured the park in 1895; writings and ephemera of the OTO Ranch and its founder, Dick Randall; log books from backcountry cabins and the Old Faithful Visitor Center, and records from the Gardiner Electric Light and Water Company, the Blue J Café, and Red Cross activities in Gardiner during World War II. The library added 34 microform items, 295 books, 2 DVDs, and 30 maps relating to various Yellowstone topics.

Collection Conservation

Through NPS funding of several projects and the monetary support of the Yellowstone Association (YA) and the Yellowstone Park Foundation (YPF), temporary staff was hired to catalog and rehouse numerous collections during 2010 for better conservation and accessibility. This included improving exhibit conditions at the Museum of the National Park Ranger and rehousing its firearms, textiles, and paper objects. Time contributed by 25 volunteers (equivalent to 1 FTE), including 14 participants in a weeklong Elderhostel Service Program hosted by the HRC in February, was spent on projects such as rehousing oversize documents, cataloging photograph albums, inventorying the map collection and photographic negatives, creating bibliographies, and archival research.

Museum technicians began an aggressive pest monitoring and preventive maintenance program for the park's historic vehicle collection and a museum emergency operations plan for the HRC and its collections to provide guidance to HRC staff and first responders. Staff also updated the park's Scope of Collections Statement, which provides guidance to ensure that only items important to the park's mission statement, history, and science are added to the collections. The NPS regional archivist helped staff improve archives management and organization, and identify personnel records for retention.

Staff worked with Division of Interpretation staff to provide collection objects for the Old Faithful Visitor Education Center and with the Wolf Project and Dr. Sue Ware of the Denver Museum of Nature and Science to improve the cleaning of collected wolf skeletal materials and make them more accessible for study.

Historical Research

In 2010 the park historian completed a history of Mammoth Hot Springs and continued to work on a book on the history of animals of the greater Yellowstone region, a long-term project funded by the Yellowstone Park Foundation. He assisted park staff and outside researchers in answering questions about Yellowstone history and identifying and dating photographs and objects in the park museum collection.

The oral historian conducted 14 interviews with local residents as well as key retired park and NPS personnel and, through community outreach with Park and Gallatin Counties and the Gardiner School District, collected interviews from area residents about their noteworthy experiences in the park.

A 1917 seven-passenger White Motor Company limousine (or touring car), one of the 30 horse-drawn and motorized conveyances in the HRC's vehicle collection.

Research Assistance and Outreach

More than 2,000 people made use of the collections and other resources available at the HRC during 2010 through on-site visits as well as telephone, email, and written requests. This included 833 inquiries regarding the archives (526 from NPS employees) and requests for historical photographs that led to the scanning of several hundred images. In response to requests, the bookmobile service, which makes the library's collections and resources more accessible to NPS and Yellowstone Association employees in the park interior, increased the number of stops it makes.

In addition to 30 public tours of the facility held during the summer, HRC staff gave presentations on the collections to groups that included a Bozeman High School history class, a Belgrade High School photography class, Xanterra employees, the Mountain Plains Museum Association annual conference, the Museums Association of Montana annual conference, a Yellowstone Park Foundation fundraising event, and Yellowstone Association Institute classes.

SECTION II.

Natural Resources

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

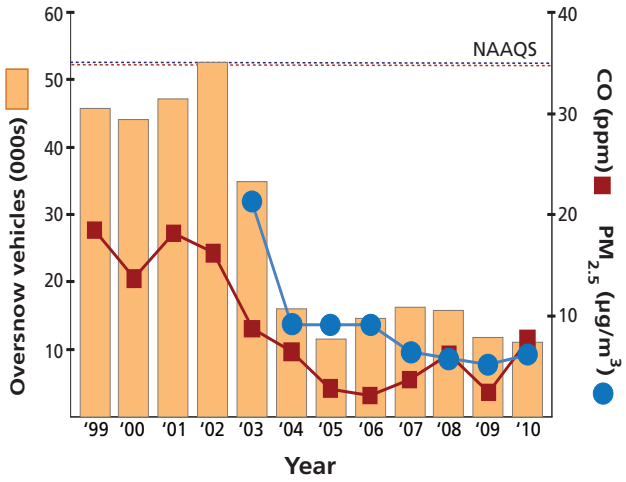
- Air Quality
- Geology
- Vegetation
- Resource Management Operations
- Aquatic Resources
- Bears
- Birds
- Ungulates
- Wolves
- Yellowstone Wildlife Health Program

A Yellowstone Wildlife Health Program technician checks a park bat for potential disease and overall health.

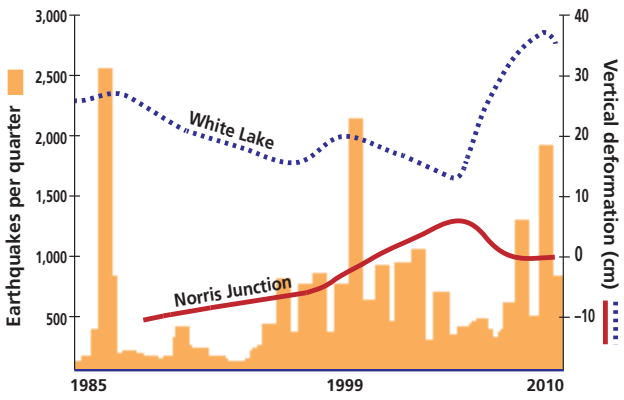
Air Quality

No National Ambient Air Quality Standards were exceeded in Yellowstone in 2010 for the four measured criteria pollutants: ozone, particulate matter, nitrogen oxides, and carbon monoxide. The Air Quality in National Parks Annual Performance and Progress Report (2010) indicated that air quality neither deteriorated nor improved in Yellowstone from 1999 through 2008. Nitrogen deposition, however, continues to be of significant concern because it is occurring at levels known to be harmful to sensitive resources, including alpine areas, wetlands, arid areas, and grasslands. Nitrogen oxide (NO_2) is at about 50% of the standard (100 ppb, one-hour maximum) at the West Entrance and below 10 ppb at Old Faithful. Emissions from vehicles, power plants, industry, agriculture, and fires may contribute to nitrogen deposition.

Air quality is monitored at the West Entrance and at Old Faithful during the winter because of concern about the effects of oversnow vehicles. The carbon monoxide (CO) and particulate matter ($PM_{2.5}$) attributable to oversnow vehicles (OSVs) in the park is well below federal and state air quality standards. The smaller number of snowmobiles in the park and the "Best Available Technology" (BAT) requirement have reduced the levels of these pollutants since 2002. CO levels in congested areas remain higher in winter (7.6 ppm at the West Entrance in 2010) than in summer (typically about 0.8 ppm) because of OSV engines and winter atmospheric conditions that inhibit the dispersal of emissions. Nitrogen deposition is emerging as a winter use issue because although the BAT-required 4-stroke engines emit 85% less CO than 2-stroke snowmobiles, they emit about 15 times more nitrogen dioxide, which has been at concentrations above the federal standard for short periods during the winter.



Maximum one-hour CO levels at the West Entrance and 24-hour $PM_{2.5}$ levels (98th percentile) at Old Faithful, compared to national air quality standards (NAAQS).



Earthquakes per quarter, 1985-2010, and vertical uplift recorded at two sites during the same time period.

Geology

In 2010 there were 3,254 earthquakes detected in the park, the largest number since 1985. From mid-January to mid-February, a swarm of about 2,400 quakes occurred about 10 miles northwest of Old Faithful, with 14 reaching over magnitude 3. The two largest earthquakes, magnitude 3.7 and 3.8, were felt throughout the park and in surrounding communities, but both occurred after 11PM, so they had little effect on visitors.

Beginning in 2004, GPS and InSAR measurements indicated that parts of the Yellowstone caldera were rising up to 7 centimeters (cm) per year, while an area near the northern caldera boundary started to subside. The largest vertical movement was recorded at the White Lake GPS station, inside the caldera's eastern rim, where the total uplift from 2004 to 2009 was about 25 cm.

Uplift rates decreased from 2006 and 2009, and the caldera began to subside during the first half of 2010, about 3 cm so far. Episodes of uplift and subsidence have been correlated with earthquake occurrence in the park.

No geyser-basin scale changes were detected in the park's geothermal activity in 2010. Oil, gas, and groundwater development outside the park and drilling in "Known Geothermal Resources Areas" identified by the USGS in Island Park, Idaho, and Corwin Springs, Montana, could alter the natural functioning of geothermal systems in the park.

Work continued on the park's geothermal monitoring program, with progress made in documenting the status and trends of the geothermal system by measuring the total amount of thermal water and the total heat output for selected geyser basins. Aircraft and helicopter thermal infrared images are being used to document changes in the park's hydrothermal areas.

Vegetation

Inventory and Monitoring

Park staff have met the service-wide inventory and monitoring goal of documenting at least 90% of the park's 1,346 vascular plant species and incorporating the information into the NPSpecies biodiversity database, which now includes the approximately 10,241 specimens in the park's herbarium. During the 2010 field season, at least 51 vascular plant specimens were collected for addition to the herbarium.

To prevent impacts on rare plant populations, park staff conduct surveys prior to construction projects, trail re-routes, and other activities that disturb soil. In addition to complying with statutory requirements, these surveys collect valuable information: during 2010, 144 sites were documented with GIS data for plants that are rare in the park and are Wyoming species of special concern.

Summer fieldwork for comprehensive planning resource inventories took place primarily in the Old Faithful developed area, where 608 sites containing 21 rare species have now been documented, and in the Lake developed area where 13 sites containing two rare species were documented. Park staff also continued surveys for 10 rare plant species in the Mammoth/Gardiner developed areas.

Gardiner Basin Restoration

As part of the long-term project to restore former agricultural fields to native vegetation along the Yellowstone River corridor inside the park's north boundary, 50 acres were treated with herbicides and seeded with preparatory cover crops with financial support from Recreation Fee Demonstration funds. The sites are fenced to exclude wildlife while native vegetation is re-established.

Insect Infestations

The primary cause of tree mortality in the park is native bark beetles. Although both Douglas-fir

beetle and Engelmann spruce beetle activity have declined to endemic levels since 2000, other forest insects of economic and ecological importance remain active. Aerial detection surveys for forest insect activity conducted during the summer of 2010 found widespread western balsam bark beetle activity throughout high- elevation subalpine fir stands. Mountain pine beetle activity continued in high-elevation whitebark pine stands, particularly in the northwest portion of the park, and appeared to be increasing in lower-elevation lodgepole pine forests throughout the park. Defoliation of Douglas fir and Engelmann spruce by the western spruce budworm along the Yellowstone and Lamar River valleys was considerably lower in 2010 than previous years, and is likely to continue to decrease in 2011. Research on the interactive effects of mountain pine beetle activity on fire behavior in lodgepole-dominated forests was published in an article on measured fuel structure and modeled fire behavior parameters, and a second effort was initiated to compare the fire hazard from bark beetles in lodgepole pine with that in Douglas fir forests. Cooperators include the University of Wisconsin-Madison and Colorado State University.

Newly restored native vegetation in the Gardiner Basin.

Other Vegetation Research and Monitoring

The possible effects of changing elk abundance and wolf reintroduction on woody vegetation on the northern range (aspen, willow, and cottonwood) continued to support diverse research opportunities in 2010, including:

- Completion of a ground-based effort to map, measure, and taxonomically classify willow communities on 378 kilometers (262 miles) of stream drainages on the park's northern range (in partnership with the Greater Yellowstone Inventory and Monitoring Network and the Big Sky Institute at Montana State University).
- Monitoring of elk use and aspen in 113 aspen clones across the park's northern range (with the University of Wisconsin–Stevens Point, and Oregon State University).
- The fourth and final year of investigating beaver occupancy in streams throughout the greater Yellowstone area over the last 2,000 years (with the University of New Mexico).
- Initiation of a study using motion-detection cameras to determine the timing, intensity, and identity of winter willow browsers at 15 established sites (with Colorado State University).

Investigations into other vegetation issues with resource management implications include:

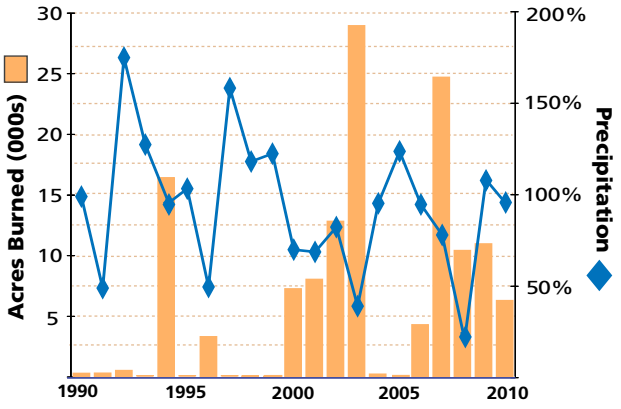
- Characterization of watersheds, hydrology, and soil characteristics for "vanishing wetlands" on the northern range (Colorado State University).
- Ongoing work to evaluate historic range (grassland and shrubland) monitoring in northern Yellowstone and improve future monitoring techniques. Cooperators include the USDA Fire Sciences Lab and USGS Northern Rocky Mountain Science Center with financial support from the Yellowstone Park Foundation.

Fire Management

In 2010, a total of 6,232 acres burned in Yellowstone from 11 known wildland fire starts, of which two were considered human-caused, including one downed power line. Four of the fires quickly went out on their own before burning more than a half acre; five of the fires were suppressed; and two, including the largest (5,510 acres), were allowed to burn naturally to the greatest extent possible while providing for firefighter and public safety.

The vegetation management specialist served on the Yellowstone Fire Management Type III Incident Overhead Team as a Long Term Fire Behavior Analyst (LTAN) for the Beach, Arthur 2, and Antelope fires. Duties included evaluation of current and forecasted weather and site-specific fuel conditions for go/no-go decisions on initial fire reports, making long-term weather/fire behavior projections and daily weather/fire behavior assessments, daily aerial mapping of fires, and briefing line officers and fire crews on observed and expected fire behavior.

The Antelope wildfire, 2010's largest, burned 5,510 acres.



Total acreage burned in wildfires, 1990-2010, and summer precipitation for the same 20-year period (expressed as a percentage of the 1970–2000 average).

Integrated Pest Management

As the park's Integrated Pest Management Coordinator, the vegetation management specialist completed 28 pesticide use logs for specific pesticides used in the park during 2009, and submitted 24 pesticide use requests for approval for use in 2010. The IPM coordinator responded to 25 different complaints involving small mammals, insects, spiders, and birds, and provided mitigation.

Resource Management Operations

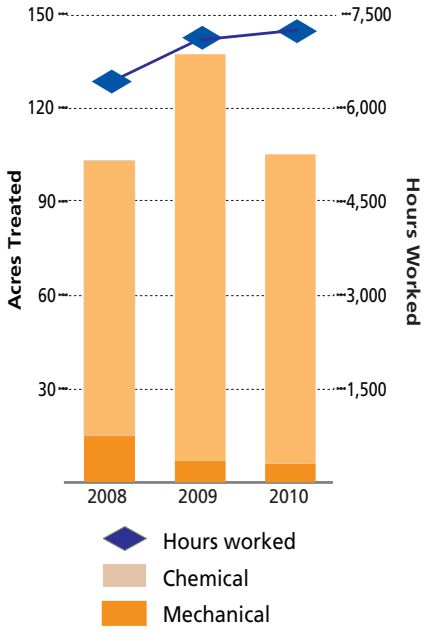
The primary role of YCR's resource management staff is to intervene in the day-to-day situations in which the park's cultural or natural resource values are at risk because of human activities. By working with other park staff in the maintenance, interpretation, and protection divisions, they help manage backcountry areas, remove hazard trees, provide logistical support for other park staff through boat shuttles, address wildlife management and hazardous spill incidents, monitor the geyser basins and remove the thousands of items that are thrown or dropped in the thermal features, and educate visitors in protecting park resources. Nearly half of the staff time in 2010 was spent educating the public about invasive aquatic and plant species, and monitoring and controlling their spread.

Nonnative Plants

For more than three decades, field crews have waged an aggressive struggle to keep nonnative plants from spreading into the park and surrounding ecosystem. Control work is primarily conducted along roads and in developments where most new infestations first appear, typically in patches. Controlling their spread requires preventing the establishment of new populations via systematic surveys, immediate eradication of individual plants through mechanical removal such as pulling and targeted application of approved herbicides, and regular spraying of established patches to prevent further spread. Unfortunately, once a root system and a seed base are in place, eradication of a population is rare. The extent to which nonnative plants can be controlled in the park depends on the amount of labor allocated, the ability of the field crews to

identify nonnative plants, and consistent herbicide application. The short summer seasons and limited number of seasonal staff remain the greatest challenges in containing the spread of invasive plant patches.

No new nonnative species were reported in the park in 2010, but many of the 218 known and established nonnative species continued expanding their ranges. More than 7,210 hours were devoted to exotic vegetation identification and control by 26 members of the park staff, 3 Student Conservation Association interns, 10 full-time summer volunteers, a crew from the NPS Exotic Plant Management Team, and dozens of other individual volunteers and groups. The addition of four Montana Conservation Corp crews, primarily treating spotted knapweed, hounds tongue, ox-eye daisy and assorted non-native thistles. greatly improved control-work productivity and enabled NPS crews to reach high-priority areas that would otherwise not have been treated.



Acres of infested area receiving chemical and mechanical treatment, and hours spent on plant surveys and treatment by NPS staff, interns, and volunteers.

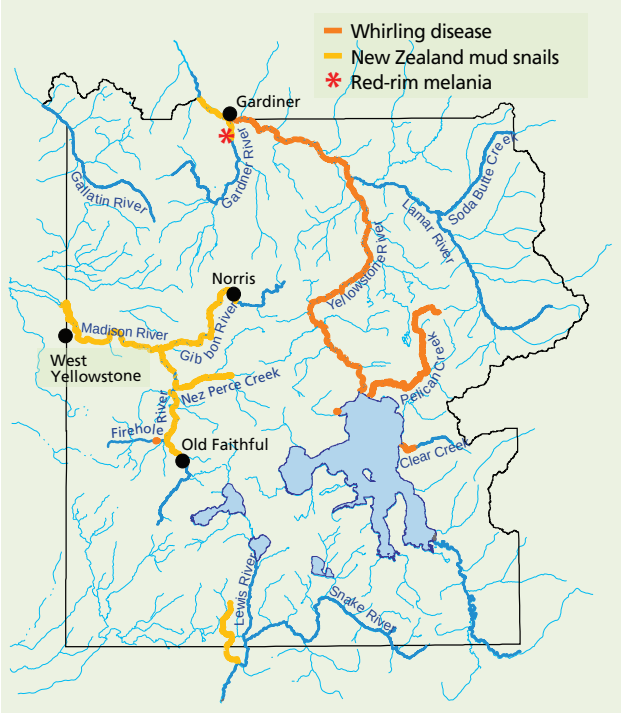
In 2010, staff surveyed 20,291 acres of vegetation on foot. About 4,640 of the surveyed acres were infested by nonnative vegetation. Within the infested acreage, a total of 96 acres of nonnative vegetation were isolated and treated, 9 of those acres were re-treated to increase effectiveness, for a total of 105 treatment acres. Herbicides were used in 99 treatment acres and plants were physically pulled on 6 treatment acres. Most of the 44 species targeted for treatment are listed by the states of Idaho, Montana, and/or Wyoming as "noxious weeds", which means that they are considered detrimental to agriculture, aquatic navigation, fish and wildlife, or public health. Roadways and developed areas comprised 75% of the treatment acres and the remaining 25% occurred along the park's trails and in the backcountry.

To prevent the arrival of nonnative plants, resource management staff oversaw entrance station inspection of hay transported through the park, and inspected and cleaned numerous vehicles associated with wildland fire operations and road construction projects. With assistance from a contractor provided by the Greater Yellowstone Coordinating Committee, park staff conducted three inspections for invasive plants at sand and gravel pits in the greater Yellowstone area, resulting in the approval of two pits for use of their material in the park. Park staff and the GYCC also worked with seven cooperative weed management areas to map and treat weeds on land adjacent to the park, monitor biological control release sites, and support weed education efforts.

Aquatic Invasive Species

The resource management staff leads efforts to monitor, detect and prevent the presence of aquatic invasive species (AIS) that are harmful to park aquatic ecosystems and water utility systems. Staff members also work with other agencies and non-governmental organizations to keep AIS out of the greater Yellowstone area.

In addition to lake trout, two other nonnative species are having a significant detrimental effect on the park's aquatic ecology. New Zealand mud snails are now in all of the major watersheds, where they form dense colonies and compete with native species. *Myxobolus cerebralis*, the parasite that causes whirling disease in cutthroat trout and other fish species, has been found in the Firehole River and Yellowstone Lake watershed. A third species, the red-rim melania (*Melanoides tuberculatus)*, a small snail imported to the United States in the 1930s by the aquarium trade, was discovered in the warm swimming area at the confluence of the Boiling River with the Gardner River in 2009. However, a subsequent survey of 18 of the park's most popular hot springs found melania only in the Boiling River soaking area and downstream approximately one kilometer. The species has a narrow temperature tolerance (18–32°C) and is unlikely to survive down-



Locations in YNP where whirling disease, New Zealand mud snails, and red-rim melania have been documented.

stream of the Boiling River during the winter, but it could become established in other thermal water in the park. In 2010, the second of a three-year Yellowstone Park Foundation funded project, no new aquatic invaders were found in the park.

During the summer, a small team of technicians and volunteers meets visitors at entrance stations or park waters before they use their boats or angling gear, and inspect and clean the equipment if necessary, using high-pressure water or a disinfectant. Such decontamination is usually adequate to prevent the entry of most AIS; however, some life stages of certain mussels and other organisms cannot be easily detected or decontaminated. Occasionally, boat size and design make it impossible to assure complete decontamination. When this is the case, a watercraft may be denied entry into park waters. During 2010, AIS staff made 464 visitor contacts and identified eight watercraft suspected of harboring AIS. Of these, seven were cleaned and then admitted, while one was refused entry because of the potential for zebra or quagga mussel introduction. A fourth pressure washer was purchased for use at the South Entrance Ranger Station, where small vessels can be inspected and cleaned.

Hazard Trees

To protect people and property, potentially hazardous trees in areas of high visitor and employee use must be identified and removed. Resource management staff use an established protocol to conduct surveys on foot and identify hazard trees in park campgrounds, picnic areas, trailheads, along public and administrative roads, and in other developed areas. With training provided by the vegetation management specialist and assistance from maintenance and fire cache crews, Xanterra, and Northwestern Energy, a total of 1,383 hazardous trees (nearly all of them dead) were removed in 2010.

Aquatic Resources

The top priorities for the park's Fisheries Program are the preservation of Yellowstone cutthroat trout (YCT, *Oncorhynchus clarki bouvieri*) in Yellowstone Lake and restoration of fluvial populations of native trout, many of which have been lost because of nonnative species introductions.

Yellowstone Cutthroat Trout Preservation

Yellowstone Lake. The YCT population in the Yellowstone Lake ecosystem has declined substantially over the past three decades, due to nonnative lake trout that prey on it and compete with it for food, the exotic parasite that causes whirling disease, and low water flows in a series of drought years. The number of YCT caught per net at lakewide sampling sites during an annual monitoring program that began in 1969 reached 19.1 in 1984 and dropped to an all-time low of 5.3 in 2010. Lake trout appear insusceptible to the whirling disease that has severely reduced cutthroat trout abundance in Pelican Creek, a tributary to Yellowstone Lake. Although approximately 41% of the YCT in the 2010 catch were greater than 330 millimeters (mm) in total length, recent catches have lacked fish in the 200 to 250 mm range—fish that would continue into adulthood.

Park streams. Genetically pure YCT still reside in about two-thirds of the 3,000 km of park streams that were part of the species' native habitat outside the Yellowstone Lake watershed; the other streams have YCT hybridized with introduced rainbow trout. Because of recent invasions of Slough and Soda Butte creeks by rainbow trout, planning con-

tinued in 2010 to save the YCT in these drainages, including the possible construction of fish barriers in both creeks. As in past years, park staff participated in a multi-agency effort that significantly reduced the brook trout in Soda Butte Creek.

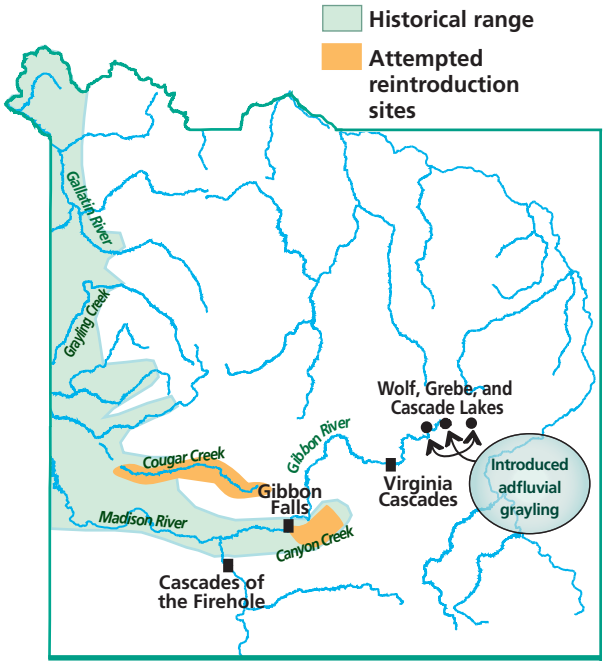
Lake Trout Removal

Since the presence of nonnative lake trout in Yellowstone Lake was confirmed in 1994, the effort to reduce the population has grown larger and more sophisticated. The total number of lake trout removed by various means increased from about 100,000 in 2009 to more than 146,000 in 2010. To augment the removal efforts of Yellowstone staff, the National Park Service contracted with Hickey Brothers Fishery, LLC, of Baileys Harbor, Wisconsin, to use their research vessel, which can set 18,000 to 27,000 feet of gill net per day in Yellowstone Lake. During their 10-week contract in 2010, they caught more than 31,600 lake trout. A total of almost 550,000 lake trout have been removed since 1994; however, the number of lake trout caught per 100 meters of net in one night, or catch per unit of effort (CPUE), has been rising since 2002, suggesting that the lake trout population has been increasing faster than the fish are being removed. Whether current techniques can collapse the population to an insignificant level remains uncertain.

Native Trout Restoration

Westslope cutthroat trout. After receiving piscicide treatments to remove the nonnative fish, High Lake has been stocked annually since 2007 with westslope cutthroat trout (*Oncorhynchus clarki lewisi*) from the two known genetically pure westslope cutthroat trout populations in the park and Upper Missouri River brood stock from a hatchery. In 2010, the first reproduction of the WCT in High Lake was documented; fry were visible in the inlet streams and various locations around the lake margin, adult fish were seen in the littoral zone feeding on aquatic invertebrates, and otters and other piscivorous wildlife had returned. Restocking of WCT began in East Fork Specimen Creek, where efforts were made to improve the integrity of the fish barrier. The project is progressing toward completion in 2012.

Arctic grayling. By the 1950s, competition from introduced fish species eliminated the fluvial Arctic grayling that were native to park waters. The lower



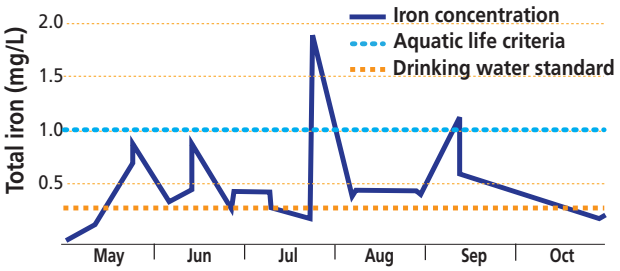
Former distribution of Arctic grayling in Yellowstone National Park and attempted restoration sites.

reaches of Grayling Creek, where grayling were most abundant, were submerged by the completion of the Hebgen Dam. The uppermost reaches of Grayling Creek, considered a potential site for fluvial grayling restoration, are occupied by brown trout and hybridized cutthroats. The restoration project on Grayling Creek was included as a potential action in the Native Fish Conservation Plan/Environmental Assessment begun in 2010.

Water Quality

Water temperature, dissolved oxygen, pH, specific conductance, turbidity, and total suspended solids are monitored monthly at 11 stream and seven lake sites in the park. Chemical parameters are also collected from nine of the stream sites. In 2010, three of the stream sites did not meet EPA and/or state standards for pH in at least one monthly sampling. However, these low pH values are the result of local geology and contributions from nearby thermal sources.

Based on water quality standards for aquatic life, the state of Montana considers a portion of Reese Creek on the park's northern boundary as impaired. The adjudicated water rights with adjacent landowners stipulate that Reese Creek is to have a mini-



Iron concentrations in Soda Butte Creek at the park boundary from May to October, 2009, compared to aquatic life and drinking water standards.

mum flow of 1.306 ft^3/sec from April 15 to October 15, but irrigation on land outside the park often leaves too little water to sustain healthy invertebrate and fish populations in the creek. During 2010, discharge on Reese Creek remained above that minimum threshold, ranging from 1.78 to 12.45 ft^3/sec.

As a result of previous mining activity 8 km from the park, tailings remain in the Soda Butte Creek floodplain and the state of Montana lists the segment of the creek that extends downstream to the park boundary as impaired. Park staff measure arsenic, copper, iron, and selenium in the water and sediment at the boundary during annual high and low flow periods. The iron concentrations exceeded standards for aquatic life in two out of 36 visits in 2009 and three out of 24 visits in 2010. However, aquatic invertebrate sampling indicated that the site scored high in supporting aquatic life. State and federal agencies are working on a plan to remove the mine tailings from the streambed.

Bears

About 150 grizzly bears *(Ursus arctos horribilis)* are thought to have territories that lie partly or entirely within the park. Unlike the grizzly bear, which is considered a threatened species under the Endangered Species Act, the park's population of black bears *(Ursus americanus)* is not closely monitored, but they are considered common in the park.

Bear Foods Monitoring

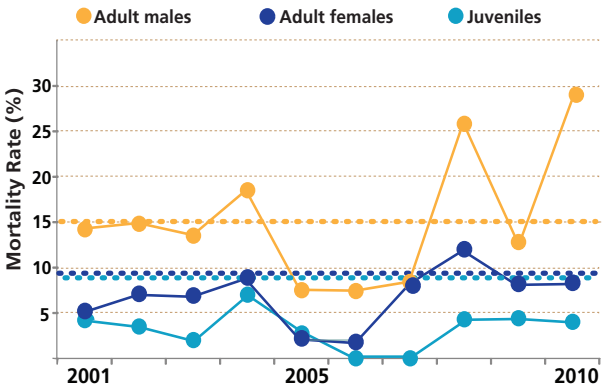
The annual availability and abundance of native bear foods has a strong influence on grizzly bear cub production and survival, and the number of incidents in which bears attempt to obtain human (anthropogenic) foods. Park staff monitor the availability of some key grizzly bear food sources: winter-killed carcasses, spawning cutthroat trout, and whitebark pine seeds. In 2010, the availability of high quality, concentrated bear foods was below average during the spring and early summer seasons, average during mid-summer, and poor during late summer and fall. During spring, winter-killed ungulate carcasses were scarce on both the northern ungulate winter range and in higher elevation thermally influenced winter range. A total of 24 ungulate carcasses were documented along 255.9 km of survey routes from April to early May, an average of 0.09 carcasses/km (2002–2009 range: 0.08 to 0.45).

The spring season was exceptionally cold, delaying snow melt and the phenological development of bear plant foods. During spring and early summer, vegetable bear foods were scarce and very few spawning cutthroat trout were counted in tributary streams of Yellowstone Lake, but evidence of grizzly bear fishing activity (grizzly track, bear scat containing fish parts) was observed along Bridge and Sandy creeks. In late spring and early summer, grizzly bears preyed extensively on newborn elk calves. Vegetable bear foods were scarce throughout the summer and whitebark pine seed production was poor; trees monitored in transects in the park averaged only 3.2 cones per tree (1987–2009 average: 15.8). Although mountain pine beetle had been causing significant mortality of whitebark pine in the transects since 2003, only one of the 100 trees monitored in 2010 in the park had been killed by beetles this past year.

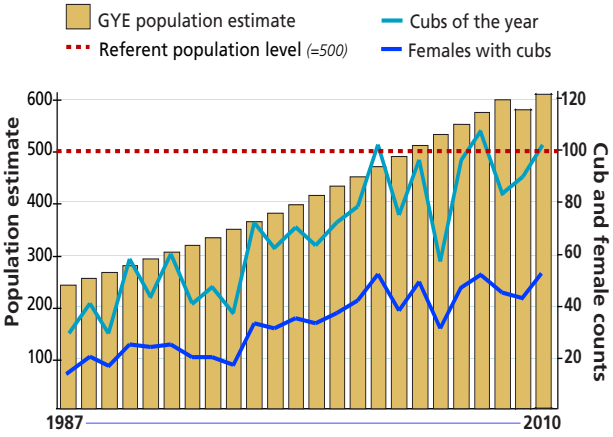
Bear Management

Despite the poor food year for bears, sanitation practices intended to prevent bears from obtaining human foods and garbage helped limit the number of bear-human conflicts in the park in 2010 to 11 (1994–2009 average: 13)—2 grizzly bears, 7 black bears, and 2 unidentified. Bears obtained human foods or garbage in six incidents and damaged property without obtaining anthropogenic food in five incidents. As a result of these conflicts, one grizzly bear was sent to a zoo and two black bears were euthanized. With a contribution from the Yellowstone Park Foundation, bear management and Youth Conservation Corps staff installed 42 bear-proof food storage boxes in five park campgrounds and six backcountry campsites.

Currently, the biggest bear management challenge in Yellowstone is the hundreds of bear jams caused each summer when people stop along the road to watch and photograph bears. Habituated bears tolerate visitors at a close distance in order to get to the natural foods found in roadside meadows. While roadside bear viewing is very popular with park visitors, managing bear-jams to ensure visitor and bear safety is very costly in terms of personnel time. A total of 994 bear jams were reported in the park in 2010, with slightly more involving black bears than grizzly bears. Park staff managed visitors at 904 (91%) of these bear-jams, spending over 3,000 personnel hours managing traffic and ensuring that visitors did not approach or feed bears.



Estimated grizzly bear mortality rates for 2001-2010 in the GYA with recovery criteria: <15% for adult males; <9% for adult females; and <9% for dependent young including only human-caused deaths.



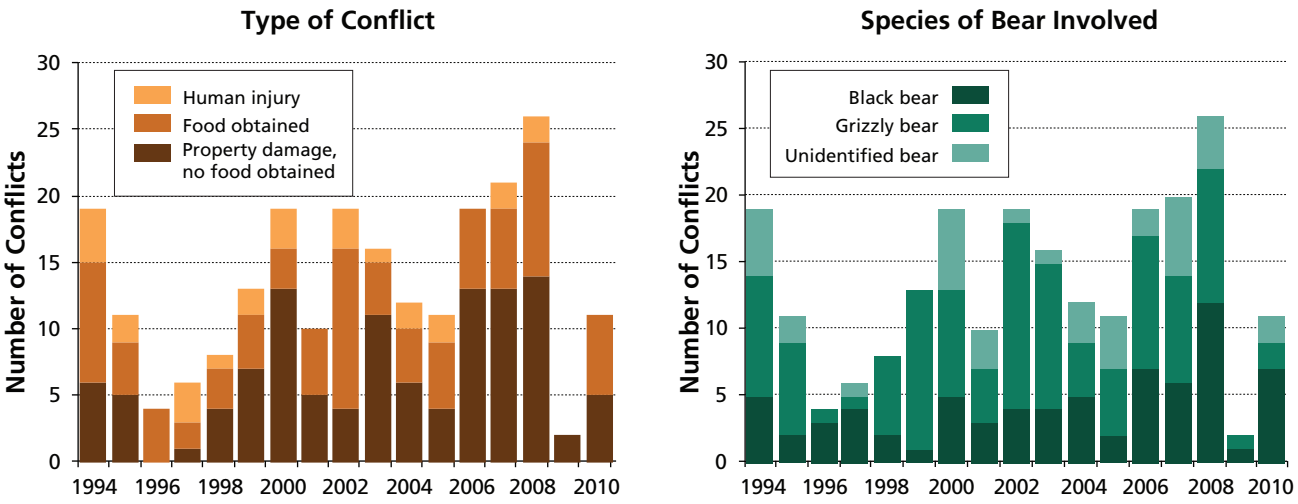
Counts of grizzly bear females and cubs, and estimated population in the GYA, 1987–2010. One recovery criteria is a population estimate of at least 500 (dashed line).

Grizzly Bear Status

Grizzly bears were listed as a threatened species in 1975 due to unsustainable levels of human-caused mortality, habitat loss, and significant habitat alteration. In 1998, grizzly bears in the greater Yellowstone area (GYA) met all of the demographic goals of the Grizzly Bear Recovery Plan for the first time. In 2007 grizzly bears in the GYA were designated as a distinct population segment and removed from threatened species status and the US Fish and Wildlife Service (USFWS) turned over management authority to individual state and federal land and wildlife management agencies under the direction of the Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area (USFWS 2007). Bear advocacy groups challenged the delisting in court and it was overturned in 2009. The judge ruled that the regulatory mechanisms to protect the grizzly once it is delisted were inadequate and that the USFWS did not adequately consider the impact of global warming and other factors on whitebark pine nuts, a grizzly food source. The USFWS filed an appeal in January 2010, and a decision is expected in 2011.

Monitoring. The Interagency Grizzly Bear Study Team (IGBST) has representatives from the NPS, the USFWS, the US Forest Service, the US Geological Survey, and from the states of Idaho, Montana, and Wyoming. It monitors population numbers, distribution, habitat use, reproduction, and mortality in the GYA. To help carry out this monitoring, the IGBST tries to maintain radio collars on 25 adult female grizzly bears. During 2010, the IGBST maintained nine trap sites in Yellowstone at which 12 grizzly bears were captured a total of 20 times; the 12 bears were radio-collared for monitoring. The estimated GYA population in 2010 was 602 grizzly bears, including at least 51 females with 101 cubs of the year. Approximately 150 grizzly bears occupied ranges located partly or entirely within the park.

Reproduction. At least 21 female grizzly bears with home ranges either wholly or partially in the park produced a total of at least 40 cubs. There were 8 one-cub litters, 8 two-cub litters, 4 three-cub litters, and 1 four-cub litter observed. The annual number of females producing cubs in the park has been relatively stable since 1996, suggesting that the



Types of reported bear–human conflicts in Yellowstone National Park and species of bear involved, 1994–2010.

park may be at or near ecological carrying capacity for grizzly bears. The IGBST reports an approximately 5% increase in GYA cub production over 2009, suggesting healthy population growth here as well.

Mortality. Of the 41 grizzly mortalities known to have occurred in the GYA in 2010, three were confirmed to be of natural cause, three were of undetermined cause, and the other 35 were human-caused. In addition to hunting-related deaths and road accidents, management actions resulted in the live removal of 6 bears and the death of 15 bears, including 7 bears that had killed livestock and 2 that had killed humans. The two human fatalities, which both occurred on national forest land, were the first in the GYE since 1986.

In 2010, there were 6 known grizzly-bear mortalities and 5 known black-bear mortalities in the park. Grizzly mortalities included 3 from natural causes, 1 vehicle-strike mortality, 1 live management removal, and 1 accidental management death of a yearling that likely would have died from wounds inflicted by another predator. Black-bear mortalities included 1 from natural causes, 2 vehicle-strike mortalities, and 2 black bears that were removed in management actions.

Birds

Bird monitoring in Yellowstone National Park includes three general groups: raptors, wetland birds, and passerine or near passerine birds. Notable bird sightings during 2010 included a great egret, pileated woodpecker, black-and-white warbler, and tufted titmouse.

Raptors

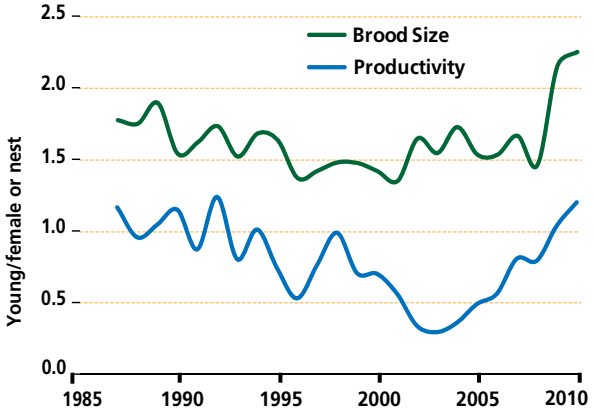
Although more than 30 raptor species have been observed in the park, raptor monitoring has traditionally focused on bald eagles, osprey, and peregrine falcons. In 2010, a grant from the University of Wyoming Park Studies Unit provided seed money for the Yellowstone Raptor Initiative to inventory and monitor red-tailed hawks, golden eagles, and Swainson's hawks; document raptor migration; and eventually inventory owls. Future funds are pending and if successful, will build on data gathered this first year and involve outside collaborators. In 2010, participants discovered a fall migration route through Hayden Valley where they documented hundreds of individual birds of numerous raptor species, some of which do not breed in the park.

Peregrine falcons. Of 26 eyries monitored for evidence of breeding 16 were occupied by a breeding pair, 12 of which fledged a total of 27 young. For the first time, staff spent time in August and September collecting eggshell fragments and prey remains from seven nests. Eggshell thickness, an indicator of environmental contaminants, was within the normal range for healthy peregrines. The prey remains indicated a varied diet that included fish, snake, pine marten and several bird species that do not breed in the park but pass through during spring and fall migration. Four sites contained feathers

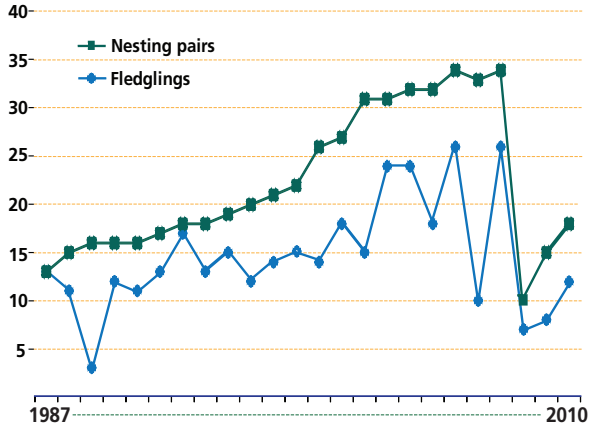
from Franklin's gull, thus it may occur more often in the park than is suggested by reported observations.

Bald eagles. Surveys conducted via fixed-wing aircraft found 22 occupied bald eagle territories, of which 18 had active nests; 9 of the nests produced a total of 12 fledglings. While the bald eagle population remains stable in the park, nest success was only 30% in the Yellowstone Lake area, compared to 75% for other areas in the park. The decreased reproductive success observed for eagles nesting in the lake area in recent years may be due to reductions in cutthroat trout abundance or human disturbance.

Osprey. Surveys conducted via fixed-wing aircraft found 30 active osprey nests, of which 16 fledged a total of 36 young. Following a decline starting in 1987, the park's osprey population has been increasing since 2003, but only five pairs nested on Yellowstone Lake and none of them produced fledglings. To determine if lake trout introduction in the lake in the mid-1980s has affected osprey foraging, Anders Søyland from the Institute of Nature Management (INA) of the Norwegian University of Life Science conducted field work on osprey foraging patterns in 2010. During his observation period in June and July, ospreys were only occasionally observed at the lake and were never seen attempting to forage on it. A second study nearing completion is an evaluation of the relationship between cutthroat trout declines and bald eagle and osprey reproduction at Yellowstone Lake (nest attempts, nest success and productivity) compared with elsewhere in the park.



Osprey productivity and brood size, 1987-2010.



Bald eagle nesting-pair and fledgling counts, 1987–2010.

Wetland Birds

Trumpeter swans. Only one pair of trumpeter swans in Yellowstone National Park made a nest attempt during 2010, and it failed during the incubation stage, probably because of early-season flooding. The mid-winter survey found 18 adults and 5 cygnets in the park; the autumn count was 3 adults and no cygnets.

Common loons. The 2010 survey of 11 previously occupied loon sites in July and August found 17 adults and 3 loonlets at nine lakes. Although the park's adult population has remained stable, the number of nesting pairs and fledglings has decreased since 1987.

Colonial nesting birds. Based on the annual Molly Islands survey, the nesting success of double-crested cormorants and American white pelicans appears to be stable despite large year-to-year variability in weather and lake water levels. American white pelicans fledged 87 young from a total of 427 nest attempts, while double-crested cormorants fledged 59 young from 35 nests. However, no Caspian terns and only one California gull was observed in 2010.

Passerine Birds

Bird program staff continued to monitor songbirds via three surveys: breeding bird survey routes, willow transects, and transects in burned sites to monitor the effects of forest fire on bird species community composition three to five years post-fire. The study of willow-songbird relationships, initiated by Montana State University in 2005, recorded Wilson's warblers in sites previously unoccupied by this willow-obligate species.

A very young bison calf, summer 2010.

Ungulates

Bighorn Sheep

About 10 to 13 bands of interbreeding bighorn sheep occupy the steep, rocky terrain of the upper Yellowstone River drainage. Mount Everts receives the most concentrated use by bighorn sheep year-round, but they also use habitat that extends more than 20 miles north of the park boundary.

From the 1890s to the mid-1960s, the bighorn sheep population fluctuated between 100 and 400. The count reached a high of 487 in 1981, but a pinkeye epidemic caused by *Chlamydia* reduced the population by 60% the following winter. Counts did not increase significantly over the next 15 years and reached a low of 134 sheep after the severe winter of 1996–1997. Since then, the overall trend has been upward, with 353 sheep counted in 2008. Recruitment dropped to a range of 7–11 lambs per 100 ewes during the winters of 1996–1997 and 1997–1998, but in more recent years has fluctuated between 21 and 34 lambs per 100 ewes.

Although wolves occasionally prey on bighorn sheep, the population has increased since wolf reintroduction began in 1995. Long-term monitoring will show whether changes in the sheep population size are correlated with changes in the northern range elk herd, which has dropped 50% since 1994.

In autumn 2009, biologists and university faculty representing the Wyoming Game and Fish Department, Montana Fish, Wildlife and Parks, Idaho Department of Fish and Game, the National Park Service, and Montana State University initiated a research effort focused on bighorn sheep and mountain goat ecology. During 2010, the partners undertook a thorough scientific review of the current state of knowledge regarding potential competitive interactions between the two species, developed GIS capabilities and data layers for the greater Yellowstone area mountain goat and bighorn sheep habitat models, and identified potential sites for comparative field studies of bighorn sheep and mountain goat herds.

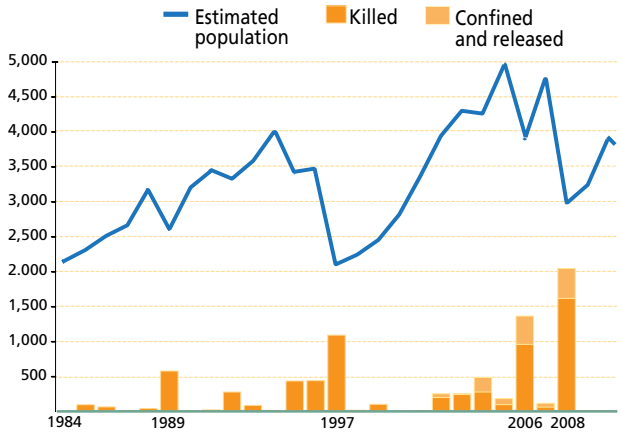
Bison

Park staff participated for the 11th year in the Interagency Bison Management Plan with the state of Montana and the US Department of Agriculture Animal and Plant Health Inspection Service and Forest Service. The plan is designed to manage the risk of brucellosis transmission from bison to cattle, conserve the ecological role of the bison population in the ecosystem, and allow for gradually increased tolerance of bison outside the park on national forest land.

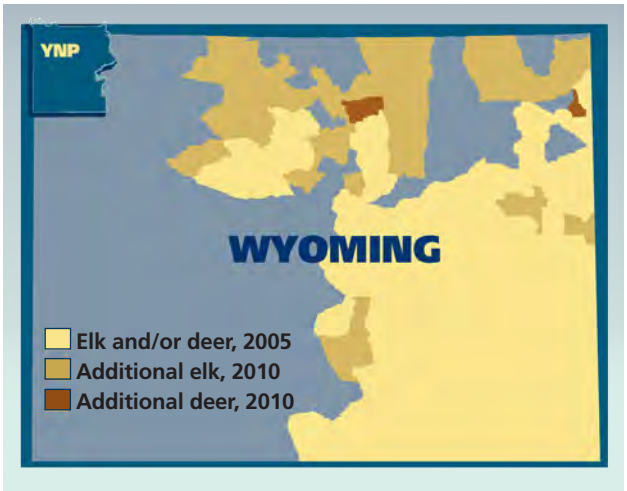
Although few bison migrated to lower elevation ranges along the park boundary during the winter of 2009–2010, approximately 708 bison approached the west boundary in the spring, resulting in up to 600 bison on ranges outside the park in mid-May. A large interagency operation moved the bison back within the park and no bison had to be removed to meet brucellosis risk management goals. Four bison were harvested outside the park in Montana by licensed state and tribal hunters. The population size was estimated at 3,900 based on aerial surveys in June and July, compared to 3,300 bison in summer 2009 and 3,000 adult and yearling bison in late winter 2010. The peak population estimate of 5,000 bison was recorded in summer 2005.

Elk

Yellowstone's largest elk herd winters on range along and north of the park's northern boundary in Montana. The Northern Yellowstone Cooperative Wildlife Working Group, which includes park staff and representatives from Montana Fish, Wildlife and Parks, the US Forest Service, and the US Geological Survey, conducts aerial surveys of this northern Yellowstone elk population each winter. The winter count, approximately 17,000 when wolf reintroduction began in 1995, had fallen below 10,000 by 2003. As the wolf population on the northern range in the park declined from 94 in 2007 to 38 in 2010, the elk winter count fluctuated between roughly 6,000 and 7,000; it was 6,070 in 2010. In addition to wolf predation, the recent elk population decline has been attributed to a growing bear population and possible drought-related effects on pregnancy and survival from 1998 to 2004. The state of Montana has reduced the number of antlerless permits issued in recent years so that hunting now has little impact on population size.



Estimated summer population and the number of bison killed the preceding winter, including those harvested by hunters, 1984–2010.



Hunt areas in which the Wyoming Game and Fish Department has identified deer and elk with chronic wasting disease.

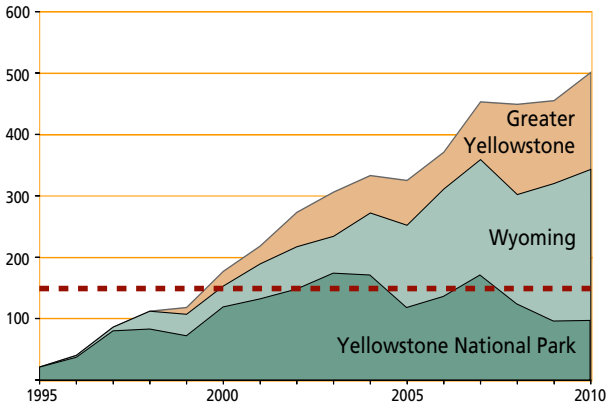
Mountain Goats

Descendants of mountain goats introduced in Montana during the 1940s and 1950s have colonized northern areas of the park; aerial counts of goats inside or within one kilometer of the park have increased from 24 to 178 since 1997. The total population in that surveyed area was estimated to be 200 to 300 goats in 2009. This has raised concerns about the apparent effects on native alpine vegetation and competition with the native bighorn sheep. Studies by Idaho State University and the National Park Service from 2008 to 2010 suggest that goats are affecting the soil chemistry of sites they inhabit by increasing the availability of soil nitrogen through deposition of urine and feces. Soil rockiness may be increasing slightly over time at sites with high goat presence, but no large-scale effects have been detected so far with respect to vegetation.

As part of the long-term collaborative research program on bighorn sheep and mountain goats begun in 2010 with Montana State University and other federal and state agencies, the NPS anticipates three broad types of field studies: (1) statistically rigorous distribution (occupancy) surveys, (2) short-duration telemetry movement studies with Global Positioning System collars, and 3) long-duration telemetry studies of reproduction and survival with VHF collars.

Mule Deer

Aerial surveys conducted in the spring of 2009 by the Northern Yellowstone Cooperative Wildlife Working Group recorded 2,154 mule deer on the northern range in and outside the park, the third highest count since 1996. While the relative distribution of mule deer across their winter range has remained similar over the last two decades, the population appears to have increased in recent years.



Wolf counts for the greater Yellowstone area, Wyoming, and Yellowstone National Park. Dashed line indicates a referent population level of at least 150 wolves, one of various criteria established for recovery in Wyoming.

Wolves

Population Status. At the end of 2010, at least 97 wolves (11 packs and 6 loners) occupied territories located partly or entirely in Yellowstone National Park. The wolf count was one more than in 2009, but has dropped substantially from 171 in 2007. Most of the decrease has been on the northern range, where it has been attributed primarily to the decline in the elk population there; the interior wolf population has declined less, probably because they augment their diet with bison. Pack size ranged from 3 to 16 and averaged 8.3, compared to the long-term average of 10 wolves per pack.

Intraspecific strife was again the leading cause of mortality among radio-collared wolves in the park, causing four of the nine deaths and probably indicating food stress among wolves. One wolf was killed by a bear, one died of disease or malnutrition, and the cause of the other three deaths of radio-collared wolves could not be determined but appeared to be natural. The severity of mange declined in 2010 and there was no evidence of distemper being a mortality factor as it was in some prior years.

The total wolf count in the GYA has continued to increase since reintroduction began in 1995, reaching 478 in 2010. With a total of more than 1,600 wolves in Idaho, Montana, and Wyoming, the Northern Rocky Mountain recovery areas have met the demographic criteria established for a recovered wolf population, and in 2009 the US Fish and Wildlife Service removed the gray wolf from the endangered species list in Idaho and Montana, but litigation caused wolves to be re-listed in August 2010. Wyoming does not yet have a wolf management plan approved by the USFWS.

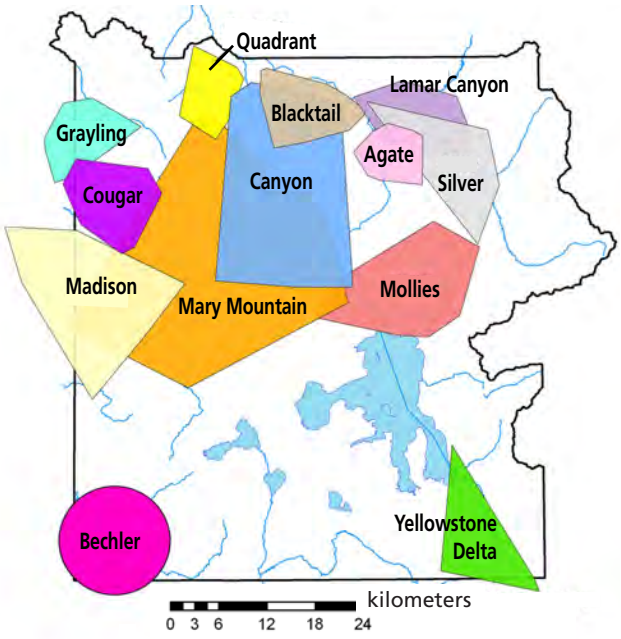
Wolf management. Nearly one third of the wolves in the park wear radio collars for research and monitoring purposes, including 18 wolves that were captured and collared in 2010. Collared wolves were used to locate den and rendezvous sites, three of which were closed to public access. On three occasions wolves were hazed away from developed areas or roads to prevent them from becoming habituated to people. Park staff also monitored visitors in wolf viewing areas.

Wolf research. Staff detected 268 wolf kills in 2010, including 211 elk (79%), 25 bison (9%), and 7 deer (3%), as well as 4 wolves, 2 pronghorn, 4 coyotes, 2 ravens, 2 moose, and 10 unknown prey. While the number of elk killed per wolf has declined in recent years, estimated kilograms consumed per wolf daily has remained relatively stable since 1995.

Disease research in 2010 focused on sarcoptic mange, an infection caused by a mite *(Sarcoptes scabiei)* which reached epidemic proportions on the northern range in 2009. The mite is primarily transmitted through direct contact and burrows into its host's skin where it feeds and lays its eggs. This can initiate an extreme allergic reaction in the host, causing the host to scratch infected areas, resulting in hair loss and secondary infections. In 2010, park staff continued to collect data on mange patterns in the population, and began to analyze the impacts of mange on the survival, reproduction, and behavior of Yellowstone's wolves.

In collaboration with the USGS and Penn State and Princeton universities, park staff started a project that will use thermal imagery cameras to measure body-heat loss associated with infection-induced hair loss. This information will make it possible to estimate the caloric costs of infection and address questions about how infection alters the energy balance that wolves must maintain for survival.

Other research topics included population genetics, hunting behavior, spatial analyses of territory use, wolf pack leadership, multi-carnivore–scavenger interactions, breeding behavior, dispersal, and observations of wolf, grizzly bear, and bison interactions in Pelican Valley.



Wolf packs with territory inside the park during 2010.

Yellowstone Wildlife Health Program

The Yellowstone Wildlife Health Program (YWHP) was established in 2006 by the NPS, Montana State University, and the University of California–Davis School of Veterinary Medicine's Wildlife Health Center. Its mission is to integrate wildlife and human health efforts in and around Yellowstone using science, technology, and education. The Yellowstone Park Foundation is providing one quarter of the funding for its first five years.

The YWHP has initiated 24 wildlife health projects in collaboration with 21 partner agencies, ranging in scope from managing diseases affecting wildlife to reducing disease risk to park staff and visitors.

Amphibians. The YWHP's amphibian disease surveillance focuses on *Batrachochytrium dendrobatidis* (Bd, a chytrid fungus) and ranaviruses, both of which cause lethal infections in frogs and toads. During 2010, the YWHP sampled 296 Columbia spotted frogs throughout the park to determine the presence of Bd by DNA analysis of skin swabs and sent amphibian carcasses collected from observed die-offs to the National Wildlife Health Center for identification of disease-related effects.

Vector-borne diseases. West Nile virus has spread throughout the US since 1999, transmitted by mosquitoes with birds serving as amplifying hosts. With help from the US Air Force Research Laboratory in San Antonio, Texas, 1,780 mosquitoes from 14 sites in the park were tested during the summer of 2010. All of the mosquitoes were negative for the virus, and all fleas collected from Uinta ground squirrels tested negative for infectious pathogens.

Bats. White-nose syndrome (WNS) has been responsible for unprecedented bat deaths in the eastern United States since its detection in 2006. This disease is caused by a cold-loving fungus *(Geomyces destructans)* which disrupts hibernation and causes bats to deplete the body reserves needed to survive the winter. Suspected cases have been found as far west as Oklahoma and bat experts believe it is only a matter of time until WNS arrives in the western states. Several bat species that hibernate in Yellowstone would be susceptible to infection. Working with bat biologists from the University of Kentucky, Bat Conservation International, and Cascadia Research Collective, the YWHP initiated a bat surveillance program in 2010 that focuses on early detection of WNS as well as monitoring bat abundance and species diversity. During 2010, the YWHP examined 111 bats, none of which showed signs of *G. destructans* infection. The 12 bats that were fitted with radio transmitters and tracked during late summer and early fall remained active despite below-freezing temperatures and provided information on foraging and migratory behavior and the timing of bat migration.

Birds. In collaboration with Colorado State University's School of Veterinary Medicine and the National Park Service's Biological Resource Management Division, in 2010 the YWHP developed and implemented an avian disease surveillance plan that focused on waterfowl in the park. The plan includes waterfowl field surveys and procedures for collecting and shipping carcasses for laboratory diagnoses. Environmental sampling (water temperature, pH, salinity, and conductivity) is used to classify park waters as high- or low-risk areas for outbreaks and agent maintenance.

Bison parturition and brucellosis risk. During 2010, the YWHP worked with the park's bison program to publish a paper in *Wildlife Biology* that estimated the timing and location of parturition events in Yellowstone bison. Calving sites outside the park may harbor infectious tissues and fluids that pose a

A uinta ground squirrel's fur yields fleas for testing.

transmission risk to cattle that arrive later at the site. Abortions were observed from January to mid-May, peak calving (80% of births) occurred from late April to late May, and calving finished by the first week of June. From 2004 through 2007, observed bison parturition events occurred in the park or on the Horse Butte peninsula in Montana, where cattle are not present at any time of the year.

Vaccination strategies. The risk of brucellosis transmission to cattle from Yellowstone bison has led to proposals for vaccinating the park's bison herd. Vaccination is unlikely to eradicate *Brucella abortus* from Yellowstone bison, but could be an effective tool for reducing the level of infection. In 2010, the YWHP published a paper in the journal *Vaccine* that described a model used to evaluate how brucellosis infection might respond under various strategies: (1) vaccination of female calves and yearlings captured at the park boundary when bison arrive there, (2) combining boundary vaccination with remote delivery of vaccine-filled biodegradable bullets to female calves and yearlings throughout the park, and (3) vaccinating all female bison during boundary capture and throughout the park using remote delivery. Model simulations suggested that vaccinating all eligible female bison by combining boundary vaccination with remote delivery would be the most effective strategy. This approach allows bison to receive multiple vaccinations that are expected to extend the duration of vaccine protection and defend against recurring infection in chronically infected animals.

Safe work practices. Findings from a 2009 survey to determine work-related zoonotic disease exposure among field technicians and biologists showed that National Park Service biologists and technicians displayed a good working knowledge of zoonotic diseases overall and a willingness to use personal protective equipment (PPE, e.g. disposable gloves, eye protection, and respirators). Activities that increased exposure to zoonotic diseases occurred more frequently outdoors during field work. The awareness of perceived risks was an important motivator in the decision to use PPE or undertake protective behaviors, particularly when working with a species known to transmit infectious disease. The survey helped identify areas for staff improvement including hand hygiene before eating and drinking, PPE use, and frequency of insect repellant application, particularly when working in areas inhabited by mosquitoes or ticks. The survey also addressed potential improvement areas for park management that included better access, availability, and portability of PPE for the field, as well as training and educational opportunities for increased awareness regarding zoonotic disease.

An amphibian survey, Yellowstone Lake.

SECTION III.

Professional Support

This section summarizes the 2010 accomplishments of Yellowstone Center for Resources (YCR) staff who provide services for other YCR branches and park divisions, in these areas:

- Environmental Quality
- Spatial Analysis Center
- Research Permit Office
- Science Communication
- YCR Administration

National Historic Preservation Act consultations addressed relocation of the Haynes photo shop at Old Faithful.

Environmental Quality

In 2010, a major focus of the Environmental Compliance Branch (also known as the Resources Compliance Branch) was continuing to work with park staff to improve how compliance is integrated efficiently into the project planning process. The branch was involved in:

- Implementing the Environmental Assessment (EA) for the Wireless Communication Services Plan through continued involvement on the Telecommunications Committee, which reviews requests for wireless communications projects in the park.
- Drafting the EA for the Norris to Golden Gate road reconstruction project, intended to reconstruct this section to the park standard paved width of 30 feet and improve parking areas and pullouts while avoiding wetlands, thermal areas, and archeological resources.
- Assisting the Fisheries Branch in the planning, preparation, and consultation prior to release of the Native Fish Conservation Plan/EA.
- Drafting the EA for the North Entrance Project, which proposes to improve traffic flow and safety for visitors, employees, contractors, and local residents entering and exiting the park by making minor changes to the roads in the vicinity and adding a second entrance kiosk.
- Initiating an EA for the Isa Lake Bridge reconstruction project, to provide a safe and efficient crossing of the lake at the top of Craig Pass.
- Coordinating with Grand Teton National Park and the Denver Service Center in the scoping and planning process for the Snake River Headwaters Wild & Scenic Comprehensive River Management Plan. This work involved the identification of Outstandingly Remarkable Values (fisheries, cultural resources and wildlife) for the designated segments.

The Environmental Assessment for the upcoming Norris to Golden Gate road reconstruction project was released to the public in 2010.

- Forming an interdisciplinary team to oversee the preparation of an EA for the participation of Yellowstone National Park in the National Ecological Observatory Network, which is monitoring the effects of climate change on a nationwide scale.
- Assisting other park staff in preparation of the Old Faithful and Lake Comprehensive Plans/EAs as well as implementation of the Tower-Roosevelt Comprehensive Plan.
- Completing approximately 30 National Environmental Policy Act Categorical Exclusion documents for projects such as fiber-optic cable placement, culvert replacements, and Old Faithful site rehabilitations. These documented decisions are a small portion of the projects the branch assists with to determine the level of compliance needed; most projects do not require a decision document.
- Completing five Compliance Standard Operating Procedures and associated programmatic categorical exclusions in an effort to streamline project compliance.
- Completing approximately thirty Section 106 National Historic Preservation Act consultations with State Historic Preservation Officers for projects affecting historic properties in the park, including upgrades to the Lake Fish Hatchery Building, relocation of the Haynes photo shop at Old Faithful, and upgrading of windows in Mission 66 housing located in Mammoth.
- Submitting annual reports to the US Fish and Wildlife Service on road improvement and fire-related activities which could affect threatened and endangered species.
- Coordinating Section 7 Consultation training for Yellowstone, Grand Teton, and other local agency staff.

The Environmental Quality Branch also continues to provide assistance, educate, and inform park employees, contractors, and partners about the NEPA process to establish a better understanding and appreciation of this important legislation as it relates to the protection of Yellowstone National Park's natural and cultural resources.

Benefits Sharing

On March 5, 2010, NPS Deputy Director Daniel Wenk signed the Record of Decision (ROD) for the Benefits-Sharing Final Environmental Impact Statement (FEIS), concluding a decade-long NEPA process. The ROD announced the decision to implement benefits-sharing agreements with some scientists who conduct research in National Park System units. If research results lead to the development of commercially valuable products or services, such agreements could provide parks with scientific benefits, in-kind services, royalties or other monetary benefits. The FEIS proposed that benefits would be used for scientific purposes to conserve resources protected and managed by the NPS.

A work crew upgrades windows in a Mission 66 house in Mammoth, April 2010.

Following release of the ROD, park staff began negotiating the park's first post-EIS benefits-sharing agreement and working with WASO staff to implement a benefits-sharing program servicewide. Team members included staff from the DOI Solicitor's Office and advisors from other NPS units. Prior to beginning negotiations, benefits-sharing tools, protocols, and policies must be developed. The Yellowstone negotiations team is preparing to engage the first

three Yellowstone agreement partners in early 2011.

Environmental Quality staff provided updated information to the US Fish and Wildlife Service on road improvement and fire-related activities that could affect threatened and endangered species.

Spatial Analysis

The Spatial Analysis Center (SAC) provides a variety of global positioning system (GPS) and geographic information system (GIS) services to respond to hundreds of requests each year for maps and data. About 60% of the requests come from Yellowstone staff; the remainder are from other NPS staff; other federal, state, and local agencies; university faculty and students; and the general public. Behind the simple interface of a map lies a network of carefully crafted data. For example, on a quarterly basis, and as needed for specific projects, SAC staff query the National Geospatial Intelligence Agency website (https://warp.nga.mil/) to obtain free, constantly updated satellite imagery that is used to update GIS data layers and as background imagery for cartographic products. The SAC also maintains and provides training for 23 GPS units ranging from recreational grade Garmin units to high-end, sub-meter accuracy mapping grade units that are available for NPS staff and cooperators to check out from the GIS intranet site.

The Spatial Analysis Center works with all divisions to ensure that decisions are made using quality spatial data. Major projects in 2010 included:

Park infrastructure. SAC is working with Maintenance to map park utilities and link them to the Facilities Management Software System (FMSS) database. Data are collected through fieldwork, interviews, and digitized, georeferenced, paper plans which are stored in a spatial database. End users are evaluating the utility of digital map projects for the office and paper map books that can be carried in their vehicles. Maintenance personnel at Old Faithful are testing GPS units loaded with utilities and other background maps to help them navigate to the particular pipe or valve they need. The goal of the project is to provide accurate data about utilities in whatever form is most useful. By year-end 2010, more than 4,000 water features and 2,000 sewer features had been mapped, including 110 miles of water lines and 74 miles of sewer lines. The project's inventory phase will be completed in 2011.

Before the FMSS database was linked to building footprints in GIS, there was no way to graphically represent statistical data such as the indices used to implement the Park Asset Management Plan: the Asset Priority Index (importance of the structure) and Facility Condition Index (condition of the structure). Now those data sets can be represented in a simple overview format, allowing managers to view the buildings as more than just items on a spreadsheet. In addition, a building's statistics can be viewed in relation to the surrounding structures, creating an overall picture of the area for better planning purposes. Roads, parking areas, bridges, fords, culverts, trailheads, and campsites are also being linked to the FMSS database.

Container inventory. All waste containers and bear-resistant food storage boxes parkwide were added to inventory, in response to a Maintenance request to document the locations of recycling containers in the park for use in a new recycling contract. Nearly 700 waste containers, 230 recycling

Intern Dana Fernbach uses a GPS unit with submeter accuracy to collect and record data on Grayling Creek.

containers, and 130 bear boxes were inventoried. The locations, sizes, and photos of the recycling containers were used to generate maps for the contract. By gathering these data points and combining them with other infrastructure data, managers and contractors can determine the best location for future containers or consolidate existing facilities.

Routing emergency services. In order to route emergency services personnel quickly to a particular house or business requires more than just lines on a map. An enhanced 911 system (e911) uses roads tagged with information: the name of the road, whether it is one way, the range of addresses along each road segment, which side of the road the address is on. By using this data an e911 system allows dispatchers to get location and routing information to the people who need it. All this is built on GIS data created by SAC personnel working with rangers, dispatchers, and coordinating with the GIS staff of five counties in three states. The road lines are spatially correct, with addresses indicated, and each road in the park is now named. The next stage of this project includes delivering park road and addressing data to the selected e911 contractor, keeping the data current, and delivering updates as needed.

Support for planning efforts. SAC staff continued to create and improve three-dimensional computer models of the Mammoth, Lake, Tower, and Old Faithful developed areas, complete with realistic buildings, trees, and terrain. They worked closely with Planning and YCR staff on the Old Faithful and Lake Comprehensive Plans and the Mammoth charrette. Allowing users to view the consequences of different planning scenarios on the landscape increases the likelihood that everyone will understand the proposals and not be surprised by the end results. The Spatial Analysis Center also supports the environmental analysis (EA) process by participating on ID teams and supplying planners with numerous map and analysis products.

Wildland fire and WUI support. Every year the SAC staff dedicates a significant portion of the summer to mapping wildland fires in the park and creating information products for fire crews, the Public Affairs Office, and the public (via the park's website). Staff also participate throughout the year in the wildland-urban interface (WUI) planning efforts.

Grayling Creek mapping. To provide information that will enable the Aquatic Resources Program to minimize the piscicide needed to eradicate the nonnative fish in Grayling Creek, SAC-trained staff obtained GPS coordinates and width and depth data for 23 miles of the main stem and tributaries as well as for ponds, springs, wetlands, and barriers. This required week-long trips into a backcountry area while preventing the creation of trails. This project is slated to continue during the summer of 2011.

Backcountry lakes. The Aquatic Resources Program had paper records about water chemistry, aquatic plants, plankton, invertebrates, and fish in the park's backcountry lakes that had been gathered from the 1960s to the 1980s. SAC staff input this data in the GIS lakes layer, which had previous been largely limited to the size and name of the lake, scanned the original paper bathymetry maps, and linked the digital maps to the individual lake polygon.

Bison habitat models. SAC staff are working with Bison Management to use Landsat-derived products to run models developed by the Yellowstone

Ecological Research Center and the NASA Ames Research Center to predict the amount of forage available at the end of the growing season, which may affect the movement of ungulate species such as bison, elk, deer, and pronghorn. Archival Landsat imagery and GPS collar locations of bison are being used to test the model for 1990 through present.

Bear–human interactions. SAC staff are using GPS locations of bears and hikers to help determine when, where, and how often the two groups are in close proximity and whether the current bear management closures are supportive of NPS management goals.

C. E. HELLQUIST

Aquatic plant researcher C. Barre Hellquist collects pondweed (Stuckenia pectinata) *from a shallow pond in the Lower Geyser Basin, summer 2010.*

Science Information

Research Permits

The Research Permit Office (RPO) issues and manages approximately 200 research permits each year to scientists from around the world, monitors fieldwork, and communicates research results to park managers to support informed decisions. In 2010, RPO staff received approximately 70 permit inquiries, processed 27 new project requests, managed the park's research dormitory, and provided low-cost housing to 30 groups. This was the first year the RPO used a web-based application through the Greater Yellowstone Science Learning Center for researchers to post field itineraries online, a helpful tool for both the researchers and park staff.

RPO staff members assisted 15 research groups in the field during 2010 to increase staff understanding of specific project objectives and implications the results may have for park management. They also ensure researchers use minimum-impact techniques and that their efforts do not alter park resources or conflict with other park goals. Among the groups that RPO staff worked with: a group from University of Wyoming investigating hybridization of white and Englemann spruce, University of Montana and Wyoming state archeologists who inventoried road corridors and developed areas for evidence of prehistoric use; Synthetic Genomics Inc., a research group trying to identify microorganisms useful in biofuels production; and researchers looking at the genetic adaptations of the yellow monkey flower, a plant that survives in both warm thermal areas and cool habitats.

Roughly 120 articles related to research done in Yellowstone were published in scholarly journals in 2010. RPO staff distributed the articles, as well as several theses and dissertations based on Yellowstone research that were completed by students earning their Masters or PhD degrees, to park staff, public libraries, and online databases that house NPS study results. They also created content for the Greater Yellowstone Science Learning Center website based on the publications.

Science Communication

The mission of the science communication team is to synthesize scientific and technical information and make it available in language and formats that are accessible to researchers, other agency

A researcher counts the seed capsules on a non-thermal variety of yellow monkey flower as part of a 2010 project arranged through YCR's Research Permit Office.

scientists, interested members of the public, and park managers who need to take research results into consideration when making decisions about park policies and priorities. Through presentations, events, printed and electronic publications, and outreach efforts, staff strive to contribute to the scientific body of knowledge about the park, discussion of park issues and policies by a variety of participants, and promote resource conservation and visitor enjoyment through improved understanding of ecological issues.

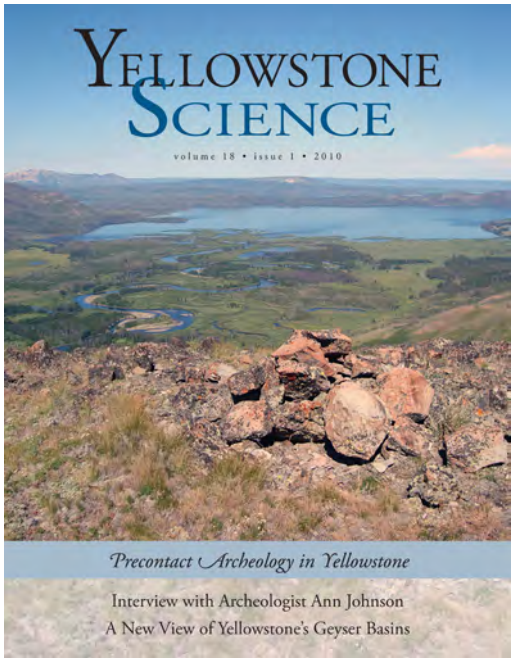
Personnel worked toward those goals in 2010 by producing three issues of Yellowstone Science; creating content for and working through a restructuring of the Greater Yellowstone Science Learning Center website; planning, staffing, and presenting at the 10th Biennial Scientific Conference on the Greater Yellowstone Ecosystem; producing a variety of other materials and technical assistance in support of the YCR and other divisions; and providing assistance to other NPS programs.

Yellowstone Science journal. In its 18th year of publication, Yellowstone Science presented information on many aspects of the park's natural and cultural resources for nearly 4,000 subscribing individuals and institutions (the Yellowstone Association's mailing list was incorporated into the YCR mailing list in 2009). Among the highlights this year was an article on the Greater Yellowstone Science Agenda for climate change, land use change, and invasive species resulting from a November 2009 workshop. Other topics included archeology in the park, new images of Yellowstone's geyser basins that can improve understanding of large thermal areas, maps of the thermal features at Mammoth Hot Springs, and a program that connects students and researchers while increasing observations of those features. In 2010, Yellowstone Science introduced a new department devoted to brief summaries of recent relevant published papers and research reports.

Other Publications. Other recurring publications in 2010 included annual reports on Yellowstone Center for Resources activities, the Wolf Project, the Yellowstone Fisheries and Aquatic Sciences program, the Bird Program, and the Wildlife Health Program, all of which were edited and designed by science communications. Special publications included the design, layout, and printing of the Historic Structures Report on the Haynes Picture Shops Headquarters in Mammoth Hot Springs, Nature and Culture at Fishing Bridge, Scientific Review Panel Evaluation of the NPS Lake Trout Suppression Program in Yellowstone Lake, an updated Old Faithful Rare Plants Field Guide, a Cody Days briefing booklet, the Native Fish Conservation Plan/Environmental Assessment, and the Bison Remote Vaccination Draft Environmental Impact Statement. Support to other NPS groups also included editing, designing, and producing the layout for the servicewide Climate Change Response Strategy, and assisting with editing and layout of the Greater Yellowstone Network's Whitebark Pine Protocol and various climate briefs, reports, and syntheses for the network and the Great Northern Landscape Conservation Cooperative.

Greater Yellowstone Science Learning Center. The Greater Yellowstone Science Learning Center (GYSLC) is a partnership among the Yellowstone

Center for Resources, the Greater Yellowstone Inventory and Monitoring Network, the Rocky Mountains Cooperative Ecosystem Studies Unit, Montana State University, the Sonoran Institute, the Yellowstone Association, the Yellowstone Park Foundation, and Canon U.S.A., Inc., as part of the Eyes on Yellowstone made possible by Canon program. Its primary purposes are to promote mission-oriented research in the Greater Yellowstone Inventory and Monitoring Network (Yellowstone and Grand Teton national parks, John D. Rockefeller, Jr. Memorial Parkway, and the Bighorn Canyon National Recreation Area) and explain the need for, and results of, research in the network to park managers, researchers, educators, students, and interested public. It has been recognized as a servicewide model for a website strategy for NPS Research Learning Centers (RLC) and Inventory and Monitoring Networks and five similar websites went online in 2010. In a joint effort with the Learning Center of the American Southwest, a developer and webmaster hired through a Cooperative Ecosystem Studies Unit (CESU) agreement with the Sonoran Institute continued site improvement. Staff developed content for 25 new website topics, many of which focused on cultural resources and climate change, and updated existing topics. Staff also gave presentations at an Inventory and Monitoring climate change workshop on high-elevation parks and at the 10th Biennial Scientific Conference about the website, and assisted members of the Inventory and Monitoring Network and other park units with their products.



In 2010, Yellowstone Science *introduced a new department devoted to brief summaries of recent relevant published papers and research reports.*

Biennial Scientific Conference. In 2010, staff completed planning for the 10th Biennial Scientific Conference on the Greater Yellowstone Ecosystem, "Questioning Greater Yellowstone's Future: Climate, Land Use, and Invasive Species," held on October 11 to 13 at the Mammoth Hot Springs Hotel with nearly 60 presenters and approximately 200 attendees. The planning committee, comprised of science communication and other YCR staff, oversaw all aspects of the coordination, organization, and logistics for the conference. Staff supported the selection of papers and posters; served as the point-of-contact for all conference-related inquiries; edited, designed, and produced the layouts for various conference materials; worked with the venue staff; and maintained a web page on the GYSLC as a portal to the conference. Among the approximately 200 attendees were agency managers, scientists, university researchers and students from the United States. A writer-editor hired through a Cooperative Ecosystem Studies Unit (the University of Wyoming Ruckelshaus Institute) will prepare the proceedings, which will be available in print and electronic form in 2011.

Assistance and Support. During 2010, science communication staff produced miscellaneous flyers, maps, presentations, and graphics for park staff. They provided guidance and support services to park staff on working with the Government Printing Office and obtaining printing bids, and gave technical assistance on graphics software and layout issues. In addition, they coordinated reviews of various publications for the park's Division of Interpretation. Staff updated and presented the YCR's seasonal orientation presentations, provided logistics assistance for division meetings, and continued to assist with biennial postings of the park's World Heritage Site state of conservation report to the World Heritage Committee.

Funding and Personnnel

Base Operating Budget

The Yellowstone Center for Resources was allocated a FY10 base operating budget of $5,361,750.

The increase of $63,050 over FY09 funding levels included funds received to partially cover the annual pay cost increase. The base operating budget accounted for 67% of the YCR total for FY10. This compares to an average of 60% for the period FY95–09. A detailed breakdown of FY10 funding sources and comparable data on YCR's funding history for fiscal years 1993 through 2009 can be found in the figure below and in the table at right.

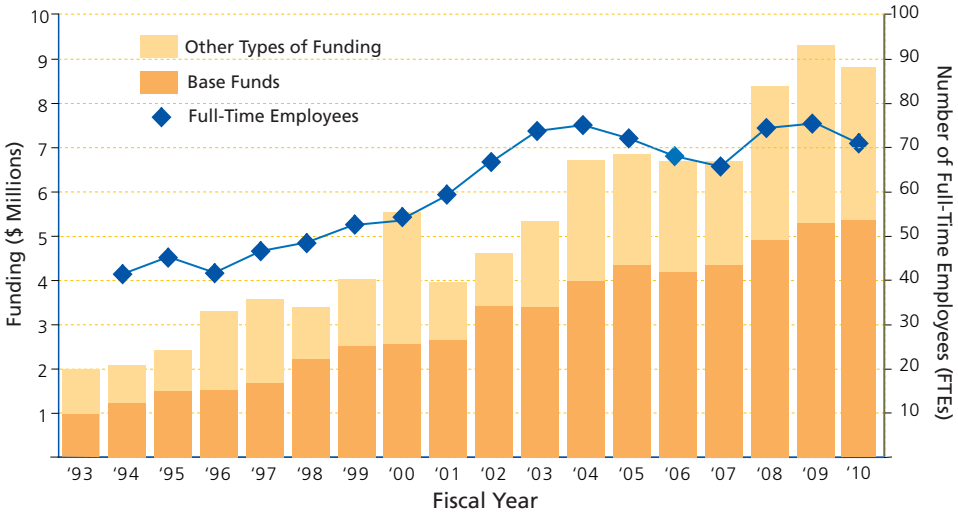
Additional Funding

Donations. A total of $332,500 was donated to the park by private organizations or individuals in support of various YCR projects, including the wolf recovery program, cultural resource preservation projects, a project to control aquatic nuisance species, studies of Yellowstone's northern range riparian habitats, and support for the Greater Yellowstone Science Learning Center and Yellowstone Wildlife Health Initiative. Most of this funding ($298,200) came through the Yellowstone Park Foundation.

Recreation Fee Demonstration Funds. The fee demo program provided $1,282,600 in FY10 for new projects in natural resource management. Visitor fees also provided $1,282,600 for ongoing projects: renovation of and improvements to interpretive exhibits along the Nez Perce Trail, northern range riparian studies, a westslope cutthroat fishery conservation project, improvement of collections storage and additional visitor service assistance at the Heritage and Research Center, a condition survey of historic structures with high visitor use, hazard tree reduction and exotic plant control programs, and the Gardiner Basin wildlife habitat restoration project. Since the YCR began receiving fee demo money in 1997, about $5.5 million has been allocated from this funding program for more than 30 different projects.

Fishing Fee Program. The YCR received authorization to use $356,800 from fishing permit fee revenue to cover part of the cost of the Fisheries and Aquatic Sciences program in FY10.

Federal Lands Highway Program. Federal Highways funded $656,700 for natural resource inventories, archeological surveys, and resource compliance along the road corridors in the park scheduled for major repair or reconstruction in the near future, and to control nonnative plant species in the completed construction areas undergoing revegetation.



YCR funding and full-time equivalent staff (FTE), FY1993–2010. "Base funds" from the NPS's annual congressional appropriation are intended to cover each park's basic operating costs; about 70–75% of YCR's base funds are used for permanent employees' salaries and benefits. Other types of funding include project-specific funds from the NPS and other federal agencies, fee revenues, and donations. The NPS provided a large increase in one-time funding in FY2000 for preparation of environmental impact statements on bison management and benefits sharing. YCR staff and base funding increased in FY2008 partly as result of a parkwide reorganization that transferred several work units to the division.

Special Emphasis Program Allocation System. The special emphasis program provided $425,300 to the Branch of Cultural Resources for special projects. The Branch of Natural Resources received $210,100 for several ongoing air quality monitoring projects, the second year of a three-year study on mountain goat habitat vegetation, and the second year of a three-year project to evaluate the effectiveness of grizzly bear management closures.

Other Park Service Funds. The YCR continued work on the Benefits-Sharing EIS in FY10 with

Yellowstone Center for Resources, Funding History (FY 1993–2010)

YCR Base Increase	FY	National Park Service Funds: Park Base	Nat Res Project Funds	Cult Res Project Funds	Fish Fee	FLHP	Fee Demo	Other NPS	Other Federal	Private	Total	% Soft Funded
	93	1,004,600	16,000	—	—	—	—	785,000	188,000	20,000	2,013,600	50%
245,400	94	1,250,000	260,000	33,200	65,000	43,300	—	320,600	79,600	10,000	2,061,700	39%
250,000	95	1,500,000	420,000	45,000	65,000	303,600	—	59,800	20,000	5,300	2,418,700	38%
44,100	96	1,544,100	404,000	201,100	274,500	626,700	—	157,800	65,000	31,500	3,304,700	53%
130,000	97	1,674,100	204,000	228,400	213,400	433,700	340,000	42,700	398,300	48,000	3,582,600	53%
571,500	98	2,245,600	130,500	242,100	284,800	330,800	31,000	24,000	65,300	37,700	3,391,800	34%
286,300	99	2,531,900	—	221,900	285,000	396,500	298,000	152,900	105,200	56,700	4,048,100	37%
36,700	00	2,568,600	237,500	101,000	280,000	214,900	631,000	1,418,000	41,300	52,700	5,545,000	54%
93,300	01	2,661,900	297,000	216,700	285,100	409,000	—	—	15,000	85,500	3,970,200	33%
772,900	02	3,434,800	293,000	198,700	261,900	293,200	6,000	—	11,700	126,400	4,625,700	26%
(16,100)	03	3,418,700	101,000	326,300	250,000	431,000	103,000	454,400	24,000	224,300	5,332,700	36%
569,700	04	3,988,400	92,600	470,400	332,600	623,500	133,000	855,000	22,400	229,200	6,747,100	41%
375,700	05	4,364,100	218,000	676,900	342,300	495,900	167,700	367,800	23,700	181,300	6,837,700	36%
(152,800)	06	4,211,300	193,800	466,890	368,400	427,700	224,500	249,000	224,200	340,400	6,706,190	37%
136,700	07	4,348,000	205,200	208,900	333,400	567,100	349,700	162,000	296,900	226,100	6,697,300	35%
569,700	08	4,917,700	113,100	532,100	351,900	647,500	575,200	709,300	172,500	375,300	8,394,600	41%
381,000	09	5,298,700	106,600	349,900	337,500	647,800	1,624,300	137,200	593,800	215,900	9,311,700	43%
63,050	10	5,361,750	210,100	425,300	356,800	656,700	1,282,600	90,200	128,500	332,500	8,844,450	39%

YCR Distribution of FY10 Funds											% Total Funding
Professional Support	1,752,700	—	—	—	16,300	14,300	90,200	—	8,400	1,881,900	21.3%
Natural Resources	3,212,150	210,100	—	356,800	411,800	1,108,300	—	128,500	319,600	5,747,250	65.0%
Cultural Resources	396,900	—	425,300	—	228,600	160,000	—	—	4,500	1,215,300	13.7%
Total:	**5,361,750**	**210,100**	**425,300**	**356,800**	**656,700**	**1,282,600**	**90,200**	**128,500**	**332,500**	**8,844,450**	**100.0%**
									Base:	**5,361,750**	**61.0%**
									All other:	**3,482,700**	**39.0%**

Other NPS:

90,200 Benefits Sharing EIS

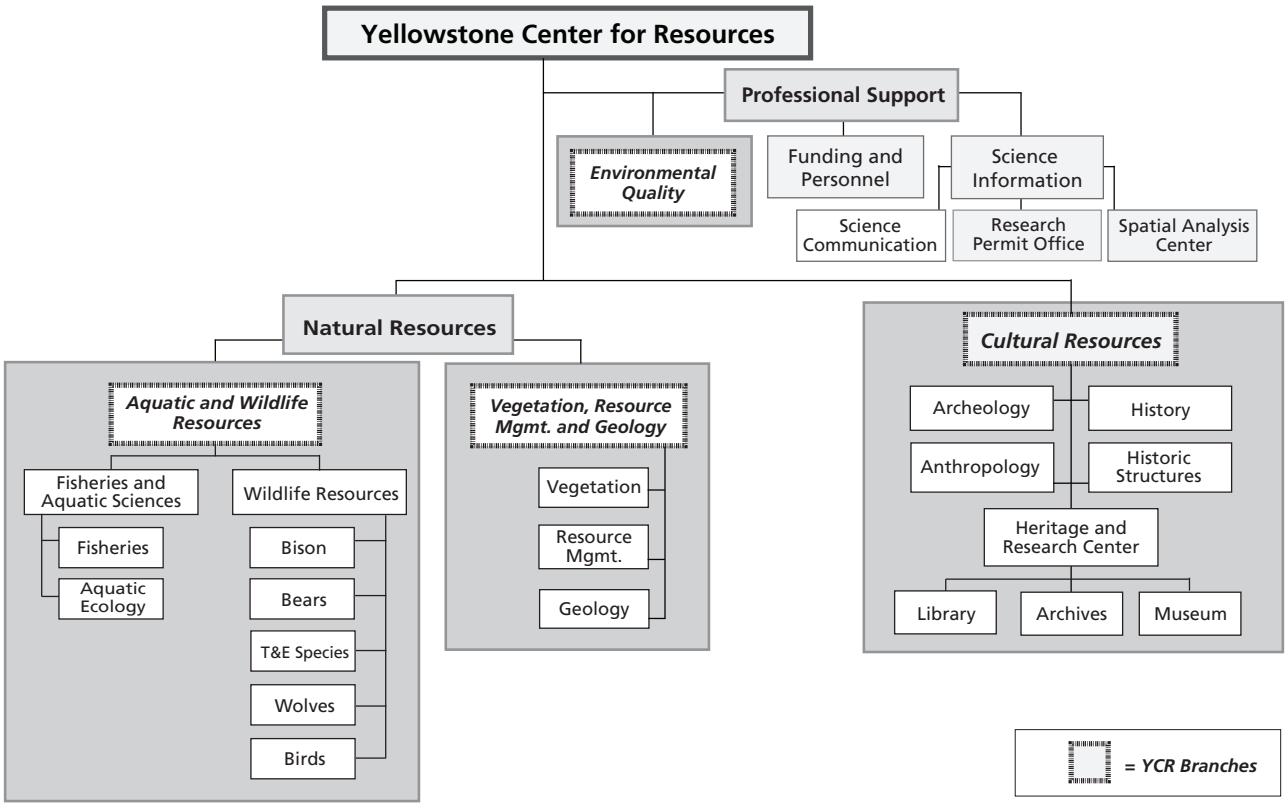
Other Federal:

122,700 USFWS — Grizzly Conservation Strategy
4,300 BLM, Joint Fire Sciences Program
69,700 USFS-GYCC Fish Distribution Survey
128,500

Private:

12,500 Fisheries Donations
13,100 Bear Donations
1,900 Other Donations
4,800 Xanterra
2,000 Montana Dept of Transportation
298,200 Yellowstone Park Foundation
332,500

Not included: $7,100 for USGS–BRD Bear Study Team (No YCR; pass-through only)



Yellowstone Center for Resources organizational structure as of September 30, 2010 (end of FY2010).

funds provided by the NPS servicewide planning office ($90,200).

Other Federal Funds. A total of $128,500 was provided to Yellowstone from other federal agencies, most of it from the US Fish and Wildlife Service provided funds for increased monitoring of grizzly bears ($122,700) in the wake of their removal from and subsequent replacement on the endangered species list. The Bureau of Land Management's Joint Fire Sciences Program ($4,300) also provided some funds for YCR to complete a study between federal partners and three universities on bark beetle infestation effects on fuels and fire hazards.

Administration

Personnel. A total of 120 people were on the YCR payroll for all or part of FY10, which was equivalent to 76 full-time employees. YCR Support Staff processed 270 personnel actions in FY10. The YCR organizational chart for FY10 (above) outlines the basic structure of the division and names individual programs within each branch. A list of 2010 personnel and positions,can be found in Appendix A of this report.

Assistance Agreements. Staff processed 49 assistance agreements and task orders in FY10, totaling obligations of $2,002,500 in partnership agreements.

Procurement Actions. Staff processed 640 procurement actions in FY10. Of those, 166 purchase requests were prepared in the Interior Department Electronic Acquisition System to request acquisition services from the Yellowstone Procurement and Contracting Office, while 474 acquisitions were accomplished primarily through administrative staff credit card orders.

Clerical Support. Staff processed a total of 938 pieces of correspondence and 136 travel authorizations during FY10.

APPENDIX A.

Personnel Roster

Cultural Resources Branch

			YCR FTE*	Non-YCR FTE
1.	Caloia, Stephanie	Library Technician	0.24	*(*Full-Time Employee)*
2.	Conley, Molly	Museum Technician	0.12	
3.	Curry, Colleen	Museum Curator	1.00	
4.	Foster, Anne	Archivist	0.48	
5.	Guild, Bridgette	Museum Registrar	0.98	
6.	Mosley, Derek	Archives Technician	0.27	
7.	Reid, Charissa	Cultural Anthropologist	0.24	
8.	Robertson, Mariah	Archives Technician	0.93	
9.	Roop, Tobin	Chief of Cultural Resources	1.01	
10.	Whittlesey, Lee	Historian	1.00	
	Corral operations support to archeology projects		—	0.13
		Cultural Resources Branch:	**6.27**	**0.13**

Natural Resources Branch

Geology

1.	Carr, Brett	Geologist	0.15	
2.	Heasler, Hank	Geologist	1.00	
3.	Jaworowski, Cheryl	Geologist	0.96	
4.	Mahony, Dan	Fisheries Biologist	1.00	
	Assistance to geology projects		—	0.01
		subtotal Geology:	**3.11**	**0.01**

Vegetation

1.	Anderson, Heidi	Botanist	0.93	
2.	Burson, Shan	Ecologist (Bioacoustics)	0.45	
3.	Corry, Patricia	Biological Science Technician	0.50	
4.	Hektner, Mary	Sprv. Vegetation Mgt Specialist	1.00	
5.	Kashi, Natalie	Biological Science Technician	0.39	
6.	Klaptosky, John	Biological Science Technician	1.03	
7.	Osgood, Michelle	Biological Science Technician	0.50	
8.	Renkin, Roy	Vegetation Mgt Specialist	1.04	
9.	Whipple, Jennifer	Botanist	0.73	
	Air quality monitoring assistance		—	0.04
	Bioacoustic monitoring assistance		—	0.06
	Interdivisional support to Gardiner Basin project		—	0.24
		subtotal Vegetation:	**6.57**	**0.34**

	Resource Management Operations		**YCR FTE**	**Non-YCR FTE**
1.	Barnes, Zachary	Biological Science Technician	0.37	
2.	Bontranger, Jonathan	Biological Science Technician	0.26	
3.	Bosserman, Heather	Biological Science Technician	0.37	
4.	Cloghessy, Mitchell	Biological Science Aid	0.23	
5.	Donovon, Mary A.	Biological Science Technician	0.31	
6.	Fey, Margie	Biological Science Technician	0.34	
7.	Gerot, Sharon	Biological Science Technician	0.41	
8.	Guy, F.A.	Biological Science Technician	0.17	
9.	Haynes, James	Biological Science Technician	0.45	
10.	Holdren, Anita	Biological Science Technician	0.12	
11.	Nagashima, Vincent	Biological Science Technician	0.34	
12.	Nedved, Troy	Asst Resource Mgt Specialist	0.66	
13.	Overbaugh, Chris	Biological Science Technician	0.99	
14.	Park, Katrina	Biological Science Technician	0.50	
15.	Pearson, Kari	Biological Science Technician	0.36	
16.	Pearson, Kathy	Biological Science Technician	0.37	
17.	Perrotti, Patrick	Resource Mgt Specialist	1.00	
18.	Pokorzynski, Ryan	Biological Science Technician	0.25	
19.	Reinertson, Eric	Asst Resource Mgt Specialist	0.59	
20.	Reinhart, Daniel	Sprv. Resource Mgt Specialist	1.02	
21.	Roper, Jaime	Biological Science Technician	0.44	
22.	Sechrist, George	Biological Science Technician	0.33	
23.	Smith, Hilary	Biological Science Technician	0.33	
24.	Teets, Brian	Biological Science Technician	0.75	
25.	Welch, Nancy	Biological Science Technician	0.37	
26.	Westmark, Amy	Biological Science Technician	0.33	
	Resource management equipment maintenance assistance		—	0.02
		subtotal Res Mgt Operations:	**11.66**	**0.02**
	Aquatic Resources			
1.	Adams, Rebecca	Biological Science Technician	0.09	
2.	Arnold, Jeff	Aquatic Ecologist	1.00	
3.	Bigelow, Pat	Fisheries Biologist	1.00	
4.	Bunn, Jason	Biological Science Technician	0.50	
5.	Bywater, Tim	Administrative Support Assistant	0.13	
6.	Consolo, Michael	Biological Science Technician	0.42	
7.	Doepke, Phil	Biological Science Technician	1.01	
8.	Drescher, Earl	Biological Science Technician	0.41	
9.	Dumond, Paul	Biological Science Technician	0.06	

			YCR FTE	Non-YCR FTE
10.	Ertel, Brian	Biological Science Technician	1.01	
11.	Firmage, David	Biological Science Technician	0.06	
12.	Gunderman, Hannah	Biological Science Technician	0.27	
13.	Koel, Todd	Sprv. Fisheries Biologist	1.00	
14.	Lewandoski, Sean	Biological Science Technician	0.38	
15.	Lohmeyer, Adam	Biological Science Technician	0.44	
16.	Olsen, Kate	Biological Science Technician	0.57	
17.	Pasbrig, Chelsey	Biological Science Technician	0.42	
18.	Rupert, Derek	Biological Science Technician	0.14	
19.	Stewart, Kole	Biological Science Technician	0.38	
	Assistance to fisheries special projects		—	0.09
		subtotal Aquatic Resources:	**9.29**	**0.09**
	Wildlife Resources			
1.	Albers, Erin	Biological Science Technician	0.98	
2.	Baril, Lisa	Biological Science Technician	0.51	
3.	Blanton, Doug	Biological Science Technician	1.01	
4.	Bramblett, Amanda	Biological Science Technician	0.73	
5.	Clarke, Lynn	Biological Science Technician	0.49	
6.	Coleman, Tyler	Biological Science Technician	0.47	
7.	Davis, Troy	Biological Science Technician	0.27	
8.	Geremia, Chris	Biological Science Technician	0.74	
9.	Gunther, Kerry	Wildlife Biologist	1.05	
10.	Henry, Leslie	Biological Science Technician	0.39	
11.	Madsen, Forrest	Biological Science Aid	0.18	
12.	McAllister, Jack	Biological Science Technician	0.22	
13.	McIntyre, Rick	Biological Science Technician	0.50	
14.	Sacklin, JD	Biological Science Aid	0.17	
15.	Smith, Doug	Senior Wildlife Biologist	1.02	
16.	Stahler, Dan	Wildlife Biologist	0.70	
17.	Tallian, Aimee	Biological Science Technician	0.94	
18.	Treanor, John	Wildlife Biologist	1.01	
19.	Waddell, James	Biological Science Technician	0.43	
20.	Wallen, Rick	Wildlife Biologist	1.00	
21.	White, PJ	Sprv. Wildlife Biologist	1.00	
22.	Wyman, Travis	Biological Science Technician	1.04	
	Grizzly Bear Conservation Strategy monitoring		—	1.38
		subtotal Wildlife Resources:	**14.85**	**1.38**

Natural Resources Administration		YCR FTE	Non-YCR FTE
1. Plumb, Glenn	Chief of Natural Resources	0.95	
Horse handler & packer support		—	0.31
	subtotal Nat Resources Admin:	**0.95**	**0.31**
	Natural Resources Branch:	**46.43**	**2.15**

Professional Support

Environmental Quality		YCR FTE	Non-YCR FTE
1. Desmet, Adrienne	Administrative Assistant	0.50	
2. Deutch, Ann	Environmental Protection Assistant	0.42	
3. Hale, Elaine	Archeologist	1.00	
4. Klein, Bianca	Environmental Protection Specialist	0.99	
5. Madsen, Douglas	Outdoor Recreation Planner	1.05	
6. Mazzu, Linda	Sprv. Environmental Protection Spec	1.00	
7. Mills, Sue	Environmental Protection Specialist	1.00	
	Environmental Quality:	**5.96**	**—**

Science Information

Spatial Analysis Center

1. Comer, Greg	Cartographic Technician	0.03	
2. Gager, Steven	Cartographic Technician	0.35	
3. Gillan, Jeffrey	Cartographic Technician	0.25	
4. Guiles, Carrie	Cartographic Technician	0.90	
5. Klein, Allison	Cartographic Technician	0.34	
6. Miller, Steve	Cartographic Technician	0.45	
7. Rodman, Ann	Sprv. GIS Specialist	1.03	
8. Schoengold, Julie	Cartographic Technician	0.45	
9. Sobiech, Michael	Cartographic Technician	0.39	
	subtotal Spatial Analysis:	**4.19**	**—**

Research Permit Office

1. Gunther, Stacey	Environmental Protection Assistant	0.86	
2. Hendrix, Christie	Environmental Protection Assistant	1.00	
	subtotal Research Permit Office:	**1.86**	**—**

Science Communication

1. Blackford, Tami	Editor	1.00	
2. Franke, Mary Ann	Technical Writer-Editor	0.24	
3. Stevenson, Sarah	Technical Writer-Editor	0.11	
4. Waller, Janine	Editorial Assistant	0.96	
5. Warner, Virginia	Editorial Assistant	0.11	
	subtotal Science Communication:	**2.42**	**—**
	Science Information:	**8.47**	**—**

	YCR Administration		YCR FTE	Non-YCR FTE
1.	Cline, Barbara	Administrative Support Assistant	1.01	
2.	Franken, Kevin	Administrative Support Assistant	0.24	
3.	Lindstrom, Montana	Budget Analyst	1.00	
4.	McAdam, Melissa	Sprv. Budget Analyst	1.00	
5.	Olliff, Tom	Division Chief	0.10	
6.	Wyman, Becky	Administrative Support Assistant	1.00	
	Administrative support to backfill vacant part-time position		—	0.03
	Maintenance & custodial assistance (Lake Research Dorm)		—	0.02
		Subtotal YCR Administration:	**4.35**	**0.05**
		Professional Support:	**18.78**	**0.05**
120	**YCR Employees**	**TOTAL FTE (Fiscal Year 2010):**	**71.48**	**2.33**

APPENDIX B.

Publications and Reports

Professional Publications

Almberg, E., P. Cross, and D.W. Smith. 2010. Persistence of canine distemper virus in the Greater Yellowstone Ecosystem's carnivore community. *Ecological Applications* 20(7):2058–2074.

Barnowe-Meyer, K., P.J. White, T.L. Davis, D.W. Smith, R.L. Crabtree, and J.A. Byers. 2010. Influences of wolves and high-elevation dispersion on reproductive success of pronghorn (*Antilocapra americana*). *Journal of Mammalogy* 91:712–721.

Carr, B.B., C. Jaworowski, and H.P. Heasler. 2010. It's not drying up, just changing: mapping change at Mammoth Hot Springs using aerial photographs and visual observations. *Yellowstone Science* 18(1):15–22.

Evans, W.C., D. Bergfeld, J.P. McGeehin, J.C. King, and H.P. Heasler. 2010. Tree-ring 14C links seismic swarm to CO_2 spike at Yellowstone, USA. *Geology* 38(12): 1075–1078; doi: 10.1130/G31345.1; 3 figures; Data Repository item 2010296.

Gardner, P.W., D.D. Susong, D.K. Solomon, and H.P. Heasler. 2010. Using noble gases measured in spring discharge to trace hydrothermal processes in the Norris Geyser Basin, Yellowstone National Park. *Journal of Volcanology and Geothermal Research* 198:394–404.

Haroldson, M.A., C.C. Schwartz, K.C. Kendall, K.A. Gunther, D.S. Moody, K. Frey, and D. Paetkau. 2010. Genetic analysis of individual origins supports isolation of grizzly bears in the Greater Yellowstone Ecosystem. *Ursus* 21(1):1–13.

Heasler, H.P. 2010. An Exceptional Day at Biscuit Basin. *Yellowstone Science* 18(1):16.

Hopkins, J.B., S. Herrero, R.T. Shideler, K.A. Gunther, C.C. Schwartz, and S.T. Kalinowski. 2010. A proposed lexicon of terms and concepts for human-bear management in North America. *Ursus* 21(2):154–168.

Jaworowski, C., H.P. Heasler, C.M.U. Neale, and S. Sivarajan. 2010. Using thermal infrared imagery and LiDAR in Yellowstone geyser basins. *Yellowstone Science* 18(1):8–19.

Jones, J.D., J.J. Treanor, R.L. Wallen, and P.J. White. 2010. Timing of parturition events in Yellowstone bison: implications for bison conservation and brucellosis transmission risk to cattle. *Wildlife Biology* 16:333–339.

Mitchell, M.S., D.W. Smith, J.A. Gude, D.E. Ausband, C.A. Sime, E.E. Bangs, M.D. Jimenez, C.M. Mack, T.J. Meier, and M.S. Nadeau. 2010. Temporal validation of an estimator for successful breeding pairs of wolves *Canis lupus* in the US northern Rocky Mountains. *Wildlife Biology* 16:101–106.

Murray, D.L., D.W. Smith, E.E. Bangs, C. Mack, J.K. Oakleaf, J. Fontaine, D. Boyd, M. Jiminez, C. Niemeyer, T.J. Meier, D.R. Stahler, J. Holyan, and V. Asher. 2010. Death from anthropogenic causes is partially compensatory in recovering wolf populations. *Biological Conservation* 143(11):2514–2524.

Proffitt, K.M., P.J. White, and R.A. Garrott. 2010.Spatio-temporal overlap between Yellowstone bison and elk: implications of wolf restoration and other factors for brucellosis transmission risk. *Journal of Applied Ecology* 47:281–289.

Proffitt, K.M., T.P. McEneaney, P.J. White, and R.A. Garrott. 2010. Productivity and fledging success of trumpeter swans in Yellowstone National Park, 1987–2007. *Waterbirds* 33:341–348.

Schwartz, C.C., M.A. Haroldson, and K.A. Gunther. 2010. Understanding grizzlies: science of the Interagency Grizzly Bear Study Team. In *Knowing Yellowstone: science in America's first national park*, ed. J. Johnson, 51–63. Lanham, Maryland: Taylor Trade Publishing.

Smith, D.W., E.E. Bangs, J.K. Oakleaf, C. Mack, J. Fontaine, D. Boyd, M. Jimenez, D.H. Pletscher, C.C. Niemeyer, T.J. Meier, D.R. Stahler, J. Holyan, V.J. Asher, D. Murray. 2010. Survival of colonizing wolves in the northern Rocky Mountains of the United States, 1982–2004. *Journal of Wildlife Management* 74:620–634.

Treanor, J.J., J.S. Johnson, R.L. Wallen, S. Cilles, P.H. Crowley, J.J. Cox, D.S. Maehr, P.J. White, and G.E. Plumb. 2010. Vaccination strategies for managing brucellosis in Yellowstone bison. *Vaccine* 28S:F64–F72.

VonHoldt, B.M., D.R. Stahler, E.E. Bangs, D.W. Smith, M.D. Jimenez, C.M. Mack, C.C. Niemeyer, J.P. Pollinger, and R.K. Wayne. 2010. A novel assessment of population structure and gene flow in grey wolf populations of the Northern Rocky Mountains of the United States. *Molecular Ecology* 19(20):4412–4427.

White, P.J., K.M. Proffitt, L.D. Mech, S.B. Evans, J.A. Cunningham, and K.L. Hamlin. 2010. Migration of northern Yellowstone elk: implications of spatial structuring. *Journal of Mammalogy* 91:27–837.

Administrative Reports

Baril, L.M., L. Henry, and D.W. Smith. 2010. Yellowstone Bird Program: Annual report, 2009. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming, YCR-2010-04.

Gunther, K.A. 2010. Yellowstone National Park Recreational Use. Page 36 *in* C.C. Schwartz, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: Annual report of the Interagency Grizzly Bear Study Team, 2009. US Geological Survey, Bozeman, Montana.

Gunther, K.A., B. Aber, M.T. Bruscino, S.L. Cain, K. Frey, M.A. Haroldson, and C.C. Schwartz. 2010. Grizzly bear–human conflicts in the Greater Yellowstone Ecosystem. Pages 38-40 *in* C.C. Schwartz, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: Annual report of the Interagency Grizzly Bear Study Team, 2009. US Geological Survey, Bozeman, Montana.

Gunther, K.A., T. Wyman, T. Coleman, A. Tallian, A. Bramblett, and S. Gunther. 2010. Bear management office administrative annual report for calendar year 2009. National Park Service, Yellowstone Center for Resources. Yellowstone National Park, Wyoming.

Gunther, K.A., T.M. Koel, P. Perrotti, and E. Reinertson. 2010. Spawning cutthroat trout. Pages 27-29 *in* C.C. Schwartz, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2009. US Geological Survey, Bozeman, Montana.

Gunther, K.A. 2010. Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area: 2009 tasks and accomplishments. Bear management office administrative report. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming.

Heasler, H.P., D. Mahony, and C. Jaworowski. 2010. Site visit to the proposed Xanterra food service chiller pad, Old Faithful Inn area, Yellowstone National Park. Geology program internal report. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming.

Heasler, H.P. and C. Jaworowski. 2010. Geologic observations of the Old Faithful kitchen renovation project, 3 May 2010. Geology program internal report. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming.

Heasler, H.P. and C. Jaworowski. 2010. Hydrothermal areas along the Norris to Golden Gate Road, Yellowstone National Park. Geology program internal report. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming.

Heasler, H.P., C. Jaworowski, and L. Bueter. 2010. Visual assessment of Old Faithful eruption heights. Geology program internal report. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming.

Jaworowski, C. and H.P. Heasler. 2010. Geology along the proposed routes of the Qwest Data line, Mammoth Hot Springs. Geology program internal report. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming.

Jaworowski, C., C. Feeney, S. Agopian, and L. Harriman. Using aerial photographs to document changing water levels in Floating Island, Lacomb, and Little Trumpeter lakes, Yellowstone National Park, Wyoming. Report presented at the 10th Biennial Science Conference, October 11–13, 2010, Mammoth Hot Springs, Yellowstone National Park, Wyoming.

Koel, T.M., J.L. Arnold, and P.E. Bigelow. 2010. Yellowstone Fisheries & Aquatic Sciences: Annual report, 2008. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming, YCR-2010-03.

Podruzny S., K..A. Gunther, and T. Wyman. 2010. Spring ungulate availability and use by grizzly bears in Yellowstone National Park. Pages 24-26 *in* C.C. Schwartz, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2009. US Geological Survey, Bozeman, Montana.

Schullery, P. 2010. Nature and Culture at Fishing Bridge: A History of the Fishing Bridge Development in Yellowstone National Park. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming, YCR-2010-02.

Smith, D.W., D.R. Stahler, E. Albers, R. McIntyre, M. Metz, K. Cassidy, J. Irving, R. Raymond, H. Zaranek, C. Anton, and N. Bowersock. 2010. Yellowstone Wolf Project: Annual report, 2009. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming, YCR-2010-06.

White, P.J. 2010. Yellowstone's Wildlife in Transition: An assessment of ecological process management. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming, YCR-2010-08.

Yellowstone Volcano Observatory. 2010. Protocols for geologic hazards response by the Yellowstone Volcano Observatory. US Geological Survey Circular 1351. [http://pubs.usgs.gov/circ/1351/].

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Yellowstone Center for Resources

National Park Service
Yellowstone National Park, Wyoming

YCR-2011-09