YELLOWSTONE
CENTER FOR RESOURCES

2007 ANNUAL REPORT

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Yellowstone Center for Resources
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Cover photos: clockwise from left, a natural winter soundscape (NPS/Shan Burson); Clepsydra geyser in the Fountain Paint Pots area (NPS/Shan Burson); dwarf purple monkeyflower (*Mimulus nanus*) (NPS/Jennifer Whipple); results of a fen study became available in 2007 (Joanna Lemly photo).

Contents

Upper Blacktail cabin.

Introduction iv

Part I: Cultural Resource Programs
- Archeology 1
- Archives, Library, and Museum Collections 3
- Ethnography 6
- Historic Road Rehabilitation 7
- Historic Structures 10
- Yellowstone History 13

Part II: Natural Resource Programs
- Air Quality 15
- Water Quality 16
- Aquatic Resources 18
- Geology 22
- Vegetation 23
- Wildlife 28
  - Bears 28
  - Ungulates 31
  - Wolves 32
  - Other Wildlife Issues 36

Part III: Professional Support Programs
- Spatial Analysis Center 39
- Research Permit Office 41
- Benefits-Sharing EIS 42
- Resource Information Team 42
- Funding and Personnel 44

Appendix I: Personnel Roster, 2007 49

Appendix II: Publications, Reports, and Papers 53

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.

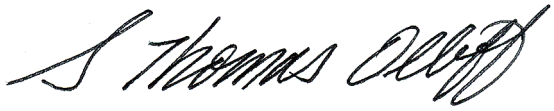
During 2007, the Core Operations Analysis culminated in two new branches, Compliance and Resource Operations, being added to the YCR. We will begin to report on their programs and activities in the 2008 annual report. After much hard work, the Servicewide Benefits-Sharing Draft Environmental Impact Statement was completed and released for public comment; 9,600 comments were received, responses were developed, and the final was ready for internal review by the end of the year.

Almost 2,500 people used the Heritage and Research Center in 2007. Six new archeological sites were discovered during a survey of park land near Gardiner, Montana, and work continued on developing information about the Nez Perce National Historic Trail and the Bannock Trail. As park of historic road rehabilitation projects, private and federal funds were combined to include rehabilitation of the historic Artist Point viewing area in the redesign of the parking area.

In 2007, the U.S. Fish and Wildlife Service removed the Greater Yellowstone Ecosystem grizzly bear from the list of threatened species under the Endangered Species Act. More than 75,000 lake trout were removed from Yellowstone Lake, bringing the total number removed since 1994 to more than 270,000. Three new non-native plant species were discovered in the park. The late summer bison population numbered 4,700, and 171 wolves occupied the park.

The YCR's partnerships and agreements with other federal and state agencies, academia, and public organizations continued to be critical to our successes in stewardship. The YCR also continued to benefit from the hard work of many volunteers and cooperators. Research Permit Office (RPO) staff authorized almost 200 research permits to investigators from across the U.S. and foreign countries.

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



Tom Olliff
Chief, Yellowstone Center for Resources

PART I

Cultural Resource Programs

Upper Blacktail barn prior to stabilization.

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

- Archeology
- Archives, Library, and Museum Collections
- Ethnography
- Historic Road Rehabilitation
- Historic Structures
- Yellowstone History

Archeology

Archeology in Yellowstone National Park (YNP) is critical to understanding the precontact and historical record of the Greater Yellowstone Area. By studying the types of stone that were used and discarded, staff can track the early human residents as they lived and traveled in the park and beyond it. Because the intensity of use varies through time as environmental conditions become more or less favorable, the archeological sites and their contents also provide a means for interdisciplinary investigations of past climate and biotic change.

Other Inventories

Prior to Fuel Reductions. The Office of the Wyoming State Archaeologist, affiliated with the University of Wyoming, conducted a sample inventory of 1,200 acres around Abiathar Mountain near the Northeast Entrance in preparation for future hazard fuel reduction. The inventoried acres were selected based on slope and vegetation cover. No new prehistoric sites were located, probably because of the steepness of the terrain and the lack of water. The most important find was a pristine section of the Cooke City Miners' Road.

In connection with the Wildland-Urban Interface program, archeological inventories were also carried out at Old Faithful and Daly Creek with negative results.

Yellowstone and Madison Rivers. Two archeological inventory reports covering the area along the Yellowstone River between Fishing Bridge and Gardiner, Montana, and a third report on the south bank of the Madison River were completed. Archeological sites near populated areas seem to be subject to unauthorized artifact collection as they contain fewer tools than are expected.

Road Reconstruction. In preparation for road reconstruction, shovel tests and test excavation units were conducted at two sites. Several areas with buried concentrations of cultural material were excavated north of the Norris campground, one of them near a thermally active area, providing evidence of precontact use. Based on current findings, it appears that the cultural concentrations can be avoided during road reconstruction. At the second site, obsidian flake debris were investigated. Ratios of the flake size, count, and weight will be used in a statistical analysis of the specific stages of stone tool manufacture. The thick growth of lodgepole pine in the area, which burned in 1988, has impacted the discrete deposits of flake debris.

More than 11 additional historic sites were recorded during a block survey of approximately 700 acres within the primary and secondary road corridors in the Old Faithful area. Test excavations were conducted in the area where the first military cabins were constructed, but a sewer system installed in the 1960s mixed buried cultural deposits. An intact area on Wylie Hill at the location of the original Wylie tent camp was recorded. Remnants

University of Montana field school participants.

of the auto camp at Old Faithful remain visible even though the camp was removed in the late 1960s and natural vegetation returned.

Montana-Yellowstone Archeological Project

The Montana-Yellowstone Archeological Project (MYAP) is an archeological and cultural resource management collaboration between the University of Montana and YNP. The 2007 field school was funded largely by the Rocky Mountains Cooperative Ecosystem Studies Unit (CESU) with supplemental funds from the University of Montana. While providing training for 11 University of Montana students, the MYAP team completed the first year of a two-year survey of 700 acres of park land near Gardiner to ensure that a proposed native plant restoration effort does not impact archeological resources. The MYAP team fulfilled the primary objective, which was to verify the location of the former Cinnabar railroad station, the train stop used by park visitors from 1883 until 1903, when it was largely abandoned because Northern Pacific had extended its rail line to Gardiner. Testing a line of river cobbles led to a 5-foot-deep mortared river cobble foundation, presumably for the Cinnabar Hotel or some other large building. The MYAP team excavated the corner of the foundation and the entry way to another building. Artifacts pulled from the excavations included a Northern Pacific rail sign, revolver bullets, newspaper fragments, and the sole of a cowboy boot.

The MYAP team documented 14 archeological sites during the survey, including 8 that had previously been recorded and 6 that were new; 6 sites contained evidence of both prehistoric and historical occupations. Five hearths that were eroding out of the banks of the Yellowstone River downstream of Cinnabar were salvaged and a radiocarbon date of 1670 B.P. was obtained. The hearths are similar to others in adjacent areas and suggest intensive use during that time.

Nez Perce National Historic Trail

With funding provided by the Yellowstone Park Foundation, work continued to analyze and prepare a report on the 2006 inventory of selected areas of the Nez Perce National Historic Trail (see Ethnography section).

Volunteer Support

The assistance of a very capable group of volunteers was essential in carrying out the archeology program's day-to-day summer activities. In the field, they relocated previously documented sites and carried out condition assessments. In the lab, they prepared site maps, cataloged artifacts, printed site photographs, and prepared manuscripts for printing. Long term volunteer John Reynolds organized and led the team of Marjorie Siegel and Allan Hard from Virginia, Robin Szamuhel from Canada, and Stanford Intern Brendan Selby. Volunteer Mary Meagher again facilitated backcountry site and cabin assessments by horseback. We are indebted to corral operations and everyone else who loaned the horses and/or trailers needed for this work. Volunteer Bob Flather continued to conduct field and archival research on backcountry cabins, the Cooke City Miners' Road, and early historic use of the Lower Geyser Basin.

Archives, Library, and Museum Collections

Yellowstone National Park's archives, library, and museum collections comprise more than 5.3 million items that document the cultural and natural history of the park, making them the second largest group of collections in the National Park Service (NPS). 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 nearly 3,000 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, 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. Because of this affiliation, the park retains permanent federal records on-site rather than transferring them to NARA facilities. In addition to federal records, the archives includes donated historical records and collections, records of park concessioners, and an extensive oral history collection. The archives and museum collections are heavily used by park staff and outside researchers studying all aspects of park history.

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 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 Database (WYLD) of the Wyoming Library Consortium.

Elderhostel Service Program volunteers assisting with separating and rehousing the map collections.

Collection Conservation

Through the generosity of donors to the Yellowstone Association and Yellowstone Park Foundation, staff were able to improve storage conditions for a variety of materials. They procured additional flat file cabinets for the proper storage of the large archives and library map collections, as well as a special cabinet and wall-mounted cantilevered rack to store oversized rolled maps and documents. The library contracted with Shaffner's Bindery in Missoula to bind 47 theses and dissertations, 17 books, and 23 journals.

The major preventive conservation project in 2007 involved the cleaning of approximately 20 wolf skulls. They had initially been treated with dermestid beetles, which are often used to remove soft tissue from skeletons, but the skulls still had some flesh in hard to reach crevices, creating an insect problem

Greg McDonald, NPS senior curator of natural history, Sue Ware of the Denver Museum of Natural History, and HRC staff with cleaned wolf skulls.

in the storage cabinet. Some of the skulls were from the wolves relocated to the park in 1995 and 1996 and their offspring. Greg McDonald, NPS senior curator for natural history, and Sue Ware, from the Denver Museum of Natural History, spent a week training staff on how to remove the flesh without damaging the bone material and assisted in extracting teeth from certain skulls needed by researchers with the Wolf Project.

Assisting Researchers

Staff served 296 on-site research visits to the archives during 2007 (a 15% increase from 2006) and responded to 267 telephone, email, and written research requests. Of those visits, 192 were NPS employees (a 39% increase from 2006). The librarians assisted 546 researchers and answered 135 reference questions by telephone and email. Museum staff assisted approximately 100 researchers with historical photographs and other collection requests, which resulted in the scanning of over 220 images. Staff also provided continuing assistance to researchers from Ken Burns's Florentine Films for the upcoming documentary on the National Park Service.

Internships and Volunteer Support

While the summer internship program with Montana State University (MSU) and Stanford University completed its third year of operation, staff worked with MSU faculty to develop a winter internship program. One MSU intern (Ramona Williams) completed almost 370 hours of project work by cataloging part of the park's large backlog as well as planning, researching, and installing an exhibit on "The Grand Loop in the Early Years" for the main lobby of the Heritage and Research Center (HRC). This exhibit chronicled what it was like to tour the park before automobiles were allowed entry. Six interns completed a total of 2,240 hours of project work with the history, museum, archeology, and ethnography programs. Interns working with the museum program, Alicia Murphy from MSU and Carla Pugliese from Stanford, cataloged and rehoused artifacts as well as planned and installed two temporary exhibits on the HRC upper floor: "Yellowstone's First Naturalist: Milton P. Skinner" and "Edmund Sawyer and the Art of Interpretation."

Thirteen volunteers contributed 2,350 hours (over 1.0 FTE) to archives, library, and museum projects in 2007. Jay Antle returned to complete the inventory of 150 linear feet of 1988 fire records which he had begun in 2006, and which will enable staff to catalog this collection and make it more accessible to researchers. Karen Reinhart aided the librarians by staffing the reference desk and creating a list of periodical titles. Keith and Cheryl Chamberlain spent a month staffing the HRC information desk as well as assisting with the microfiche/scrapbook project, creating original catalog records for newspaper clippings, and participating in the 100% inventory of museum collections. Rosalind Beckmann staffed the HRC information desk for the entire summer and worked on the library vertical files. In addition to helping the park archeologist with research projects, Robert Flather inventoried

A case in the 2007 HRC lobby exhibit, "The Grand Loop in the Early Years," created by MSU intern Ramona Williams.

postcards for the museum collection and assisted the staff with inventorying maps in the library and archives collections.

Staff hosted Elderhostel Service Programs for the first time in 2007. Arranged through the University of Montana–Western, two sessions were held, in February and May, each with 25 participants who provided a total of almost 1,200 hours of volunteer assistance on much needed projects. The archives, library, and museum staff divided each group into smaller groups that worked on inventories, separating maps, rehousing archival items and library vertical files, making new labels, and cleaning the historic vehicle collection.

Elderhostel Service Program volunteers rehousing archives documents and creating new labels for Army ledgers.

Database on Former Employees

The most frequently asked reference question in the archives and library is for information about former NPS and concessioner employees. Staff are using an Access database developed by Roger Whiteside of Computer Support Services to compile information such as payroll records, personnel rosters, staff listings, and organizational charts. Volunteers continued to enter the names of thousands of former employees and where they worked in the park, bringing the total records created to about 8,000. This database is proving to be a very useful tool for assisting genealogical research.

Assistance to Other Divisions and Parks

Almost 2,500 people used the HRC during 2007 for public and special tours, meetings in the conference rooms, appointments with collections personnel, library patronage, and visitor use. About 400 people participated in the public tours of the facility that were offered twice a week from May 29 to September 6 and helped raise public awareness of the HRC and its mission.

Long-time volunteer Bob Flather and Chief of the Branch of Cultural Resources Ann Johnson look over historic documents and images.

The librarians created a bookmobile system in 2006 to give more park volunteers and NPS and Yellowstone Association employees in the park's interior access to a lending library and other library services without having to come to the HRC. In 2007, staff expanded the operation to three additional stops within the park and began it earlier in the year. Bookmobile circulation increased 12.5% during the summer.

Museum staff continued to assist the Division of Interpretation with exhibit planning for the new Old Faithful Visitor Education Center as well as with providing images for wayside exhibits.

Noteworthy Accessions

Museum. Accessions in 2007 included a circa 1920s dress made out of Yellowstone Cigar ribbons, a collection of rare Yellowstone books, early souvenirs and stereoviews donated by photographer Tom Murphy, and the papers of former Superintendent Lemuel (Lon) Garrison donated by his family. Garrison was instrumental in the Mission 66 planning in Yellowstone and throughout the NPS. Through the Yellowstone Park Foundation, staff were able to purchase eight rare stereoviews of the park by H.B. Calfee (Bozeman) and Bundy & Train (Helena).

Archives. The retirement of park ornithologist Terry McEneaney resulted in the transfer of 20 linear feet of his records to the archives. The Winter Use Planning Office transferred 10 linear feet of records and YCR sent 3.5 linear feet of ungulate surveys from the 1970s to the 1990s. Marian Albright Schenck, Horace Albright's daughter, donated 50 of his personal maps containing handwritten notations. None of these records had been processed by the end of the year.

Library. Through the Yellowstone Association, the library purchased 110 items for the collection as well as 25 theses/dissertations in order to enhance that scholarly collection. The library also received special funds from Scott and Carolyn Heppel, through the Yellowstone Park Foundation, to purchase rare books, including *Three Thousand Miles through the Rocky Mountains* (1869) by Alexander Kelly McClure and *Locating the Iron Trail* (1925) by Edward Gillette.

Ethnography

The goals of the Ethnography Program are to develop the programs, guidelines, and information needed to help management identify and protect culturally significant resources of peoples traditionally associated with the park, and to support relationships between the park and the peoples whose customary ways of life may be affected by park activities.

Ethnographic Resources Inventory

The Ethnographic Resources Inventory (ERI) is the National Park Service database that stores information about tribally significant natural and cultural resources, also referred to as "ethnographic resources." These resources have been identified by park-associated tribes as having continuing significance based on their historical associations with the park. Ethnographic resources can include wildlife, hydrothermal features, and plants as well as archeological sites.

Yellowstone National Park is one of the pilot program sites for the ERI. Through Greater Yellowstone Coordinating Committee (GYCC) funding and in agreement with two national forests (Bridger-Teton and Shoshone), two national parks (Grand Teton and Yellowstone), and the National Elk Refuge (U.S. Fish and Wildlife Service), the ERI at Yellowstone has become the repository for information about ethnographic resources in the Greater Yellowstone Area (GYA). The database currently contains 1,073 resource entries, mostly natural resources. Database fields include resource description, location, explanation of cultural significance and uses, and the source of the information. Resource information contained in the database is used in park planning, resource management, and visitor education.

Thanks to the GYCC infusion of funds, the Ethnography Program was able to contract for research to identify the significance of the GYCC's priority resources to seven tribes who have been named in U.S. treaties as having aboriginal association with the GYA (the Blackfeet, Crow, Eastern Shoshone, Gros Ventre, Nez Perce, Salish, and Shoshone-Bannock). The GYCC priority resources include watersheds, aquatic ecosystems, whitebark pine, cutthroat trout, and species that are considered threatened or endangered (trumpeter swans, wolverines, bears, moose, lynx, and eagles). Information was gleaned from ethnographies conducted by nineteenth and twentieth century anthropologists while working among the tribes mentioned.

Now that the voluminous information has been collected, it is being entered into the ERI by student interns and volunteers. The data entry is expected to be complete by summer's end 2008. Information in the ERI, which can be used by any GYA jurisdiction in their environmental planning, has already been helpful in preparing the *Final Bison and Elk Management Plan/Environmental Impact Statement* for Grand Teton National Park and the National Elk Refuge.

Nez Perce National Historic Trail

The 1,170-mile route taken by the Nez Perce as they fled from the U.S. Army toward Canada in 1877, now designated the Nez Perce National Historic Trail (NPNHT), includes a segment in Yellowstone National Park. It is the only Congressionally-designated, nationally significant resource in Yellowstone National Park. The Ethnography Program is working with the Division of Interpretation and three tribes (the Joseph Band of the Confederated Tribes of the Colville Indian Reservation, Confederated Tribes of the Umatilla Indian Reservation, and Nez Perce Tribe) to develop

information for visitors about the trail. With funding from the NPNHT Administration of the USDA Forest Service, the Ethnography Program hired a University of Montana graduate student in cultural anthropology to enter what is known about the Yellowstone segment of the trail—including oral histories, historical documents, other archival finds, and information from last year's National Endowment for the Humanities scholars' meeting—into a software database that has already been used by interpreters in preparing presentations on the 1877 Nez Perce War. In 2008, the database will be used to begin writing content for the park's website and materials for upgrading the roadside exhibit near Nez Perce Creek.

Bannock Trail

In response to a request from the Shoshone-Bannock Tribes, ethnography staff were given the responsibility for compiling information on what is known as the "Bannock Trail" in the park. The Shoshone-Bannock are working with their Congressional delegation to establish the Bannock Trail through the park as a "national historic trail." This status does not require that intact segments of the trail be located, only that a historic corridor be identified. The process for such a designation can take up to 10 years.

The trail is named on two historical maps, in other archival documents, and in the oral tradition of the Bannock, but no physical evidence of the trail has been found and no comprehensive archeological inventory has been undertaken. The Ethnography Program received a $10,000 CESU grant to synthesize the archeological, historical, and ethnographic research that has been done on the Bannock Trail to identify gaps in the data and make recommendations on management options.

With funding from the Yellowstone Association, the Ethnography Program started collecting oral histories from Shoshone-Bannock elders to document their perspectives on trails in the park used by their tribes.

Volunteer Support

Work in the Ethnography Program could not have been accomplished without the able assistance of student interns and other volunteers. Full-time staff Rosemary Sucec and Katie White wish to gratefully acknowledge the numerous hours donated by student interns from Columbia University (Amy Johnson), Stanford University (Aimee Miles and Andrea Runyon), and the University of Montana (Sarah Parker). Adrienne DeSmet and Barbara Read also provided generous volunteer support.

Katie White interviewed Ramona Walema and Charley-Plenty Wounds about the Bannock Trail. The other Bannock speaker is Ralph Burnes, of the Northern Paiute at Pyramid Lake, Nevada.

Historic Road Rehabilitation

Yellowstone National Parks historic roads are a nationally significant example of early public road construction. Cultural Resources staff make every effort to insure that rehabilitation of these roads retains their integrity of materials, workmanship, feeling, and association through the use of natural materials and a design philosophy that calls for preservation of historical curves and blending with the natural landscape.

The park's long-range (20- to 30-year) program of principal road system improvements is covered under a Programmatic Agreement (PA) that meets the Section 106 requirements of the National Historic Preservation Act, as amended. The PA has been in effect since January 1993, when it was signed by the National Park Service (NPS), the Advisory Council on Historic Preservation, and the Wyoming and Montana state historic preservation officers.

Beartooth Highway National Register Nomination

Considered one of the most scenic high altitude roads in the West, the Beartooth Highway extends roughly 60 miles from the park's Northeast Entrance in Montana through Wyoming to the Rock Creek drainage, south of Red Lodge, Montana. The first and most substantial road to be constructed under the 1931 Park Approaches Act, aspects of its engineering reflect road-building standards of the 1930s. The collaboration of the Bureau of Public Roads, precursor to the Federal Highway Administration (FHWA), with the NPS and the U.S. Forest Service continues with a 2003 Memorandum of Agreement (MOA) that provides measures to mitigate adverse effects of the reconstruction planned for the Beartooth Highway. The FHWA contracted the research and preparation of the draft National Register (NR) nomination to allow Yellowstone National Park to initiate the NR review process on behalf of the Beartooth Highway's owners and managers.

History of the Fishing Bridge Area

The NPS and the FHWA continued plans for reconstructing the remaining segment of the East Entrance Road, proceeding eastward from the Fishing Bridge to the reconstructed portion of the road past Pelican Creek. The Fishing Bridge Historic District is geophysically complex as well as culturally, historically, and ecologically significant due to the thermal activity under and around Yellowstone Lake. The area possesses evidence of intermittent human occupation for more than 10,000 years.

Phasing Out Material Extraction at Sylvan Pass

Extraction of rock material from the Sylvan Pass talus slopes needed for road construction projects in the park began more than 15 years ago in order to reduce both the cost of road construction and the impact on the roads from hauling the material into the park from outside sources. The extraction, crushing, and gravel washing operations have been monitored to determine if they were causing any degradation of the area's natural qualities. Although natural events such as intense precipitation and spring snow melt cause the transport of fine materials into the underground water flows, in 2004 it was found that the gravel washing activities were augmenting this process and causing turbidity in Middle Creek, a tributary of the North Fork of the Shoshone River, and in Mammoth Crystal Springs in the Middle Creek drainage. The gravel washing operations were therefore relocated and restrictions were placed on crushing and waste storage at Sylvan Pass.

Further investigation into the extraction and gravel crushing operations at Sylvan Pass found that the Pleistocene-age permafrost beneath the surface talus was being exposed by the removal of materials and subsequently melting. The permafrost's presence was known when the extraction operations began at Sylvan Pass, but it was not considered a "resource of concern" at that time. The NPS now considers the permafrost a non-renewable natural resource that it will preserve when possible. The NPS is therefore phasing out the material extraction of the Sylvan Pass talus slopes and seeking outside sources for the materials necessary for road projects. Material already extracted from Sylvan Pass will be transported to a new staging and stockpile area north of Fishing Bridge in an area previously impacted by sewage treatment settling ponds. Plans for the restoration and remediation of the Sylvan Pass material source area are underway and will be incorporated into the road reconstruction work.

Road Reconstruction Progress

Sylvan Pass to East Entrance Road. The final inspection of the Sylvan Pass to East Entrance reconstructed road segment was conducted by the NPS, the FHWA, and H-K Contractors, Inc., on October 4, 2007. H-K Contractors, which has completed several other road reconstruction projects in the park, said that this was the most difficult and nerve-wracking. The terrain is some of the steepest in the park, requiring both cut and fill side retaining walls to decrease the impact on steep slopes. Landslides during two construction seasons resulted in the loss of a major historic culvert, requiring additional effort and expense to replace it as quickly and aesthetically as possible. Major forest fires closed the road intermittently and caused smoky working conditions. The problems at the Sylvan Pass material extraction area, grizzly bear issues, and efforts necessary to prevent the contamination of pristine waters with mud snails and whirling disease caused further complications.The natural curvature and

dramatic vertical alignment of the road corridor was retained with the widening and reconstruction work. Natural-looking rockery walls were constructed at various locations using boulders from the road cuts to match the existing rock faces. Micro-blasting techniques were used to bring down the rock where necessary to widen the road, giving the newly exposed rock a more natural look. Crenulated masonry guardwalls were constructed on the eastern end of the road segment to provide continuity with similar guardwalls on the western end. Three parking areas were added to the road corridor to provide safe views of two dramatic watercourses and of the historic Corkscrew Bridge along the bottom of Middle Creek drainage. Existing historical masonry retaining walls were repaired in-kind and a masonry guardwall was added to the top of the modern metal bin wall on the fill side of the road, enhancing the road's historical character.

A new masonry guardwall on the East Entrance Road.

Artist Point Viewing Area and Parking Lot. The NPS was able to combine private funds donated to the Yellowstone Park Foundation with funds from federal transportation legislation to include rehabilitation of the historic Artist Point viewing area in the redesign of the modern Artist Point parking area which is part of the resurfacing, restoration, and rehabilitation of the North and South Rim drives. Field analysis of boulders from various locations was conducted to ensure that the new stone features match the color, size, and shape of the historical boulders at Artist Point.

A rockery wall was constructed to abate sloughing of the thermally altered soils on the north side of the parking area. The plaster-finished concrete retaining wall on the south side of the parking area was sand blasted to remove the failing plaster finish and provide visual continuity with the concrete curbing. The parking area was raised, partially bury-

Constructing new stone seating on the promenade to Artist Point.

Constructing a rockery wall in the Artist Point parking area.

ing the concrete wall to make it less obtrusive. Three large drain systems were installed to improve the drainage under the parking area while establishing some "green" areas in the previously all-asphalt surface. Both the upper and lower viewing platforms at Artist Point were rehabilitated. Erosion of thermally altered soils was repaired using a mixture of native soils and cement stabilizer. The parking area and the viewing area received the first lift of asphalt before snow shut down construction for the season.

North Rim Drive. To get as much work done as possible in the camper services area after the fall closure so that it could open on schedule in the late spring of 2008, a dump station for recreational vehicles (RV) was roughed in and grading was completed for construction of an RV parking area near the campground registration building.

The Madison to Norris Road. Some patchy repairs were made after the massive retaining walls separated from the road and began tilting as a result of the 1959 earthquake, but poor drainage, erosion, and vehicle strikes contributed to further damage. In 2007 a geotechnical survey was conducted to evaluate the extent and nature of the extensive repairs that will be needed to stabilize the historic masonry walls in the Gibbon Falls area and preserve the historic character of the roadside feature. The designs for the new bridge to be constructed north of Gibbon Falls are nearly complete. Plans for the repair of Beryl Springs Bridge are, for the most part, in-kind. Archival research was conducted to better understand the process of constructing the wood structure over a thermally active area after damage to the road from the 1959 earthquake. The bridge was documented and a request for concurrence with the NPS's determination of NR eligibility was sent to the Wyoming State Historic Preservation Officer.

Lamar River Bridge. Recent assessments of the Lamar River Bridge, for which the concrete piers were repaired in the 1970s, found the bridge deck to be failing. In 2007 an extensive engineering analysis assessed the elements in need of reconstruction, and preparations for drafting an environmental assessment began.

Canyon to Tower Reconstruction. The design process continued for the second half of the reconstruction of the road from Chittenden Road up Mount Washburn to Tower Junction, which is planned for 2010. Road design challenges include the massive slumping of the landform under Overhanging Cliff, causing cracks in the roadway and the historic retaining walls; the raveling retaining wall associated with the historic bridge over Tower Creek; limited space for the road corridor between rock formations, historic features, and specimen trees; thermally altered slopes; the proximity to Antelope Creek; changes in the overall plan for the Tower Falls store area; and redesign of the Calcite Springs parking area.

Golden Gate to Norris Reconstruction. Resource identification and initial road designs are being developed to assess the potential impacts of reconstructing this road segment. Before drafting the environmental assessment begins, assessment of adverse effects may be required for a possible reroute of the roadway around Frying Pan Springs. Although this road corridor traverses relatively flat terrain, it is an area rich with historical and precontact cultural resources and significant natural resource concerns.

Historic Structures

In addition to providing facilities for visitor use and park management, many Yellowstone structures have historical, architectural, and/or engineering significance. The park's National Register designated Historic Districts include the Grand Loop Road, Lake Fish Hatchery, and Lamar Buffalo Ranch. Also on the National Register of Historic Places are the Lake Hotel, Queen's Laundry Bath House in the Lower Geyser Basin, Post Office in Mammoth Hot Springs, and six National Historic Landmarks: Fort Yellowstone and five influential examples of park "rustic" architecture—the Old Faithful Inn, Northeast Entrance Station, and Norris, Madison, and Fishing Bridge museums.

List of Classified Structures Survey

With the help of the regional coordinator of the List of Classified Structures (LCS) Program and his staff, the park's historic architect surveyed the National Park Service (NPS) and concession buildings in the Roosevelt Historic District and the Lake area for the first time since 2002. They found that the number of buildings in the Lake area in poor condition had been reduced significantly, primarily because of work completed on guest cabins at Lake

The Lake Fish Hatchery log column rot.

The Lake Fish Hatchery was surveyed for a Historic Structure Report on the building.

Hotel and Lake Lodge, where fire-resistant wood shingle roofs were constructed on the "logs out" cabins. The historic architect assessed the condition of the Heart Lake patrol cabin and barn and the Pelican Cone Lookout to update the LCS database. The LCS active database now includes 953 buildings, roads, and bridges, utility structures, grave markers, and other constructed features in Yellowstone.

Work under the Historic Structures Strategic Plan began with the initiation of Historic Structure Reports on up to 17 park buildings through a Cooperative Agreement with the Montana Preservation Alliance and with the assistance of the park historian.

Tauck Volunteer Program

Sponsored by Tauck World Discovery and the Tauck Foundation, the Tauck World Discovery Guest Volunteer Program began its fifth year of operation in May 2007. Groups were able to work in the Norris area for the first time this year, part of an effort to include sites farther from Old Faithful where the program headquarters are located. The combined value of the 2,766 hours of work completed by 1,903 volunteers, the donated and paid hours of the Tauck Volunteer Coordinator, Bruce Fladmark, and his assistant Dave Holmstrom, and a cash contribution of $25,000 from Tauck came to approximately $88,000 for maintaining visitor and operational facilities in 2007. The cumulative effect has been enormous. Although it may be difficult to remember

The Madison Museum is a National Historic Landmark and an example of park "rustic" architecture.

what the areas around Lake and Old Faithful were like prior to the onset of this program, the work that these volunteers have accomplished since 2003 can be seen in clean picnic areas, stained sitrails, stained buildings, cleaned up parking lots, and stabilized structures. The Tauck Volunteer Coordinator also assisted with work on the Norris Bookstore by the Michigan Volunteers and an Elderhostel group that stained the building after the construction work was completed.

Review and Compliance

The Historic Structures Program was assigned the task of handling all Section 106 compliance for the Concessions Management Division. This has resulted in a close working relationship with the major concessioners in the park, including Xanterra Parks and Resorts, Inc., and Delaware North Corporation, along with the Yellowstone Park Service Station concessioner.

During 2007, the historic architect worked with Maintenance to obtain concurrence from the Wyoming State Historic Preservation Officer on an innovative reroofing project for Building 70 in the Mammoth Hot Springs Historic District. The historic architect also assisted with Section 106 compliance on the revised construction drawings for the Old Faithful Visitor Education Center. Concessions projects included rehabilitation of the Old Faithful Lodge and the Mammoth Hot Springs Hotel cabins, planning a major structural and cosmetic upgrade of the Lake Hotel, reroofing Lake Lodge cabins, the Old Faithful upper and lower Stores, and planning rehabilitation of the Tower Falls and the Lake general stores.

Historic Structures Projects and Plans

In the winter of 2006–07, the Carpenter Shop added a staircase to access the attic space, eliminating the safety hazard posed by a folding staircase that had led to several employee injuries over the years. Restoration of the stonework foundation on the east elevation has been entered into the Historic Structures Stabilization program funding requests for a future year.

The Norris Bookstore, which is part of the Norris Trailside Museum National Historic Landmark, had severely deteriorated barge logs directly over the public entrance, rotted eight-inch diameter rafters on the west elevation, along with the three purlin crowns on the south elevation, and deteriorated log crowns on the corners that projected outward from

A deteriorated purlin crown on the Norris Bookstore.

Michigan Volunteers team (above) worked with an NPS master craftsman to stabilize the Norris Bookstore.

the building. Al Williams, a master craftsman from the Western Heritage Center in Grand Teton National Park came to guide and assist the Michigan Volunteers team that did the work. The volunteers also rebuilt the buck and rail fence that skirts one of the small geysers adjacent to the store. They completed the work flawlessly in about eight days, without injury to anyone, for slightly less than $8,000. The project clearly demonstrated a new method of safely using skilled and semi-skilled volunteers with NPS master craftsmen for outstanding cost savings.

The Upper Blacktail barn and cabin with new roofs.

The ongoing stabilization of the Mail Carrier's House in the Mammoth Hot Springs Historic District was contracted through the Montana Preservation Alliance to complete the work begun by the Virginia City Historic Preservation Team. A reinforced concrete foundation was poured under the house and the two additions, and a new fire-retardant treated wood shingle roof was installed. This work on the Mail Carrier's House and the stabilization of the Upper Blacktail Patrol cabin and barn brought structures on the brink of ruin back to being in good usable condition and preserving the cultural heritage of the park.

Yellowstone History

The park historian completed the researching and writing of histories of the Lake Area for the Lake Charette, the Haynes Picture Shop (later the

The work on the Mail Carrier's House helps to preserve the park's cultural heritage.

Log wall stabilization in the front room of the Mail Carrier's House.

Hamilton Nature Store) in Mammoth, the West Entrance road, and the Fort Yellowstone Jail. He shepherded to publication articles on Moran Point and Artist Point (*Yellowstone Science*) and, for *Montana: the Magazine of Western History,* on the Nez Perces in Yellowstone and on Larry Matthews, an early park concessioner.

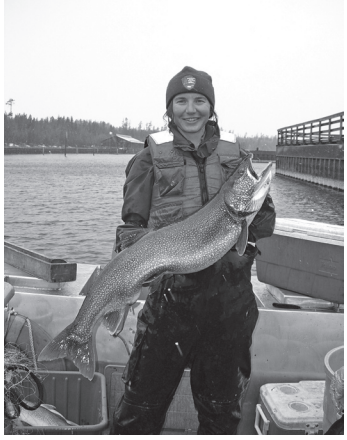
He hosted and oversaw three interns from Montana State University (J. J. Hill, Michael Barton, and Jakob Nakonechny) each of whom spent a semester reading and summarizing dozens of newspaper and other published historic accounts of trips to Yellowstone for a large, ongoing database that is used constantly in the history program. Barton also produced a paper on the early hell-heaven comparisons in Yellowstone, and Nakonechny a paper on the life of Collins John "Yellowstone Jack" Baronett. The historian supervised the work of VIPs Mary Anne Bellingham and Tom Carter. Bellingham is summarizing dozens of historical magazine, newspaper, and diary accounts for a computer database and working with Carter on a history of Yellowstone backcountry trails for which Carter is preparing an article for *Yellowstone Science*.

Working with Ann Rodman and Paul Schullery on the *Atlas of Yellowstone National Park* project that is being spearheaded by the University of Oregon, the historian wrote the section on place names, reviewed the exploration portion, and helped in selecting and writing text for the historical maps.

The historian spoke to nine different groups about Yellowstone and its history, including two classes on the northern roadside history and the military history of Yellowstone, and assisted many researchers in the library. For the park's museum collection, he helped acquire an 1899 scrapbook of a trip to Yellowstone that contains about 100 photographs as well as 13 rare stereopticon views of the park by photographer T. W. Ingersoll.

PART II

Natural Resource Programs



NPS fisheries technician Stacey Sigler with a lake trout from Yellowstone Lake.

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

- Air Quality
- Water Quality
- Aquatic Resources
- Geology
- Vegetation
- Wildlife

Air Quality

Air Quality Monitoring

Yellowstone participates in a nationwide interagency air quality monitoring network designed to determine levels of air pollutants, trends in air quality, and compliance with National Ambient Air Quality Standards. YCR staff collect samples and data on atmospheric deposition and wet (acid rain) and dry atmospheric deposition at Tower Ranger Station, visibility (fine particulates, $PM_{2.5}$) and gaseous pollutants (ozone and sulfur dioxides) at the Lake water tank, and carbon monoxide and fine particulates at Old Faithful and at the West Entrance. The samples and raw data are sent to various national programs for analysis.

The NPS Air Quality Division's 2006 Annual Performance and Progress Report (available at www2.nature.nps.gov/air), which presented data collected from 1996 to 2005, noted that no measured Clean Air Act standards were exceeded in Yellowstone; the park's air quality, including visibility, is generally considered excellent. There was a statistically significant improvement in visibility during the 20% clearest days and an improvement (not statistically significant) in the 20% of the park's haziest days. There was also a statistically significant increase in ammonium in precipitation (rain and snow). Increases such as these can be of concern because of the potential ecological effects (e.g., acidification of surface waters and nutrient enrichment that disrupts natural systems). On a national level, the NPS continues to work with the Environmental Protection Agency and state air quality agencies to better understand the sources of the increased ammonium (e.g., oil and gas development, coal-fired power plants, and agricultural production) and the causes and effects of nitrogen loadings, and to explore options for protecting ecosystem health.

Most of Yellowstone's efforts in regard to local air quality issues involve winter use and monitoring at the West Entrance and Old Faithful. As measured by carbon monoxide (CO) and particulate matter ($PM_{2.5}$) concentrations, air quality has been stable or improving since the Best Available Technology (BAT) requirement was instituted four winters ago. The combination of reduced emissions by the snowmobiles using BAT and fewer winter vehicles entering the park has greatly reduced CO and $PM_{2.5}$ concentrations. These concentrations at the West Entrance in the winter of 2006–07 were similar to that of the past few years. The maximum hourly CO at the West Entrance was slightly higher, but the averages of 8-hours and for the season were lower. The CO and $PM_{2.5}$ concentrations at Old Faithful were slightly lower. Although the winter season has multiple high hourly CO concentrations, the winter and summer averages are fairly similar, even though summer traffic is 60 times higher.

With funding from the park through an

Interagency Agreement in keeping with the winter use monitoring and adaptive management program, the state of Montana opened an air quality monitoring station in West Yellowstone on January 1, 2007. The station is located within three blocks of several snowmobile and snowcoach rental businesses and snowcoach departure points, making it a good place to monitor CO and $PM_{2.5}$ concentrations produced by activity within the town.

GYA Clean Air Partnership

The Greater Yellowstone Area Clean Air Partnership (GYACAP) includes representatives from Yellowstone and Grand Teton national parks, Gallatin, Custer, Beaverhead, Shoshone, Bridger-Teton, and Targhee national forests, Red Rock Lakes National Wildlife Refuge, the Idaho National Environmental and Energy Laboratory, the Bureau of Land Management, and the Montana, Idaho, and Wyoming departments of environmental quality. Its primary purposes are to advise the Greater Yellowstone Coordinating Committee on air quality issues and coordinate air quality monitoring among federal agencies. The group is focused on addressing the four main air quality threats in Greater Yellowstone: (1) urban and industrial emissions, (2) oil and gas development in southwest Wyoming, (3) prescribed and wildfire smoke, and (4) snowmobile emissions.

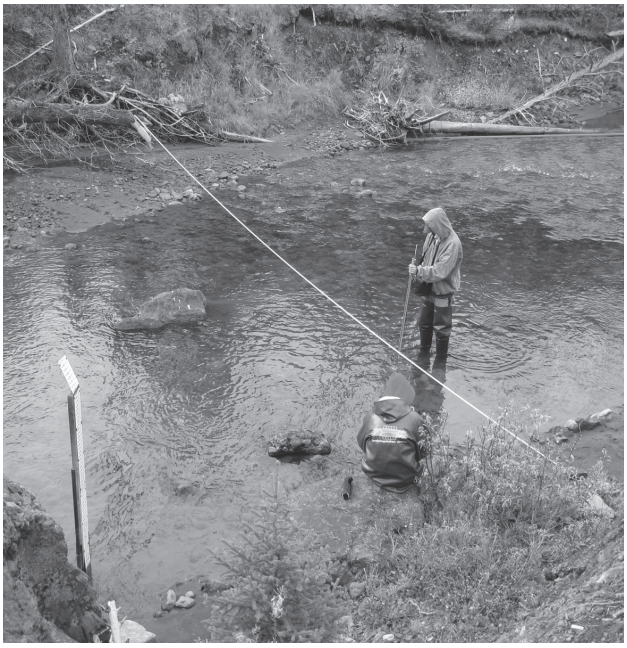
Topics discussed at the 11th annual meeting, held in Pocatello, Idaho, in October 2007, included: Idaho's stationary source permitting program; the Montana Fuels for Schools program, which is installing boiler-type wood burners that emit more particulates than propane or natural gas; Montana's transportation biofuels program; areas in Montana where particulate matter levels exceed national air quality standards (e.g., Libby, Hamilton, and Butte); monitoring of oil refineries in the Billings area; mitigation for energy development in southwest Wyoming; industrial sources of air pollution in northwest Wyoming; trends in snowpack chemistry sampling by the U.S. Geological Survey, and smoke monitoring during the 2007 fire season.

Yellowstone staff reported on recent trends in the park's winter air quality and greening program. Under a contract with the Yellowstone Park Foundation, Ecos Climate Solutions of Portland, Oregon, conducted an inventory of greenhouse gas emissions at the park and proposed projects for their reduction. Yellowstone managers are considering goals that would reduce greenhouse gas production in Yellowstone 30% by 2016 and 50% by 2025 through reductions in electricity use, wood burning, water consumption, and banning in-park sales of plastic water bottles and bags.

Water Quality

Water Quality Monitoring

Water quality monitoring of Yellowstone National Park's major surface waters is done by the Fisheries and Aquatic Sciences Section staff in cooperation with the Greater Yellowstone Network's Inventory and Monitoring Program. The purpose of the long-term water quality program is to acquire baseline information for Yellowstone's surface waters that can be used to evaluate overall ecosystem health, ascertain impacts of potential stressors (e.g., road construction activities or accidental sewage spills), and identify any changes that may be associated with water quality degradation. In general, physical and chemical characteristics of the park's waters are related to seasonal changes, elevation, precipitation events, and presence or absence of thermal features. As is typical of mountain streams with minimal sediment contribution, water clarity usually remains



MSU water quality technician Ty Harrison collecting data from the Lamar River.

very good throughout the year, with more turbid conditions observed during snowmelt and after rainfall events.

The quality of the park's surface waters is monitored monthly year-round at 12 sites on major rivers and during the ice-free period from May to October at seven sites on Yellowstone Lake. A multiparameter probe is used to collect water temperature, dissolved oxygen, pH, specific conductance, and turbidity. Water samples were also collected and processed for suspended solid (total, volatile, and fixed) and chemical analysis, which includes anions (sulfate, chloride, bicarbonate, and carbonate), cations (calcium, magnesium, sodium, and potassium) and nutrients (nitrate, nitrite, ammonia, total phosphorus, and orthophosphate).

At their confluence, Soda Butte Creek (left) is much more turbid after a rain shower than is the Lamar River (right).

Mining Impacts

Dissolved and total metals in the water and sediments are measured during high- and low-flow periods in Soda Butte Creek. The state of Montana has listed the water quality of Soda Butte Creek upstream of the park's Northeast Entrance as "impaired" because of elevated metal concentrations from the McLaren mine tailings located near Cooke City and within the Soda Butte Creek floodplain. Sampling at the park boundary in 2007 found that levels of total and dissolved arsenic, copper, selenium, and iron in the water were below detection limits, total iron concentration did not exceed the state's aquatic-life standards, and arsenic and selenium in the sediment were below detection limits. The Montana Department of Environmental Quality (MT DEQ) announced its intention to begin cleanup of the tailings located within the Soda Butte Creek valley immediately upstream of the park's boundary. The NPS Water Resources and Geologic Resources Divisions are providing technical assistance in discussions with the MT DEQ on the upcoming work.

Park staff continued to monitor proposed and ongoing reclamation projects associated with two historical mining sites outside the park: the New World Mining District and the McLaren mine tailings. Environmental cleanup of mining impacts in the New World Mining District adjacent to the park's Northeast Entrance is proceeding. The U.S. Forest Service has completed most of the major restoration work and is developing a long-term plan that includes revegetation, trail restoration, and monitoring of the New World Waste Repository and associated surface water and groundwater quality.

Snow Survey

More than 75% of the surface water supply in the West comes from snowmelt in the higher mountainous areas. Conditions from year to year and region to region can range from extreme drought to severe flooding, putting hundreds of millions of dollars at risk annually in agriculture, hydropower, dam operation, flood control, drought mitigation, and recreation. To help manage this resource for public safety, health, and economic viability, the Natural

Resource Conservation Service (NRCS) of the U.S. Department of Agriculture maintains and collects snowpack and related climate information under the federally mandated Snow Survey and Water Supply Forecasting Program. As the headwater areas for two major river systems (the Yellowstone River east of the Continental Divide that feeds into the Mississippi River system, and the Snake River on the west that flows into the Columbia River), the park has 10 NRCS SNOTEL (snowpack telemetry) stations and 5 manual snow course sites.

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

Weather Data

Park staff began working with the National Oceanographic and Atmospheric Administration (NOAA) and the U.S. Geological Survey (USGS) to improve weather data collection and reporting for Yellowstone. Radiation shields were added to the temperature sensors on the USGS stream flow gages on Soda Butte Creek and the Madison and Firehole rivers to improve the quality of data that will be used for real-time rainfall and temperature monitoring as well as to support ongoing research. A fully automated weather station was added to Hoyt Peak above Sylvan Pass to improve avalanche predictions. When the station is fully operational, wind speed and direction, precipitation, temperature, and relative humidity data will be transmitted every hour via a satellite hookup.

Plans are underway to upgrade the NOAA weather stations at Old Faithful, Mammoth Hot Springs, and Tower Junction so that they include wind, temperature, precipitation, and relative humidity data transmitted every hour via satellite. The NPS as well as the general public will be able to obtain the real-time data via "MesoWest" or any other collection method that can read the satellite-encoded data. The data will also be archived semi-annually from the datalogger on-site.

Aquatic Resources

The two main priorities of the park's Fisheries Program are the preservation of cutthroat trout in Yellowstone Lake, which has the largest remaining concentration of genetically pure inland cutthroat trout in the world, and restoration of fluvial populations of native trout, many of which have been lost because of non-native species introductions.

Yellowstone Cutthroat Trout Preservation

The park's Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*, YCT) face three threats: non-native lake trout (*Salvelinus namaycush*), the exotic parasite *Myxobolus cerebralis* that causes whirling disease, and the effects of a drought across the Intermountain West. Because of the relatively limited distribution of whirling disease, most of the YCT loss has been attributed to lake trout predation and continued drought conditions. Whirling disease severe enough to cause a population-level decline has been documented only in Pelican Creek and potentially the Yellowstone River downstream of Fishing Bridge. The persistent drought continues to reduce available habitat and disconnect tributaries from Yellowstone Lake, especially during late summer and fall, when YCT fry are typically attempting to move to the lake.

NPS fisheries technician Stacey Sigler and Student Conservation Association intern Allison Millar lifting a lake trout gillnet from Yellowstone Lake.

Lake Trout Removal. More than 74,000 lake trout were removed from Yellowstone Lake in 2007, and more than 270,000 since 1994, undoubtedly saving hundreds of thousands of YCT from predation. An early ice-off on Yellowstone Lake, May 14, and several veteran gill-netting technicians made possible the largest annual removal yet, mostly by targeting young lake trout that typically reside at greater depths than those occupied by cutthroat trout. Almost half (46%) of the lake trout removed through this control netting were caught in the smallest commonly used mesh size (25-mm), indicating that lake trout spawning remains strong but the removal effort has kept the age structure of the lake trout population dominated by immature fish. Using a geographic information system to map catch rates of both lake trout and cutthroat trout for each gillnet mesh size has made it possible to adapt site selection during the netting season and maintain high catch rates of lake trout while minimizing the catch of YCT. When nets are set in shallow water, every effort is made to check them daily so that any YCT can be released alive.

Pat Bigelow with an underwater video camera used to look for lake trout spawning areas.

Larger lake trout are targeted by gillnetting in identified spawning areas from late August until early October, but the shift to a wider range of mesh sizes has resulted in catching both more fish in total and more fish that would not have spawned. The average length of mature lake trout removed in spawner nets has remained relatively stable at 535 mm. Spawners were also removed with the help of an electrofishing boat loaned by the U.S. Fish and Wildlife Service Fisheries Assistance Office in Ahsahka, Idaho; the Wyoming Game and Fish Department provided use of both their electrofishing boat and their staff. However, despite an increased electrofishing effort on the spawning shoals, the number of lake trout removed (533) with this method was less than half that obtained in the previous three years.

Along with increases in the number of fish harvested, catch-per-unit-effort has increased since 2002, which is cause for concern (Figure 1). Catches

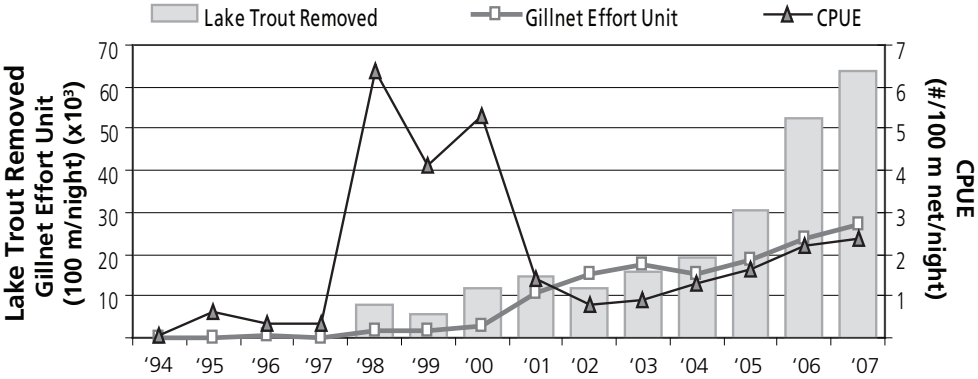


Figure 1. Number of lake trout removed, gillnet units of effort used, and catch per unit of effort (CPUE) on Yellowstone Lake with control nets, 1994–2007.

from both control netting (targeting younger lake trout) and spawner netting (targeting fish congregating in preparation to spawn) indicate exponential growth in numbers ($r^2 = 0.89$ and $r^2 = 0.91$, respectively).

YCT Population Monitoring. The number of upstream-migrating YCT counted at Clear Creek, one of the largest spawning tributaries to Yellowstone Lake, was 538 during 2007, not much higher than the 2006 count of 489, but the first year since 1998 that it did not decrease (Figure 2). It was also the first time in several years that spawning fish under 400 mm have been observed, indicating a small influx of first-time spawners into the population. The slight increase in adult YCT ascending spawning tributaries and the increased catch of YCT during the fall assessment netting in Yellowstone Lake are signs that the lake trout removal program is having the desired effect. However, the YCT population remains low compared to historical levels and several more years of recovery will be required to replace the lost reproductive potential caused by lake trout predation, whirling disease, and drought.

Fisheries technician Brian Ertel leading an electrofishing crew on a small tributary to Mountain Creek.

Native Trout Restoration

Westslope Cutthroat Trout. Only two populations of genetically pure westslope cutthroat trout (*Onchorhynchus clarkii lewisi,* WCT) are known to exist in the park: in a small tributary of Grayling Creek, now known as "Last Chance Creek," and in the Oxbow/Geode Complex in the Yellowstone River drainage, where WCT were probably stocked in the 1920s. After checking the efficacy of the 2006 piscicide treatments to remove the introduced YCT from the 7.1-acre High Lake, more than 1,300 advanced-stage WCT eggs from Last Chance Creek and Sun Ranch Hatchery broodstock (Ennis, Montana) were placed in incubators there in June and July 2007. In mid-July, 1,150 juvenile and adult WCT were transported by helicopter from Geode Creek to High Lake. Subsequent observation of abundant fry near the incubators and healthy WCT in the lake indicated the initial success of these restocking efforts, which are expected to be repeated through 2009.

The project did experience a significant setback when the lightning-caused, 2,810-acre Owl Fire burned through the East Fork Specimen Creek drainage and destroyed the water diversion structure built in 2006 and approximately 40 mule loads of equipment and supplies. Because of the hazard created by the thou-

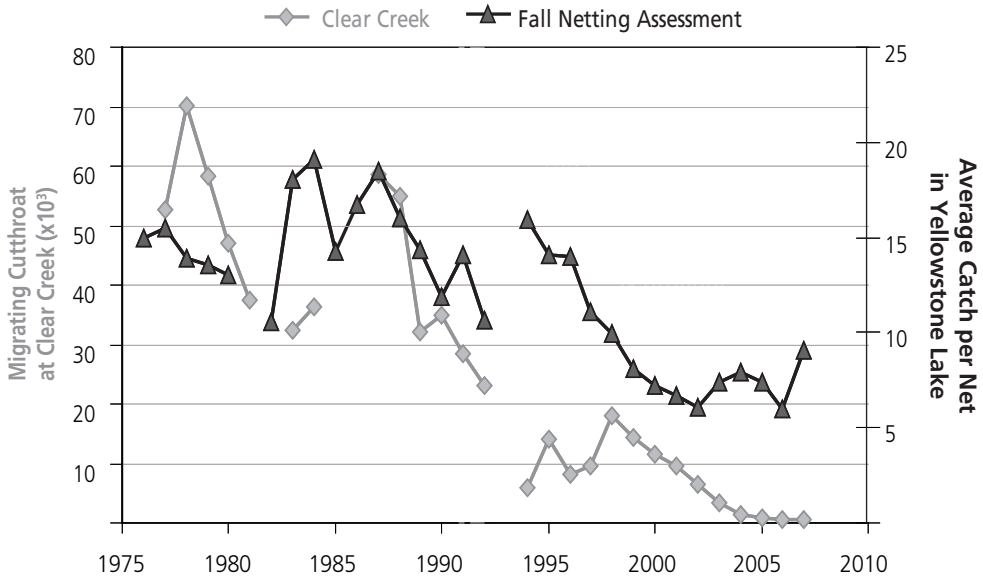


Figure 2. Upstream migrating cutthroat trout counted at Clear Creek spawning trap and average number collected per net on Yellowstone Lake during the fall, 1975–2007.

Checking for surviving fish at High Lake after piscicide treatment.

Fisheries crew collecting genetically-pure westslope cutthroat trout from Geode Creek to be stocked in High Lake.

sands of dead standing trees, further work on the fish barrier was postponed until 2008.

Several streams were surveyed as possible WCT restoration sites, including Black Butte, Daly, and Grayling creeks. Grayling Creek, which showed the greatest potential for both WCT and Arctic grayling restoration, was the most thoroughly explored and will be surveyed further in 2008.

Effect of Piscicides on Amphibians. An important component of the restoration program is to determine any long-term effects that the use of piscicides may have on non-target organisms. The park's four native amphibian species are the Columbia spotted frog (CSF), *Rana pretiosa*; the boreal chorus frog (BCF), *Pseudacris triseriata maculate*; the boreal toad (BT), *Bufo boreas boreas*; and the blotched tiger salamander (BTS), *Ambystoma tigrinum melanostictum*. In spring 2006 prior to rotenone treatment in High Lake, amphibian breeding populations were recorded at six locations in the Specimen Creek drainage, including five sites for CSF and three sites for BCF.

A pair of blotched tiger salamanders at a wetland near the Gibbon River.

CSF larvae were found only in the lake outlet area. In spring 2007, however, adults, egg masses, and tadpoles were observed all around the lake perimeter, which is characterized by having shallow margins dominated by sedge and appears to be an important substrate for egg laying of the CSF. Research undertaken in collaboration with Idaho State University is intended to study the impacts of rotenone on amphibians and explain the observed increase in amphibian use of High Lake littoral areas immediately following removal of the YCT, which are major predators of amphibians in mountain lakes.

Between May and July 2007, potential areas for trout restoration were examined for amphibian habitat in wetlands identified by the U.S. Fish and Wildlife Service's 1998 National Wetlands Inventory. They included wetlands on the northern range (83 sites) and in the drainages of the Madison River (15 sites) and Specimen Creek (24 sites) in the northwest region of the park. Of these 122 wetland sites, 46 (38%) had adequate surface water to warrant a survey; the other 76 (62%) were not surveyed because they were not suitable for amphibian inhabitation at the time. At the seven surveyed sites in the Specimen Creek drainage, evidence of breeding CSF and/or BCF (larvae or egg masses) was found at four sites. At the 33 surveyed sites on the northern range (the Blacktail Deer, Elk, and Rose creek drainages and the small watershed that encompasses Trout Lake), evidence of breeding CSF, BCF, and BTS was found, with BTS the most frequently observed.

Effect of Piscicides on Aquatic Invertebrates. Monitoring aquatic invertebrate communities is important because the species are relatively immobile, sensitive to environmental changes, and can live up to four years. The most sensitive aquatic insects belong to the Ephemeroptera, Plecoptera, and Trichoptera orders, collectively referred to as EPT taxa. Aquatic invertebrates have been collected each August since 2004 at six sites in East Fork Specimen Creek and High Lake. The percentage of major invertebrate groups downstream of the piscicide treatment area has remained relatively constant during this period, providing strong evidence that the piscicide application and other restoration activities at High Lake have not affected these aquatic invertebrates. Invertebrate sampling found 50% were EPT taxa in 2005 and 55% in 2006. Following piscicide treatment in 2006, the samples were 47% EPT in 2006 and 51% in 2007.

The invertebrate communities most affected by the piscicide treatment were located in outlet and inlet stream segments in the immediate vicinity of High Lake. In 2006 prior to treatment, 68 invertebrate taxa were identified from seven samples; in 2007 after treatment, 53 taxa were identified from three samples. Invertebrate taxa in the outlet stream segments were 33% EPT prior to treatment and 11% after treatment; in the inlet streams the decline was from 38% to 10%. A concurrent increase in aquatic fly larvae was also documented in these streams. The invertebrate taxa found in the inlet stream in 2007 remained similar to the 2006 post-treatment conditions, but densities of both non-insect taxa and EPT taxa increased dramatically in the outlet stream. The fingernail clams (*Pisidium compressum*), which were encountered in low densities during 2006 prior to treatment, reached densities of nearly 3,000/m^2 in 2007. These higher densities could be due to natural variation within the population or possibly a direct response by the fingernail clams to the trout removal.

Geology

Protection and monitoring of the park's geothermal resources remains the focal point of the park's geology program.

Montana Water Rights Compact

The Montana Water Rights Compact, established in 1994 between the state of Montana and the National Park Service (NPS), protects Yellowstone's geothermal features by limiting groundwater withdrawal in a designated area north and west of the park. In 2007, the NPS funded $168,000 under the Montana Bureau of Mines and Geology Cooperative Agreement for monitoring and database maintenance of this Controlled Groundwater Area, and $23,000 to the Montana Department of Natural Resources and Conservation for oversight of permits and water meters for the area. The geology staff participated on the Technical Oversight Committee in ongoing discussions to determine the best way to plug a geothermal well drilled by the Church Universal and Triumphant north of the park in the late 1980s.

Yellowstone Volcano Observatory

A partnership set up by the U.S. Geological Survey (USGS) with the NPS and the University of Utah, the Yellowstone Volcano Observatory (YVO) monitors volcano and earthquake hazards in the park using a network of 26 seismic and 13 GPS leveling stations. In a continued effort to improve its volcanic and seismic monitoring capability, the YVO upgraded equipment at existing locations and installed equipment at new locations, as described in the Volcano and Earthquake Monitoring Plan for the Yellowstone Volcano Observatory, 2006–15 (http://pubs.usgs.gov/sir/2006/5276/).

2007 Seismic Activity. There were 947 earthquakes in Yellowstone in 2007, compared to a range of 872–3,172 per year during 1995–2006. Data from GPS ground stations and the European Space Agency's Envisat satellite indicate that parts of the Yellowstone caldera rose as much as 7 cm per year from 2004 to 2006. The largest uplift has been recorded at the White Lake GPS station, inside the caldera's eastern rim, where the total uplift from 2004 to October 2007 was about 17 cm (Figure 3). Given the area's geologic history, YVO scientists think that the current period of uplift will likely cease and be followed by another cycle of subsidence. Norris Geyser Basin, which uplifted 12 cm from 1996 to 2004, has subsided 6 cm since then.

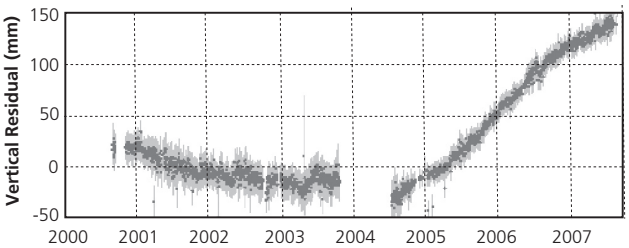


Figure 3. This plot shows the up-down movement at the White Lake GPS station. After moving downward about 50 mm from 1997 to 2004, this area moved 170 mm upward from mid-2004 to October 2007. (Figure courtesy of University of Utah.)

Hazards Assessment. In March 2007 the USGS released its "Preliminary Hazards Assessment of Yellowstone National Park and Vicinity," which addresses potential events in the area's hydrothermal, magmatic, and tectonic systems and is intended to serve as a guide for future YVO activities and emergency management. The assessment will be expanded during the next two years to include a seismic hazards analysis.

Other Geothermal Collaborations

A key aspect of geothermal monitoring are projects carried out through the Rocky Mountains Cooperative Ecosystem Studies Unit by Montana State University, the National Center for Landscape Fire Analysis at the University of Montana, Missoula, and the Utah State University Remote Sensing and GIS Laboratory. The NPS is also working with USGS and University of Utah scientists to determine the age of thermal and non-thermal groundwaters at Norris Geyser Basin in order to better delineate the areas that recharge the basin's geothermal features.

Assistance to Other Agencies and Park Divisions

The geology staff led field trips for the Wyoming State Geological Survey, the Jackson Hole geologists, and U.S. Forest Service geologists from the Intermountain and Northern regions. The Yellowstone geologist served as chair of the Scientific Advisory Team for the Old Faithful Visitor Education Center, identified mineral specimens for court hearings, worked with Law Enforcement to remove boardwalks at Mammoth, discussed options for Beryl Springs Bridge with a consultant hired by Federal Highways, advised Maintenance on the removal of landslide debris at Overhanging Cliff, reviewed plans for remediation of a 750-gallon heating oil spill at the Snow Lodge, assessed hydrothermal gases in the Safety Office, served on the Advanced National Seismic System Committee, and assisted with training of Yellowstone's interpreters.

Vegetation

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

YCR's vegetation group helps carry out the National Park Service's responsibilities for the protection, perpetuation, and restoration of Yellowstone's vegetation communities and their enjoyment by the public, management of threatened or endangered plant species, mitigation of human-induced effects, and assessment of threats from external sources.

Plant Inventories

The vascular plant flora of Yellowstone includes 1,350 species. Park staff have met the servicewide inventory and monitoring goal of documenting at least 90% of the park's vascular plant species and incorporating the information into the NPSpecies biodiversity database.

Non-native Species. Three non-native species were documented in the park for the first time in 2007: Jerusalem oak (*Dysphania botrys* [L.] Mosyakin & Clemants) behind the Fire Cache in Mammoth on disturbed soil, perennial pepperweed (*Lepidium latifolium* L.) near Slough Creek, and Dwarf nettle (*Urtica urens* L.) under the YCR porch. Unlike the many non-native plant species that have become well established in the park, these relatively small populations are likely to be successfully eradicated.

Rare Plant Surveys. To prevent negative impacts on rare plant populations, park staff conduct surveys prior to construction projects, trail re-routes, and other activities that will disturb the soil. In addition to complying with statutory requirements, these surveys collect valuable data: 131 additional sites were documented during 2007 for the GIS layer of Wyoming species of special concern and plants that are rare in the park. Summer fieldwork for Federal Highways projects took place primarily in the Old Faithful area, where 378 sites containing rare species have now been documented; plant communities with "species of special concern" occupy habitats that include thermally heated sites, wetlands, and barren black obsidian sand. Also surveyed for wetlands or rare plants was the area to be used for the expansion of the Grant Village Wastewater Facility drying ponds, clearance for a satellite dish at Lamar Buffalo Ranch, and several backcountry trails where major reconstruction was being planned.

Yellowstone Herbarium

The Yellowstone National Park Herbarium houses approximately 9,000 specimens that have been curated and entered into a database. The specimens are used by NPS personnel and outside researchers to identify vascular plant taxa as well as the bryophytes, fungi, and lichens that occur in the park, and to document the presence, variation, and distribution of native species, and the arrival and spread of non-native species. During the 2007 field season, 15 vascular plant specimens were collected for addition to the herbarium to document the native flora in under-collected portions of Yellowstone and non-native species. Park staff made significant inroads on the specimen backlog, with more than 1,000 specimens in the process of being labeled, mounted, and added to the NPS's Automated National Catalog System database.

Bryophyte Survey

Bryophytes (mosses, liverworts, and hornworts) represent an under-sampled and relatively poorly understood component of the ecosystem. With funding provided by Canon U.S.A., Inc., through the Yellowstone Park Foundation, Judy Harpel began a two-year survey in 2006 to prepare a comprehensive bryophyte species list for the park. During the 2007 field season, she located a small population of *Buxbaumia aphylla,* an unusual moss that does not have a perennial gametophyte (leafy part). The only visible part is the sporophyte or capsule that grows on soil or rotten wood and when mature is about ¼ of an inch tall and resembles a tiny insect on a very short stalk; hence the plant's common name: bug on a stick. This species had been identified in the park once before, in 1951, by Elva Lawton, a prominent bryologist from the University of Washington, but the site, which was thought to be about seven miles from Canyon on the road to Norris, has never been relocated. At the 2007 site, 75 sporophytes were growing on about one square meter of soil on an old root wad in a lodgepole pine forest near Yellowstone Lake, providing a better idea of the habitat of this rarely encountered species. Field work for this survey is expected to be completed by September 2008.

Fens Study

Fens are wetland habitats in which a constant supply of surface or ground water maintains permanently saturated soils and, over thousands of years, causes thick layers of partially decomposed organic

JOANNA LEMLY

Colorado State University researcher Dr. David Cooper in a fen wetland at Cascade Meadows.

matter to accumulate. This organic soil, called peat, is common in far northern climates. Although fens occupy little land area in Yellowstone, they include a diverse range of areas occupied by plant and animal species that rely on permanently moist environments, and they serve as examples of how complex fen ecosystems function in a pristine state. Many of the major wildlife species of the park spend at least some of their time in fens, which provide both forage and a cool, moist place to go in the heat of the summer.

Joanna Lemly of Colorado State University, who spent two summers mapping and describing 166 fens in watersheds across the park to understand how different landscape-scale environmental variables affect the distribution of plant species in fens, completed her master's thesis in 2007. Fens were found to occupy a wide range of habitats below 2,800 meters with mean annual precipitation ranging from 380 to 1,400 mm, and groundwater pH ranging from 2.89 to 7.98. Fens were found in depressions, on gentle slopes of less than 10 degrees, steep slopes up to 25 degrees, and around localized points of upwelling groundwater. They were found on rhyolite, basalt, andesite, glacial till, and rarely encountered geothermal peatlands. Fen vegetation ranged from spike rush or lily pad/pondweed-dominated aquatic and semi-aquatic communities to communities dominated by sedges, willows, or mosses. Fens were also found in forested areas dominated by Engelmann spruce, subalpine fir, or lodgepole pine. Twenty-three species of vascular plants found in the fens are Wyoming species of special concern.

Woody Vegetation

The controversies surrounding the status of woody vegetation on the northern range (aspen, willow, and cottonwood) as it has been affected by changing elk population levels and wolf reintroduction continued to support diverse research opportunities in 2007, including:

- The last year of a three-year study of bird species diversity in willow communities of varying structure and size, with Dr. Andrew Hansen of Montana State University.
- The last year of a two-year study of temperature influences on willow growth and phenolic production in areas with varying wolf and elk densities throughout Greater Yellowstone by Dr. Don Despain (U.S. Geological Survey, retired) and Dr.

JOANNA LEMLY

Buckbean (Menyanthes trifoliata) *is found in fens.*

Rex Cates (Brigham Young University).

- Ground-based willow mapping of selected stream drainages to complement previous mapping efforts, with Robert Stottlemyer (USGS-Biological Resources Discipline, Fort Collins Science Center) and Mike Tercek (University of Colorado).
- The first year of a study on the influence of hydrology and herbivory on cottonwood establishment and persistence, with Dr. David Cooper and graduate student Josh Rose, Colorado State University.

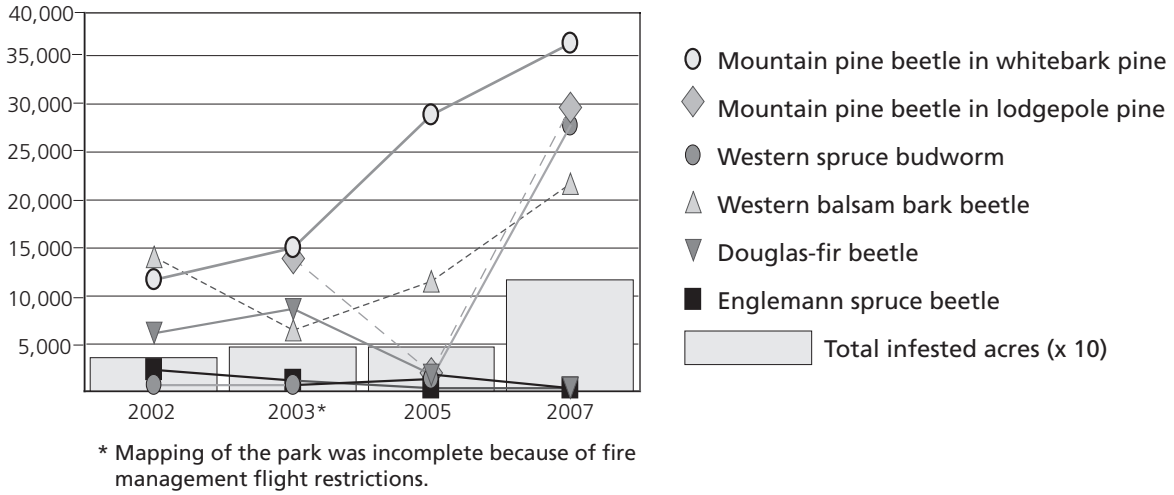
Alpine Vegetation

Ken Aho completed his dissertation at Montana State University on alpine and cliff ecosystems in the north-central Rocky Mountains. In addition to quantitatively describing alpine plant communities on 10 peaks in and near Yellowstone's northeast boundary, Aho established permanent transects as a baseline for monitoring impacts from the non-native mountain goats that are increasingly using the area. Alpine plant diversity and cover have declined in Olympic National Park as a result of non-native mountain goats. While the net effects of global warming on terrestrial vegetation communities are difficult to gauge, alpine communities are likely to be particularly altered. In Greater Yellowstone, treelines are expected to move up, reducing the extent of alpine areas and alpine diversity. In a three-year project beginning in FY08, Aho will resample and expand upon his transects and begin monitoring the abundance, distribution, and demographics of mountain goats to provide the information needed for evaluating management alternatives and developing an adaptive management plan to protect the alpine ecosystem.

Forest Insect Infestations

An aerial survey of the park conducted during 2007 with the help of U.S. Forest Service mappers confirmed that the insect-caused mortality of overstory trees that erupted early in the decade continues (Figure 4). Pockets of red-needled trees are evident throughout the park. The cause of the mortality is primarily small ($^1/_8$" long) native bark beetles in the Scolytidae family. The beetles tend to be host-specific, selecting for an individual or closely-related tree species. They are often referred to as "primary" beetles because through sheer numbers their feeding activity can girdle a tree and be directly responsible for its death. A tree attacked during the summer will have a red crown the following summer, and the red needles usually drop within the next year, leaving a standing dead tree. Secondary beetles, like the native wood-boring and longhorn beetles, are larger ($^3/_4$" or more) and attack trees that are already dying or dead.

Both Douglas-fir beetle and Engelmann spruce beetle activity have declined since 2000. Engelmann spruce beetles are likely to continue to decline in the near future because they have killed almost all of their preferred food source (spruce trees >10 inches in diameter at breast height). Mountain pine beetle



* Mapping of the park was incomplete because of fire management flight restrictions.

Figure 4. Acres of forest insect activity in Yellowstone observed in the last four aerial surveys. Although the Douglas-fir beetle and Englemann spruce beetle each infested less than an estimated 400 acres in 2007, the total infested area rose to more than 117, 000 acres because of the increase in activity by other forest insects.

activity in high-elevation whitebark pine forests remains at epidemic levels, affecting some 25% of the area occupied by mature whitebark pine stands in the park. Mountain pine beetle activity in lower-elevation lodgepole pine over the past two years has increased 20-fold throughout much of the West.

Another native foliage-eating insect, the spruce budworm, is showing widespread but variable intensities throughout the lower elevations of the Lamar and Yellowstone river valleys. Host trees are primarily Douglas-fir and secondarily Engelmann spruce. During the budworm's caterpillar life stage, the developing larvae feed on new needles as they emerge, leaving behind a brown cast or "halo" on the outer portion of the tree crown. The spruce budworm usually does not feed on old growth needles or kill mature overstory trees except in severe outbreaks, but at high densities it can cause local pockets of mortality among understory seedlings and saplings. The most conspicuous defoliation in the park is visible along Reese Creek, above the Mammoth Terraces, at Lava Creek, on Bunsen Peak, and near the Hellroaring trailhead.

Landscape-scale drought and the availability of suitable host trees are the primary forces in the initiation and persistence of insect outbreaks. Healthy trees can successfully defend themselves from beetle attack by "pitching out" adult females as they try to bore into the tree. Extreme winter temperatures can kill off overwintering broods and wet summer weather impedes the insects from invading additional trees. Insect activity also decreases as the older, more preferred, and susceptible trees are killed off. Winter 2007 precipitation may reduce the decade-long drought stress on many trees, thereby increasing the trees' ability to defend themselves against insect attack. However, any short- or long-term relief on new tree infestations will depend in part on climatic conditions in subsequent years.

An effort to determine what, if any, influence insect infestations may have on landscape-level fire patterns and vice versa, and whether extensive fires may set the stage for future insect infestations continued in 2007 through Rocky Mountains and Great Lakes Cooperative Ecosystem Studies Units agreements between the park and three researchers: Dr. Dan Tinker (University of Wyoming), Dr. Monica Turner (University of Wisconsin–Madison), and Dr. William Romme (Colorado State University).

Vegetation Management

Fire Management. The park experienced 27 fires that burned approximately 24,700 acres during the busy 2007 fire season. The vegetation management specialist made long-term fire behavior risk projections, briefed management staff and field crews on expected fire behavior, and consulted with fire behavior analysts on suppression efforts and aerial mapping of the fires. The vegetation management staff also assisted with fire and fuel moisture monitoring and participated in a 68-acre prescribed burn adjacent to the Norris developed area to reduce fuel loading.

Hazard Tree Management. To protect people and property, potentially hazardous trees in areas of high visitor and employee use must be identified and removed. As part of the Hazard Tree Management Plan, the Vegetation Management Specialist trains resource management sawyer crews in hazard tree identification, assists with hazard tree assessments, and maintains records of hazard tree removals. During 2007, 1,145 hazardous trees were removed parkwide, and an additional 120 trees were marked for removal in 2008 at the backcountry fisheries project worksite along the East Fork of Specimen Creek, which burned in 2007.

Vegetation Education

In addition to identifying plant species upon request for other park staff, outside researchers, and the public, the vegetation staff participated in more formal education efforts during 2007, including:

- weed identification for the Northern Rocky Mountain Exotic Plant Management Team, Yellowstone resource management personnel, Montana Conservation Corp, and Gallatin National Forest;
- 18 field seminars for various university, international, and media groups on topics including northern range/woody vegetation issues, fire ecology, forest insect activity, and disturbed lands restoration;
- rare plant and vegetation overviews for the Division of Interpretation, the Montana Native Plant Society, and the Bozeman chapter of the American Association of Retired People; and
- a course on Yellowstone wildflowers through the Yellowstone Association Institute.

Wildlife

Bears

In 2007, the U.S. Fish and Wildlife Service (USFWS) announced that the Greater Yellowstone Ecosystem (GYE) grizzly bear population segment had recovered sufficient numbers and distribution to be removed from the threatened list. However, the potential for conflicts when the need or opportunity arises for a grizzly bear to obtain human food in its range of hundreds of square miles will make the presence of a viable grizzly population in Greater Yellowstone a continuing challenge for land managers and property owners. Grizzly bear management in YNP has not changed significantly as a result of delisting. Park staff continue to protect bear habitat for both grizzly and black bears, and emphasize prevention of bear-caused property damages, bear-inflicted human injuries, and human-caused bear mortalities through public education, sanitation, and enforcement of food and garbage storage regulations.

Grizzly Bear Conservation Strategy

The Greater Yellowstone Ecosystem (GYE) and northwest Montana are the only areas south of Canada that still have large grizzly bear (*Ursus arctos*) populations. The government agencies with jurisdiction over GYE grizzly bears have approved a conservation strategy for managing them as a recovered population within the Primary Conservation Area (PCA) and adjacent areas with adequate habitat and acceptable risk of human-caused mortality (Figure 5). The USFWS has approved the plans developed by Idaho, Montana, and Wyoming for grizzly bear management outside the PCA, where more consideration is given to human use. On private land and other areas not considered suitable habitat, the states may deter grizzly bear use through removals, relocations, and regulated hunting. The Interagency Grizzly Bear Study Team, which has members from the U.S. Geological Survey, the USFWS, the National Park Service, the U.S. Forest Service, and the states of Idaho, Montana, and Wyoming, will continue to monitor population numbers, distribution, habitat use, reproduction, and mortality. About 15% of GYE grizzly bears are radio-collared.

Figure 5. Area currently occupied by grizzly bears and Primary Conservation Area in which they will receive greatest protection.

At least 14 females with home ranges wholly or partially within the park produced litters with a total of at least 33 cubs in 2007 (Figure 6). With seven litters of triplets and only two single-cub litters, the average size of the observed litters was 2.4. The number of females producing cubs each year appears to have stabilized, suggesting that the park may be at or near carrying capacity for grizzly bears.

Bear Foods Monitoring

Park staff monitor the availability of elk and bison carcasses, cutthroat trout (*Onchorynchus clarkii*), and whitebark pine (*Pinus albicaulis*) seeds, which are four of the highest sources of energy available to grizzly bears in the park.

Winter-killed Ungulate Carcasses. The Yellowstone Ecosystem is unique among areas inhabited by grizzly bears in North America because of the substantial use of ungulates as food by grizzly bears during the spring season, as indicated by analysis of bear scats, bear feeding sites, and bear hair isotopes. On average, approximately 79% of the diet of adult male and 45% of the diet of adult female grizzly bears in the Yellowstone Ecosystem is estimated to come from meat. In contrast, in Glacier

National Park, most of the diet of both adult male and female grizzly bears comes from vegetation. Ungulates are important to bears because they provide a high quality food source during early spring before most vegetal foods become available.

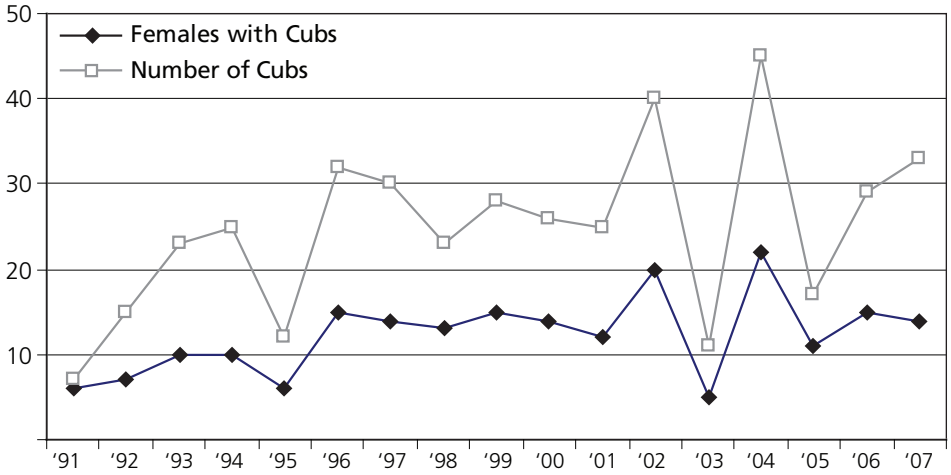


Figure 6. Female grizzly bears with cubs and total cubs counted in Yellowstone National Park, 1991–2007.

During the 2007 survey to monitor the relative abundance of winter-killed ungulate carcasses, a total of 30 elk, 6 bison, 1 pronghorn, and 1 mule deer carcasses were documented along the 267.2 km of survey routes (an average of 0.14 carcasses/km surveyed). Three of the bison carcasses and six of the elk carcasses had conclusive evidence of scavenging by bears. Grizzly bears or their tracks were observed on 20 (69%) of the 29 survey routes. Black bears or their tracks were observed on 2 (7%) of the 29 survey routes.

Spawning Cutthroat Trout. In the past, an estimated 68 grizzly bears were known to prey on spawning cutthroat trout (*Oncorhynchus clarkii*) in at least 36 different tributary streams of Yellowstone Lake each year. Bears also occasionally prey on cutthroat trout in other areas of the park, including the cutthroat-rainbow trout hybrids in the inlet creek to Trout Lake. Because of the threat to cutthroat trout from non-native lake trout in Yellowstone Lake, whirling disease, and drought, monitoring of the park's cutthroat trout population has been part of the grizzly bear conservation strategy.

The number of spawners in the north shore and West Thumb tributaries to Yellowstone Lake has decreased significantly since 1989. A total of 11 spawners were counted in four of the nine streams that were monitored in 2007. Grizzly bear tracks were observed along two of the streams, but there was no evidence of grizzly bear or black bear fishing activity on these streams or on the inlet to Trout Lake. The 538 spawners counted in Clear Creek on the east of the lake was one of the lowest counts since monitoring began in 1945.

A three-year study that began in 2007 is documenting the extent to which bears have shifted from fish to other foods. Preliminary results confirm that very few bears still eat fish, and that most of the bears that previously ate fish are now focused on preying on elk calves adjacent to the lake, where elk are now calving in the blow-down that followed the 1988 fires.

Whitebark Pine Seeds. Whitebark pine seeds are an important fall food for bears due to their high fat content and their potential abundance as a pre-hibernation food source. During years with low availability of natural bear foods, especially fall foods, bears often seek alternate foods in association with human activities and both the number of bear–human conflicts and human-caused bear mortalities increase. As part of an ecosystemwide whitebark pine survey, cone counts are conducted at 19 whitebark pine transects in the GYE. On the 10 transects located in YNP, cone counts averaged 11.9 (± 23.4 SD) cones per tree in 2007. This was slightly below the long-term (1987–2006) average of 14.4 (± 31.9 SD) cones per tree, per year for transects located in the park. A high level of mountain pine beetle-caused tree mortality has been observed in the whitebark pine transects in the park in recent years. An estimated 5% of the whitebark pine trees in the park's surveyed transects were killed by beetles in 2007.

Bear Conflicts and Confrontations

Bear–human conflicts are defined as incidents in which bears damage property, obtain human foods, or injure people. In most cases when bears obtain

human foods, they damage property in the process, and in most cases when bears damage property, they are attempting to obtain human foods, garbage, or other attractants. In 2007, there were 20 reported bear–human conflicts involving 8 grizzly bears, 6 black bears, and 6 bears of unidentified species. This compares to an average of 11.3 conflicts a year during 1994–2006 (Figure 7). In 13 of the incidents that took place in 2007, property damage occurred, but no food was obtained; in 5 incidents, food was obtained. The other two incidents resulted in human injury: a man taking photographs alone in the Hayden Valley backcountry in May was severely wounded by a grizzly sow with a cub, and a park employee participating in a carcass study for the wolf project received minor injuries from a black bear who bit her in July. Bear-inflicted injuries during 1994–2006 averaged 1.5 per year.

A concern that the increase in bears along roads who have become habituated to people would lead to an increase in bear–human conflicts has not been borne out. Despite a larger population of grizzly bears and an increasing number of bear-jams, the number of bear–human conflicts decreased from an annual average of 15.1 (9.1 grizzly and 6.0 black) for 1980–1989 when habituation was not tolerated to 9.2 for 1990–2007 (5.1 grizzly and 4.1 black). The number of bears killed by vehicles has increased slightly, from an annual average of 1.1 for 1980–1989 to 1.5 for 1990–2007.

Bear–human confrontations are defined as incidents in which, without inflicting human injury, bears (1) approach or follow people, (2) charge or otherwise act aggressively toward people (posture, slap ground, pop jaws, etc.), (3) enter frontcountry developments, or (4) enter occupied backcountry campsites. Because of the potential threat to human safety, incidents in which bears enter developments or occupied backcountry campsites are counted as confrontations even if the bears did not behave aggressively. In 2007, there were 193 reported incidents of bear–human confrontations, 123 involving grizzly bears, 62 with black bears, and 8 in which the species was not identified. This compares to an average of 120 confrontations a year during 1999–2006, but the increase is almost entirely from more grizzly bears entering developed areas (Figure 8). The number of confrontations with grizzly bears has exceeded those with black bears since 2005.

Bear Management Actions

In 2007, there were 979 bear-related incidents in which management action was taken, including:

- 822 incidents in which park staff responded to roadside bear-jams to provide traffic control, answer visitors' questions, and ensure that visitors did not approach or throw food to bears;
- 98 incidents in which bears were hazed out of developed areas or away from roadsides due to concern for visitor safety;

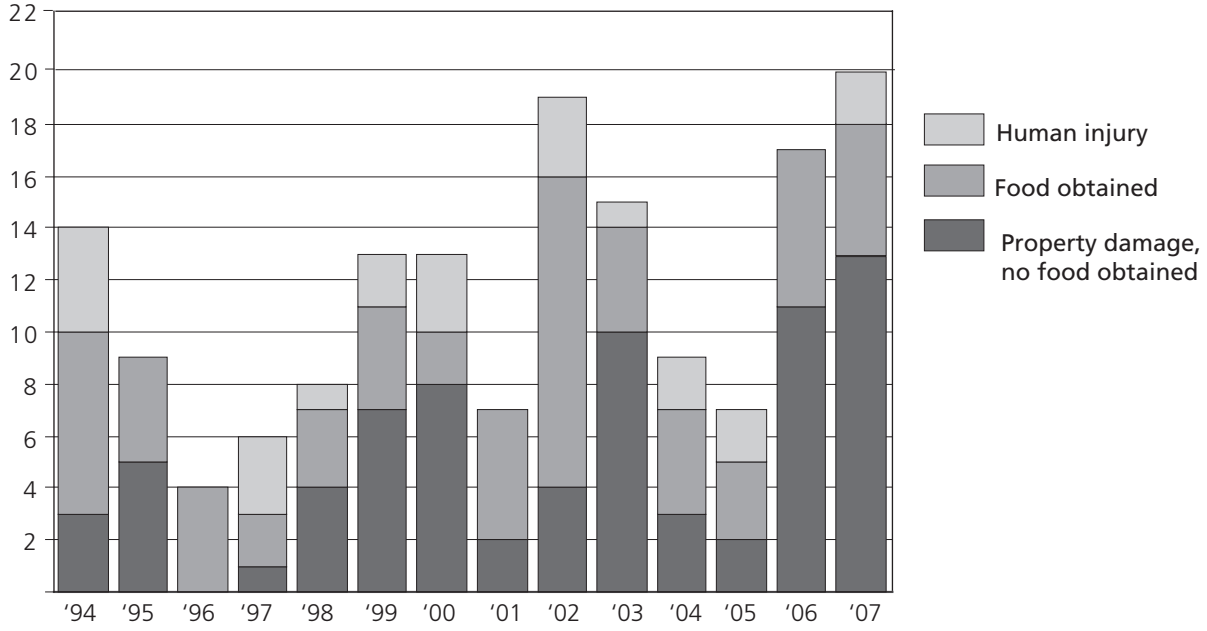


Figure 7. Number of bear–human conflicts in Yellowstone National Park, 1994–2007.

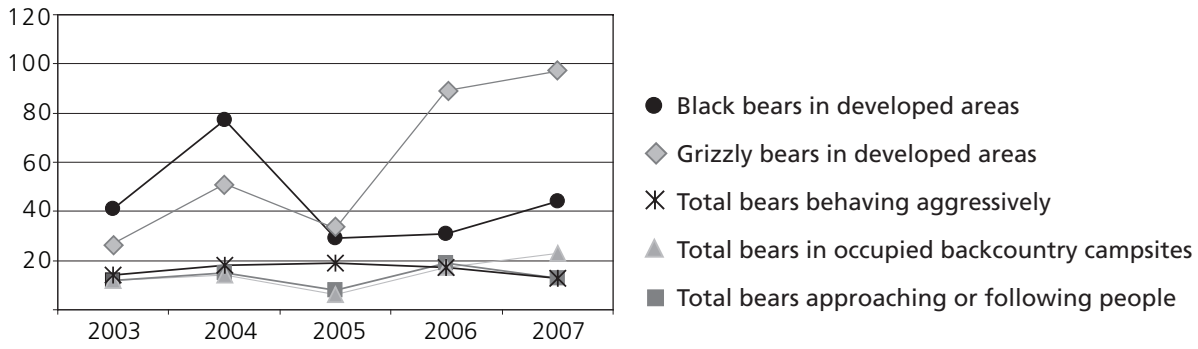


Figure 8. Five types of bear–human confrontations in Yellowstone National Park, 2003–07. Although the total number of confrontations has increased as a result of more grizzly bears entering developed areas, the number of bears behaving aggressively toward people has remained about the same.

- 28 times when trails, campsites, or other areas were closed to the public due to safety concerns related to bear activity;
- 27 times when bear warnings were posted at trails, campsites, or other areas due to bear activity;
- 3 incidents in which a bear was captured and relocated within the park;
- 1 incident in which a bear was captured and removed from the park.

The bear that had to be removed from the park was a female grizzly that had been involved in five incidents of property damage in the Lake Village and Fishing Bridge developments in 2006 and had been frequently hazed using bean bags, cracker shells, sling-shots, or vehicles and eventually relocated to the opposite side of Yellowstone Lake. Although relocation rarely works with adult bears, it is occasionally successful with subadults. However, this bear was back to chewing through sewage hoses in the employee trailer park at Lake in 2007. Now weighing about 140 pounds, she was trapped behind the Lake Village housing area on June 26 and sent by helicopter to a Gallatin Mountains location in the park, but returned again. Because she had been involved in multiple instances of property damage, obtained some food, and become habituated to human presence, she was trapped at Fishing Bridge on August 20 and driven to the Washington State University Bear Research, Education, and Conservation Program. The bear management program in Yellowstone has assisted with and benefited from the non-invasive ecology, nutrition, and physiology studies on bears performed at this facility for more than 20 years.

As a way to deal with the increasing number of incidents in which bears damage tents, the Bear Management Office contracted a tent designed with an electric fence charger that delivers 6,000 volts. The first day it was set up at the Hellroaring campsite where a black bear had been investigating and pawing tents, the bear touched his nose to the tent and departed. Although the bear appeared to stay away from tents, he did start going after food poles.

Ungulates

Bison. Park staff participated for the seventh year in the Interagency Bison Management Plan with the state of Montana and the Animal and Plant Health Inspection Service and the U.S. Forest Service of the U.S. Department of Agriculture. The plan is designed to manage the risk of brucellosis transmission from bison to cattle, conserve the bison population, and allow for gradually increased tolerance of bison out-

Bison on a groomed park road in winter

side the park on national forest land. After a drop in the late summer population to approximately 3,900 in 2006, relatively mild weather reduced migration from the park during the following winter. In the hunt conducted by the state of Montana, 64 bison were killed outside the park. Outside the west boundary, the Montana Department of Livestock sent four bison to slaughter and 57 bison captured in June to the Stephens Creek facility near the north boundary where they were held briefly before release into the park. The late summer population was estimated to be 4,700 based on aerial surveys conducted in July and August 2007 (Figure 9).

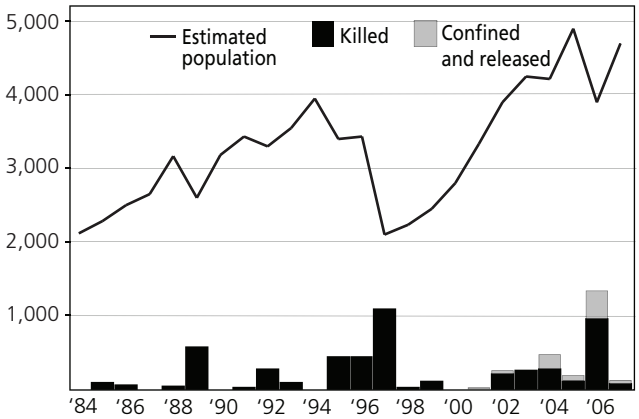


Figure 9. Bison killed each winter (in boundary control operations or by hunters), bison temporarily confined at the boundary, and the estimated population the following summer.

Elk. The Northern Yellowstone Cooperative Wildlife Working Group, which includes park staff along with representatives from Montana Fish, Wildlife and Parks, the U.S. Forest Service, and the U.S. Geological Survey-Northern Rocky Mountain Science Center, conducted its annual survey of the northern Yellowstone elk population. The winter count, which was approximately 17,000 in 1995, has been approximately 6,700 elk during 2002–07. The decline has been attributed to predation by reintroduced wolves, a growing bear population, hunter harvest, and possibly drought-related effects on pregnancy and survival. The state of Montana has reduced the number of antlerless permits issued in recent years so that hunting has little impact on population size.

Pronghorn. There have been serious concerns about the long-term viability of Yellowstone pronghorn since a decrease in counts from 536 to 235 pronghorn during 1992–95. Causes of this rapid decrease remain unclear, but fawn survival has remained low due to coyote predation. Development of private lands outside the park has reduced available winter range to a relatively small, isolated area. Much of the current pronghorn winter range in the park is former agricultural land infested with exotic vegetation of low nutritional quality. The pronghorn count, which remained relatively constant during 1996–2006, at approximately 196–235, reached 291 in 2007, the highest since 1993.

Wolves

Population Monitoring

Population Status. At the end of 2007, at least 171 wolves occupied Yellowstone National Park (YNP), a 26% increase over the 2006 count and close to the 2003 population peak of 174 (Figure 10). The number of packs dropped from 13 to 11 during 2007, but the average pack size increased from 10.5 to 14.2, and there were more wolves that did not belong to packs, including a radio-collared wolf that dispersed into the park from the Steel Mountain pack in Idaho. Pack size at year's end ranged from 4 to 22 wolves. Ten packs ended the year with a breeding pair and at least two surviving pups. The male and female alphas in the Hayden Valley pack were both killed by Mollie's pack in October. A new pack that formed (Gardners Hole) and produced a pup appeared to have dissolved by year's end. Wolf distribution across the park continued to remain largely unchanged, indicating that all available wolf habitat is being used (Figure 11).

Reproduction. Of the 11 packs that produced pups, three had multiple litters, including the Hayden Valley pack, which was the first recorded case of an interior pack having more than one. The pup survival rate was good; of the 77 pups counted at dens, 64 were alive at year's end (83%). The average number of pups per pack in early winter was 5.8.

Mortalities. As in past years, the primary cause of mortality was intraspecific strife. It was responsible for four of the six deaths of collared wolves; one collared wolf died as a result of a vehicular collision, the cause of the other's death is unknown. The deaths of six uncollared wolves were attributed to intraspecific strife (3), old age (2, one of them mange

related), and vehicular collision (1).

Wolf Management

Collaring. At year's end, 57 (33%) of the wolves in the park wore radio collars, including 22 that had been darted from a helicopter and collared during 2007. Three types of radio collars were deployed: VHF (still the most commonly used), downloadable Global Positioning System (GPS), and ARGOS. Three GPS collars programmed to collect location data every 30 minutes were used on wolves on the northern range to enhance understanding of seasonal predation patterns, spatial and temporal interactions with other carnivores, wolf movements with respect to dens during pup rearing season, and wolf territory size, use, and overlap.

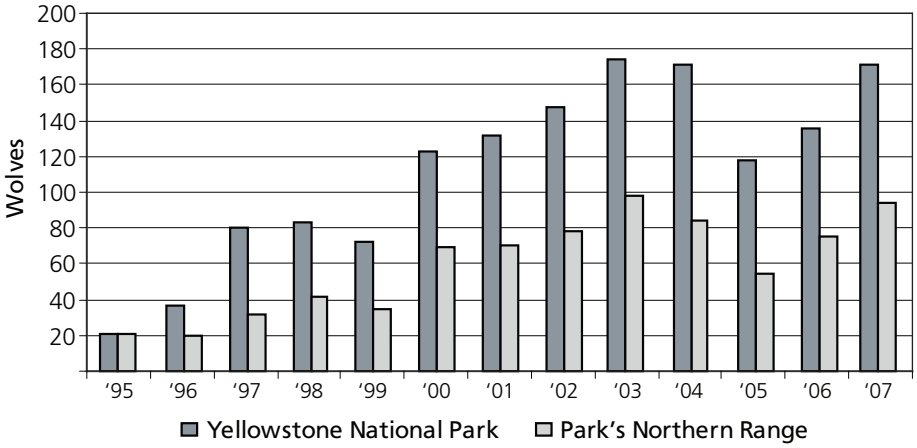


Figure 10. Comparison of total Yellowstone National Park wolf count (early winter) to the count on the park's northern range.

Area Closures. On the northern range, temporary closures were instituted around the den sites following the birth of litters in the Oxbow Creek, Slough Creek, and Druid Peak packs until mid-May. In the interior, where the Hayden Valley pack's den site was close to a trail and highly visible from the road, a section of the trail was temporarily closed. However, the pack was viewed from across the Yellowstone River by hundreds of people at close proximity. Possibly because of this prolonged contact, the Hayden Valley pack is the most human-tolerant in the park, which is cause for concern for both the wolves' and human welfare. A section of trail near the den site of the Snake River pack near the south entrance of the park was also temporarily closed to off-trail hiking.

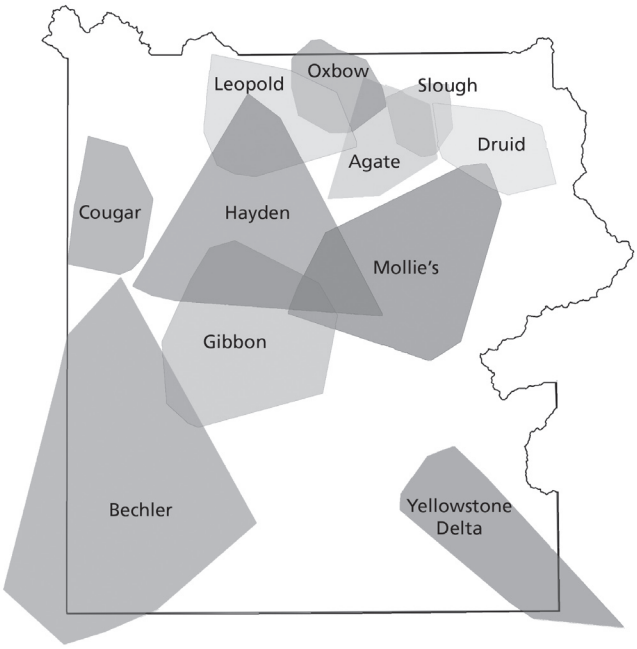


Figure 11. Approximate territories occupied by the 11 wolf packs residing primary in Yellowstone National Park at the end of 2007.

Deb Guernsey and Doug Smith with Hayden Valley wolves.

Habituated Wolves. In December a male adult and a female pup that were frequently seen in

The Slough Creek pack traveling single file in deep snow.

Mammoth, probably from the disbanded Gardners Hole pack, exhibited a lack of fear of humans and a mild case of mange. After the pup was hazed with cracker shells, neither wolf frequented Mammoth again. Unsuccessful efforts were made to haze the uncollared and hard-to-track Slough Creek alpha male who had been approaching people and lying in the road; he subsequently died as a result of a vehicle collision.

Wolf Research

Winter Predation Studies. Wolf–prey relationships were documented by observing predation directly and by recording the characteristics of prey at kill sites. Wolf packs were intensively radio-tracked for two 30-day study sessions in March and from mid-November to mid-December. All packs were monitored from aircraft. The Leopold, Druid Peak, Agate Creek (March 2007), and Oxbow Creek (November–December 2007) packs were also routinely monitored by three-person ground crews; ground monitoring of the Slough Creek, Hellroaring, and Mollie's packs was opportunistic. The Cougar Creek, Hayden, and Gibbon Meadows packs were monitored from aircraft only. The Yellowstone Delta and Bechler packs were rarely located by ground or air because of their absence from the park or poor conditions for aerial monitoring in the southern part of the park.

During the winter sessions, Wolf Project staff recorded behavioral interactions between wolves and prey, predation rates, the total time wolves fed on their kills, percent consumption of kills by wolves and scavengers, characteristics of wolf prey, and characteristics of kill sites. Similar data were collected opportunistically throughout the year during weekly monitoring flights and ground observations. After a switch during the early winter study of 2006 to selection for calves, this year returned to the previous years' pattern of selection for bulls. Although difficult to test, Wolf Project staff hypothesized that drought conditions resulted in poor forage quality that, when coupled with the energetically costly behavior of rutting bull elk, made this age and sex class more vulnerable to predation in early winter than females and calves. The number of elk killed by wolves during the winter on the northern range continues to be closely correlated with the size of the northern range wolf population (Figure 12).

Summer Predation Studies. Wolf Project staff continued efforts to document summer predation patterns of wolves, which is problematic due to the lack of snow for tracking, increased nighttime activity of wolves, decreased pack cohesiveness, and smaller prey size, resulting in faster consumption and loss of evidence. Although GPS collars were placed on three wolves on the northern range in part to collected data on predation patterns, two of the collars failed shortly after deployment. The third collar, on a female yearling in the Leopold pack, enabled staff to document the killing of one mule deer doe and 29 elk (58% bulls, 24% calves, 17% cows). The majority of bull elk (80%) killed in May had gelatinous bone marrow, indicating that they had not yet recovered from winter's effects. As the summer progressed, wolves began to kill more elk calves and cows.

Composition of Wolf Kills. Including definite,

probable, and possible kills, Wolf Project staff documented a total of 323 kills in 2007, including 272 elk (84%), 11 bison (3.4%), 7 wolves (2%), 4 deer, 4 coyotes, 3 moose, 2 black bears, 1 pronghorn, 1 golden eagle, 1 red fox, 1 otter, and 16 unknown prey (5%). The composition of elk kills was 41% bulls, 21% calves (0–12 months), 16% cows (1–9 years old), 12% old cows (≥10 years old), and 10% elk of unknown sex and/or age. Bison kills included 6 calves (unknown sex), 3 bulls, and 2 adults of unknown sex.

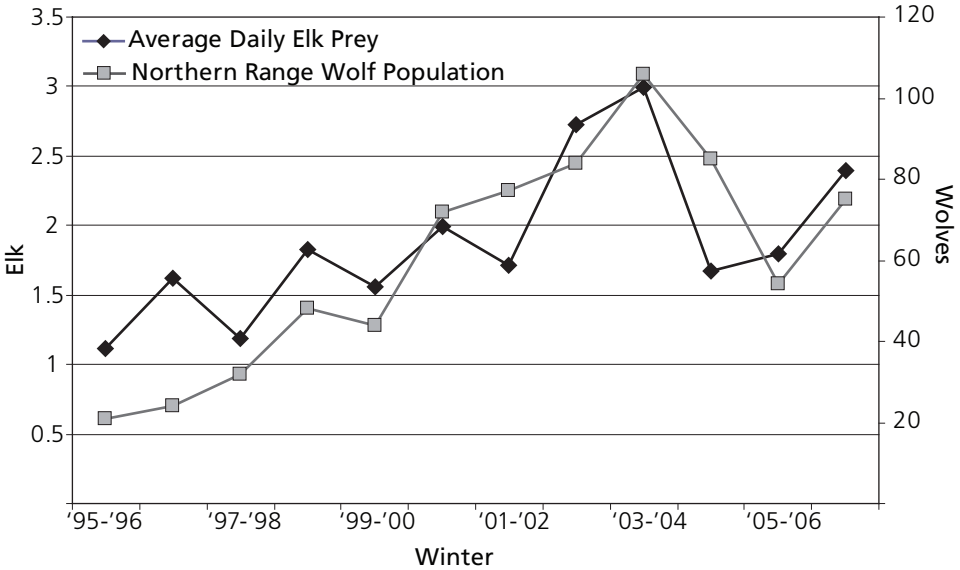


Figure 12. Average number of elk killed per day during the winters (November–March) of 1995–96 to 2006–07 and wolf population on the northern range.

Druid Peak wolves pursuing a bull elk in December 2007. They covered 1.7 miles but when the elk stopped running and stood his ground, the wolves conceded.

Population Genetics. A collaborative effort with the University of California at Los Angeles that began in 2005 continued as Dan Stahler attended UCLA for the first half of 2007. The Wolf Project staff and members of Dr. Robert Wayne's canid genetics lab published the first study on Yellowstone wolf genetics, in the journal *Molecular Ecology*. Their analysis of DNA samples collected from hundreds of wolves in Yellowstone since reintroduction in 1995 found that the population had maintained high levels of genetic variation and low levels of inbreeding. The genealogies of major pack lineages were reconstructed based on genetic and field data, showing that Yellowstone wolves have deterred inbreeding through male-biased dispersal, female-biased subordinate breeding, and the avoidance of breeding with related pack members despite the high probability of within-pack inbreeding opportunities and extensive kinship ties between adjacent packs. A larger scale analysis that was nearly completed in 2007 will address issues of population connectivity and migratory exchange among the three Rocky Mountain recovery areas and the importance this has for genetic diversity and long-term population sustainability.

Disease. Research on disease in the Yellowstone wolf population is ongoing. As part of a pilot study

on non-invasive disease monitoring, wolf scats collected from 12 packs are being screened for canine parvovirus (CPV) and canine adenovirus type-1 (CAV-1), two viral pathogens known to be circulating through Yellowstone that cause morbidity and mortality in domestic dogs. Serology results from wolves captured during 2006 and 2007 suggest that exposure to CPV and CAV-1 remains high. The majority of adult wolves handled in 2006–07 demonstrated previous exposure to canine distemper virus (CDV), probably as a result of living through the 2005 outbreak in Yellowstone. However, pups handled during the same time exhibited very low levels of exposure, suggesting that the virus had been largely cleared from the park by the summer of 2006. Ongoing research seeks to identify the various factors influencing the frequency of distemper outbreaks in Yellowstone, including the role of multiple host species.

Sarcoptic mange, which is prevalent outside the park, was documented in Mollie's pack in 2005–06 but did not spread to the rest of the pack, which showed no clinical symptoms of the disease at year's end. However, in late 2007 two wolves in the territory used by the Gardners Hole pack and one wolf associated with a pair of dispersers near Druid territory exhibited the characteristic hair loss associated with mange. Ongoing monitoring will enable us to determine whether these remain isolated cases or whether the mite will spread within the park.

Public Involvement and Outreach

Volunteers on the Wolf Project worked a total of 4,660 hours in 2007. Wolf Project staff gave 76 talks and 52 interviews. For the seventh year, they rode horseback into outfitter camps north of the park on the Gallatin National Forest to discuss wolf issues. This year's trip was coordinated through the USFS Gardiner District.

Since wolf reintroduction, certain areas of the park have become popular for wolf viewing. In 2000, YCR, Resource and Visitor Protection, and the Division of Interpretation began a coordinated effort to address the opportunities and problems that result from large numbers of wolf watchers. The objectives are human safety, wolf safety, visitor enjoyment, and wolf monitoring and research. During a 117-day period from late May to late September when wolves were visible every day in the Lamar and/or Hayden valleys, the road management crew made 8,775 visitor contacts and gave 230 informal talks to 2,300 visitors.

Other Wildlife Issues

Beaver. The beaver (*Castor canadensis*) affects habitat structure and dynamics through the damming and diverting of streams, and the felling of trees and other woody vegetation. With the subsequent flooding and creation of habitable ponds, beavers help make the area favorable to willows and aspens, their preferred winter foods. Although little is known about beaver density and distribution in Yellowstone prior to the late 1980s, current data indicate that the park now has a sustainable population. Some of the approximately 129 beavers that were reintroduced to several Gallatin National Forest drainages by the U.S. Forest Service in the mid-1990s moved downstream into the park, where the northern range has experienced a resurgence of willow. The number of active beaver colonies found in a bi-annual survey increased from 49 in 1996 to 85 in 2003. Most of the 127 colonies found in a parkwide aerial census in 2007 were concentrated in three locations: the northwest (Madison-Grayling Creek-lower Gallatin River drainages); the southwest corner (Bechler River area), and the upper Yellowstone River from the southeast arm of Yellowstone Lake to the Thorofare. All of the colonies observed in 2007 were found in willow communities and none were cutting aspen. Willow is more common in the park than aspen and a hardier shrub that quickly regenerates after being clipped by beavers.

Birds of Special Interest

Bald eagle. The U.S. Fish and Wildlife Service removed the bald eagle from the list of threatened species in August 2007. In Yellowstone, where 13 pairs produced 13 fledglings in 1987, 34 pairs produced 26 fledglings in 2007 (Figure 13). The trend suggests that the park population may not yet have reached carrying capacity and may increase further in the future.

Peregrine Falcon. The peregrine falcon density in Yellowstone continues to be as high as anywhere in the Northern Rockies. One new eyrie was found in 2007, bringing the total number of eyries in the park to 32, from which 47 young fledged, the fourth

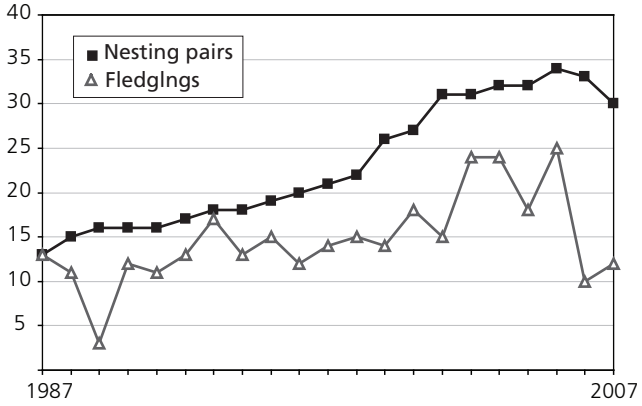


Figure 13. Number of bald eagle nesting pairs and fledglings counted in Yellowstone National Park, 1987–2007.

highest number since records began 25 years ago.

Trumpeter Swan. The park's resident trumpeter swan count was only 14 in 2006, the lowest since the 1930s, and declined further to 7 adults and no young in 2007. This was the first time in 26 years of trumpeter swan surveys that none were found in the Bechler area. We are collaborating with Montana State University to identify threats to the persistence of the Yellowstone trumpeter swan and mitigation strategies that could prevent its local extirpation.

Mid-sized Carnivores

Yellowstone supports a variety of mid-sized carnivores, including the American marten, river otter, and red fox, as well as two uncommon species, the wolverine (*Gulo gulo*) and the Canada lynx (*Lynx canadensis*). The wolverine and Canada lynx are rarely seen because of their small numbers and affinity for boreal forests and alpine habitats, but they carry strong aesthetic and existence values for the public. The mission of the mid-sized carnivore program is to improve the information available for resource management, planning, and interpretation staff in the park. The program also provides data that supports the NPS's responsibility to consult with the U.S. Fish and Wildlife Service (USFWS) concerning the effect of park management activities on endangered species.

Lynx. The Canada lynx was federally listed as threatened in the contiguous United States in 2000. It is rare in Greater Yellowstone, where its distribution is generally limited to spruce-fir, Douglas-fir, and lodgepole pine forests above 7,700 feet. Implementation of measures outlined in the multi-agency Lynx Conservation and Assessment Strategy (2000) and National Forest Plan amendments should improve or at least maintain existing conditions for the species by setting standards and guidelines that protect lynx denning habitat and the habitat of its principal winter prey, the snowshoe hare, which requires conifer downfall and windfall, and dense stands of brush in forest understories. Silvicultural or fire fuels treatments that reduce horizontal cover are detrimental to hares and may reduce potential denning sites for lynx.

Snow-tracking and DNA analysis of hair snares have detected lynx in Yellowstone (Murphy et al. 2006), but the data are insufficient to estimate population size. A radio-collared lynx that presumably dispersed from a population reintroduced in Colorado was sighted in the park in 2007.

Wolverine.The wolverine, the largest member of the weasel family, has emerged as a species of primary concern for land managers in the Rocky Mountains because of its low population density and reproductive rate, large home ranges, genetic fragmentation, and possible sensitivity to human disturbance. Although the USFWS has rejected previous petitions because of a dearth of information about the wolverine's life history and ecological requirements, the species is likely to eventually receive protection under the Endangered Species Act. Wolverines evolved with large paws that are advantageous when traveling great distances through deep snow, and pregnant wolverines conceal their dens under several feet of snow where they give birth to one to three kits. Climate change models predict that by 2050 the spring snow-pack needed for wolverine denning and hunting will be limited to portions of Greater Yellowstone, the southern Rocky Mountains, and the Sierra Nevada Range. Of these areas, only Greater Yellowstone currently has a wolverine population.

With the continued support of the Yellowstone Park Foundation, in 2007 the Absaroka-Beartooth Wolverine Project completed its second winter season of efforts to live-trap wolverine in order to document more information about the species' status and ecology in the eastern half of Greater Yellowstone. Participating in this project with Yellowstone National Park are the U.S. Forest Service, the Rocky Mountain Research Station of the U.S. Department of Agriculture, Montana Fish, Wildlife and Parks,

JASON WILMOT, ABSAROKA-BEARTOOTH WOLVERINE PROJECT

Wolverine tracks in the Madison Range, Montana.

the Wyoming Game and Fish Department, and the Rocky Mountains Cooperative Ecosystem Studies Unit. (The Wildlife Conservation Society is monitoring wolverine in suitable habitat west and north of the park.)

A multi-agency team of eight technicians and six volunteers working out of Gardiner, Cooke City, Lake Village, Canyon Village, and Sunlight Basin baited and maintained 32 log-box traps for a total of 2,715 trap nights, a 50% increase over the previous winter. The two young wolverines, one male and one female, that were captured in the same area north of the park in March, each received an intraperitoneal implant VHF transmitter and GPS collar. Non-target captures included 115 red fox, 52 marten, 3 coyote, and 1 cougar. One of the two wolverines that was captured in 2006 was legally taken by a Montana trapper in February 2007; the other one shed his GPS collar but still has a functional VHF transmitter

A second goal of the project is to foster support for wolverine conservation through public education. Two wolverine study day camps were held in Yellowstone gateway communities during the summer in cooperation with the park's Division of Interpretation.

Wildlife Health

Disease has become a critical factor in the long-term survival or sustainability of desired population levels for many wildlife species. Sarcoptic mange, a highly contagious skin disease caused by mites, may be contributing to wolf mortality in Yellowstone. Deer, elk, and moose in the park are at moderate risk for infection by chronic wasting disease, which is transmitted by animal-to-animal contact and through the environment. It has spread across Wyoming toward the park, with infected cervids having been found approximately 130 miles away. In 2006, the NPS signed a Memorandum of Understanding with Montana State University (MSU) and the Wildlife Health Center in the School of Veterinary Medicine at the University of California–Davis, to establish a long-term collaborative program to address wildlife disease problems in Yellowstone. In August 2007, park staff held a workshop at which the U.S. Geological Survey's National Wildlife Health Center provided training on how to expand surveillance for CWD and, if necessary, implement management actions that will reduce or stabilize its prevalence in deer and elk.

In October, a multidisciplinary team met in Davis, California, to develop a plan to tackle brucellosis questions in the park. This meeting catalyzed UC Davis, in collaboration with experts and institutions from across the country, to put forward major proposals to the United States Department of Agriculture and the National Science Foundation for grant funding consideration.

Park staff initiated a pilot study with MSU to evaluate the bison immune system and understand how nutritional condition affects the bison's defense against brucellosis infection. During the winter 2007–08, blood will be collected in the field from radio-collared adult female bison to determine pregnancy and diagnose brucellosis infection. These bison will be resampled to develop a profile of bison immune status.

PART III

Professional Support Programs

Mule deer buck.

This section summarizes the 2007 accomplishments of YCR staff who provide services for other YCR branches and park divisions:

- Spatial Analysis Center
- Research Permit Office
- Benefits-Sharing EIS
- Resource Information Team
- Funding and Personnel Support

Spatial Analysis Center

The Spatial Analysis Center (SAC) provides a variety of GPS (global positioning system) and GIS (geographic information system) services to park staff and Yellowstone partners by repackaging technology and technical data to suit a variety of information needs.

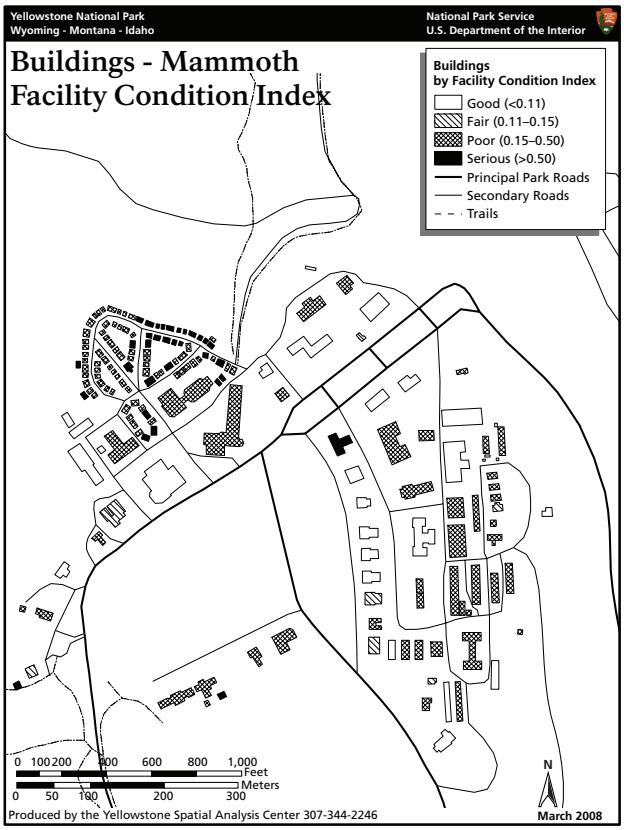
GIS Data on Utilities

In the past, information about the park's water and sewer systems was stored on hard-copy maps and only sporadically updated. SAC and Maintenance staff are working together to map these utilities throughout the park. Data are collected through a combination of fieldwork, interviews, and digitized, geo-referenced paper plans which are stored in a spatial database. End users are currently evaluating the utility of Google Earth-like computer projects in the office and paper map books that can be carried in their vehicles. The long-range goal is to provide current, accurate information about utilities to every user in whatever form is most useful. By the end of 2007, nearly 3,000 water features and 2,000 sewer features had been mapped, including nearly 67 miles of water lines and 31 miles of sewer lines.

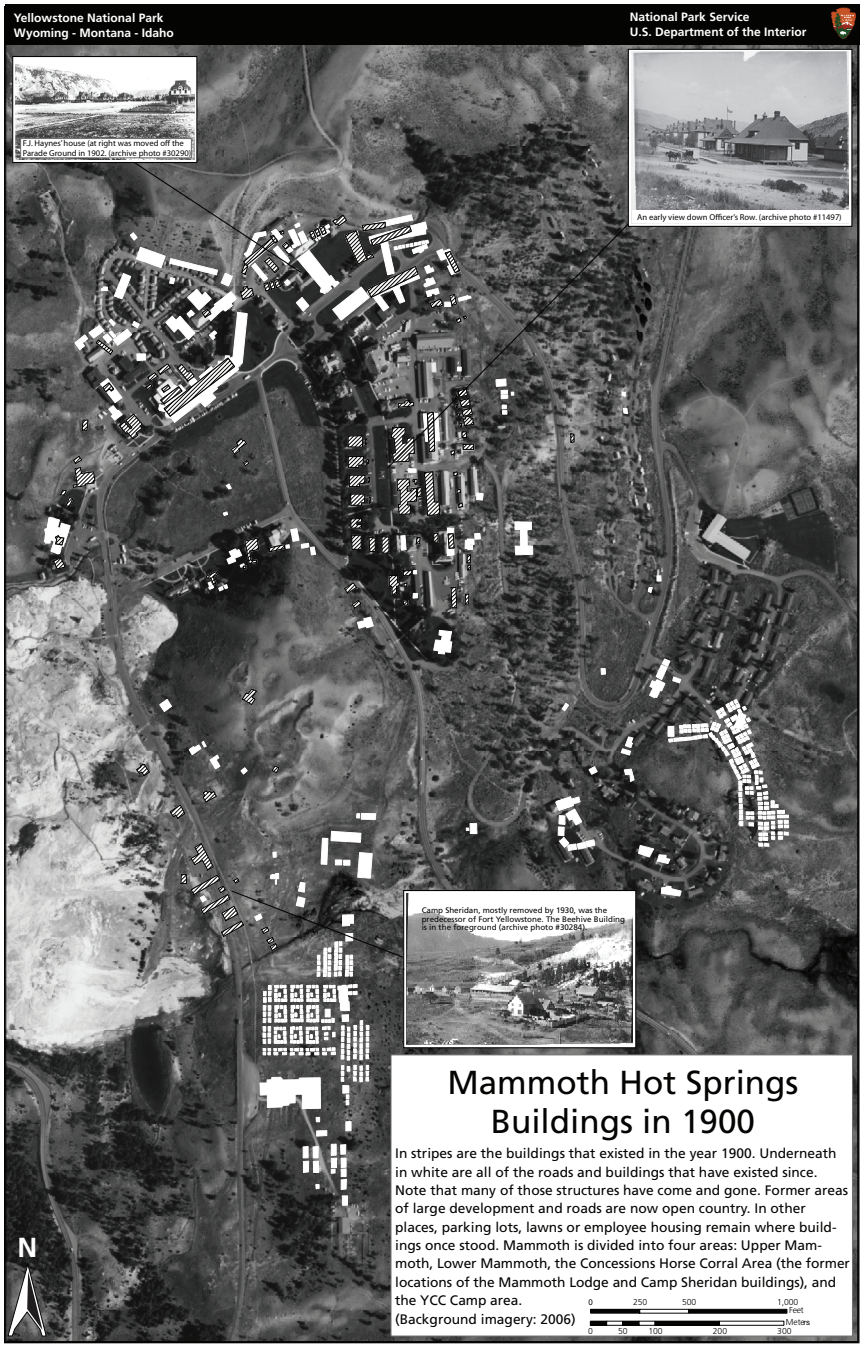
GIS Data on Buildings

Linking the acilities Management Software System (FMSS) database to buildings in GIS now makes it possible to graphically represent statistical data such as the Asset Priority Index (importance of the structure) and the Facility Condition Index (condition of the structure) in a simple overview format, allowing managers to view the buildings as more than just entries on a spreadsheet (Figure 14).

In conjunction with the Yellowstone Historic



Structures Management Plan and the four ongoing Comprehensive Area Plans, SAC staff have begun mapping the park's historically significant buildings in eight of the park's developed areas to create a data layer that depicts the footprint of development on the landscape during the park's history. For example, while the Mammoth area currently has 347 buildings, its data layer will show the digitized footprints of 1,063 buildings that have existed since 1872 (Figure 15).



Support for Planning, EAs, and Wildland Fire

SAC staff continued to work with other YCR staff and Planning, Compliance, and Landscape Architecture to create maps and other products, including three-dimensional computer models of the Mammoth, Lake, Tower, and Old Faithful developed areas, complete with realistic buildings, trees, and terrain. 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.

As in past years, SAC staff dedicated a significant portion of the summer to mapping fires in the park and producing maps for fire crews, the Public Affairs Office, and the public via the park's website. SAC staff also participate throughout the year in the Wildland-Urban interface planning efforts through data analysis and the creation of information products.

Other Responsibilities

Thermal Inventory. Temperature, pH, photos, and GPS locations were collected from more than 500 additional features during SAC's 10th field season of digitally mapping the park's thermal features. The database, which now includes approximately 10,900 thermal features, enables park staff and outside researchers to identify individual features with particular combinations of temperature, pH, and location.

Historic Wildlife Sightings. YCR staff has searched archives for hundreds of narratives to provide information about the distribution and abundance of wildlife from 1796 to 1882. Data on 3,500 sightings of wildlife from 1796 to 1874 have been entered into a relational database

and the locations were mapped using GIS, and the number of sightings in the database is expected to double as the project is completed. By enabling analysis of large numbers of wildlife observations, this interdisciplinary study will provide a useful tool for regional land managers, researchers, interpreters, and constituency groups seeking accurate historical information regarding ecological conditions in Greater Yellowstone during the last two centuries.

Map and Data Requests. Of the hundreds of requests for maps and data that SAC responds to throughout the year, about 60% are from park staff. The remainder are from other federal, state, and local agencies; university faculty and students; and the general public. These requests range from the creation of a map of all the thermal features in the Upper Geyser Basin for Old Faithful interpretation to a map of bison locations and movement for Governor Schweitzer of Montana.

GPS Support. The Spatial Analysis Center maintains and provides training for an inventory of 23 GPS units ranging from recreational grade Garmin units to high-end, sub-meter accuracy mapping grade units. The units are available for park staff and cooperators to check out from the GIS intranet site.

Computer and Software Support. By helping park employees in the YCR solve computer, network, printer, and GIS questions, SAC staff enable Computer Support Services to spend more time helping other employees on higher priority, more technical problems.

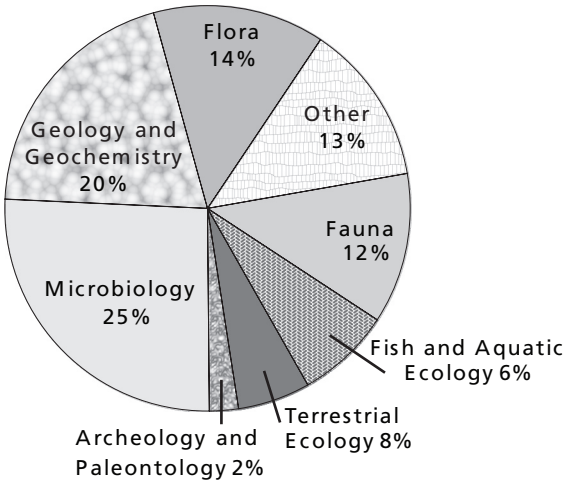
Research Permit Office

Yellowstone National Park is the proud host of numerous research studies each year. The Research Permit Office is tasked with issuing permits to researchers who conduct scientific studies in a variety of disciplines and monitoring their fieldwork to ensure that it does not negatively affect park resources or conflict with other park goals or missions. National Park Service policy also requires that we promote research in the park, and collect and appropriately disseminate the results of park-related scientific inquiry to the widest possible audience. Our stakeholders include research scientists, park staff, land managers, and the public. We do this through various means including scheduling research talks and disseminating journal articles, theses, and research reports to interested parties.

During 2007, Yellowstone's Research Permit Office issued 195 research permits to scientists from 35 U.S. states and 7 foreign countries. This year was the first in several years that the number of permits dropped below 200. Several scientists contacted the park and requested that we put their permits on hold for one year, due to lack of research funding. The 195 permits issued in 2007 included 32 new projects that had been approved by Yellowstone's Research Review Team as well as renewal permits for ongoing studies. An additional 22 scientists inquired about conducting research in Yellowstone, but did not pursue obtaining a research permit. Twenty-one investigators reported the conclusion of their studies and submitted their research findings and publications to the park.

The Research Permit Office staff provided general park information and logistical support to researchers throughout the year, and accompanied several research groups in the field, enabling us to better understand their project's needs as well as ensure that no park resources were harmed. During these field outings our staff and the researchers usually discover better ways to record data or collect samples as well as minimize any potential negative affects on resources. These ideas for "best practices" are documented and transferred to our staff and other researchers when applicable.

Though Yellowstone is widely known for its abundant wildlife and unique geothermal features, scientific research is conducted in a variety of disciplines. A breakdown of research studies, by topic, is as follows:



Benefits-Sharing EIS

A draft of the Servicewide Benefits-Sharing Environmental Impact Statement (EIS) was completed and released to the public in September 2006. The key issue examined in this, the first servicewide EIS that the National Park Service (NPS) has ever prepared, is whether the NPS should share in the potential scientific and economic benefits when researchers studying park resources discover or invent something commercially valuable from their research. The EIS sought to clarify the rights and responsibilities of researchers and the NPS in these instances by considering three alternatives:

- The Preferred Alternative would require researchers who study park specimens to enter into benefits-sharing agreements with the NPS before using their research results for any commercial purpose. Engaging park researchers in benefits-sharing agreements could return scientific benefits, in-kind services, and sometimes royalties and other monetary benefits to parks for conservation-related purposes.
- Another alternative would prohibit scientific research involving NPS specimens if associated with the development of commercial products.
- The "No-Action" alternative would allow research that may lead to commercial products to continue in parks without any obligation to share any resulting benefits with the NPS.

A 130-day public review of the draft EIS concluded in early 2007. Approximately 9,600 individuals and organizations submitted comments. The EIS team conducted a thorough review of all the correspondence and developed responses to the comments in accordance with Council on Environmental Quality regulations. During this process, the team worked extensively with external partners and the NPS Washington Office staff in order to resolve lingering concerns. A final EIS was ready for internal review in December 2007. When legal clearances are received from the Department of the Interior Solicitor's Office and Washington-level reviews are completed, the EIS process will conclude with release of the final EIS and its decision document.

The EIS team also continued to address the massive August 2005 Freedom of Information Act (FOIA) request with assistance from the Solicitor's Office and staff from the Assistant U.S. Attorney's Office. Complying with the FOIA required the review and handling of hundreds of documents that covered four years of work on the EIS. At the request of the NPS Washington Office and individual park units, the EIS team provided assistance on issues related to benefits-sharing and bioprospecting, such as questions about Material Transfer Agreements and national level policy issues.

Resource Information Team

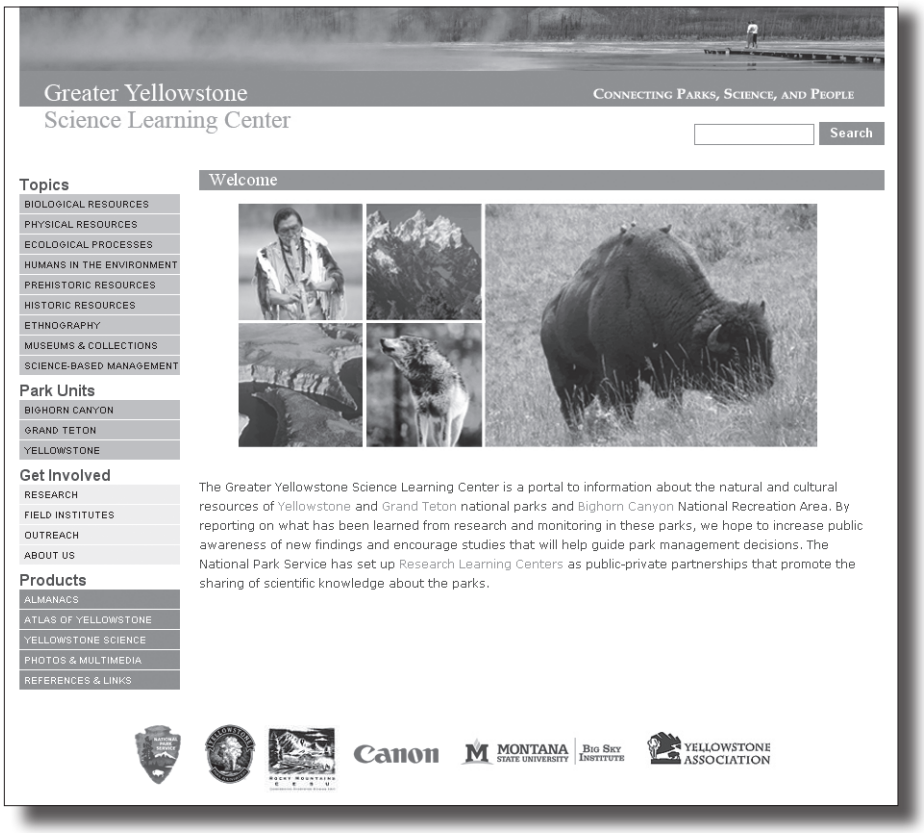
The mission of the Resource Information Team is to synthesize scientific and technical information and make it available in language and formats that are accessible to researchers, other agency scientists, interested members of the public, and park managers who need to take research results into consideration when making decisions about park policies and priorities. Through presentations, events, printed and electronic publications, and outreach efforts, staff strive to promote discussion of park issues and policies by a variety of participants; contribute to the scientific body of knowledge about the park; and promote resource conservation and visitor enjoyment through improved understanding of ecological issues.

Personnel worked toward those goals in 2007 by producing three issues of *Yellowstone Science* magazine; creating content for and working through a restructuring of the Greater Yellowstone Science Learning Center website with support from the Yellowstone Park Foundation and Canon U.S.A., Inc.; developing plans for the 9th Biennial Scientific Conference on the Greater Yellowstone Ecosystem; and producing a variety of other materials in support of YCR and other divisions.

Yellowstone Science magazine

In 2007, the quarterly journal *Yellowstone Science* entered its fifteenth year, presenting information on many aspects of the park's natural and

cultural resources for nearly 2,600 subscribing individuals and institutions. In addition to an issue devoted to wildlife diseases and health initiatives in Greater Yellowstone, topics included proteins that can effectively operate in the park's geothermal areas at high temperatures, park visitors' preferences regarding their backcountry experience, and Theodore Roosevelt's 1903 camping trip in the park.



Other Publications

Other recurring publications in 2007 included annual reports on Yellowstone Center for Resources activities, the Wolf Project, Yellowstone Fisheries and Aquatic Sciences, and pronghorn winter distribution, all of which were edited and designed by resource information staff. Special publications included the editing, design, and layout of the *Core Operations One-Year Report* for the Superintendent's Office.

After the public comment period for the *Draft Servicewide Benefits-Sharing Draft Environmental Impact Statement* ended in early 2007, editing and layout of the final EIS began and continued through the end of the year. Research and writing also continued on a history of the Fishing Bridge peninsula that will be used to guide the road reconstruction design in that area, and on *An Ecological History of Greater Yellowstone Wildlife, 1800–1882*. A grant provided by the Yellowstone Park Foundation has been used to create a GIS database containing hundreds of early narratives about wildlife that can be analyzed to reveal spatial and quantitative patterns otherwise concealed beneath the sheer volume of material. The database will be a useful tool for land managers, researchers, interpreters, and constituency groups seeking accurate information regarding previous ecological conditions in Greater Yellowstone.

Greater Yellowstone Science Learning Center

The Greater Yellowstone Science Learning Center (GYSLC) is a partnership between the Yellowstone Center for Resources, the Greater Yellowstone Inventory and Monitoring Program, the Rocky Mountains Cooperative Ecosystem Studies Unit, Montana State University's Big Sky Institute, the Yellowstone Association, the Yellowstone Park Foundation, and Canon U.S.A., Inc., as part of the *Eyes on Yellowstone* is made possible by Canon program. It has been adopted as the servicewide model for a website strategy for NPS Research Learning Centers and Inventory and Monitoring Networks. Its primary purposes are to promote mission-oriented research in the Greater Yellowstone Inventory and Monitoring Network (Yellowstone and Grand Teton national parks and Bighorn Canyon National Recreation Area), and to explain the need for and results of research in the network to park managers, researchers, educators, students, and interested public. During 2007, resource information staff worked with the Big Sky Institute to restructure the website from a park-based, static site to a resource-centric, dynamic site. Staff also developed, format-

ted, and posted content for 20 additional topics on the website and updated information on existing topics. The site can be accessed at www.greateryellowstonescience.org.

Ninth Biennial Scientific Conference

In recognition of the 20th anniversary of the Yellowstone 1988 fires, the National Park Service is co-sponsoring the Biennial Scientific Conference on the Greater Yellowstone Ecosystem with another organization, the International Association of Wildland Fire (IAWF). This has required resource information staff to work with an IAWF committee to plan a conference that will meet the objectives of both organizations while accommodating a much larger number of participants than in prior years. "The '88 Fires: Yellowstone and Beyond" is scheduled to be held in Jackson, Wyoming, on September 22–27, 2008.

Assistance and Support

During 2007, resource information staff produced miscellaneous flyers, maps, and graphics for park staff, including a redesign and reprint of the aquatic nuisance species brochure and four posters on the park's fisheries. They also provided guidance to park staff on working with the Government Printing Office and obtaining printing bids, and technical assistance on graphics software and layout issues; reviewed publications for the Division of Interpretation; and facilitated public comment on the site progress report to the World Heritage Committee on the park's status as a World Heritage site.

Funding and Personnel

Base Operating Budget

The final base operating budget was $4,348,000 for the Yellowstone Center for Resources in FY07. The increase of $136,700 over FY06 funding levels represented the return of funding from the park-wide lapse fund to support filling previously lapsed permanent and term positions. The base operating budget accounted for 65% of YCR's total for FY07. This compares to an average of 60% for the period FY95–06.

Additional Funding

Recreation Fee Demonstration Funds. The fee demo program provided $194,700 in funding for four new resource management projects in FY07: (1) improve collections storage at the Heritage and Research Center (HRC), (2) provide additional visitor service assistance at the HRC, (3) begin a condition survey of historic structures with high visitor use, and (4) restore westslope cutthroat trout to native habitats. Visitor fees also provided $155,000 to continue ongoing projects: renovation of and improvements to interpretive exhibits along the Nez Perce trail, installation of external lighting at the public entrance to the HRC, mapping utilities systems in preparation for building improvements, northern range riparian studies, a geothermal features inventory, a whirling disease survey, and a fisheries conservation project. Since the YCR began receiving fee demo money in 1997, about $2.284 million has been allocated from this funding program for 24 different projects..

Fishing Fee Program. The YCR received authorization to use $333,400 from fishing permit fee revenue to cover part of the estimated $925,000 cost of the aquatic resources program in FY07. The funding authorization was lower in FY07 than in previous years due to an anticipated reduction in revenues with the closure of some popular waters to protect fish during drought conditions. The portion of YCR's fisheries program funded out of permit revenues was also scaled back to be more commensurate with income trends over the last 10 years.

Federal Lands Highway Program. Federal Highways funded $567,100 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.

Special Emphasis Program Allocation System. The Branch of Cultural Resources successfully competed for a total of $208,900 in special emphasis program funding that was used to stabilize and maintain historic buildings (Fort Yellowstone NCO quarters, Blacktail Cabin, and the Norris Museum) and support four museum cataloging projects.

The special emphasis program also provided $205,200 for the Branch of Natural Resources for the final years of a three-year study on the declining pronghorn population, a three-year study for a trumpeter swan statistical analysis, and a two-year study of the Norris Geyser Basin groundwater system, and for several air quality monitoring projects.

Other Park Service Funds. YCR continued work on the Benefits-Sharing EIS in FY07 with funds provided by the servicewide planning office of the National Park Service ($162,000).

Other Federal Funds. Funds were provided by the Greater Yellowstone Coordinating Committee ($6,000) to conduct a Yellowstone whitebark pine study and produce a summary report of GYCC projects in FY07. The bulk of the funding in this category, however, was provided by the U.S. Fish and Wildlife Service for increased monitoring of grizzly bears in preparation for their removal from the Endangered Species List ($81,500) and the Bureau of Land Management for a Joint Fire Sciences Program fire behavior study ($209,400).

Private Funds. A total of $226,100 was donated to the park by private organizations or individuals in support of various YCR projects including whirling disease surveys, restoration of westslope cutthroat trout, Yellowstone cutthroat trout conservation efforts, wolf recovery program operations, the Tauck World Discovery volunteer program for historic structures conservation, cultural resource preservation projects, a bear management oral history project, the Yellowstone Atlas project, a wolverine survey, and to support the Greater Yellowstone Science Learning Center. Most of this funding ($191,500) came through the Yellowstone Park Foundation. The Montana Whirling Disease Initiative provided $22,900.

Personnel

At the end of July 2007, park management solidified many staffing decisions and subsequently published the *Core Operations One-year Report* in October 2007. This report signified the culmination of two years of the Core Operations Analysis effort and presented scenarios to address the park's base budget realities, starting with actual 2005 finances and ending with 2010 financial projections. The decisions that went into this report gave Yellowstone and the YCR a foundation for sustainable park operations and position management and provide a framework for future decision-making.

By the end of FY07, the YCR had largely completed the difficult position changes that were needed in order to meet the projected FY10 budget. Of the many positions on the park organization chart that have been eliminated since FY04 to address the budget shortfall, 11 were retirements or transfers out of YCR. It is expected that two additional positions will be vacated through retirements by FY10.

As a result of the parkwide reorganization and consolidation, personnel from both Resource Operations and Compliance were transferred to YCR effective October 1, 2007, adding two branches to the existing three (Natural Resources, Cultural Resources, and Professional Support). Park management committed to funding a new Compliance Coordinator position to head the Branch of Compliance, and it was agreed that discussion about selecting a permanent Branch Chief for Resource Operations would be deferred until alternatives for incorporating the program into the YCR target organization have been evaluated. Because the transition to the new branch configuration took place at the beginning of FY08, FTE and staffing changes are not reflected in this report, but will be incorporated into the Annual Report for 2008.

During FY07, YCR's management team continued to apply position management strategies that had been identified in the Core Operations Analysis, allowing for long-term financial solvency while focusing human resources on the highest park priorities. Of the 276 personnel actions processed by YCR in FY07, these were of special note:

- The lead position for YCR's Resource Information and Publications group, which had been vacant since October 2004, was restructured, reestab-

lished, and filled by Technical Writer-Editor Tami Blackford on a permanent basis under the title of Editor as of October 29, 2006.

- Montana Lindstrom successfully competed for and accepted a promotion to the permanent position of YCR Budget Analyst effective December 10, 2006, after backfilling the vacant position on a four-month detail.
- In January 2007, the GS-11 permanent GIS Specialist position vacated by Shannon Savage the year before was lapsed indefinitely and the workload was assumed by two GS-07 Cartographic Technicians (Carrie Guiles and Steven Miller) on four-year subject-to-furlough term appointments to evaluate the possible increased efficiency of this organizational structure.
- The YCR Chief of Cultural Resources and Resource Information, Roger Anderson, accepted a position with the Nature Conservancy and resigned from the National Park Service to relocate to Florida in February 2007. Roger's wife, HRC Program Manager Carol Shively, accompanied Roger and was later offered employment with an NPS servicewide interpretation project duty-stationed at nearby Canaveral National Seashore. The HRC Program Manager position was eliminated after Carol's departure as prescribed by the Core Operations target staffing plan.
- Park Archeologist Ann Johnson accepted a temporary promotion and assumed the supervisory duties of the Chief of Cultural Resources beginning March 4, 2007, for the remainder of the year.
- Due to persistent illness, boat operator Don Wethington was granted medical accommodation and reassigned from the Lake gillnetting operation to fish restoration projects based in Mammoth. His duties at Lake were assigned to a temporary employee for the summer. Following the approval of Don's medical disability petition and separation from the NPS in July 2007, the permanent, subject-to-furlough boat operator position he had occupied was lapsed indefinitely as part of the Core Operations efficiencies plan.
- Editorial Assistant Virginia Warner accepted a permanent position with the park's central Backcountry Office as of June 24, 2007. Her position was backfilled on a temporary basis by Janine Warner, who came to YCR after her seasonal appointment as an interpreter at the Albright Visitor Center in Mammoth concluded in October 2007.
- In August 2007, Yellowstone assumed administrative responsibility for the Ecologist position shared with, and previously administered by, Grand Teton National Park for bioacoustic analysis related to winter use monitoring. Shan Burson was selected for this highly specialized work and added to the YCR staff, but remained at Grand Teton as the most convenient location for the project base.
- Senior staff Wildlife Biologist PJ White was selected to fill the Supervisory Wildlife Biologist position, vice-Glenn Plumb, effective August 26, 2007. His former position as the park ungulate biologist was discontinued as an organizational efficiency per the Core Operations plan, although some of the duties remained with PJ in addition to his new responsibilities.
- When the lead biological technician term appointment with the lake trout control program expired, it was determined that although a similar position was still necessary for the short-term, it could be made subject-to-furlough as an efficiency. Phil Doepke was selected for this new position as of September 7, 2007.

The total FTE of the YCR staff was equivalent to 65 full-time employees for FY07 (Appendix 1, FTEs). This represents a significant reduction from the FY05 Core Operations baseline of 72 FTE, and a major change in staffing levels and organization structure in YCR from the peak level of 76 FTE in FY04.

Other Administrative Activities

Assistance Agreements. Staff processed 40 assistance agreements and task orders in FY07, totaling obligations of $1,431,800, of which 34% was used for administration of the Montana Water Compact and geothermal monitoring plan. Other significant investments were made in cultural resources studies, research related to fire ecology and vegetation on Yellowstone's northern range, wildlife research, aquatic resources studies, and research in support

of winter use studies.

Procurement Actions. Staff processed 631 procurement actions. Beginning January 1, 2007, all Yellowstone divisions were required to use the Interior Department Electronic Acquisition System (IDEAS) to request acquisition services from the Yellowstone Procurement and Contracting Office. This created a new workload for the YCR administrative staff and a larger workload for staff involved in the credit card purchasing process because more micro-purchasing was done internally. During this implementation year, 237 purchase requests were prepared in IDEAS, while 394 acquisitions were accomplished primarily through administrative staff credit card orders, for a total of 631 procurement actions in FY07, resulting in approximately $672,700 in expenditures.

Clerical Support. Staff processed 949 pieces of correspondence and 226 travel authorizations in FY07. Due to a concerted effort to reduce travel expenses parkwide, the number of approved YCR travel authorizations was cut by 34% from FY05–06 levels and 62% from FY02–03 levels, the division's highest.

Funding history (FY 1993–07), Center for Resources, Yellowstone National Park (new allocations only).

		National Park Service Funds										
YCR Base Increase	FY	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%

YCR distribution of FY07 funds (includes carryover).

Support: Mgt, Admin, Sci, Pubs, GIS	862,700	-	-	-	36,200	26,300	162,000	-	17,500	1,104,700	16.4%
Natural Resources	2,849,400	205,200	-	333,400	280,100	160,900	-	295,900	169,900	4,294,800	63.9%
Cultural Resources	635,900	-	208,900	-	250,800	191,000	-	1,000	38,700	1,326,300	19.7%
Total:	**4,348,000**	**205,200**	**208,900**	**333,400**	**567,100**	**378,200**	**162,000**	**296,900**	**226,100**	**6,725,800**	**100%**

Other NPS:	
Benefits Sharing EIS	**162,000**
Other Federal:	
BLM - Joint Fire Sciences Program	209,400
USFWS - Grizzly Conservation Strategy	81,500
GYCC - Whitebark Pine Study	5,000
GYCC - Conference Proceedings	1,000
Total:	**296,900**

Private:	
Travel Reimbursements	5,100
General Donations	300
Archeology Donations	1,800
MT Whirling Disease Initiative	22,900
UWY DNA Markers Grant	4,500
Yellowstone Park Foundation	191,500
Total:	**226,100**
Not Included:	
USGS-BRD Bear Study Team (no YCR charges - pass through only)	**4,300**

Base:	**4,348,000**	**65%**
All Other:	**2,377,800**	**35%**

APPENDIX I

Personnel Roster, 2007

Professional Support Branch

Management and Administration

			YCR FTE	Non-YCR FTE
1.	Cline, Barbara	Division Secretary	1.00	
2.	Deutch, Ann	Environmental Protection Assistant	0.57	
3.	Hendrix, Christie	Environmental Protection Assistant	1.00	
4.	Housley, Sara	Center Clerk	0.15	
5.	Lindstrom, Montana	Budget Analyst	1.02	
6.	McAdam, Melissa	Sprv. Budget Analyst	1.00	
7.	Mills, Sue	Environmental Protection Specialist	1.00	
8.	Olliff, Tom	Division Chief	1.01	
9.	Shively, Carol	Program Manager - HRC	0.33	
10.	Smith, Christine	Environmental Protection Assistant	0.83	
	Maintenance & custodial assistance (Lake Research Dorm)		-	0.02
		subtotal Management & Admin:	**7.91**	**0.02**

Resource Information Team

11.	Blackford, Tami	Editor	1.00	
12.	Franke, Mary Ann	Technical Writer-Editor	0.39	
13.	Lawson, Cecilia	Editorial Assistant	0.35	
14.	Schullery, Paul	Resource Naturalist	0.51	
15.	Stevenson, Sarah	Technical Writer-Editor	0.05	
16.	Warner, Virginia	Editorial Assistant	0.71	
		subtotal Resource Information:	**3.01**	**-**

Spatial Analysis Center

17.	Allred, Samuel	Cartographic Technician	0.19	
18.	Avila, James	Cartographic Technician	0.07	
19.	Bone, Sarah	Cartographic Technician	0.51	
20.	Coleman, Katrina	Cartographic Technician	0.21	
21.	Comer, Greg	Cartographic Technician	0.23	
22.	Fano, Elisabeth	Cartographic Technician	0.10	
23.	Guiles, Carrie	Cartographic Technician	1.02	
24.	Miller, Steve	Cartographic Technician	0.82	

25.	Park, Brian	Cartographic Technician	0.40	
26.	Rice, Matthew	Cartographic Technician	0.12	
27.	Rodman, Ann	Sprv. GIS Specialist	1.02	
28.	Spritzer, John	Cartographic Technician	0.27	
29.	Wolf, Sarah	Cartographic Technician	0.07	
		subtotal Spatial Analysis:	**5.03**	**-**
Professional Support Branch FTE:			**15.95**	**0.02**

Natural Resources Branch

Natural Resources Administration

1.	Burson, Shan	Ecologist (Bioacoustics)	0.06	
2.	Cole, Stephanie	Administrative Support Assistant	0.04	
3.	Plumb, Glenn	Chief of Natural Resources	1.00	
4.	Wyman, Becky	Administrative Support Assistant	0.99	
	Horse handler & packer support (bison, fish, geology projects)		-	0.28
	Winter Use Monitoring Assistance (wildlife, air quality, acoustic)		-	0.76
		subtotal NR Admin FTE:	**2.09**	**1.04**

Wildlife Resources Team

5.	Blanton, Doug	Biological Science Technician	1.01
6.	Boyce, Michael	Biological Science Technician	0.44
7.	Byron, Carrie	Biological Science Technician	0.38
8.	Cole, Stephanie	Administrative Support Assistant	0.16
9.	Coleman, Tyler	Biological Science Technician	0.41
10.	Davis, Troy	Biological Science Technician	1.04
11.	Geremia, Chris	Biological Science Technician	1.00
12.	Guernsey, Deb	Biological Science Technician	0.97
13.	Gunther, Kerry	Wildlife Biologist	1.03
14.	Jones, Jennifer	Biological Science Technician	0.99
15.	Linch, Jonathan	Biological Science Technician	0.25
16.	Loveless, Karen	Biological Science Technician	0.22
17.	McEneaney, Terry	Wildlife Biologist	1.00
18.	McIntyre, Rick	Biological Science Technician	0.50
19.	Murphy, Kerry	Wildlife Biologist	0.97
20.	Quinn, Daniel	Biological Science Technician	0.26
21.	Smith, Doug	Wildlife Biologist	1.02
22.	Smith, Jeremiah	Biological Science Technician	0.42
23.	Stahler, Dan	Biologist	0.32
24.	Tallian, Aimee	Biological Science Technician	0.54

25.	Treanor, John	Biological Science Technician	0.87	
26.	Wallen, Rick	Wildlife Biologist	1.00	
27.	Wells, Kimberly	Biological Science Technician	0.30	
28.	White, PJ	Wildlife Biologist	1.00	
29.	Wyman, Travis	Biological Science Technician	1.14	
		subtotal Wildlife FTE:	**17.24**	**-**

Fisheries and Aquatic Resources

30.	Adams, Rebecca	Biological Science Technician	0.50	
31.	Arnold, Jeff	Ecologist	1.00	
32.	Bigelow, Pat	Fishery Biologist	1.00	
33.	Billman, Hilary	Biological Science Technician	0.35	
34.	Bywater, Tim	Administrative Support Assistant	0.13	
35.	Doepke, Phil	Biological Science Technician	1.00	
36.	Erickson, Jeremy	Biological Science Technician	1.00	
37.	Ertel, Brian	Biological Science Technician	0.96	
38.	Glaser, Nicholas	Biological Science Technician	0.01	
39.	Koel, Todd	Sprv. Fishery Biologist	1.00	
40.	Kreiner, Ryan J.	Biological Science Technician	0.08	
41.	Legere, Nicole	Biological Science Technician	0.50	
42.	Mahony, Dan	Fishery Biologist	0.54	
43.	Olszewski, Brad	Biological Science Technician	0.44	
44.	Romankiewicz, Chris	Biological Science Technician	0.26	
45.	Squires, Audrey	Biological Science Technician	0.38	
46.	Sigler, Stacey	Biological Science Technician	0.54	
47.	Wethington, Don	Small Craft Operator	0.15	
48.	Wiggins, Justin	Biological Science Technician	0.08	
		subtotal Aquatic Resources FTE:	**9.92**	-

Vegetation Management

49.	Anderson, Heidi	Botanist	0.85	
50.	Hektner, Mary	Sprv. Vegetation Specialist	1.00	
51.	Izlar, Kay	Biological Science Technician	0.40	
52.	Klaptosky, John	Biological Science Technician	0.55	
53.	Miller, Steve	Cartographic Technician	0.13	
54.	Regula, Vicki	Biological Science Technician	0.08	
55.	Renkin, Roy	Vegetation Management Specialist	1.01	
56.	Whipple, Jennifer	Botanist	0.79	
57.	Woodin, Mary K.	Biological Science Technician	0.23	
		subtotal Vegetation FTE:	**5.04**	**-**

Geology and Physical Sciences

58.	Eagan, Sean	Hydrologist	1.00	
59.	Heasler, Hank	Geologist	1.00	
60.	Jaworowski, Cheryl	Geologist	0.97	
61.	Mahony, Dan	Fishery Biologist	0.46	
		subtotal Geology FTE:	**3.43**	-
Natural Resources Branch FTE:			**37.72**	**1.04**

Cultural Resources Branch

1.	Anderson, Roger	Chief of Cultural Resources	0.53	
2.	Curry, Colleen	Museum Curator	1.00	
3.	Dawson, Herb	Historic Architect	1.00	
4.	Felton, Tasha	Cultural Resources Technician	0.75	
5.	Finn, Lauren	Archives Technician	0.36	
6.	Guild, Bridgette	Museum Technician	0.86	
7.	Hale, Elaine	Archeologist	0.96	
8.	Hamerman, Meryl	Library Technician	0.23	
9.	Housley, Harold	Archivist	0.58	
10.	Housley, Sara	Center Clerk	0.11	
11.	Johnson, Ann	Archeologist	1.00	
12.	Reid, Charissa	Cultural Anthropologist	0.50	
13.	Sucec, Rosemary	Cultural Anthropologist	0.96	
14.	Washburn, Andrew	Museum Technician	0.37	
15.	White, Katie	Anthropology Technician	0.98	
16.	Whittlesey, Lee	Historian	1.00	
17.	Zirngibl, Wendy	Museum Technician	0.25	
18.	Historic Structures Preservation Projects Assistance		-	1.32
		Cultural Resources Branch:	**11.44**	**1.32**
104.	**YCR Employees**	**TOTAL YCR FY07 FTE:**	**65.11**	**2.38**

APPENDIX II

Publications, Reports, and Papers

Professional Publications

Bruggeman, J. E., R. A. Garrott, P. J. White, F. G. R. Watson, and R. Wallen. 2007. Covariates affecting spatial variability in bison travel behavior in Yellowstone National Park. *Ecological Applications* 17(5):1411–1423.

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Administrative Reports

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Christiansen, R. L., J. B. Lowenstern, R. B. Smith, H. Heasler, L. A. Morgan, M. Nathenson, L. G. Mastin, L. J. Patrick Muffler, and J. E. Robinson 2007. Preliminary assessment of volcanic and hydrothermal hazards in Yellowstone National

Park and vicinity. U.S. Geological Survey Open-file Report 2007-1071. <http://pubs.usgs.gov/of/2007/1071/>

Fey, M., P. Perotti, D. Reinhart, S. O'Ney, and E. Reinertson. 2007. Aquatic nuisance species project report. Resource Management Operations, Yellowstone National Park, Wyoming.

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_____. 2007. Yellowstone National Park recreational use. Page 30 *in* C. C. Schwartz, M. A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: Annual report of the Interagency Grizzly Bear Study Team, 2006. U.S. Geological Survey, Bozeman, Montana.

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_____. 2007. Analyses of rain-induced turbidity events July 25 and 26, 2007 Sylvan Pass, Yellowstone National Park. Yellowstone Center for Resources internal report, Yellowstone National Park, Wyoming.

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Jaworowski, C., and H. Heasler. 2007. Hydrothermal gases at the Safety Office and Blacksmith's Shop, Mammoth Hot Springs, Yellowstone National Park. Yellowstone Center for Resources internal report, Yellowstone National Park, Wyoming.

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_____. 2007. Where are all the bears? Information Paper No. BMO-4. U.S. Department of the Interior, National. Park Service, Yellowstone National Park.

_____. 2007. Yellowstone National Park bear-related injuries/fatalities. Information Paper No. BMO-1. U.S. Department of the Interior, National Park Service, Yellowstone National Park.