101/D-1041

YELLOWSTONE CENTER FOR RESOURCES

ANNUAL REPORT 1997

Color Scans
11/12/2003

Yellowstone Center for Resources 1997 Annual Report

Yellowstone Center for Resources
National Park Service
Yellowstone National Park, Wyoming
YCR-AR-97
1998

Table of Contents

NPS photo

Introduction and Dedication

The year 1997, in which we marked the 125th anniversary of Yellowstone National Park, is memorable for several reasons. We might reflect upon how much has changed—or has not—in the park's long and controversial history. When the park was created, the American public and its stewards thought to protect the wildlife and the outstanding scenic wonders, the "*natural* curiosities" that were documented by early visitors to the region. They likely did not imagine the future value society would place on Yellowstone as a *cultural* icon—as a place where a great idea was implemented, one that took hold and spread across the world. A place where the people who came, the structures they left behind, and the events that occurred would come to be valued for their contribution to the history of the conservation movement and to our understanding of the overall relationship between humans and the landscape over generations of time.

In 1997 we celebrated that history with our fourth biennial science conference on *People and Place: The Human Experience in Greater Yellowstone.* As we did so, we acknowledged that while we have made great strides in the appreciation of our cultural resources, we have much yet to do to provide the professional program of cultural resource management that we think Yellowstone's priceless heritage deserves.

With regard to our natural resources, we think we continue to make some outstanding progress, such as in endangered species recovery and through a potentially ground-breaking agreement to manage "bioprospecting." Yet we have a sense of *déjà vu.* Some of the issues of great debate 100 years ago seem like ever-spinning wheels that fail to touch ground and move down the road to the 21st century. The management of the park's northern range and its bison, topics of management angst early in Yellowstone's history, remain contentious and dominate the public and staff agendas yet today. Though it has been decades since

we stopped deliberately stocking exotic fish species, the conflict over protecting natives from non-native but popular sport fishes caused us to pause and reconsider restoring native westslope cutthroat trout.

Major projects undertaken by the many professionals in and assisting the Yellowstone Center for Resources (YCR) are summarized in this report. Some projects also provide additional detailed information in technical publications or a special report. As ever, this report does not include all the work activities done by park resource specialists in 1997. Interested persons may contact us at (307) 344-2203 if they desire more information about any of Yellowstone's cultural or natural resources.

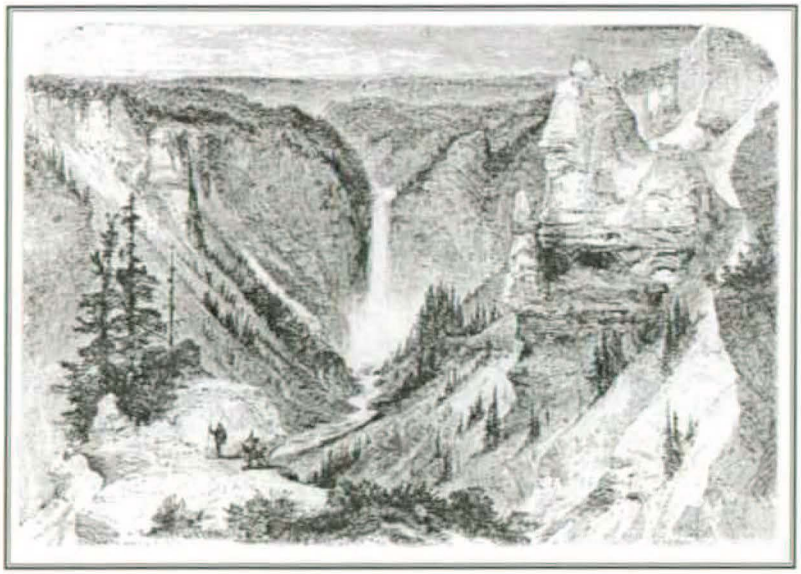
Sadly, 1997 will perhaps be most remembered by Yellowstone's staff as the year in which we lost a valued member of our own. Our friend and colleague, Roderick A. "Rick" Hutchinson, came to Yellowstone, like many park staff, as a seasonal employee in 1970. He began his career as a dedicated geyser-watcher, settled in to replace George Marler, the original park geologist, in 1973, and went on to finish his master's degree. In sight of Old Faithful Geyser, Rick met his wife, Jennifer Whipple, who became the park botanist/herbarium curator, and together they became fixtures of the Yellowstone resource staff throughout the 1980s and 1990s.

Rick was a bit of a renaissance figure, a uniformed (though admittedly, his wearing of the green left some standards-bearers cringing) employee proud to be called a Research Geologist. For more than a quarter of a century he lived and worked in the park interior, snowbound in winter within a half mile of his beloved Upper Geyser Basin. A product of an older, less-specialized era in the parks, he never hesitated to volunteer assistance with visitor assists, medical, or search-and-rescue operations, or to provide interpretation to visiting geologists or the general public when asked. And while genuinely interested in the entire park, he gently but persistently reminded many of us that the public and administrative obsession with charismatic creatures and hot-button issues often made us overlook what are arguably the most unique resources of Yellowstone—the world's largest volcanic caldera and two-thirds of its geysers and hot springs.

No one alive rivalled Rick's knowledge of Yellowstone's geothermal features, gained through countless hours of personal observation and voluminous readings from geologic journals. He loved to travel into the backcountry, solo or in the company of anyone who appreciated the park, and it was from one of those forays that he never returned. On March 3, 1997, while on an annual winter inspection of the Heart Lake Geyser Basin, he and a volunteer research associate died in an avalanche. The park flags flew at half mast while his fellow employees and "geyser gazers" everywhere mourned the passing of a truly irreplaceable friend of Yellowstone's resources.

We dedicate this year's YCR annual report to our absent friend, Rick Hutchinson, whose contributions to the preservation and appreciation of Yellowstone's resources will not be forgotten.

John D. Varley, Director
Yellowstone Center for Resources



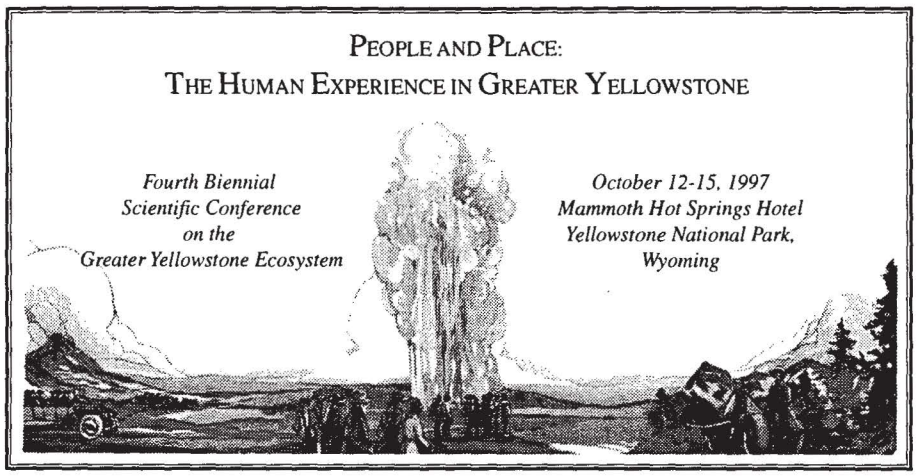
Part I. Resource Highlights

125TH Anniversary Events

To help celebrate the 125th anniversary of the establishment of the park, YCR staff helped plan and carry out a wide variety of events. Cultural resources staff wrote press releases, contributed to *The Yellowstone Album: A Photographic Celebration of the First National Park* (a collection from the park's archives), assisted with the August 17th "Protectors of Yellowstone" event at Mammoth, and coordinated the participation of tribal representatives at the Old Faithful celebration on August 25. This event included a traditional welcome by a Crow tribal member, and dancing and drumming by representatives of the Shoshone-Bannock tribes.

Fourth Biennial Conference on the Greater Yellowstone Ecosystem

More than 225 people gathered at the Mammoth Hot Springs Hotel on October 12–15, 1997, to learn about the past, present, and future of the area's cultural resources at the park's fourth biennial scientific conference: "People and Place: The Human Experience in Greater Yellowstone." The goal of this biennial conference is to promote the spread of research information between scientists, managers, and interested citizens. YCR staff assisted Montana State University staff in organizing and running the conference, which the university co-sponsored with the NPS. Conference sessions included topics such as



tourism, wilderness, prehistory, indigenous peoples, nature writing, cultural heritage, women's experiences, and the park's establishment.

The opening speech, "How Things Work in Yellowstone" was made by Paul Schullery, part-time Yellowstone employee, adjunct professor of American Studies at the University of Wyoming, affiliate professor of History at Montana State University, and author of many books about Yellowstone.

The conference featured the A. Starker Leopold Lecture Series Banquet, honoring one of the century's most influential wildlife ecologists and writers. This year's Leopold Lecturer was T.H. Watkins, author of numerous works on 20th century conservation and the first Wallace Stegner Distinguished Professor of Western American Studies at Montana State University. Watkins' speech, "Consensus and the Camel's Nose: An Inquiry into How Far We Can Go Before the Beast Occupies the Entire Tent," addressed the difficulties of consensus, particularly with regard to environmental policy and land management decisions.

This conference inaugurated the Aubrey L. Haines Luncheon and Lecture, in honor of Yellowstone's premier historian, who was presented with an award by Lake District Ranger John Lounsbury. The Aubrey L. Haines lecturer was Dr. Peter Nabokov, UCLA associate professor of American Indian studies and World Arts and Cultures, and author of books on Native Americans, who is drafting the park's Ethnographic Overview and Assessment. His speech, "Reintroducing the Indian: Observations of a Yellowstone Amateur," was illustrated by vivid slides showing the cultural histories of American Indian peoples who have significant relationships to the greater Yellowstone ecosystem.

Patricia Nelson Limerick, Professor and MacArthur Fellow at the University of Colorado, presented the humorous and thought-provoking "Lessons and Lesions of History: Yellowstone and Progress." Limerick is the author of *The Legacy of Conquest*, which has had a major impact on the field of Western American history.

Donald Worster, Hall Distinguished Professor of American History at the University of Kansas and author of books on western ecology, spoke on a comparative perspective of the conservation movement in North America for the Superintendent's International Luncheon.

Lynda Bourque Moss, Director of the Western Heritage Center, discussed the region's heritage preservation and partnership efforts.

To ensure the widest possible distribution of the papers presented at the conference, the

proceedings were to be put on the world wide web, with Susan Rhoades Neel (Montana State University) and Paul Schullery serving as general editors and seeking print publication of selected groups of papers in appropriate forums.

Yellowstone Signs First Bioprospecting Agreement

On August 17, Yellowstone set a milestone in the history of the National Park Service by signing the first "bioprospecting" arrangement with Diversa Corporation, a company headquartered in San Diego, California, that specializes in the industrial application of biocatalysts. Scientific interest in the park's hot spring microbes has increased steadily since the late 1980s, when cloned versions of an enzyme produced by *Thermus aquaticus*, first found in a Yellowstone hot spring, revolutionized DNA technology through their use in fingerprint analysis and the detection of genetic diseases. Revenues in excess of several hundred million dollars have been generated from the use of that technology, and debate ensued over the propriety of national park resources being used for commercial value, and without compensation paid.

While the new agreement does not permit Diversa to do anything in Yellowstone that would have been prohibited in the past, the company has pledged a portion of its future profits from the results of its microorganism sampling in the park for conservation and the park's related scientific and public education activities. The agreement was reached with the assistance of the World Foundation for Environment and Development (WFED), an independent nongovernmental organization that was established to facilitate negotiations in the field of environment and development. At the end of the year the pioneering agreement was being reviewed by solicitors and senior managers in the Washington Office of the NPS.

Researchers collecting microbes in one of Yellowstone's many thermal pools.

At a workshop on "Biodiversity and Bioprospecting in the National Parks: The Yellowstone Experience," held on October 15, panelists from the park, WFED, and conservation organizations discussed related legal, philosophical, and management issues with a University of Utah law professor and a representative of the American Type Culture Collection, repository for microbiological samples taken from Yellowstone and elsewhere.

National Academy of Science Completes Report on Bison Brucellosis

In May, the Department of the Interior commissioned a report by the National Academy of Science (NAS) to evaluate the existing science on the question of whether bison or elk could transmit the bacteria *Brucella abortus* to cattle. The NAS report, which was released in December, emphasized that brucellosis affects both elk and bison, and encompasses the entire greater Yellowstone area (GYA), not simply Yellowstone National Park, and that "it would be impossible to vaccinate all GYA elk." But the NAS review identified studies that could lead to the development of techniques

that could make eradication of brucellosis from GYA wildlife possible in the future. The report's primary finding is that risk management is critical to controlling the disease in the GYA until a proven, effective vaccine and a practical delivery mechanism for inoculating elk and bison are found. A final report incorporating agencys' comments was expected to be published in 1998.

Northern Range History and Science Summarized

In June, the park released a 150-page book entitled *Yellowstone's Northern Range: Complexity and Change in a Wildland Ecosystem.* The report summarizes the long history, controversial management issues, and past, current, and still-needed research related to this critical resource. The northern range, home one of the nation's largest herds of elk as well as a full complement of other native ungulates and associated predators, has been a subject of hundreds of research studies, numerous other books and articles, and several high-level scientific review panels. The report was printed with a generous donation from Canon U.S.A., Inc., and copies are available to interested readers who contact the Yellowstone Center for Resources by phone at (307) 344-2203 or via email to: yell_resources@nps.gov.

Reclamation of Two Abandoned Gravel Quarries Completed

Reclamation of two long-abandoned park gravel quarries was completed as part of a cooperative effort between the park and the Wyoming Department of Environmental Quality's Abandoned Mine Land (AML) Division. The project, funded by a grant from the AML, permanently closed the Little Thumb and Dry Creek quarries and associated roads. Gravel eroding from the 11.5-acre Little Thumb quarry raised the bed of Little Thumb Creek, causing it to dry out during trout spawning runs. As a result of the restoration, it is estimated that the effective habitat for both spawning trout and associated grizzly bear fishing was increased by half. The project deepened the creek, recontoured the quarry to prevent additional erosion, removed the access road, and revegetated the area with native species. Reclamation of the 5-acre Dry Creek quarry was similar, allowing the removal of the 4.3-mile-long access road and reclamation of about 1.6 acres of wetland. The park and the State of Wyoming hope to continue this partnership in land reclamation to benefit park plants and wildlife, aesthetics, and public safety.

Archeologic Surveys Reveal Important Information

During the 1997 field season, park staff, cooperators, and volunteers contributed to park archeology studies and made a number of new discoveries. The general patterns of obsidian use are beginning to emerge through determination of the sources of obsidian found in a variety of locations. Along the Yellowstone River upstream from Gardiner, Montana, Obsidian Cliff obsidian dominates the samples found and studied to date, but Bear Gulch obsidian from southern Idaho is present in minor amounts. The obsidian in the gravels at Park Point, on the east shore of Yellowstone Lake, is from an unknown source. As more samples are taken, the researchers hope to

determine if distinct patterns of obsidian use can be identified for people at different times in the past.

Along the Yellowstone River corridor, data from three eroding roasting pits/hearths were salvaged and two other sites were tested. All the sites were prehistoric in age and had been severely damaged by the 500-year floods that occurred earlier in the summer. One site contained Intermountain ware (radiocarbon dated at between 630 and 930 ± 60 yrs. Before Present) from the most recent period of prehistoric occupation. This is only the second prehistoric ceramic site identified in the park.

A historical archeology crew led by Ken Karsmizki from the Museum of the Rockies mapped and tested the Soda Butte Soldier Station along the Northeast Entrance road. When the Army managed Yellowstone, there were 16 such posts throughout the park. The archeology work, in combination with archival data, is clarifying the chronology and function of select features at the site.

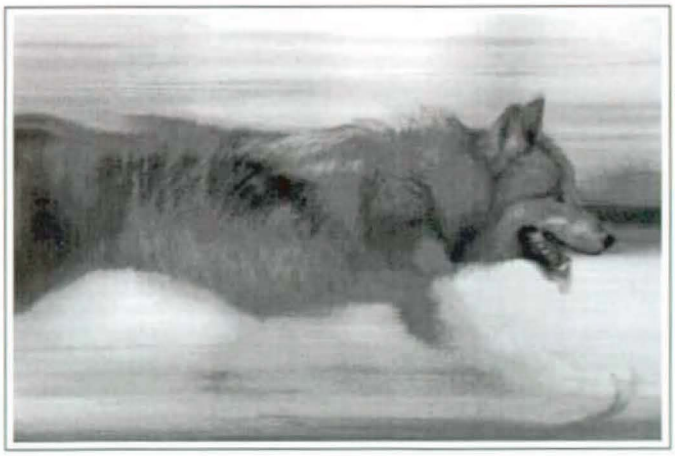
Of particular interest is the discovery of very young bison calf bones at another Lamar Valley site. A radiocarbon age of 2480±70 years B.P. was obtained using a bison ulna. This is the first archeologic site in the park that clearly shows human occupation during a particular season, based upon the fact that bison calving occurs annually in late spring.

Giant Geyser Renews "Frequent" Activity

In recent years, Giant Geyser, one of the park's largest geysers, located in the Upper Geyser Basin near Old Faithful, has had one eruption per year, usually occurring in the fall. During 1997, a total of 47 eruptions were recorded of this spectacular feature, which erupts from a massive, partially blown out cone to a height often exceeding 200 feet. Park staff and volunteers were able to predict an eruption of Giant Geyser within a few days. This resulted in renewed appreciation by a new generation of visitors who were fortunate enough to have witnessed one of the greatest geysers in the world.

Wolf Population Grows, but Legal Setback Casts a Shadow on the Future

In just three years since first transplanted back in Yellowstone from Canada, gray wolves wander the ecosystem by the dozens. In the spring of 1997, 9 wolf packs produced 13 litters of 67 pups, 73 percent of which still survived at the end of the year. Despite wolf mortalities from a number of causes, including management actions to remove livestock-depredating animals, the greater Yellowstone wolf population numbered about 86 in December. As in previous years, thousands of park visitors had the opportunity to thrill at the sight



Sawtooth pup, moved to Yellowstone from north central Montana, in Rose Creek pen. Photo by Joel Sartore.

or howl of a wild wolf in America's first national park—an experience missing for decades.

Ironically, in the face of early success in wolf production and survivorship, a legal setback occurred on December 12, when a U.S. District Court judge ruled that the restoration effort in Yellowstone and central Idaho had violated the Endangered Species Act. He ordered the wolves removed—but immediately stayed his order pending anticipated appeal. The future of Yellowstone's wolves lay uncertainly in the hands of the nation's legal system, far from the natural habitat where they appear once again quite at home.

Part II. Resource Team Reports

Introduction

Beginning in 1994, Yellowstone began to formally marshal its interdisciplinary resources as needed to address priority resource management operations, research, monitoring, and planning projects. Resource teams are convened when appropriate by the park's Resource Council—a group of senior managers and resource specialists who meet regularly to review priorities, objectives, and results of specific, defined projects. Teams are made up of resource specialists as well as professionals from other fields of expertise, as needed for the assigned project: rangers, maintenance, interpretation, concessions management, administration, planning, and public affairs.

In 1997, YCR staff continued working on several long-term priority resource team projects that are summarized here and discussed in more detail under the Cultural and Natural Resources chapters.

Bison Management Planning

The park's free-ranging bison herd has increasingly been of concern to public land managers and private landowners when bison move outside park boundaries. While efforts to produce a multi-agency long-range bison management plan have been underway since at least 1992, interim bison management actions continued in and outside park boundaries during the winter. In 1996–97, the

issue was exacerbated by a long and severe winter in which a record number of bison were killed or sent to slaughter as they left the park.

Project Status: The NPS, USDA Animal and Plant Health Inspection Service (APHIS), U.S. Forest Service, and Montana Department of Livestock (DOL) continued to develop alternatives to put forth to the public in a draft plan and environmental impact statement (EIS), rescheduled for public release by June 1998.

Management actions under the interim plan, revised and approved in 1996, occurred throughout the winter of 1996–97. In the autumn of 1996, the NPS had completed construction of a facility to capture bison in the Stephens Creek administrative area near the park's north boundary. A total of 1,084 bison were shipped to slaughter or shot in the field during the winter of 1996–97. The DOL shot 566 bison in the field and captured and shipped to slaughter 48 more bison. At the Stephens Creek capture facility, the National Park Service provided 462 bison to DOL for shipment to slaughter. Carcasses of animals shot in the field were donated to Native American tribes or to social service organizations for distribution. Eight bison were killed because of parasite infection or injuries sustained during capture operations.

By spring of 1997, the previous winter's control actions combined with heavy winterkill had reduced the bison population from approximately 3,500 to approximately 2,000 animals. However, by December 1997 it appeared that the winter of 1997–98 was to be much milder, and no bison had been captured or killed on or near park boundaries.

Team Leader: Wayne G. Brewster

See also: Part IV, Natural Resource Programs, Bison

Commercial Services Plan

In July 1996 the park established a team to prepare goals and alternatives to guide future management of all commercial services in the park. The YCR assigned two representatives to this team.

Project Status: The planning team met periodically, working with a team leader from the Rocky Mountain System Support Office, to incorporate comments from public scoping meetings into the development of draft goals, objectives, an assessment of existing conditions, and standards for commercial services in the park. The goal was to have a draft plan and environmental impact statement completed for public release in late 1998.

Team Leader: Edna Good

Grizzly Bear Conservation Strategy

In 1994, numerical goals outlined for biological recovery of the grizzly bear population in the greater Yellowstone ecosystem were achieved for the first time since the bears were listed as threatened under the Endangered Species Act in 1975. Accordingly, the Yellowstone Ecosystem Managers, a subcommittee of the Interagency Grizzly Bear Committee (IGBC), assigned an interagency team of biologists the task of completing a *Conservation Strategy* document. This document is intended to provide guidance for managing grizzly bears and their habitat if and when the population should be removed from the list of threatened species. Yellowstone National Park has continued to provide two staff members who have regularly participated in this team effort.

Project Status: A draft report has been in preparation and review since 1995. Due to lawsuits and delays in obtaining the data and analyses needed to prepare habitat-based management recommendations, the grizzly bear recovery coordinator set a revised goal to have a draft document complete for release to the public in late 1998. A third park resource specialist was required to spend significant

time producing maps and analysis of bear use of habitat in preparation for completing the draft *Conservation Strategy*. Staff resource specialists periodically briefed park managers about progress with the data analysis and proposed recommendations for future grizzly bear management in the park and adjacent areas.

Team Leader: Wayne Brewster

Lake Trout in Yellowstone Lake

Following the discovery of lake trout in the park's largest lake in late summer 1994, a resource team was established to prepare a strategy to assess and combat this threat. The experimental gillnetting and data collection, begun in 1995, were continued. By the end of 1997, staff were prepared to shift from "experimental" control to a long-term management control effort on non-native lake trout in Yellowstone Lake.

Project Status: Gillnetting was conducted throughout the summer months, with an overall favorable cutthroat-to-lake trout catch ratio of 1.5:1. Three different netting strategies were used to net 863 lake trout, an increase from the 580 lake trout captured during the previous year. Anglers caught another 250 lake trout, bringing the total to just over 1,100 lake trout caught in 1997. Areas that produced high catch rates last year were again good places to catch lake trout. Most adult lake trout are still in the West Thumb Basin and Breeze Channel areas. Preliminary results from hydroacoustic surveys (electronic fish finders) confirmed the suspected distribution of lake trout and revealed the deepwater (> 40 m) distribution of medium-sized (300- to 400-mm) lake trout. The big news was the discovery of at least one new spawning ground located in West Thumb, where more than 150 adult lake trout were caught; the fish were caught in deep water (20 m) and several of the females had already spawned. More than 230 lake trout (up from 180 during 1996) were also captured at a previously known spawning location near Carrington Island.

Team Leader: Stu Coleman

Research Permitting System

This team was established in 1994 to revamp the permit system so that proposed research projects in the park would receive more thorough peer review of incoming proposals. In 1996, a revised research permit system was implemented.

Project Status: A review panel, which includes a representative from each of the YCR branches of natural and cultural resources, along with representatives from each of the Divisions of Maintenance, Interpretation, and Resource Operations and Visitor Protection, met regularly to review proposals and their required peer reviews, and make recommendations on whether or not to approve a permit request.

Team Leader: Stu Coleman

Road Reconstruction Planning

The NPS, in partnership with the Federal Highway Administration, is involved in an estimated 20-year program of major park roadway reconstruction. Work to inventory resources in association with park road segments and assess the impacts of road reconstruction continued to occupy large portions of cultural and natural resource specialists' work time, as well as significant effort by the park's planning and compliance staff. During 1997, such inventory, monitoring, assessment, and planning activity continued on 11 segments of the park's road system.

Project Status: Resource data collection, including surveys to identify archeological, wetland, and herpetological resources, was underway on the Northeast Entrance road, the Mammoth-to-Gardiner road, the Tower-to-

Canyon road, and the Mammoth-to-Norris road.

Team Leader: Eleanor Williams

Wolf Restoration

The purpose of this project is to restore to the Yellowstone ecosystem a population of gray wolves that includes at least ten packs that produce pups for three consecutive years. When this is achieved and similar populations are present for three consecutive years in central Idaho and northwestern Montana, the gray wolf will be removed from the list of endangered species and managed as resident species by the respective states.

Project Status: Due to the success of the first two years' transplants, and due to the high cost of the capture and release program, no additional wolves were brought from Canada in 1997.

Sixty-seven wolf pups were born in 1997, and 32 wolves were known to have died, including 17 pups that did not live through their first year, 7 killed legally because of livestock predation, 3 shot illegally, and 1 that was killed in a collision with a vehicle. As of December, the GYA supported about 86 free-ranging wolves in 9 packs (although 2 packs lacked a breeding pair). Five wolves were being temporarily penned for the winter, following the removal of their pack's alpha female for livestock depredation in the late autumn.

Team Leader: Mike Phillips/Doug Smith

See also: Resource Highlights, Natural Resources, Wolf Restoration

Part III. Cultural Resource Programs

Introduction

Yellowstone's 125th anniversary and its fourth Biennial Conference on the Greater Yellowstone Ecosystem ("People and Place: The Human Experience in Greater Yellowstone") combined to place unprecedented attention on the park's cultural resources in 1997. These events required a great deal of cultural resource staff time, but generated valuable information about the past, present, and future of the park's cultural resources, and created partnerships between the park and researchers, supporters, and neighbors who appreciate this important component of Yellowstone.

Other priority projects in 1997 included:

- Assistance with the park-wide road reconstruction project
- National Register inventory and evaluation of historic structures
- Testing and evaluation of eroding archeological sites along the Yellowstone River
- Planning for a new collection storage facility
- Computerization of the park's library collection
- Training other divisions on cultural resource issues

To supplement the funds available from the Yellowstone park budget, funding for 1997 cultural resource projects was obtained from the Federal Highways Program ($212,550), the NPS Cultural Resources Preservation Program ($208,400), the NPS Cultural Cyclic Program ($20,000), and the Yellowstone Association ($24,200). These funds supported archeological inventories and monitoring; historic structure inventories; historic research;

Branch of Cultural Resources staff standing from left: Elaine Hale, Beth Raz, Catherine Lentz, Laura Joss, Vanessa Christopher, Susan Kraft, George Briggs. Sitting from left: Lee Whittlesey, Ann Johnson, and Barb Zafft. Photos courtesy Cultual Resources Staff.

archival, library, and museum collection management and conservation; library operation and automation; and 125th anniversary projects.

Yellowstone Heritage and Research Center

Staff from the park and the Rocky Mountain System Support Office continued their efforts to address the crowding and lack of security, fire protection, and environmental controls in the museum, library, and archival collection areas through the construction of a storage, research, and exhibit facility. Contract architects produced draft concept designs for such a facility in the Mammoth Hot Springs area. Ground-penetrating radar testing of potential sites to determine subsurface stability and identify the presence of faults or thermal features was conducted through a cooperative project with the University of Montana. Discussions continue with potential partners, including museums, academic institutions, and state agencies.

Additional Support to Park Management

Assistance was provided by the branch chief to the NPS Resources Careers initiative by evaluating its effect on Yellowstone's cultural resources staff and revisions to the new benchmark position descriptions.

The branch chief was a member of the task force set up to ensure compliance with the Government Performance and Results Act (GPRA), which was designed to improve public confidence in the federal government by holding all agencies accountable for results achieved, not just for efforts expended. Each federal agency is required to identify goals to accomplish their mission, and to document specific activities which will enable them to meet those goals by the year 2002. The branch chief assisted in assessing program needs and writing goals for the cultural and natural resource management components of Yellowstone's five-year Strategic Plan, which includes a requirement to establish service-wide standards.

ARCHEOLOGY

With only one archeologist assigned to the staff, most of the archeological fieldwork in the park continues to be done by volunteers and by cooperators from the Museum of the Rockies (Montana State University) and the Wyoming State Archeologist's Office.

Surveying Road Corridors

As is required for cultural resource compliance before ground disturbing activities are undertaken, eight sites adjacent to the park's road reconstruction project were tested to determine if they meet the National Register eligibility requirements. This included prehistoric sites on the Northeast Entrance road, near Bridge Bay on Yellowstone Lake, and at the Pelican Creek viaduct on the East Entrance

road. A Historic American Building Survey (HABS) team was contracted to document the Iron Spring Quarry in anticipation that it will be filled with excess road construction material. The HABS team recorded the production stages, from raw boulders to intermediate shapes to the finished stone blocks, that were apparently used in the guardrail and retaining wall around Gibbon Falls.

A prehistoric buried site was discovered beside the road a half mile from the North Entrance in 1973 when the Mammoth-to-Gardiner sewer was constructed. This year, in determining what part of the site was within the highway right-of-way, we found that the sewer line goes through the middle of the site. Although intact cultural deposits lie within the existing right-of-way, this area is on the edge of the site with much lower concentrations of artifacts and features than were found farther out on the terrace.

The former site of the Soda Butte Soldier Station was mapped using remote sensing techniques, and several depressions were tested in order to verify their function. Archival materials on the military in the park in general, and the soldier stations in particular, have been collected at the National Archives in Washington, D.C. With the completion of a one-kilometer survey of highway south of Bridge Bay, the inventory for the proposed Arnica Creek road segment is finished.

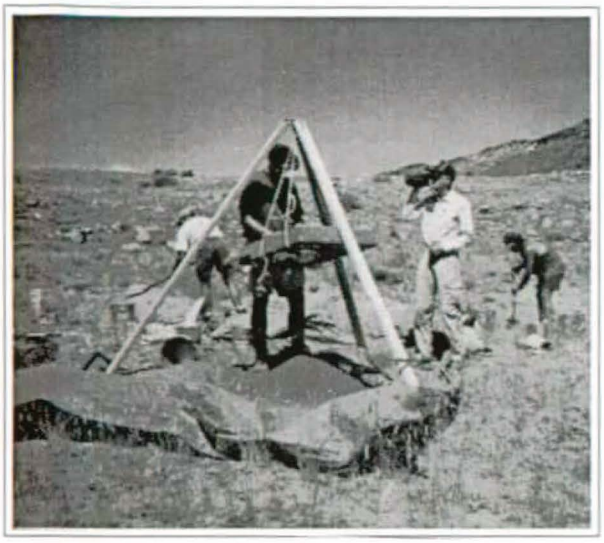
Research and Salvage

The 500-year flood that occurred this year after the 100-year flood in 1996 has exposed many sites on the eroding banks of the Yellowstone River. Four sites were tested for National Register eligibility up and downstream from Gardiner to collect artifacts, charcoal, and animal bones that were being lost.

The very large Ryder archeological site in the Black Canyon of the Yellowstone is extremely important, having at least three stratified components: Intermountain Tradition (the youngest); Pelican Lake; and an as yet unidentified component that may be McKean. Intermountain Tradition is believed to be the prehistoric archeological expression of the ancestors of the historic period Sheepeaters. The faunal material from the Ryder site is exceptionally well preserved, including archeological bones from deer, elk, pronghorn, beaver, and unidentified birds, rodents, and large ungulates that will be assigned to components. The large ungulate bones, which could not be differentiated, could be elk or bison. The youngest component, which has two radiocarbon dates, 630±70 B.P. and 930±60 B.P., contained the second discovery of pottery (Intermountain Ware) in the park.

Upstream from Reese Creek, where erosion exposed three roasting pits in part of the Sweeney site, the contents were salvaged and radiocarbon dates were identified for two of the

Ken Karsmizki's crew tests depression at location of Soda Butte Soldier Station for age and use.



Excavations on two prehistoric sites to determine age and contents. Above: Upper light soil is sterile over bank deposits, while lower dark soil contains material from three prehistoric camps.

features dated 1420±60 B.P. and 1070±50 B.P. Tests of occupational deposits around these features indicate that the area was used by more than one group at different times, but no diagnostic materials were identified.

The prehistoric component of an erosion-damaged site (24YE14), on an intermittent tributary of the Yellowstone River, has exposed hearths. A Pelican Lake point (ca. A.D. 200–1000 B.C.) on the surface and archeological bison bone were also found at this site. Evidence of the occupation appears to be about 10 cm below the present surface near the drainage.

A test unit was placed at site 24YE366, also along the Yellowstone River, to sample the archeological materials not reached by a previous test done by the Midwest Archeological Center (MWAC) about five meters to the west. No diagnostics were recovered from the deepest levels, but a date of 1580±80 B.P was obtained for the second component below the surface, which concurs with a date obtained for the MWAC work.

Results of pollen studies, macrofloral, and charcoal identification remain incomplete. Faunal and fetal identifications will shed some light on prehistoric human predation of ungulates and can be used to identify seasonal occupations. The preliminary hypothesis is that at least some of the Black Canyon sites were used in the winter because they could have provided shelter, water, firewood, and access to game on their winter range.

Volunteer Assistance

Much of the archeological work accomplished this year was done by volunteers, including participants in 4 one-week Yellowstone Institute classes that were involved in the excavations described above. One project, begun by a volunteer in 1997 and expected to take several years, is to obtain Global Positioning System (GPS) data for about 60 quarry sites on Obsidian Cliff before they are hidden by post-fire tree growth. The sites were originally located in a 1989 survey, before GPS technology was so readily available.

A volunteer in a small plane took low-elevation (500 feet) photographs at eight places where historic or prehistoric features are more conspicuous from an aerial view than at ground level, such as parts of the Bannock Trail. Several of the sites will be ground-truthed in 1998 to identify these anomalies.

Shoshone-Bannock dancers performing at 125th anniversary celebration.

Ethnography

Tribal contacts for Native American groups affiliated with the park (Blackfeet, Confederated Salish and Kootenai, Crow, Nez Perce, Northern Arapaho, Northern Cheyenne, Shoshone-Bannock) are notified regularly about park projects and issues. Branch staff have also accommodated requests by the Gros Ventre/Assiniboine and Rosebud Lakota tribes to be notified regarding bison issues in the park, and staff participated in bison-related events the Rosebud Lakota organized near the park, including a Day of Prayer and a Council of Elders meeting. The branch chief made presentations at the Native American Fish and Wildlife Society's annual meeting and attended a traditional Crow Sun Dance in Pryor, Montana.

Contractors Larry Loendorf and Peter Nabokov continued their work on Yellowstone's *Ethnographic Overview and Assessment* through research in the park and outside archives. Park staff assisted with photograph reproductions, research, and updates on current issues.

Historic Structures and Cultural Landscapes

Christine Whitacre from the Intermountain Field Area-Rocky Mountain Support Office was detailed to Yellowstone for the month of July to fill in as the park's historian, a position that has long been vacant. Her duties included conducting historic structures inventory training for park staff at the Nez Perce Patrol Cabin; surveying the Otter Creek area to prepare its historic overview; completing a Determination of Eligibility to the National Register for the Tower Falls Campground Water Supply; preparing an outline of projects needed to help preserve the Bechler Soldier Station; and coordinating the park's historic structures survey and National Register/National Historic Landmark nomination projects.

Historic Resources Study

Marcy Culpin, a historian from the Rocky Mountain Support Office, is preparing a three-part Historic Resources Study (HRS). Part one, the history of park transportation, is complete. Part two, the history of park concessions, and part three, the history of park administration, are underway and are expected to be completed in 1999. The HRS information will contribute to the park's new and revised National Register nominations, which are to be completed in 1999.

National Historic Preservation Act

Each division in the park is responsible, under the guidance of cultural resources staff, for initiating and completing compliance required under Section 106 of the National Historic Preservation Act for their projects that have a potential to affect National Register eligible or listed cultural resources. During 1997, branch staff were involved with 138

Bechler River Soldier Station.

projects, reviewed 21 satellite dish requests, and in addition reviewed 26 projects that came before the park's Resource Council to determine whether proposed projects would affect cultural resources. Staff also participated on the Research Permit Review Panel.

Of 36 projects submitted for Section 106 review, one was determined to have no effect on cultural resources, 33 were determined to have no adverse effect, and 2 were determined to have an adverse effect. An undertaking is considered to have an adverse effect when the effect on a National Register eligible or listed resource may diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association.

A full-time cultural resources specialist is responsible for coordinating compliance with Section 106 and other regulatory and NPS requirements regarding cultural resources. During 1997, such work was carried out with the help of 4 seasonal or part-time employees and more than 100 hours of work done by volunteers.

National Register Determination of Eligibility

After the Tower Junction Ranger Station Historic District determination of eligibility to the National Register was completed this year, the Wyoming State Historic Preservation Officer concurred that the district was eligible. Three other areas were assessed as to eligibility (Stephens Creek historic structures, some Stephens Creek area landscapes, and Otter Creek historic use area) and six National Register nominations (Grand Loop road, East Entrance road, Northeast Entrance road, North Entrance road, and West Entrance road) were in the process of being prepared. Section 110 of the National Historic Preservation Act requires Federal Agencies to identify, evaluate, and nominate to the National Register historic properties (cultural resources) under the jurisdiction or control of the agency. Such properties listed in or determined eligible for the National Register are managed and maintained in a way that considers the preservation of their historic, archeological, architectural, and cultural values.

Historic Structures

The cultural resources specialist worked closely with contractors and NPS staff for the National Register inventory, evaluation, and nomination process for the park's historic structures. This project has encompassed more than 1,000 structures; only 5 percent of the park's buildings remain to be inventoried in 1998. During 1997, cultural resources staff:

- conducted inventories at Bechler, East Entrance, Canyon Village (except the visitor center and campground), and one building at Norris, and labeled hundreds of photographs;
- consulted with an NPS architectural historian on recommendations for National Register eligibility;
- proposed plans for the location and design of the Bechler cabin;
- participated in HABS documentation of a National Register-eligible building (Executive House) that is threatened by an encroaching thermal feature; and
- provided field information and reviewed draft documents for the update to the List of Classified Structures (LCS), which is the primary NPS database for managing historic structures.

The branch chief led a working group that surveyed the Fort Yellowstone Mammoth Hot Springs Historic District to identify unobtrusive but technologically sound locations for residential satellite dishes.

Federal Highways Program Assistance

The cultural resource specialist is responsible for ensuring compliance with Section 106 for each phase of the park-wide road project. During 1997, the cultural resources staff:

- prepared the Environmental Assessment (EA) for Madison-to-Norris and Arnica Creek to Little Thumb Creek/Bridge Bay to Lake roads;
- completed the Northeast Entrance Road EA and submitted it to the Montana State Historic Preservation Officer (SHPO) and the Advisory Council for concurrence that there would be no adverse effect;
- showed the Wyoming SHPO staff areas that may be affected by the Madison-to-Norris road construction and discussed alternatives, scheduling, and data recovery;
- sent information on historic structures and secondary road features (unnamed features) along the Northeast Entrance Road and Arnica Creek-to-Little Thumb Creek/ Bridge Bay-to-Lake Access Road to Wyoming SHPO for review;
- monitored cultural resources along portions of the Madison-to-Biscuit Basin road, Fishing Bridge materials storage areas, and Indian Pond-to-Lake Butte road segments;
- compiled information for National Register Determinations of Eligibility of 21 archeological sites and 7 historic structures; and
- prepared the Yellowstone Parkwide Road Improvement Plan Annual Report for 1997 and submitted it to the Montana and Wyoming SHPOs and the Advisory Council.

Cultural Landscapes

The cultural resources branch and the branch of landscape architecture in the Maintenance Division jointly manage Yellowstone's cultural landscape management program. Cultural landscapes reflect human adaptation and use of natural resources, and may be associated with historic events, activities, or persons, or exhibit other cultural or aesthetic values. The goal of this program is to identify, document, and protect these landscapes. During 1997, a contractor conducted a cultural landscape inventory of the Stephens Creek nursery and the Stephens Creek administrative area. Three other areas (Fort Yellowstone, Fishing Bridge, and Old Faithful) were identified as high priorities for inventory, and funding for this work is being sought.

Paleontology

Yellowstone's paleontology program is jointly managed by the cultural and natural resources branches. In 1997, the cultural resources branch chief participated in onsite surveys in the northern region of the park. Cultural resources staff also provided logistical assistance and information about prior surveys and paleontological specimens in the park's collection to a Georgia College team that excavated a plesiosaur specimen under the direction of NPS paleontologist Vincent Santucci.

Museum Collections

In conjunction with the park's 125th anniversary, Yellowstone loaned the following items from its own collection to these museums around the country:

- The Autry Museum of Western Heritage, for its summer exhibition "Western Wonderlands: Touring America's National Parks";
- The National Building Museum, for "Lying Lightly on the Land: Building America's National Park Roads and Parkways";
- The Livingston Depot Museum, for its 125th anniversary show, "Railroads, Livingston & Yellowstone National Park"; and
- The National Gallery of Art, for the first retrospective of the works of Thomas Moran, which included a dozen watercolor sketches and a sketchbook from the park's collection, and William Henry Jackson photographs from the park archives.

The National Gallery staff also began work on a CD-ROM containing photographs from four albums that Jackson donated to the park.

More than 10,000 artifacts and specimens were added to the park's museum collection, many of them archeological materials and biological specimens collected under permit, as well as historic photographs and artifacts needed for research and educational projects. More than 6,000 items were cataloged and housed, including aerial photographs, slides, and other materials documenting the 1988 fires.

During 1997, more than 400 scholarly researchers, journalists, filmmakers, park staff members, concessions employees, and visitors used the collections, and more than 3,000 hits on the museum/archives/library link of the park's website were recorded.

Historic Vehicles

When the Yellowstone Park Foundation provided funding for the conservation of one of the park's horse-drawn vehicles, a Shaw & Powell Tent Camping Company Studebaker buggy was selected because of its rarity and its value in showing how some visitors of relatively modest means toured the park before the automobile era began. The buggy was taken to Cody, where its conservation is scheduled for completion in early 1998.

Museum technicians continued to make progress in cleaning, stabilizing, documenting and improving storage conditions for the park's historic vehicle collection. They also provided assistance on vehicle preservation to Glacier

Shaw and Powell buggy being packed for transport to Cody for conservation.

National Park, Grant Kohrs National Historic Site, the Montana Historical Society (Virginia and Nevada Cities), and other museums.

Herbarium

The park herbarium continued to be used extensively by park staff and outside researchers, especially during the summer. The collection includes approximately 7,600 specimens of vascular and non-vascular plants that are identified and mounted; 6,121 specimens of vascular plants are also catalogued in the NPS's Automated National Catalog System. During the 1997 field season, 237 specimens were collected for the herbarium, primarily to add plants that were not yet well represented, create new park records, and document the arrival or spread of exotic plants.

Research Library and Archives

Library Operation

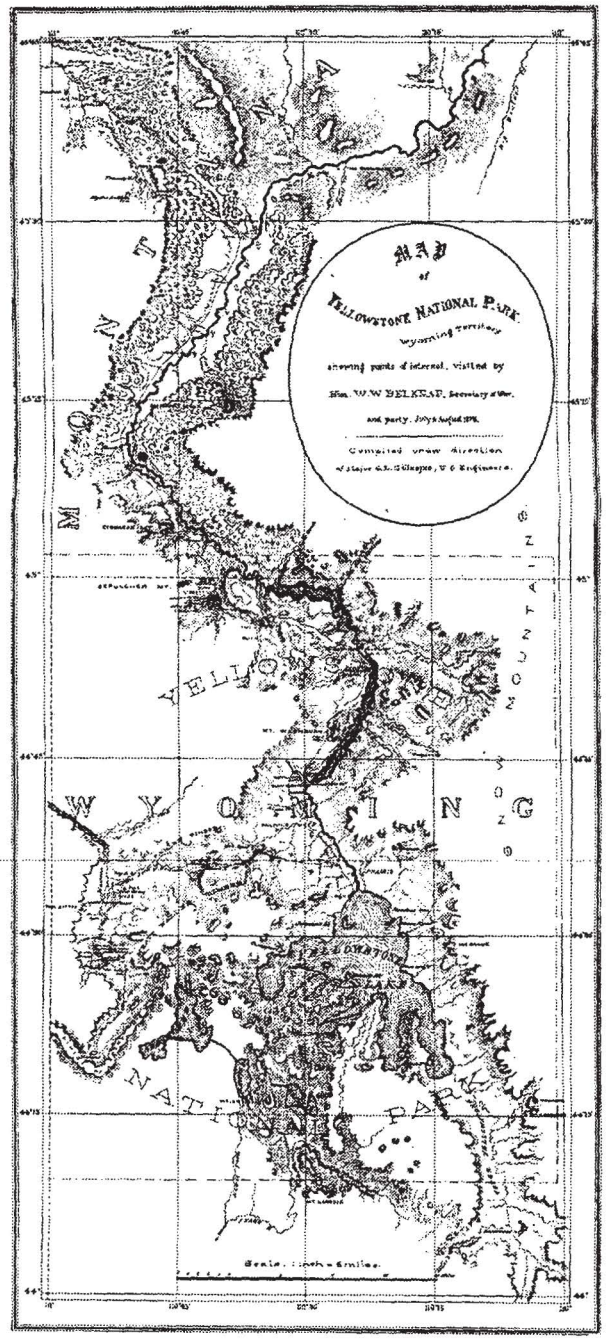
During 1997 the library served 650 researchers; circulated more than 300 books, videos, and other materials; filled more than 100 Interlibrary Loan requests; and responded to 62 telephone inquiries.

Funding from a Yellowstone Association grant enabled the library staff to continue the card catalog computerization project; so far about 80 to 90 percent of the books, and 40 percent of the vertical files have been computerized. Original cataloging is necessary for many records, and the manuscripts/rare separates files (rare separates are items that are removed from a larger collection, i.e., journal articles and book chapters) and videotapes remain to be processed. The goal is to have the entire catalog automated for the use of park patrons by 1999.

Library Acquisitions

The librarians accessioned 269 new items this year, 70 of them donated. Significant acquisitions were obtained from:

- Dean Larsen of Provo, Utah, who donated the author's personal copy of *The Yellowstone and the Great Geysers* by General W.E. Strong (1875);



Early Yellowstone map of General W.E. Strong's 1875 trip route through Yellowstone.

A TRIP TO THE YELLOWSTONE.

ON the 5th of July, 1875, I received an urgent invitation from the Secretary of War and General James W. Forsyth, U. S. Army, to join them in a trip to the National Park in Wyoming Territory, which I gladly accepted, believing it to be "the chance of a lifetime." I worked day and night for ten days to arrange my business satisfactorily, and on the evening of July 14th was fully prepared for a month's absence from Chicago.

As the country we were to travel over was almost wholly new to me, and as very little has been written of the wonders and beauties of the great Yellowstone Park, I resolved, for my own satisfaction, to keep a journal of the trip, of which the following is a copy:

JULY 15.—Left Chicago this morning at half-past ten o'clock, on Chicago and Northwestern Railroad. The party consists of General W. W. Belknap, Secretary of War; General Randolph B. Marcy, Inspector General, U. S. A.; General James W. Forsyth, U. S. A., and William E. Strong, of Chicago.

Colonel George L. Gillespie, U. S. Corps of Engineers, has gone on in advance of us to Fort Ellis, Montana, to perfect the arrangements for our trip from that point to the Park, such as organizing and equipping the pack-train, selecting saddle-horses for the party, and getting together the necessary supplies and camp equipage for a trip such as we have in view. All the party are well provided with guns and fly-rods and tackle. Mrs. Strong and little Ogden and General Sheridan were at the depot to see us off, and as the train pulled out wished us a pleasant journey, a good time, and an early and safe return.

Journal entry from General W.E. Strong's 1875 Yellowstone trip.

- Ann Martyn of San Antonio, Texas, who donated biographical materials of J.F. Cummings, including the original 28-page handwritten manuscript of Cummings's 1881 trip into Yellowstone with the governor of Wyoming;
- a purchased copy of Alfred Gurney's *A Ramble Through the United States* (1886);
- Lee Silliman has donated many recent books to our collection and is thus one of our biggest financial supporters;
- historical accounts of an 1883 trip by Dr. Henry Sheldon Reynolds (Carolyn A. Cooper donor), the 1904 trip of Samuel Preston Ewing (Scott P. Ewing donor), a copy of a 1908 diary/typescript by Mabel Fidelia Hale Knapp (Melinda South donor), an early 1920s account by Edward Rynearson (unknown donor), and an account by Yost Amrein of life as a 1940s "savage" (a park concession employee) at Canyon Lodge; and
- 63 microfilm reels containing copies of the Livingston Enterprise, Livingston Post, Park County News, and Montana Agriculturalist.

Archival Acquisitions

Several collections were added to the park archives: former park geologist Rick Hutchinson's papers, which included the logbooks of Norris Geyser Basin (1964–1974); former park plant ecologist Don Despain's papers; retired geologist Wayne Hamilton's papers; and materials from the Fire Cache. Jack Crellin of Salt Lake City, Allen Crawford of Loveland, Colorado, and Dave Bank of Raleigh, North Carolina, all donated photographs; and Albert Noyes of St. Paul, Minnesota, a scrapbook. Copies of Internet postings by the Geyser Observation and Study Association for the years 1995–1997, including daily reports of geyser activity in Yellowstone National Park and discussions among geyser experts, were also placed in the archives.

Archival Projects

In addition to the park archivist, three part-time employees, SCAs, interns, and volunteers helped on research and archival management projects. More than 200 boxes of materials from the National Archives and Records Administration (NARA) at Denver were moved to their temporary home in the old Fire Cache for accessioning, reboxing, arranging, and computer inventory.

During a trip to NARA's Kansas City regional offices, the archivist located records pertaining to attempts in the 1950s and 1960s to open the park for a winter season; bison

operations at Lamar Buffalo Ranch from 1931 to 1954; management of the northern Yellowstone elk herd from 1935 to 1955; and maintenance records about the construction of buildings at the Mammoth YCC camp, and telephone, radio, and electric lines. The intent is to copy much of this material for the park's archives in 1998.

The archivist spent 12 days with John Landrigan, who donated use of his own slide and print scanner to scan photographs from the park collections into computers for the use of anyone in the park who needs such material.

The archivist spoke about the importance of saving electronic records at an all employee meeting, and issued a park-wide reminder to hardcopy all "important" records "which they originate" in order that these government records can ultimately repose in the park archives.

With the help of the computer support staff, the 700-plus page master archival inventory was placed onto the park website at www.nps.gov/yell/archives.

Research Assistance

The archivist assisted at least 58 researchers during the year, including: Marcy Culpin, NPS historian, on her study of the history of concessions in Yellowstone; Montana State University history graduate students; geyser researcher Rocco Paperiello; Michael Heiner and Ann Rodman for their GIS project on the history of Mammoth-area buildings; Dr. Marly Merrill for her book on the Hayden survey; Jeff Birkby for his book on bathing in hot springs in the West; and former Congressman Pat Williams for his Yellowstone interview with Garrison Keillor.

PARTNERSHIPS

In addition to the many instances of joint efforts mentioned throughout this section, these are some specific projects on which cultural resources staff collaborated with other government, educational, and private organizations.

- ***The Nez Perce National Historic Trail.*** The park hosted the trail's annual cooperating committee meeting attended by representatives of the U.S. Forest Service, Bureau of Land Management, Nez Perce tribe, other national parks, and local historical societies. Park staff erected signs at the West Entrance and the Northeast Entrance to interpret the trail's general route through Yellowstone.
- ***The Yellowstone Heritage Partnership.*** This group, which includes representatives from other national parks, local museums, and private individuals along the Yellowstone River corridor from Wyoming to North Dakota, was formed to support the preservation and interpretation of the river's heritage through projects such as the creation of bike paths along abandoned railroad beds and travelling exhibits. The branch chief participated in efforts to identify future projects along the Yellowstone River corridor.
- ***The Intermountain Field Area Task Force.*** The branch chief represented Yellowstone in a cultural resources program study group which is developing strategies to meet the needs of parks and outside organizations while "downsizing" the Denver and Santa Fe regional office programs.
- ***The Intermountain satellite office.*** Cultural resources staff worked with other park staff to review the organization of a new NPS office at Montana State University (Cooperative Program, Architectural Conservation Projects) that was created by the transfer of an NPS historical architect from the Santa Fe regional office to MSU. The historical architect has worked to create partnerships among MSU, national parks, and local communities.
- ***National Forests.*** The archeologist assisted the Gallatin and Helena National Forests

with identification and descriptions of prehistoric ceramics (Intermountain Tradition) that relate to pottery found in Yellowstone.

- ***Grand Teton National Park.*** Along with Grand Teton staff and representatives from the Wyoming SHPO, the Advisory Council on Historic Preservation, the National Trust for Historic Preservation, and the Certified Local Government, the cultural resources specialist helped to rank the historic structures at Grand Teton. The ranking contributed to the park's historic structure management plan.

Visits with staff at Lowell NHP, Boston NHP, and Frederick Law Olmsted NHS provided the branch chief with valuable ideas that can be applied to Yellowstone's cultural resources program.

Branch staff participated in numerous presentations to park staff, visitors, and special groups; walking tours and tours of the archives, library, and museum storage areas; classes for the Yellowstone Institute; the annual Resource Management Workshop; orientations for park staff and Amfac employees; and interviews to radio stations, newspapers, and film crews.

Part IV. Natural Resource Programs

Introduction

Natural resource specialists conducted programs of resource monitoring and management, working cooperatively with park rangers, interpreters, and maintenance staff, as well as researchers from numerous universities and sister agencies. Parkwide road reconstruction projects continued to occupy a substantial portion of all branch employees' time and supported the hiring of numerous seasonals. Major program emphasis remained on threatened and endangered species, cross-boundary issues such as bison management, control of exotic plants and fish, and disturbed site reclamation. The absence of a park geologist for most of the year left the branch struggling to begin planning for new personnel and programs to monitor and protect geologic resources.

Base funds were augmented by several significant sources: $204,000 in Natural Resource Preservation Program funds, directed toward bison management and research; $213,400 in fishing fee monies that helped support the "new" NPS-run aquatic resources management program; $182,600 in federal highways funds for resource compliance; and $257,300 in Fee Demo funds that helped support air quality monitoring, seismic studies, the fisheries program, and other backlog resource protection projects.

Air Quality

A New Partnership

Yellowstone joined Grand Teton National Park, Red Rock Lakes National Wildlife Refuge, and the six adjoining greater Yellowstone area national forests to form a Greater Yellowstone Area Clean Air Partnership. The purpose of the partnership is to serve as a technical air quality advisory group to the Greater Yellowstone Coordinating Committee and to facilitate information exchange, reduce duplication, and increase efficiency. A resource manage-

ment specialist in the Branch of Natural Resources (BNR) was designated as Yellowstone's representative.

BEARS

Population Monitoring

Bear Sightings. During 1997, there were 1,385 observations of bears or bear sign (tracks, scats, feeding sites) recorded in the park, including 637 sightings of grizzly bears (*Ursus arctos horribilis*), 489 of black bears (*Ursus americanus*), and 49 of unidentified species of bear. These observations do not include 160 radio-telemetry reports of grizzly bears in which the bear was not seen, or reports of bear noise, or rumors of bear activity. Each group of bears observed together is recorded as one bear sighting. The reporting system was not designed to eliminate the possibility of duplicate counts; however, multiple reports obviously representing the same bear on the same day are recorded as one sighting. Because the number of sightings reported each year depends on park visitation, observer effort, ongoing bear-related research projects, availability of preferred bear foods, weather patterns, and other factors, the number of sightings reported is not an accurate indicator of population numbers or trends.

Table 1. Number of observations[a] of bears or bear sign reported in Yellowstone National Park, 1997.

	Grizzly Bears		Black Bears		Unknown		
Area	Sightings[b]	Sign[c]	Sightings	Sign	Sightings	Sign	Total
Tower	126	5	225	2	10	21	389
Mammoth	69	5	84	0	13	39	210
Lake	123	17	31	2	6	25	204
NE/Lamar	118	5	37	3	4	15	182
Canyon	94	1	16	0	6	3	120
Old Faithful	11	6	26	1	6	10	60
Snake	19	10	14	4	0	4	51
Grant	12	5	16	6	0	3	42
West	20	2	11	0	0	9	42
Madison	18	0	7	0	0	1	26
Norris	16	4	3	0	1	2	26
Bechler	6	0	17	0	2	0	25
East	5	0	2	0	1	0	8
Total	637	60	489	18	49	132	1,385

[a]Does not include radio telemetry locations in which the bear was not observed or reports of bear noise or rumors of bear activity.

[b] Each group of bears observed together was recorded as one bear sighting. Multiple reports obviously representing the same bear on the same day were also recorded as one sighting. The number of bear sightings reported each year is dependent upon park visitation, observer effort, the number of ongoing bear related research projects, availability of preferred bear foods, weather patterns, and other factors. The system was not designed to provide unduplicated samples of bear numbers; however, multiple reports obviously representing the same bear on the same day were recorded as one sighting. The number of bear sightings reported is not an indicator of population numbers or trends.

[c] Includes tracks, scat, den sites, and feeding sites.

The first recorded activity in 1997 for each species was a grizzly bear track observed just east of the Nez Perce patrol cabin on March 14 and a black bear seen scavenging on an elk carcass near Crystal Bench on April 7. The last recorded activity of the year was a subadult black bear just east of the Soda Butte formation on November 20 and a large adult grizzly bear defending a wolf-killed elk carcass from nine members of the Rose Creek wolf pack in the Antelope Creek drainage on November 21.

Bear Mortality

Only one known bear mortality occurred within the park in 1997, a grizzly bear cub that died of natural causes. There were no bear roadkills or other known human-caused bear mortalities in the park this year. The 10-year annual average (1987 to 1996) for human-caused mortalities was 1.0 (± 1.0 SD) for grizzly bears and 1.2 (± 0.8) for black bears.

The death of the grizzly bear cub occurred in June after it had been observed with its mother north of Norris Campground. Two days later both bears were captured adjacent to Norris Geyser Basin so that they could be examined. The immobilized sow appeared to have only scratches on her stomach and tears in her ear, so she was soon released and re-joined her other cub. The captured cub, which had more extensive injuries, was taken to the Mammoth Clinic and examined by a physician. Both of the cub's hind legs were paralyzed, and x-rays revealed multiple broken ribs and vertebra, liver damage, and blood in one lung. Because this damage would have made survival in the wild impossible, the cub was euthanized and considered a natural mortality.

NPS photo

A necropsy found that the cub had been bitten along the spine and lower abdomen by a larger bear.

An additional 12 grizzly bears are known to have died outside the park but within the Yellowstone ecosystem in 1997. Two of the incidents involving subadults males (one bear shot in a horse pasture and one bear removed by managers after repeated conflicts at campsites) occurred more than 10 miles beyond the recovery zone and therefore do not count against the population targets established by the Grizzly Bear Recovery Plan. The other 10 mortalities involved: one cub-of-the-year (COY) that died of unknown causes and was found by a hunter; two male COY killed by unknown predators, most likely larger bears; and seven grizzly bears that were shot and

Table 2. Annual grizzly bear population data.

	1973–1985 Annual Average	1986–1996 Annual Average	1997
Females with COY	12.0	21.0	31.0
Average Litter Size	1.9	2.1	2.0

killed by hunters who claimed self defense (3 females and 4 males).

Grizzly Bear Monitoring

Females and Cubs. As part of grizzly bear monitoring in the Yellowstone ecosystem, the Interagency Grizzly Bear Study Team (IGBST) counts the number of adult female grizzly bears with cubs-of-the year (COY) each year because they are the most reliable segment of the population to monitor. The number of cubs per litter as well as pelage-color combinations of different family groups aid in identifying individual adult females. Because adult females generally have a three-year breeding interval, the number of females with COY counted over a three-year period can be used to estimate the number of adult females in the population. Counting is done through aerial surveys and ground observations by park employees and other state and federal biologists.

The numbers of adult females (31) and COY (62) counted in the Yellowstone ecosystem in 1997 were both the second largest on record. (The highest counts, 33 females and 70 COY, were made in 1996.) Of these bears, 14 of the adult females and 30 of the COY were first observed within the park. The mean litter size was 2.0 cubs, compared to the largest average litter size of 2.4 cubs reported in 1992 and 1994.

Recovery Status. The grizzly bear has been listed as a threatened species under the Endangered Species Act since 1975. A primary purpose of the act is to recover listed species to self-sustaining, viable populations that no longer need its protection. To help achieve this, the 1993 Grizzly Bear Recovery Plan established three biological goals that must be achieved before the grizzly bear population will be considered recovered:

- an average of at least 15 adult females must have cubs-of-the-year (COY) on a six-year running average both within the recovery zone and within a 10-mile area immediately surrounding it;
- at least 16 of the 18 bear management units (BMUs) must be occupied by females with young from a running six-year sum of observations, with no two adjacent BMUs unoccupied; and
- the known human-caused mortality of grizzly bears must not exceed 4 percent of the population estimate based on the most recent three-year sum of females with cubs minus known adult female deaths, and the mortality of female grizzly bears cannot exceed 30 percent of the known human-caused mortality.

If all these goals are met and "adequate regulatory mechanisms" are in place to ensure conservation of the species, the grizzly bear may be considered for delisting from its threatened status. In 1994, the Yellowstone ecosystem grizzly bear population met all three population targets for the first time. However, in 1995, both the total mortality and adult

Table 3. Recovery status for the Yellowstone grizzly bear, 1997.

	Target	Results Through 1997	Target Achieved
Six-year average females with COY	≥15.0	24.0	Yes
Six-year average human-caused mortality	≤10.5	8.7	Yes
Six-year average human-caused female mortality	≤3.2	3.7	No
Distribution of females with young (6-year sum)	≥16 of 18 BMUs	18 BMUs	Yes

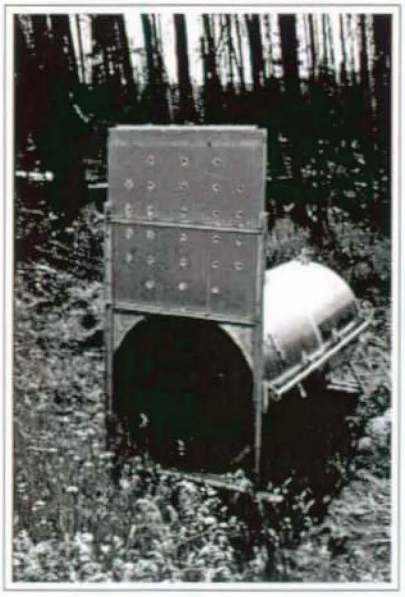
female mortality limits were exceeded, and in 1996 and 1997 the adult female mortality limit was exceeded.

Availability of Bear Foods

Except for fall foods, the abundance of high quality bear foods in the Yellowstone ecosystem was average to above average in 1997. The winter of 1996–97 brought the most severe weather and the highest number of winter-killed ungulates in all surveyed areas of the park since 1988–89. Winter-killed ungulates are an important food for bears in early spring before most vegetal foods become available. In addition to an above average number of winter-killed elk (*Cervus elaphus*), bison (*Bison bison*) carcasses were abundant in thermally influenced ungulate wintering areas, but scarce on the northern winter range. About 1,100 bison were captured and shipped to slaughter under the Interim Interagency Bison Management Plan.

During spring, scavenging ungulate carcasses and digging for pocket gophers (*Thomomys talpoides*) and their root caches were the most commonly observed grizzly bear feeding activities. During spring and early summer, grizzly bears also consumed over-wintered whitebark pine nuts (*Pinus albicaulis*) stored in red squirrel (*Tamiasciurus hudsonicus*) middens from the above average pine nut crop the fall of 1996. Elk calves, an important late spring and early summer food source, were preyed upon extensively by some individual bears. The numbers of spawning cutthroat trout (*Onchorynchus clarki*), also available to bears during the late spring and early summer, were similar to the long-term averages (1989–95) on most streams except for those in the West Thumb area, which were below average. Spawning cutthroat trout rank as one of the highest sources of net digestible energy available to bears in the Yellowstone ecosystem.

The Yellowstone ecosystem had above average snowfall during the winter and above average precipitation during the summer, keeping grasses, sedges, forbs and other bear grazing food resources succulent late into the summer. Bears were often seen digging for biscuit root (*Lomatium cous*) in mid-summer, while grizzly bears continued to dig for both biscuitroot and truffles from late summer until fall. Army cutworm moths (*Euxoa auxiliaris*),



Far left: Helicopter assists in moving a bear to a remote backcountry location. Center left: Culvert trap used to trap bears in Yellowstone. Photos courtesy of the Bear Management Office.

Table 4. Bear management actions taken, 1997.

Area	Bear Jams	Area Closures	Mgmt. Hazing	Bear Warnings	Mgmt. Captures
NE/Lamar	1	0	0	0	0
Tower	70	5	4	1	1
Mammoth	39	5	0	1	0
Norris	4	1	0	0	1
Canyon	14	2	4	2	0
Lake	26	5	5	1	0
East	0	1	0	0	0
Grant	1	0	0	0	0
Snake River	0	0	0	0	0
Madison	5	0	0	0	0
Old Faithful	2	2	1	0	0
West	2	0	0	1	0
Bechler	0	0	0	0	0
Total	164	21	14	6	2

an important late summer and fall bear food, attracted many bears to high-elevation moth sites.

The production of whitebark pine nuts, an important pre-hibernation food source because of their high fat content, was below average in most areas of the ecosystem during the fall of 1997. In years of low availability of natural bear foods, grizzly bears often seek alternate foods associated with human activities and both the number of bear-human conflicts and human-caused grizzly bear mortalities tend to increase during fall. But due to the abundance of most bear foods, including moths, truffles, and biscuitroot during the late summer and fall, the number of conflicts and confrontations reported in the Yellowstone ecosystem was below average in 1997.

Bear Management Actions

Management actions were taken in 207 bear-related incidents within the park in 1997, including: visitor control at 164 bear-jams; 21 temporary closures of campsites, trails, or other areas; 14 incidents in which bears were hazed to encourage them to leave roadsides or developed areas; and 6 incidents in which bear warnings were posted at campsites, trails, or other areas (Table 4). There were also two incidents in which bears had to be trapped: one black bear was translocated from a roadside to a remote area of the park, and one grizzly bear was trapped in a management action and released at the capture site. No bears had to be removed from the park this year. Most bear management actions occurred in the Tower, Mammoth, Lake, and Canyon subdistricts.

Bears Moved Into the Park. There were a total of 116 grizzly bear-human conflicts reported in the Yellowstone ecosystem in 1997 (Fig. 1). Of these, only three (3%) occurred within YNP. To reduce bear-human conflicts and promote the conservation of grizzly bears in the Yellowstone ecosystem, three male grizzly bears that had been involved in bear-human conflicts outside the park (killing cattle in the South Fork of the Shoshone, killing cattle and sheep near Pinedale, Wyoming, and

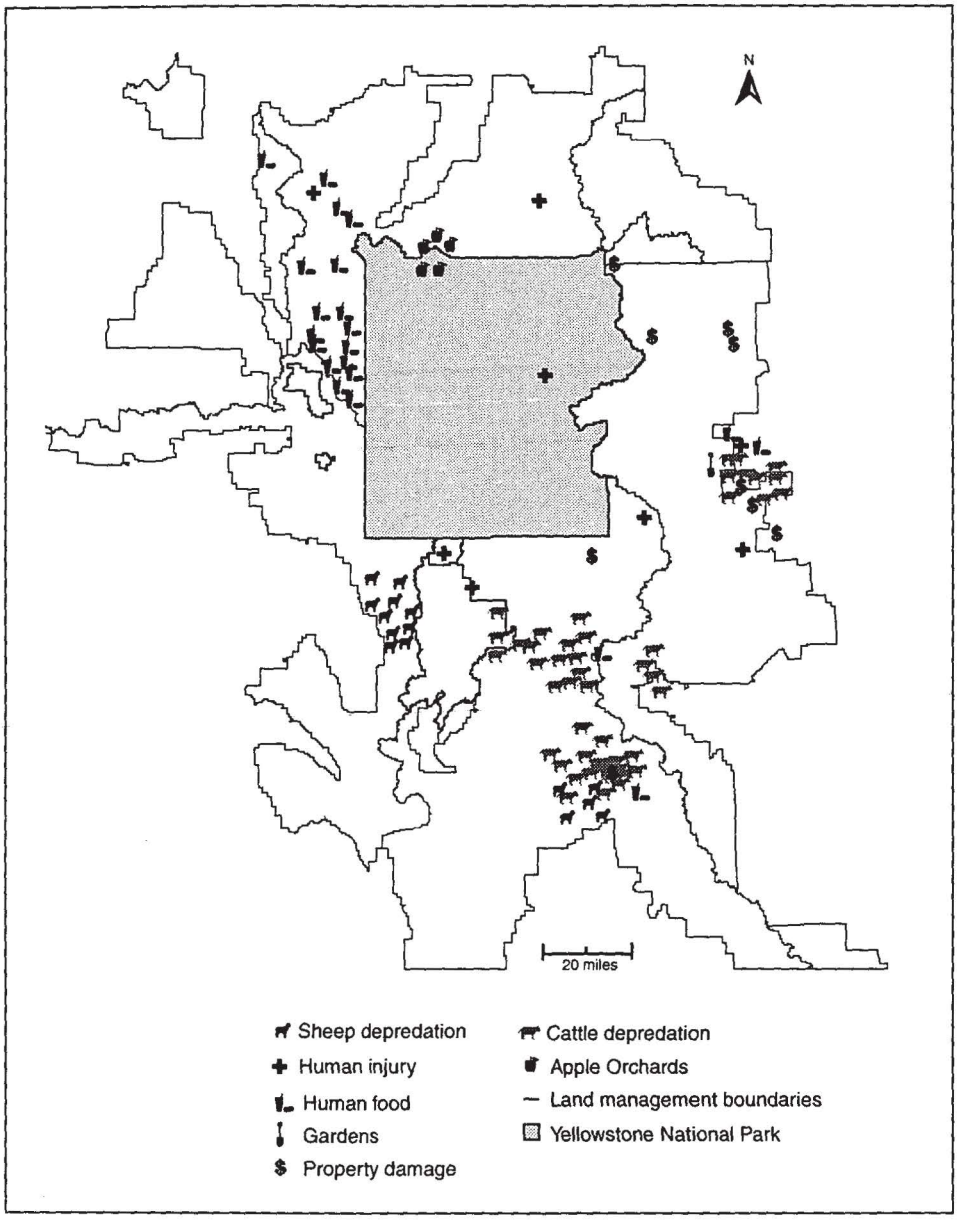


Figure 1. Locations of grizzly-human conflicts reported in the Yellowstone ecosystem, 1997.

frequenting gardens and orchards near Gardiner, Montana) were relocated into the park. None of these bears were known to be involved in any further conflicts for the rest of the year, and two of them remained within the park.

Property Damage. Two incidents were reported in which bears damaged property in the park but did not obtain human foods, one involving a black bear and the other an unidentified species. The 10-year annual average (1987 to 1996) for incidents of bear-caused property damage is 1.3 (±1.2 SD) for grizzly bears, 1.7 (±1.3 SD) for black bears, and 2.5 for unidentified bear species (Table 5).

Anthropogenic Foods. Only two incidents were reported in which bears were known to have obtained human food in the park, both of

Table 5. Bear-human conflicts in Yellowstone National Park, 1997.

Type of Incident	Grizzly Bear	Black Bear	Unknown	Total
Property damage	0	1	1	2
Human foods/ garbage	0	2	0	2
Human injury	1	1	0	2
Other confrontations	12	4	1	17
Total Incidents	13	8	2	23

them involving black bears. The 10-year annual average (1987 to 1996) for incidents of bears obtaining human food or garbage was 2.0 (±1.4 SD) for grizzly bears, 3.4 (±3.1 SD) for black bears, and 1.1 (±1.6 SD) for unidentified species of bear (Table 5).

Human Injuries. Of the two conflicts that resulted in bear-inflicted human injuries in the park in 1997, one was caused by a grizzly bear and the other by a black bear. The 10-year annual average (1987 to 1996) for grizzly bear-inflicted human injuries was 0.6 (±1.3 SD). The other injury was the first caused by a black bear since 1983 (Table 5).

Other Confrontations. Of the 17 reported confrontations in which no one was hurt, 12 involved grizzly bears, 4 involved black bears, and in one case the species could not be identified. The 10-year annual average (1987 to 1996) for confrontations was 10.4 (±5.7 SD) for grizzly bears, 3.6 (±2.0) for black bears, and 1.1 (±1.4 SD) for unknown species of bear (Table 5).

Food Storage

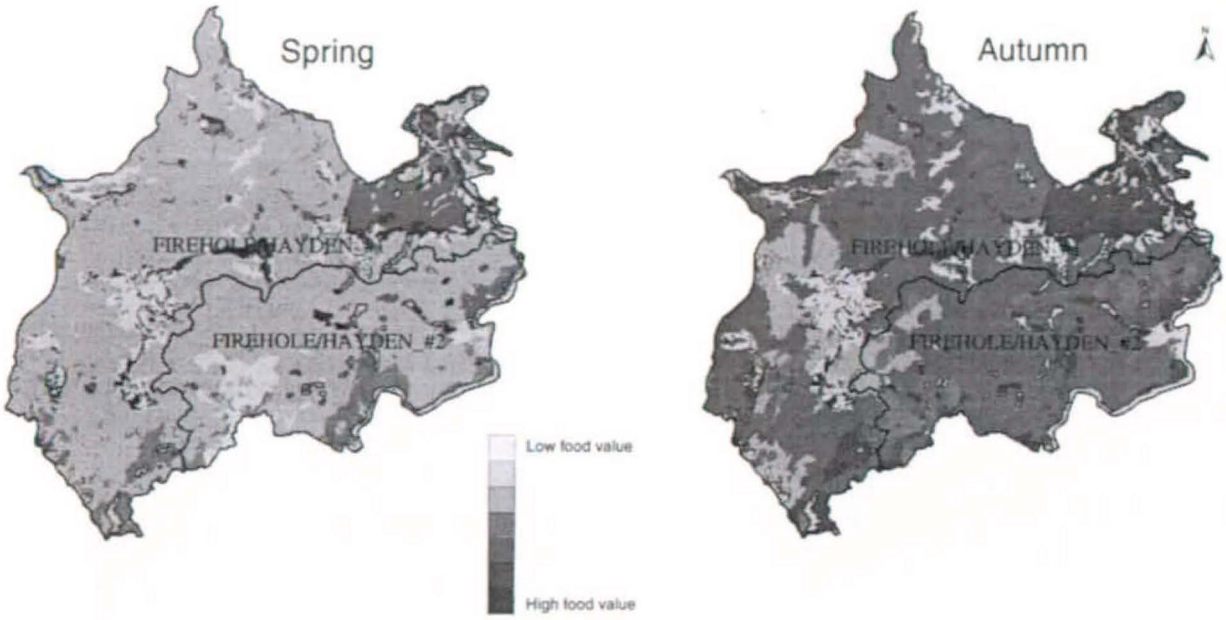
Backcountry Food Storage Poles. As part of the effort to keep human food and garbage unavailable to bears, one the park's management objectives is to provide a food storage pole at every designated backcountry campsite in the park, with two poles at every site used by large commercial stock parties. The use of these poles has helped keep the park's backcountry free of bear-related problems during the last 10 years. However, due to fatigue from normal use, high winds, and the shallow root system of lodgepole pine, not all campsites will have a food pole at all times. The poles are installed and replaced as needed within the limits of available staff and budgets. At present, 97 percent of the park's backcountry campsites have food storage poles.

Campground Food Storage Boxes. Because hitch-hikers and bicyclists are generally not traveling with a vehicle in which food can be stored, the park has installed bear-proof food storage boxes in the hiker/biker loops of park roadside campgrounds. However, bike tours of up to 300 people have become increasingly popular, with nine incidental business permittees currently operating bike tours, and the number of storage boxes is not sufficient to accommodate these large groups. Two grizzly bears have obtained food from large bike groups in park campgrounds in recent years.

In 1997, the Bear Management Office successfully competed for Regional Natural Resource Program money to purchase 38 additional food storage boxes that will be installed in park campgrounds in the summer of 1998.

Grizzly Bear Habitat Modeling

The vegetation management biologist again served as co-leader on an interagency group charged with the development and implementation of a computerized Cumulative Effects Model designed to assess the inherent capability of the landscape to support grizzly bears while simultaneously measuring the effects of human activities on landscape productivity (Fig. 2). In 1997, a major effort was under-



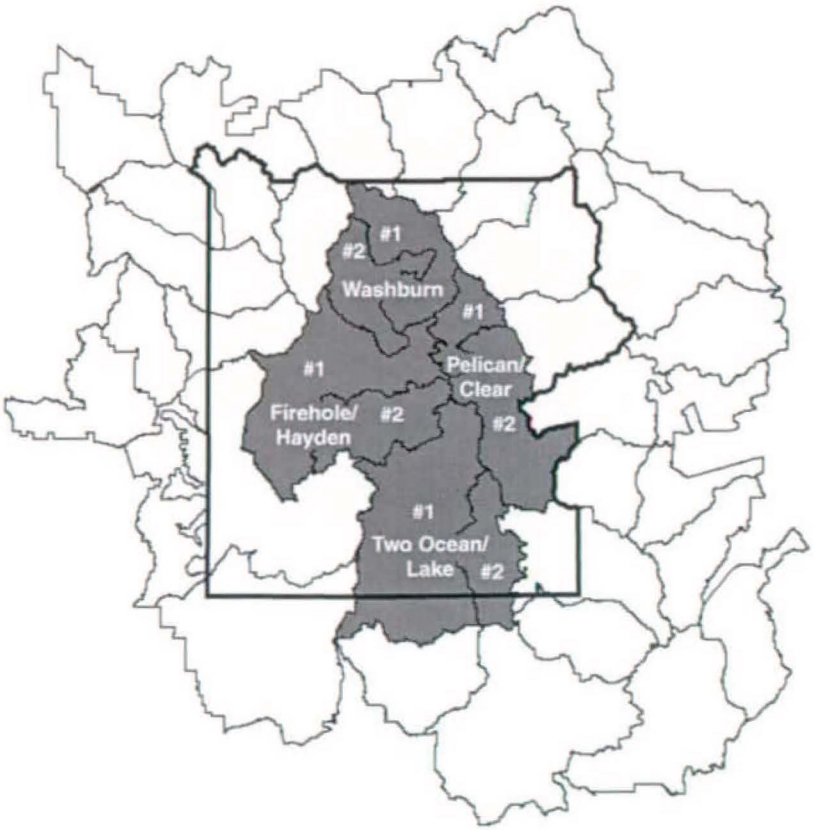


Figure 2. Left: Interagency efforts continue in determining habitat quality for grizzly bears in the Yellowstone area. During 1997 four bear management units within Yellowstone were completed. Above: Firehole/Hayden Valley bear management unit postfire mean daily habitat quality maps for spring and autumn. Ungulates, vegetation, fish, and insects are the main food sources contributing to habitat quality. These maps reflect their seasonal availability in the Firehole/Hayden Valley area.

taken to contract model updates for use on Unix workstations and acquire updated software. Quantitative model outputs were produced for four Bear Management Units (the Pelican/Clear, Firehole/Hayden, Lake/Two Ocean, and Washburn BMUs). Thirty different maps were generated for each BMU, and radio-relocation grizzly bear data were obtained from the IGBST and correlated with model outputs to assess the relative value of delineated mapping units. This effort was supported by obtaining $2,000 from the Bridger-Teton National Forest and $8,600 from the Yellowstone Ecosystem Grizzly Bear Managers' Subcommittee.

In addition, the vegetation biologist attended interagency meetings to discuss progress, ongoing modeling efforts, and the derivation and methodology for updating coefficients, and to finalize criteria and definitions for mapping and analyzing road and trail coverages according to guidelines developed by the Interagency Access Management task force. A volunteer was engaged to digitize updated information about supplemental protein sources for bears and BMU boundary lines.

For the first time since the inception of the model in the early 1980s, the goal of mapping and analyzing the whole grizzly bear recovery area for existing habitat conditions, quantitatively described, is within sight. This major modeling effort is scheduled to be completed during 1998.

Grizzly Bear Conservation Strategy

Since 1995, the park's bear management biologist and the resource naturalist have been working with an interdisciplinary team to prepare a draft *Grizzly Bear Conservation Strategy* to guide the long-term management of grizzlies and their habitat in greater Yellowstone. The document will, among other things, meet the requirement in the *Grizzly Bear Recovery Plan* to ensure that "adequate regulatory mechanisms" are in place to manage and retain a bear population if and when it is removed from the special protections of the Endangered Species Act.

In 1997, sections of the draft strategy were revised to include additional information on important bear foods (i.e., spawning cutthroat trout, whitebark pine, and winterkilled carcasses) and the current and future monitoring programs needed to track them. Much of this work has been undertaken by Yellowstone National Park staff. Other recommendations made addressed the management of nuisance bears in and outside the park. The team's revised schedule calls for a draft strategy to be completed in 1998.

Birds

Threatened and Endangered Species

Whooping Cranes. Although the whooping crane population in North America overall has been increasing slightly almost every year, it is still far from being downlisted as an endangered species. As of the end of 1997, the total number of North American whooping cranes in existence was estimated to be 362, but this included 114 birds living in captivity. Only five of these birds were in the greater Yellowstone area (GYA). The presence of summering whoopers in the GYA continues to decline, and they could disappear entirely. Only one crane was found in the park during the summer of 1997, and two other adults were elsewhere in the GYA. Since the prognosis is poor for this species in the park, it is important to record its sound and obtain whooping crane photographs for historical purposes.

Peregrine Falcons. Although classified as an endangered species, peregrines continue to thrive in Yellowstone, where they are considered ecologically recovered. Two new peregrine eyries were found in 1997, bringing the total number in the park to 13 (Fig. 3). Since

Clark's Nutcracker extracting pine seed from snow. Photo courtesy Terry McEneaney.

1983, when the park had no fledglings, the number has gradually increased to a record 25 in 1997. But even if the peregrine falcon is delisted in the near future, careful monitoring will be required to ensure the species' survival.

One reason for the peregrines' recovery in this area has been the cooperation of the Wyoming Game and Fish Department, Yellowstone National Park, and the Peregrine Fund. The park ornithologist participates in a Peregrine Falcon Working Group that discusses management of peregrines throughout greater Yellowstone.

Bald Eagles. The U.S. Fish and Wildlife Service downlisted the bald eagle from "endangered" to "threatened" in July 1995 because of its significant population gains, although some populations are still at risk because of habitat encroachment and destruction of riparian zones in the Southwest and heavy metal problems in the Great Lakes region. The greater Yellowstone population is in good shape and bald eagles continue to thrive. Habitat encroachment is of concern with the development of subdivisions outside of the park.

Figure 3. Peregrine falcon wild pairs, Yellowstone National Park.

In Yellowstone, 14 eaglets fledged from 21 nests in 1997. Nest substrate instability resulting from the 1988 Yellowstone wildfires continues to cause problems for some nesting pairs. The large number of trees expected to fall during the next decade could result in egg failure, loss of nest sites, and sudden changes in nesting territory locations. But these naturally occurring post-fire conditions are unlikely to cause a significant change in the bald eagle population as a whole.

Within the greater Yellowstone, the bald eagle population is considered thriving, with 90 eaglets fledged from 91 active nests in 1997. This represents a 391 percent increase in fledglings and a 267 percent increase in active nests since 1982, when only 23 eaglets

fledged from 34 nests. The Greater Yellowstone Bald Eagle Working Group updated the *Greater Yellowstone Bald Eagle Management Plan* in 1996 to include 1995 data. The goals of this plan are being met, with bald eagle populations being maintained at levels with high probabilities of persistence, the number and distribution of pairs attempting to breed annually above the required levels, and more than 74 eaglets fledgling each year.

The annual mid-winter bald eagle survey was conducted in the park and adjacent portions of the northern range on January 10. Of the 47 eagles counted, 44 (94%) were bald eagles and 3 (6%) were golden eagles. Since the first mid-winter survey in 1987, the annual count has ranged from 19 to 61 eagles. Weather and food availability seem to be the primary variables affecting eagle abundance and distribution. Most of the eagles were recorded in the Jardine/Gardiner/Mammoth area.

Other Species of Special Interest

Trumpeter Swans. The combined effect of predation, lack of recruitment from outside the park (e.g., Centennial Valley), and two years of record flooding have reduced trumpeter swans to a tenuous existence in Yellowstone. Only five trumpeter swan nest attempts occurred in the park in 1997, compared to four in 1996. Although cygnets hatched in three of the five 1997 nests, none fledged. The number of adults counted ranged from 20 to 23 in June and July; during the fall survey, only 18 adults were recorded in the park.

Although not identified as a major problem, increasing visitor activity calls for increased vigilance near nesting territories, especially those at Seven Mile Bridge and Trumpeter Lake. Two cygnets hatched from a floating nest platform that survived the 1997 floods at Seven Mile Bridge, but the brood was lost when the adults moved them several miles downriver, possibly because of disturbance by a photographer or someone putting a boat into the river. The presence of wolves in the Lamar Valley has attracted many people to the area, and their presence may have been a factor in the overall nest failure at Trumpeter Lake. Recommendations will be made to close the area to the public during the nesting season.

Despite flooding in the Yellowstone River, the swan population in Paradise Valley, north of the park between Livingston and Gardiner, Montana, is beginning to increase again. In addition to a pair of wild swans that fledged three cygnets at the Beaver Creek Ranch, 12 captive-raised adults survived in the valley, including 2 pairs of adults that fledged 8 cygnets at 2 other ranches. In 1997 there were historically high water levels on the Yellowstone River for the second year in a row. The DePuy's "Call of the Wild Ranch" was spared due to landowner's precautionary riprap and dike construction, but most of the swans were flushed down river. No nesting attempts were made, but the swans returned and remained on the premises. A male swan discovered ten miles down river from the DePuy ranch was raised by a rancher and then relocated and placed with a widowed female swan. After the pair hatched three young, the cygnets were moved to private land on Merrill Lake.

The park ornithologist is chairman of the Greater Yellowstone Trumpeter Swan Working Group, which was organized in 1997 to improve resident trumpeter swan numbers in the greater Yellowstone area. A special effort will be made next year to obtain additional contributors to build up the Trumpeter Swan Recovery Fund, which is used to help purchase captive-raised swans for placement on private land in Paradise Valley. The money is important, but not as important as time. It will take awhile for the project to rebound after two consecutive years of severe flooding along the Yellowstone River.

Common Loons. Although severe flooding

Table 6. Common loon production—annual results and population trends, Yellowstone National Park.

Year	Pairs Observed	No. of Adults	Large Young/Loons Fledged	Nest Attempts
1997	19	38	6	5
1996	20	41	4	5
1995	20	40	8	13
1994	22	48	11	12
1993	24	51	2	12
1992	21	48	6	11
1991	20	41	9	9
1990	19	42	9	11
1989	17	34	17	15
1988	incomplete	incomplete	incomplete	9
1987	13	incomplete	13	10
1986	incomplete	incomplete	incomplete	incomplete

resulted in only five known nest attempts in both 1996 and 1997 (from 9 to 15 attempts were made during each of the previous nine years), common loon numbers and territorial pairs continue to hold on in the park (Table 6). During 1997, only six young fledged from five nest attempts.

Ospreys. Despite substantial variations from year to year as a result of weather and nest tree instability, the Yellowstone osprey population has maintained its vigor. In 1997, 84 nesting pairs and 64 fledglings were recorded, compared to the 11-year mean of 75.8 nesting pairs and 70.7 fledglings.

Colonial Nesting Birds. The annual colonial nesting bird census was conducted in mid-May, early June, early August, and mid-September on two of the Molly Islands in Yellowstone Lake (Table 7). Because of logistical problems, only aerial surveys were done this year.

The spring weather was unusually wet and cold, and the winter's heavy snow accumulation resulted in record runoff and severe flooding on Yellowstone Lake. During the peak of the flood, Sandy Island was totally submerged and only a quarter of Rocky Island remained above water. In this limited area, 92 American white pelican nests were found in one aggregation, but only 36 pelican pairs hatched eggs. Despite the poor nesting conditions, 42 pelican chicks fledged. Of the 98 double-crested cormorant nest attempts on Rocky Island, only 75 pairs hatched eggs, resulting in 140 fledglings. All 70 California gull nests and 4 Caspian tern nests on Rocky Island failed because of flooding. On Sandy Island, rising water levels eliminated the entire production, including the 113 pelican nests and 20 double-crested cormorant nests, but no Caspian terns even tried to nest.

Illegally introduced lake trout, which compete with colonial nesting birds and other wildlife for Yellowstone cutthroat trout, continue to be detected in larger numbers each

Table 7. 1997 Molly Islands colonial nesting birds.

Species	# Nests Attempts	Successful Nests	Fledged Young
American white pelican	205	36	42
Double-crested cormorant	118	75	140
California gull	70	0	0
Caspian tern	4	0	0

Harlequin duck. Photos courtesy Terry McEneaney.

Volunteers Mark Donahue and Jeff Johnson collecting data on the Mount Washburn raptor study.

year in Yellowstone Lake, but their presence does not yet appear to have influenced colonial bird production.

Harlequin Ducks. From 16 to 20 harlequin duck pairs per year have been present in the park. Their production is so variable that collecting more information about the species is not cost-effective under the current budget for bird monitoring. The bird biologist authored an article on harlequin ducks, published in *Yellowstone Science* (5:2) in 1997, that summarizes the information known about the park's harlequin duck demographics and ecology.

Other Research and Monitoring

Mount Washburn Raptor Migration Study. This three-year study of raptor migration was completed in 1997, with 973 raptors counted at the summit of Mount Washburn during the fall monitoring period, compared to 1,262 in 1996 and 822 in 1995. On no day during the study were more than 100 raptors counted, compared to 5 days in 1996 and 2 days in 1995 (Table 8).

The 1997 raptors included 17 different species, of which 4 species accounted for more than 80 percent of the all the raptors observed. As in the previous two years, the most numerous species was the American kestrel (39.6%), followed by red-tailed hawks (16.7%), sharp-shinned hawks (14.1%), and Cooper's hawks (10.1%). A broad-winged hawk was recorded for the second year in a row and comprised only the third record for the park. The first broad-winged hawk was seen at Sedge Creek in May 1989; the second record came from this study last year.

The 1998 annual report will contain more details about the study results and a recommendation regarding future raptor monitoring.

North American Bird Migration. Yellowstone participated for the fifth consecutive year in the North American Bird Migration Count, held on the second Saturday in May. Although originally organized to collect quantitative and qualitative information on spring bird migration on a continental scale, it has become a social event similar to the Christmas Bird Count. On May 10, 1997, four observers recorded a total of 2,081 birds and 93 species in and around the park, 70 species inside Yellowstone. Trend data is difficult to ascertain from this type of information, since the number of observers and hours spent recording birds varies each year, but it does help to improve our understanding of bird migration.

Table 8. Mount Washburn raptor study. Raptor counts and period observed.

	# birds 1995		# bird 1996		# birds 1997	
American kestrel	315	Sept. 5–Oct. 10	498	Aug. 25–Oct. 6	397	Aug. 20–Oct. 5
Red-tailed hawk	150	Sept. 5–Oct. 10	215	Aug. 25–Oct. 6	144	Aug. 28–Oct. 5
Sharp-shinned hawk	87	Sept. 15–Oct. 10	200	Aug. 30–Oct. 6	145	Aug. 29–Oct. 5
Cooper's hawk	56	Sept. 11–Oct. 10	150	Aug. 25–Oct. 5	103	Aug. 29–Oct. 5
Golden eagle	70	Sept. 12–Oct. 10	38	Aug. 28–Oct. 6	10	Aug. 20–Oct. 5
Northern harrier	29	Sept. 5–Oct. 2	36	Aug. 28–Oct. 6	49	Aug. 29–Sept. 28
Merlin	32	Sept. 6–Oct. 10	23	Sept. 3–Oct. 6	10	Aug. 29–Oct. 5
Northern goshawk	5	Sept. 27–Oct. 1	22	Sept. 3–Oct. 1	15	Sept. 24–Sept. 30
Prairie falcon	15	Sept. 5–Oct. 5	14	Aug. 25–Oct. 5	15	Aug. 28–Sept. 30
Peregrine falcon	2	Sept. 27–Oct. 1	10	Sept. 11–Oct. 5	3	Aug. 29–Oct. 1
Bald eagle	10	Sept. 22–Oct. 1	9	Sept. 10–Oct. 5	13	Aug. 30–Sept. 29
Osprey	9	Sept. 5–Oct. 1	9	Sept. 3–Sept. 28	11	Aug. 29–Sept. 27
Turkey vulture	1	Oct. 4	7	Sept. 15–Sept. 21	9	Sept. 17–Sept. 23
Ferruginous hawk	2	Sept. 22–Sept. 30	4	Aug. 30–Oct. 4	11	Aug. 31–Sept. 16
Swainson's hawk	3	Sept. 5–Oct. 12	3	Aug. 28–Sept. 29	2	Sept. 23
Broad-winged hawk	0	–	1	Sept. 28	1	Sept. 17
Rough-legged hawk	3	Sept. 30–Oct. 6	0	–	0	–
Unidentified	33	–	23	–	35	–
Total	822	Sept. 5–Oct. 10	1,262	Aug. 25–Oct. 6	973	Aug. 20–Oct. 5

Christmas Bird Count. On the 25th annual Christmas Bird Count in the Yellowstone area, 1,180 birds of 33 species were recorded, plus an additional three species during the official count week. The 1997 count was the first in which the gray partridge was recorded (outside the park) and in which the house wren and the marsh wren were found in the park. While unusual birds seem to show up in the count during severe winters and storm conditions, the mild winter and pleasant weather on the count day (December 21) contributed to the average count.

Road Reconstruction-related Surveys. The Federal Highways Program provided funding in 1997 to conduct bird surveys along two road segments that are scheduled for reconstruction, Mammoth-to-Norris and Norris-to-Madison. Point count censuses were supplemented by aerial surveys.

Breeding Bird Surveys. Park personnel conducted 5 breeding bird surveys in 1997, including 3 survey routes located in the park and 2 routes in Centennial Valley, for a total of 150 census points. As part of a continental network, these standard routes are important for monitoring songbird populations. The annual reports are stored at a central data bank set up by the U.S. Fish and Wildlife Service in Laurel, Maryland. Because of time and logistical limitations, the Centennial Valley surveys will be done by observers closer to the area starting in 1998.

Northern Range Grassland Bird Data. In order to collect baseline data on birds of the northern range and gain a better understanding of passerine grassland bird abundance and distribution, 131 point counts were conducted in 1997, and more are planned for the next two years. An additional 30 points were surveyed on the Glacier Boulder trail near Canyon, and 135 points along five park road segments (West Thumb-to-South Entrance, Biscuit Basin-to-West Thumb, Highway 191 on the park's northwest boundary, Madison-to-West Yellowstone, and Norris-to-Canyon). The primary use of this data will be for the Yellowstone bird ecology and distribution study, which is expected to take several years to complete.

Checklist of Yellowstone Birds. While the *Field Checklist of Birds of Yellowstone National*

Park became available in 1996, the park ornithologist will undertake an ambitious project, "An Annotated Checklist of Yellowstone Birds," to provide details and facts regarding the status of all the bird species found in the park and to serve as a foundation for expanding future bird studies.

Museum Specimens. Study skins from road-killed birds salvaged during 1996 and 1997 will be made and submitted to the park's museum collection in 1998.

Birds in a Forested Landscape. This new program evolved from Project Tanager, one of three national science experiments under the direction of the Cornell Lab of Ornithology. Yellowstone contributed to its exploration of the question of how tanagers in North America are affected by forest fragmentation. The Birds in a Forested Landscape project extends this question to include other species of forest dwelling birds: accipiters (sharp-shinned hawks, Cooper's hawks, northern goshawks) and thrushes (hermit thrushes, Swainson's thrushes).

Cornell Laboratory of Natural Sounds Project. The park ornithologist assisted two sound technicians from Cornell who came to record bird sounds for a CD on Yellowstone birds. This project will take several years to complete.

Partnerships

In addition to participating on the Greater Yellowstone Bald Eagle Working Group, the Peregrine Falcon Working Group, and the Trumpeter Swan Working Group, the park ornithologist is chairman of the Montana Birds Record Committee, which meets once or twice a year to review new bird records and the latest changes in ornithology.

Neotropical Migrants. Yellowstone also participates in three working groups related to neotropical migrant landbirds. Two of the working groups (Montana Partners in Flight and Wyoming Partners in Flight) are state coordinated; the third, Western Working Group—Partners in Flight, includes biologists from the United States, Canada, and Mexico. These groups have been meeting once or twice a year at different locations to establish priorities for species at state and regional levels, and to ensure neotropical migrants are given adequate protection.

Mexican Biosphere Reserves. In February, the park ornithologist attended a workshop on neotropical migrants sponsored by the Colorado Bird Observatory, during which participants visited biosphere reserves and national parks in central Mexico to discuss problems and needs in this area. Afterward, he hand-delivered used NPS uniforms provided by Yellowstone employees to the Manantlan Biosphere Reserve in Jalisco, Mexico, where they were much appreciated. The NPS emblem was left on the uniforms, to be accompanied by a Manantlan Biosphere Reserve patch.

In May, Jorge Schondube, a biologist from the Manantlan Biosphere Reserve visited Yellowstone to learn about the types of field techniques the park uses and the data that is being collected on neotropical migrant birds.

Bison

For as long as there have been bison in the Yellowstone area, many of them have survived the winter by migrating to geothermal areas and lower elevation ranges both in and outside the park. But for the last three decades bison entering Montana public or private land from the park have been shipped to slaughter or shot because some of them carry brucellosis, a disease that also infects domestic livestock and often results in abortions by infected females. A vigilant national regulatory effort has reduced the number of infected cattle herds in the United States; the goal of the national brucellosis eradication program, developed cooperatively by the states and the USDA

Researchers handling bison for the epidemiology study, a cooperative project. Photo courtesy Bison Management Office.

Animal and Plant Health Inspection Service (APHIS), is eradication of the disease from cattle by 1998.

Bison Management and Planning

A multi-agency effort to produce a plan and environmental impact statement for long-term bison management has been underway since 1992. Alternatives range from testing of all bison in Yellowstone and sending to slaughter all those that test positive for brucellosis, to establishing tolerance zones for bison that wander outside park boundaries onto public lands in winter. Suggestions that Yellowstone become like other bison refuges, fencing the park and periodically culling its bison, have been resisted by park managers, whose goal is to maintain the continuity of the nation's only completely wild, free-ranging herd.

When the extreme weather conditions of the winter of 1996–1997 drove an unusually large number of bison from the park, nearly 1,100 bison were captured in or near park boundaries and killed by state and federal officers or sent to slaughter in Montana. These removals, combined with natural winter mortality, reduced the Yellowstone bison population to an estimated 2,000 animals by the spring of 1997.

During 1997, the NPS, APHIS, U.S. Forest Service, and the State of Montana met and developed alternatives for a draft plan and environmental impact statement, which was rescheduled for public release by June 1998. Concerns raised by the high bison mortality during the preceding winter prompted modifications to the previously approved *Interim Bison Management Plan*, reducing the number of bison that would have to be killed if they migrated to the park boundary. The goal continued to be to maintain Montana's brucellosis class-free status while permitting the bison herd within the park to fluctuate in response to natural ecological processes.

Probably due to the mild winter, bison movements outside the park and necessary management actions were minimal; no bison had been captured or killed as of December 31.

Bison Research

The NPS committed about $900,000 in funds from the Natural Resource Preservation

Program (NRPP) over fiscal years 1996–98 for bison research and the building of capture facilities to manage bison. The research emphasis has been on bison ecology; the ecology of the *Brucella* organism in the wild and a risk assessment of its effects on wild ungulates; and testing vaccines for their safety and efficacy in wild bison. A study is also underway in cooperation with the Fish and Wildlife program at Montana State University to develop methods for conducting aerial surveys that will provide scientifically defensible bison population estimates, including correction factors that will account for the proportion of animals not observed during the surveys.

To determine movement patterns of park bison and relate these movements to range conditions such as herbaceous standing crop, growth stage, snow depth, and snow water equivalency in areas vacated and occupied by bison, 45 bison were net-gunned and radio-collared in October. An additional 40 bison were radio-collared as part of on-going epidemiological studies of bison and brucellosis. Aerial radio-tracking flights have been on-going since that time.

Molecular Analysis of Brucellosis. A team of molecular biologists at the Conservation Genetics Laboratory at San Francisco State University and Diversa, Inc., in San Diego, California, is investigating a diagnostic test that may be able to detect the bacterium *Brucella abortus* using the polymerase chain reaction (PCR) technique. Much of the equipment, reagents, and technical skills needed for the project have been provided or loaned by the cooperators. Since December 1996, they have set up a PCR field lab at Yellowstone, collected more than 200 samples of bison blood for DNA analysis, collected 19 strains of *Brucella* species' DNA for comparison using gene-sequencing technology, and begun to compare strains of *B. abortus* from wild bison and domestic cattle to determine the genetic diversity of each. The results of this research may provide information about the pathogenicity of brucellosis and the risk of transmission between wild bison and domestic cattle that could affect the long-term management of bison in and around the park.

National Academy of Science Report. In May, the Department of the Interior commissioned a report by the National Academy of Science (NAS) to evaluate the existing science on the question of whether bison or elk could transmit the bacteria *Brucella abortus* to cattle. The NAS report, which was released in December, emphasized that brucellosis affects both elk and bison and encompasses the entire GYA, not simply Yellowstone National Park, and that "it would be impossible to vaccinate all GYA elk." But the NAS review identified studies that could lead to the development of techniques that could make eradication of brucellosis from GYA wildlife possible in the future. The report's primary finding is that risk management is critical to controlling the disease in the GYA until a proven, effective vaccine and a practical delivery mechanism for inoculating elk and bison are found. A final report incorporating agency comments was expected to be published in 1998.

Fisheries and Aquatic Resources

Lake Trout in Yellowstone Lake

After the presence of non-native lake trout (*Salvelinus namaycush*) in Yellowstone Lake was confirmed in 1994, the Aquatic Resources Center (ARC) initiated a control program based on the recommendations of an expert panel who convened in the spring of 1995. In 1997, ARC continued to refine a gillnetting program in order to maximize removal of lake trout while minimizing the associated mortality of native Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*). Cooperating

researchers at Utah State University focused on the diet, age, growth, and predatory impact of lake trout and, with the help of the Idaho Department of Fish and Game, conducted hydroacoustic surveys to learn more about the distribution and relative abundance of both species in Yellowstone Lake. Preliminary hydroacoustic estimates in the western portion of the lake, where the invaders are believed to be the most concentrated, indicate a population of at least 7,000 lake trout.

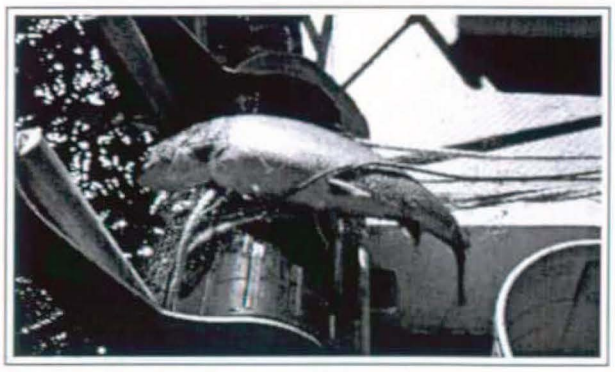
With the current gillnetting techniques, the overall catch ratio of lake trout to Yellowstone cutthroat is approximately 1:1. This has been made possible by getting better information on the distribution of lake trout and the relative abundance of both species in different parts of the lake; locating more lake trout spawning habitats; and determining the most effective gill-net mesh size. To help meet these objectives, three types of gillnetting were used to sample lake trout in 1997: distribution, control, and spawning.

Distribution Gillnetting. Distribution netting, using nets of many mesh sizes, was conducted during June, July, and August to establish the spatial distribution of all sizes of lake trout and cutthroat trout throughout the lake. More than 100 lake trout and 1,200 cutthroat trout were caught in these multimesh nets, suggesting a lake-wide ratio of 12.5 cutthroat trout for each lake trout, but a more accurate ratio will be determined as acoustic data are analyzed. Other findings:

- Lake trout caught in these nets averaged 21.5 inches (544 mm) in length with a range from 4.8 inches (123 mm) to 36 inches (914 mm).
- No differences were detected in catches of cutthroat trout and small lake trout (<20 inches, 500 mm in length) in four different areas, indicating that these fish were relatively evenly distributed throughout the lake. However, preliminary acoustics data suggests a higher density of small lake trout occur in West Thumb. Large lake trout (>20 inches, 500 mm in length) were caught in larger numbers in the West Thumb basin compared to the rest of the lake, and netting efforts indicated that large lake trout were primarily confined to that area.
- Most cutthroat trout were captured in shallow water (<33 ft., 10 m) and catches declined in nets set in progressively deeper water.
- Total lake trout catches were greatest at intermediate depths (33–82 ft., 10–25 m). Large lake trout were most efficiently captured at these depths, but small lake trout were most efficiently captured at depths exceeding 130 ft. (40 m).

Control Gillnetting. From late-May through mid-September 1997, nets of large

Aquatic resources staff gillnetting on Yellowstone Lake. Photos courtesy ARC.



Lake trout caught in gillnet.

mesh sizes were used to remove nearly 200 lake trout (Table 9), by targeting areas in which we had high catch rates in 1996. The majority (91%) of lake trout were captured in Breeze Channel and West Thumb basin. Lake trout caught in these nets averaged 20 inches (507 mm) in length, with a range from 6 inches (152 mm) to 36 inches (914 mm). Large lake trout were most efficiently captured in the 2.75-inch mesh nets, a size that captured no cutthroat trout. Overall, control gillnetting resulted in a favorable cutthroat-to-lake trout catch ratio of 1.5:1.

Spawner Gillnetting. Similar to 1996, lake trout began migrating into shallow water when surface water temperatures declined to 52° F (11° C). As they spawned from mid-September until mid- to late-October, nets of large mesh size were used to remove reproductively active lake trout from known spawning locations and also to locate new spawning areas. More than 500 adult lake trout were gillnetted, 67 percent males and 33 percent females. They ranged from 11.7 inches (298 mm) to 32.1 inches (816 mm) in length, and averaged 23.8 inches (605 mm). Spawner gillnetting proved to have the most favorable cutthroat-to-lake trout catch ratio of 0.5:1.

At Carrington Island, 239 lake trout were captured, compared to 153 in 1996. Most were captured at depths less than 20 ft. (6 m) and 92 percent of the fish captured there were reproductively mature, indicating that Carrington Island is an important spawning area for lake trout. Although the larger catch in 1997 may suggest that the 1996 gillnetting effort had little effect on lake trout productivity at this site, the removal of 392 spawners in the last two years has prevented many lake trout from reproducing.

During October, a new lake trout spawning area was located in deep water (65 ft., 20 m) in the eastern section of West Thumb, approximately 1.5 miles (2.4 km) north of the mouth of Solution Creek. From this site 133 male and 51 female lake trout were removed; 78 percent of these fish were reproductively mature. Because these results are comparable to those at Carrington Island, this new location is considered another major lake trout spawning area. Unfortunately, inspection of the gonadal tissue showed that six of the male and eight of the female fish had spawned just prior to being captured in our nets. Several other fish captured within a 1.5 mile (2.4 km) radius of this site had also recently spawned, suggesting that this site had been discovered after spawning had begun.

Total Effort. During 1997, an equivalent of 1,511 overnight gill nets were set, compared to 1,191 during 1996. This required approximately 107 boating days on the water, with an average of three crew members per boat. ARC staff were able to sustain this lake trout control program while continuing other Yellowstone cutthroat trout monitoring efforts as well as

Table 9. Lake trout gillnetting in Yellowstone Lake, 1997.

		Cutthroat trout		Lake trout		
Netting Strategy	Effort	Number Captured	Efficiency	Number Captured	Efficiency	Biomass
Distribution	111	585	14.28	167	1.50	110
Control	598	304	0.51	196	0.33	268
Spawner	802	239	0.30	500	0.62	1,123
Total	1,511	2,128		863		1,501

Effort = number of 330 ft., 100 m/net-nights
Efficiency = number captured per 330 ft., 100 m/net-night
Biomass = kilograms

additional monitoring and restoration efforts for other fisheries and aquatic resources.

The large mesh nets set in the West Thumb basin at shallow and medium depths (including spawning areas) have proved to be efficient at capturing large, reproductively mature lake trout that consume the majority of cutthroat trout and are responsible for producing the next generations of lake trout, which appear to be much more numerous. But if the smaller lake trout (10–18 in., 254–457 mm) mature in large numbers, they could overwhelm known spawning habitats and expand the lake trout population at exponential rates. Small-mesh nets set in very deep water, which will be a focus of next year's gillnetting effort, should prove useful in removing these smaller lake trout while minimizing catches of cutthroat trout.

Angler Catches. Anglers reported catching about 250 lake trout during the summer of 1997: 42 percent were captured in June, 51 percent in July, and 7 percent in August. Although angling effort was not evenly distributed throughout the lake, some information is available on the spatial distribution of these catches. Twelve percent of the angled fish were captured near islands, 66 percent near the western shore, 12 percent in the northern region, 3 percent near the eastern shore, and 7 percent in the southern region. Angled fish averaged 18.3 in. (465 mm) in length and ranged in size from approximately 11.8 in. (300 mm) to 27.5 in. (700 mm).

Long-term Goal. Since the current cutthroat trout regulations went into effect in 1975, the cutthroat trout has recovered from previous over-exploitation. Therefore, if lake trout consumption of cutthroat trout is kept to less than the current angler mortality of cutthroat (about 40,000-50,000 a year), it may be possible to keep a healthy cutthroat trout population. However, limiting cutthroat trout exploitation rates by both lake trout and anglers may require greater angler restrictions for cutthroat trout in the future.

Cutthroat Trout Monitoring

Maintaining long-term data on the age, size, and abundance of Yellowstone cutthroat trout has been underway for several decades to assess the effects of angler harvest and regulations on population maintenance. Since the discovery of lake trout in Yellowstone Lake, this data has also helped park biologists assess the impacts to the native trout. During 1997, in addition to the monitoring of spawning activity at Clear Creek and LeHardy Rapids, additional spawning surveys were instituted while developing techniques applicable to backcountry tributaries of the lake.

Clear Creek Fish Trap. A spawning run of adfluvial Yellowstone cutthroat trout enters Clear Creek from the eastern shore of Yellowstone Lake from late April or May through July. Since 1951, data on numbers of upstream and downstream spawning migrants, their size, and age has been collected using a fish trap and weir located near the mouth of the creek. This year, the trap was operated for the first time as a partnership between the ARC and Yellowstone Ecosystem Studies (YES), a non-profit organization headquartered in Bozeman, Montana. Under the terms of the agreement, YES personnel were to work under ARC supervision in following established sampling and data collection protocols, while adhering to park policies regarding backcountry use and living at Clear Creek.

Because of high water, the Clear Creek fish trap and weir were not installed until May 27, two weeks later than normal. Although some use was made of an electronic fish counter from July 17 through August 8, during most of the season fish passage, enumeration, and sampling were accomplished by dip-netting trout that entered the upstream trap box, or by visually counting trout as they swam over a wooden chute attached to the front of the trap.

Cutthroat trout in the upstream run were

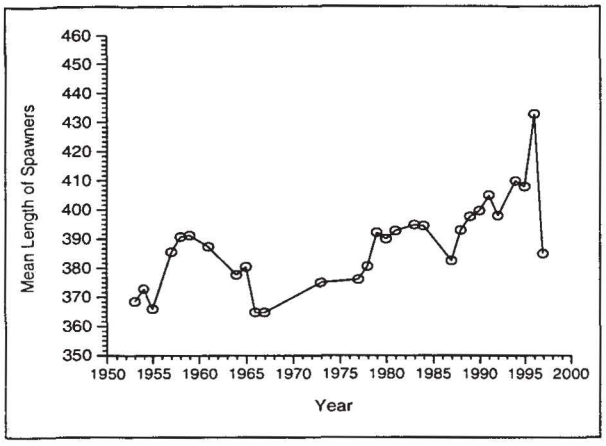


Figure 4. Mean length of cutthroat trout spawners entering Clear Creek, 1953–1997.

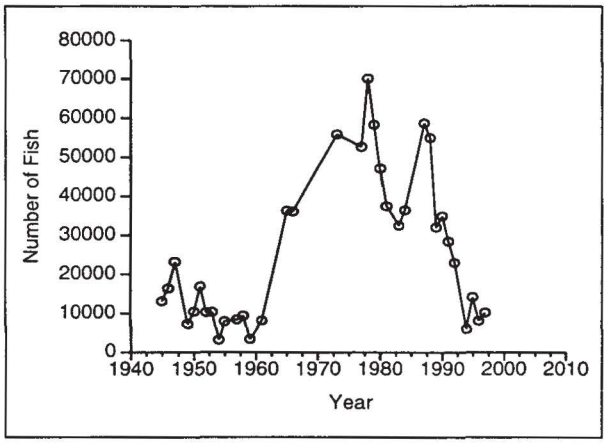


Figure 5. Number of cutthroat spawners entering Clear Creek, 1945–1997.

sampled each day from 8 A.M. to 8 P.M. At the beginning of each sampling week, 100 trout were sampled for total length, weight, sex, and stage of maturity. To the extent permitted by the number of captured trout, length frequency data were obtained from an additional 75 trout each day. Numbers of upstream migrants were totaled daily from hourly fish counter readouts and from trout sampled and released upstream of the weir. Downstream migrating fish were either tallied through the electronic counting chutes as they passed through the trap, or netted and released below the weir. Daily water temperatures were obtained with a hand-held thermometer, and stream discharge was measured as the water height from a staff gauge located approximately 400 m upstream from the weir.

A total of 10,206 cutthroat trout passed through the upstream trap and counter in 1997, but only 4,124 cutthroat trout were counted downstream in Clear Creek. Portions of the weir were removed during peak discharge, which greatly increased the potential for fish (especially downstream migrating trout) to pass through the weir uncounted. As in 1996, upstream and downstream migrant spawner counts in 1997 were assumed to be minimums because of extremely high runoff due to snowmelt and subsequent elevated lake levels.

Mean total length and weight of upstream cutthroat spawners were 15.3 inches (388 mm) and 1.2 lbs (569 g), respectively. The mean total length and weight of males was 15.6 inches (397 mm) and 1.3 lbs (589 g), respectively; females averaged 15 inches (382 mm) in total length and 1.2 lbs (556 g) in weight. The male:female ratio was 0.55:1.

The average length of cutthroat trout entering Clear Creek annually has generally increased since the mid-1960s (Fig. 4). The long-term data on the number of spawners, however, has exhibited considerable fluctuation. Prior to 1961, upstream migrants generally numbered less than 10,000, and rarely exceeded 20,000 (Fig. 5). From 1965 through 1987, the spawning run fluctuated between 30,000 and 70,000 fish, but since then the annual number of fish seen has steadily declined; this year's total was approximately 10,200 fish. Numbers counted annually from 1994 through 1997 represent the lowest spawner counts since 1961. The reasons for this trend in low spawner escapement are unexplained, as are the implications on the numerous piscivorous mammals and birds

which use the spawning migration.

Surveys at Arnica Creek. Arnica Creek, a tributary of Yellowstone Lake which enters the northern portion of West Thumb, has historically been a focus of study because it sustains one of the larger spawning migrations of Yellowstone cutthroat trout. A two-way fish trap was operated near the mouth of the stream from 1951 to 1958. In 1985 and 1986, the stream was chemically treated with antimycin to remove non-native brook trout (*Salvelinus fontinalis*) which were discovered there, and subsequent surveys have confirmed their successful extirpation.

Because large predatory lake trout are abundant in the West Thumb basin of Yellowstone Lake, Arnica Creek was selected this year as an additional site for monitoring trends in abundance, length, and age structure of the cutthroat trout spawning run. Specific objectives in 1997 were to install and operate a fish trap and weir, and to refine installation and fish sampling techniques applicable to future monitoring efforts in a backcountry setting.

The fish trap and weir were installed on June 15–16, and operated through August 11. Biologists dip-netted trout that entered the upstream trap box, which remained open during daylight hours; downstream migrating fish were collected in a separate trap in the same manner. Sampling of cutthroat trout occurred daily during morning and afternoon periods, and total length, weight, sex, and maturity were recorded. Scales were removed from a minimum of 20 fish each week. All upstream migrants were marked with a caudal fin clip, and the percentage of spawners that either migrated upstream prior to the installation of the trap, or those navigating around the trap was calculated from marked and unmarked downstream fish. Abundance of upstream and downstream migrants was calculated from the daily trap counts. Stream discharge and water temperatures were recorded.

In the upstream trap, 194 spawning migrants were counted. Of the 20 fish counted in the downstream trap, 12 fish (60%) had been marked in the upstream run. From these counts, the estimated number of cutthroats entering Arnica Creek was 272 fish, but these estimates are confounded by numerous problems we encountered in effectively blocking the stream. Openings large enough for fish to navigate were found on several occasions underneath the trap and weir. Natural mortality may also have contributed to the low estimate. To prevent this problem next year, a semi-permanent trap will be installed.

Mean total length for all fish was 14.7 inches (374 mm). Males averaged 15 inches (380 mm), whereas females were somewhat smaller 14.5 inches (368 mm). Average weight for all fish was just over 1 lb. (479 g). Average age of 192 fish was 4.4 years. Mean age of males was 4.5 years, slightly older than the average for females (4.3 years).

LeHardy Rapids Dipnetting. The spawning run at LeHardy Rapids, a series of cascades in the Yellowstone River six km downstream from Yellowstone Lake, has been monitored since 1974 to evaluate trends in the cutthroat trout population structure. In 1997, using dip nets and established sampling protocols, data on spawner abundance, total length, and weight were collected once each week from June 9 until July 28. Fish were visually identified as to sex and stage of maturity. Scales samples taken from a 20 fish sub-sample each week were analyzed for age. All fish captured were marked with a caudal fin clip and released upstream of the rapids to avoid recapture.

A total of 268 cutthroat trout were captured at LeHardy Rapids in 1997. Of these, seven were non-spawning fish whose sex could not be determined. The average total length for all trout (15.6 inches, 396 mm) was the lowest since 1988. Mean weight was 1.18 lbs (533 g). Average age of the expanded sample was 5.3 years. Male to female ratio for all fish captured

Aquatic resources staff electrofishing on Canyon Creek. Photo courtesy ARC.

was 1:1.15. Comparisons with the long-term averages (1974–1995) supports a trend of larger fish at LeHardy rapids. Mean age of cutthroat spawners has remained relatively constant, although 1997 results are the lowest annual results since 1985. At this point we cannot determine what effect, if any, the introduction of lake trout into Yellowstone Lake has had on the cutthroat trout spawning run in the Yellowstone River.

For the fifth consecutive year, the Wyoming Game & Fish Department (WGFD) also collected spawning trout at LeHardy to develop a hatchery brood stock for re-establishment within their historical range in Wyoming. After park staff completed their sampling each week, WGFD separated fish by sex and transported them to holding cages downstream. At the end of each sampling week, fish were paired, and approximately one ounce of eggs from each female was taken and fertilized with a small amount of milt from each paired male. Non-lethal ovarian fluid samples were also taken to test for infectious hematopoetic necrosis virus. The WGFD sampled 299 spawners and spawned more than 100 pairs of cutthroat trout prior to releasing the fish back into the Yellowstone River. Results of the disease testing from 1993 to 1997 have all been negative.

Westslope Cutthroat Trout Restoration

One of the park's long-term goals is to restore native westslope cutthroat trout (*Oncorhynchus clarki lewisi*) to streams within their historic range. This native fish survives in only a few streams in the park, and in some cases in a hybridized form.

Genetic testing. During late summer and early autumn 1997, staff collected samples of purported westslope cutthroat trout from seven sites in the northwest portion of the park (portions of the North and East forks of Specimen Creek, the North and East forks of Fan Creek, the Fan Creek main stem, Grayling Creek, and Gneiss Creek) for genetic identification. Fish captured at Gneiss Creek were visually identified in the field as non-native rainbow trout (*Oncorhynchus mykiss*). Fin clip samples from 91 fish collected at the other sites were sent to the University of Montana to determine the extent to which the westslope

cutthroat trout may have hybridized with introduced rainbow trout or Yellowstone cutthroat trout (native to the Yellowstone Lake and River drainage but not to the upper Missouri tributaries in northwestern Yellowstone.) Preliminary results of this genetic analysis indicate that most park populations of westslope cutthroat have hybridized with either Yellowstone cutthroat, rainbow, or both; however some genetically pure individuals were found. More complete analyses of introgression will be available at a later date.

Canyon Creek. Potential candidate streams for westslope cutthroat reintroduction include Canyon Creek, a tributary of the Gibbon River which enters approximately one km below Gibbon Falls. In 1975 and 1976, the stream was chemically treated with antimycin to remove non-native fish. An artificial log barrier was constructed to prevent re-invasion by non-natives from the Gibbon River, and an attempt was made to restore native Arctic grayling. Since that time, non-native fish have reappeared, indicating that either all fish were not eliminated or that the barrier was not effective in keeping out unwanted fish; few if any of the grayling survived in the stream.

To prepare Canyon Creek for reintroduction of westslope cutthroat trout, ARC staff began to locate and remove non-native trout, and to improve the existing log barrier to eliminate upstream movement of non-native trout present in the Gibbon River.

After obtaining the necessary approvals from the Wyoming Department of Environmental Quality and the U.S. Army Corps of Engineers, ARC staff replaced the decayed logs that supported the sides of the barrier, and raised the height of the structure by one log. This directed the majority of flow towards the center of the structure, reducing erosion along its banks while concentrating upstream migrating fish below the highest point of the barrier. In addition, plunge pools near the base of the artificial falls were reduced or eliminated by adding large boulders and other debris. Modifications were accomplished primarily with local materials.

To test the effectiveness of the barrier modifications, we marked 106 brown trout collected upstream of the barrier with adipose fin clips and released them below the structure. In addition, we observed the movements of pre-spawning brown trout congregating below the artificial falls in late October. Approximately 30 of these spawning fish were collected and marked with an anal fin clip to differentiate them from trout collected upstream of the barrier. Any marked fish collected above the barrier in the future will provide evidence of the barrier's effectiveness. Initial observations of brown trout below the artificial falls late in the season indicated that the barrier may be effective in preventing non-native fish from reentering Canyon Creek. Although many fish were seen attempting to travel upstream, they were unable to ascend over the barrier through the falls.

In the summer of 1997, ARC staff snorkeled about 400 m of stream above and below a natural waterfall to determine the distribution of non-native trout species prior to removing them. Since no trout were observed upstream of the falls, electrofishing was limited to a 3-km reach from the base of the falls downstream to the mouth of the creek. Electrofishing was performed in 100- to 200-meter sections separated by block nets, with one to three passes made in each section. Tributaries were blocked off where each entered the mainstem of Canyon Creek and electrofished separately. Fish were identified, sexed, measured for total length, and weighed.

From mid-July through October, approximately 5,000 brown trout (*Salmo trutta*), brook trout, and rainbow trout were removed from Canyon Creek and its tributaries. Brown trout were the most abundant species collected in each of the twelve sections sampled, and comprised 98.6 percent of the total catch.

Rainbow trout were captured in the lower reaches of Canyon Creek, and only one brook trout was captured in the mainstem, with one other individual collected in a tributary.

Mean total length of brown trout sampled was 5 inches (126 mm; N = 1208); brook trout and rainbow trout averaged 7.5 inches (188 mm; N = 2) and 3.8 inches (96 mm; N = 66) respectively. Nearly 70 percent of the brown trout captured in Canyon Creek were young-of-the-year; only 7 brown trout (2%) were classified as post-spawning fish, and all were sampled in late October. Eighty five percent of the rainbow trout were young-of-the-year (<100 mm), with only one mature adult individual sampled. The remaining nine fish were juveniles older than one year.

Based on the declining number of fish removed during each pass, biologists estimated that the sampled portion of Canyon Creek and its tributaries had contained 7,641 trout, about 67 percent of which they removed. The number of mature fish (>125 mm) was reduced by an estimated 92 percent. Whether it will be possible to remove the entire non-native population using electrofishing over a period of several years is not yet known. Electrofishing tends to be biased toward removal of larger fish, while smaller size classes comprise a larger portion of the actual population. The nature of the habitat, including abundant large woody debris and macrophytes, may also reduce the effectiveness of electrofishing.

In 1998 ARC staff expect to continue removal efforts with electrofishing while specifically targeting the mature trout. Although removal of these fish may be costly, requiring several years of effort, targeting them would effectively reduce reproduction, while allowing smaller size classes to become more catchable. Because brown trout were the most abundant species, undertaking control actions prior to their spawning period in the fall will further reduce recruitment. Other methods would be considered, including chemical treatment, if the efficiency of electrofishing to reduce several of the larger size classes began to decrease.

Fluvial Arctic Grayling Recovery

The distribution of Arctic grayling (*Thymallus arcticus*), which was once abundant in all the larger streams of the upper Missouri River drainage above Great Falls, Montana, has been reduced to less than 8 percent of its original range. Although a lacustrine form is present in Grebe and Wolf Lakes, where they were introduced, the fluvial or riverine form has been proposed for listing under the Endangered Species Act, and no viable populations are believed to exist in any of the park's waters in which the grayling was native.

Beginning in 1990, the NPS and U.S. Fish and Wildlife Service attempted to restore fluvial Arctic grayling by transplanting more than 2,500 fish and 50,000 eggs into Cougar Creek. Surveys in 1994–96 indicated negligible survival from these efforts. Park biologists decided to abandon restoration attempts in this stream, which appeared to provide less than optimal habitat for grayling, and consider other possible streams for grayling restoration. Historically, fluvial populations of grayling existed below Gibbon Falls, and earlier this century and again in the late 1970s and 1980s reintroductions of Arctic grayling to the stream were attempted. Although densities appear very low, numerous angler reports suggest that distribution of grayling in the Gibbon River is extensive, and individuals from the upstream lakes may be dispersing downstream.

During July 1997, we initiated studies to determine the distribution of Arctic grayling in the Gibbon River. A snorkel survey beginning 985 ft. (300 m) above Little Falls and continuing downstream to within 1,310 ft. (400 m) of Virginia Cascades revealed two grayling, both above Little Falls. Many rainbow trout were observed above these falls, with a rainbow

trout-grayling ratio of 12:1. Below Little Falls and through Virginia Meadows, only rainbow trout and brook trout were observed, with brook trout outnumbering rainbow trout 35:1.

Several factors other than scarcity may have contributed to the small number of Arctic grayling observed: (1) grayling are rather non-distinct when viewed from underwater; (2) to save time, ARC staff snorkeled in a downstream direction, which frequently reduced visibility; and (3) although grayling had been reported in the surveyed area, they may have dispersed further downstream. Future work to determine the distribution of arctic grayling will include efforts to estimate their dispersal rates in the river.

Parkwide Visitation and Fishery Data

Volunteer Angler Reports. The Volunteer Angler Report (VAR) system was developed by the U.S. Fish and Wildlife Service in 1973 to monitor angling in the park. Since 1996, the National Park Service's aquatic resource staff continued processing information obtained from the VAR system to evaluate angling regulations and to examine long-term trends in the parkwide fishery.

All visitors and employees 12 years of age and older intending to fish in the park are required to obtain a park fishing permit, which was issued to anglers for free prior to 1994, when fees were initiated. Since 1996, fishing permits remain free for anglers under the age of 16; adults are required to purchase permits ($10 for 10 days and $20 for a season-long permit). An attached postal card requests information from anglers on fishing dates, times, and locations; the numbers and lengths of species landed and creeled; whether fishing was done from boat or shore; the angler's skill level, and satisfaction with the overall fishing experience.

Park staff also conduct exit gate surveys by interviewing one person in each vehicle leaving the park during the sampling period. In 1997, 4 six-hour-long surveys were completed at the North Entrance, 5 at the Northeast Entrance, 7 at the East Entrance, and 10 at the South Entrance, and 9 at the West Entrance. Information is collected on whether visitors obtained a park fishing permit and fished; their state, Canadian province, or country of residence; and similar data to that requested on the Volunteer Angler Report.

From 1973 to 1994, the estimated number of annual anglers fluctuated between 116,000 and 156,000, with no distinct trend. Since the initiation of permit fees, the number of anglers has dropped substantially. About 2.9 million people visited Yellowstone National Park in 1997, and approximately 67,900 fishing permits were issued. Anglers returned 3,666 usable VAR cards (5.4% of those issued). Exit gate surveys revealed that 2.5 percent of permitted anglers did not fish, which resulted in an estimate of 67,045 persons fishing. Anglers averaged 2.5 hours of fishing per day for 2.5 days in 1.4 different waters per day, with a mean landing rate of 0.95 fish per hour. Nearly 78 percent of single-day anglers landed one or more fish.

Anglers landed 558,121 fish and creeled about 32,120 in 1997, releasing approximately 94 percent of all fish landed. Of those fish caught, 65 percent were cutthroat trout, 12 percent rainbow trout, 8 percent brown trout, and 8 percent brook trout. Mountain whitefish (*Prosopium williamsoni*), lake trout, Arctic grayling, and unidentified fishes made up the remaining 7 percent of angler-landed fish. Lake trout had the greatest average length (16.9 inches; 429 mm), followed by cutthroat trout (14.3 inches; 363 mm). An estimated 83 percent of park anglers reported being satisfied with their overall fishing experience. Fishery statistics for 22 lakes and streams that collectively constituted 95 percent of reported parkwide angler use are reported in Table 10.

Diseases and Aquatic Nuisance Species. Aquatic resources of the park are threatened by

Table 10. Fishery statistics for Yellowstone National Park waters with 20 or more angler days reported that collectively constituted approximately 95 percent of the estimated parkwide angler use in 1997.

	% of total parkwide angler days	Total reported angler days	Number of anglers	Mean length of angler day (h)	Angler days (trips)	Angler effort (hours)	Landing rate (fish/hr)	Creel rate (fish/hr)	Total fish landed	Total fish creeled	Mean length fish landed (inches)	Mean length fish creeled (inches)	% anglers landing 1 or more fish	% anglers satisfied with: Mean * expertise	Overall experience	Numbers caught	Sizes caught
Parkwide fishery	**100**	**6,173**	**67,045**	**2.45**	**240,141**	**587,781**	**0.95**	**0.05**	**558,121**	**32,120**	**13.0**	**12.5**	**78**	**1.94**	**83**	**72**	**78**
Yellowstone Lake	37.1	2,288	21,214	2.71	88,890	241,318	1.08	0.10	261,534	23,925	14.6	12.7	87	1.83	89	79	88
Yellowstone River	12.0	742	7,846	2.66	28,846	76,891	0.72	0.02	55,607	1,875	15.0	8.7	66	2.04	80	67	83
Slough Creek	7.8	483	5,358	3.26	18,769	61,111	0.84	0.01	51,657	804	13.8	12.5	84	2.07	84	76	85
Firehole River	7.7	477	5,980	2.51	18,536	46,605	0.94	0.02	43,824	804	10.3	10.7	81	2.01	86	75	68
Madison River	7.8	483	4,828	2.56	18,769	48,052	0.52	0.01	25,072	736	12.8	9.75	61	2.03	74	53	63
Gibbon River	5.5	338	4,188	2.10	13,127	27,505	0.87	0.03	24,006	929	8.3	9.4	75	1.83	81	65	66
Lamar River	3.1	191	2,451	2.67	7,408	19,779	0.84	0.03	16,609	653	11.2	11.3	70	1.97	81	66	68
Lewis Lake	2.1	131	1,701	3.52	5,073	17,868	0.72	0.14	12,783	2,564	14.8	15.5	73	1.88	77	70	79
Shoshone Lake	1.8	108	768	3.46	4,178	14,466	0.89	0.09	12,885	1,305	17.5	17.9	54	1.95	79	68	76
Gardiner River	1.7	102	1,244	1.95	3,945	7,676	1.46	0.09	11,185	720	9.2	7.5	87	2.04	87	77	66
Soda Butte Creek	1.7	102	1,353	2.36	3,945	9,316	0.60	0.01	5,570	110	12.1	-	64	1.93	72	54	70
Gallatin River	1.2	73	944	2.50	2,791	6,979	0.51	0.01	3,573	82	11.5	-	54	2.08	59	45	64
Grebe Lake	0.9	59	926	2.26	2,251	5,093	2.84	0.03	14,482	144	8.5	11.5	93	2.08	98	96	79
Lewis River	0.9	56	823	2.12	2,155	4,573	0.69	0.03	3,173	118	10.9	13.7	47	1.84	79	63	63
Snake River	0.6	36	436	2.15	1,364	2,937	0.92	0.02	2,721	56	9.7	13.0	80	2.08	70	70	57
Indian Creek	0.5	33	454	1.71	1,249	2,132	2.03	0.09	4,336	198	6.6	9.5	79	1.80	58	50	46
Trout Lake	0.5	32	490	2.25	1,210	2,724	0.42	0.01	1,144	32	16.9	-	76	2.00	80	80	80
Pebble Creek	0.4	26	327	2.38	979	2,330	1.11	0.01	2581	27	8.9	-	64	2.00	44	38	69
Bechler River	0.4	25	274	2.25	949	2,130	1.57	0.01	3,353	25	11.1	-	86	2.07	93	71	79
Pelican Creek	0.3	22	345	2.86	825	2,358	0.88	0.01	2,075	28	11.2	-	94	2.06	100	83	83
Heart Lake	0.3	21	165	2.71	793	2,146	0.89	0.18	1,904	393	15.7	16.3	100	1.78	100	88	88
Falls River	0.3	20	293	2.59	754	1,951	2.10	0.03	4,093	64	8.1	13.0	92	2.25	100	92	50

* Based on: 1.0 = inexperienced; 2.0 = experienced; 3.0 = expert.

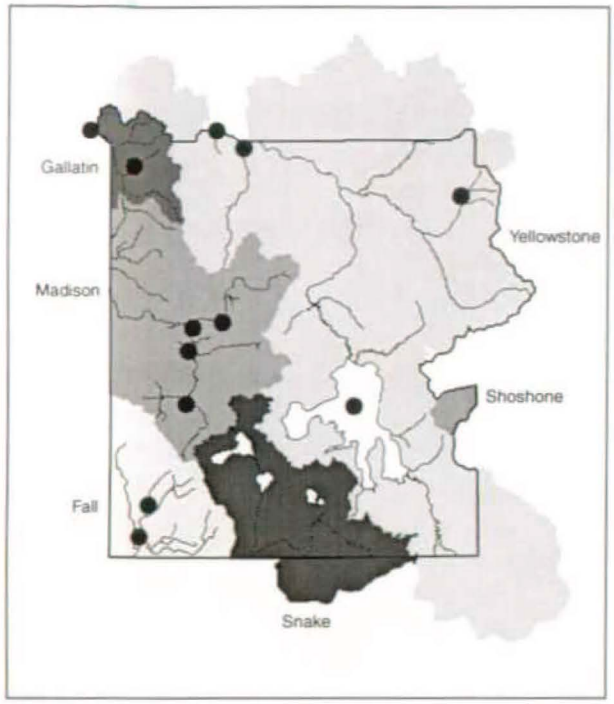


Figure 6. Whirling disease sample sites in 1997. Whirling disease has not been detected in the park.

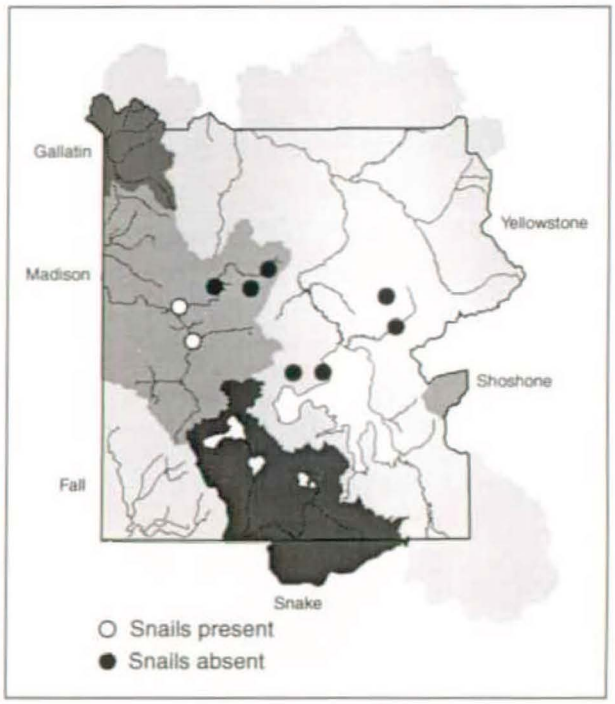


Figure 7. New Zealand mud snail sample sites in 1997.

invasive non-native organisms. In 1994, whirling disease (*Myxosoma cerebralis*) was discovered in the Madison River near Ennis, Montana, where a 90 percent reduction in abundance of young rainbow trout was observed. Several years later, this infectious parasite was located in the Yellowstone River near Livingston, Montana. Concern about the possible spread of this disease into park waters and it's potential negative impact on fish populations prompted park fishery personnel to sample numerous park waters for the presence of whirling disease (Fig. 6). Thus far, whirling disease has not been found in Yellowstone Park.

In 1994, another aquatic nuisance species, New Zealand mud snails (*Potamopyrgus antipodarum*) were discovered in the Madison River near the park boundary. Subsequent investigations by independent researchers have documented a rapid spread of this exotic species to the Firehole and lower Gibbon rivers (Fig. 7). Localized infestations in the Madison River in 1997 have approached a density of 28,000 individuals/ft.^{2} Long-term effects of this exotic species on the indigenous invertebrate fauna are unknown; however, studies conducted on the middle Snake River in central Idaho suggest that native mollusks may be reduced in abundance or eliminated entirely. Preliminary baseline surveys in the park indicate that mud snails may be impacting the invertebrate community in the Madison, Firehole, and Gibbon rivers not only through physical displacement or crowding, but also through competition for food resources.

The overall goal of park managers is to prevent the spread of both of these exotics to other Yellowstone Park waters. It is unknown how the mud snails were introduced into park streams, but human transport is strongly suspected. Similarly, it is thought that whirling

disease spores can be transported between waters by human users. Because direct control methods to eliminate these invasive species are not available, park managers are focusing on preventing further spread of these exotics. A new public education program encourages anglers and other water users to "thoroughly clean mud, plants, and debris from your fishing equipment, including footwear, before leaving your angling site. Drain live wells and only clean fish at the same body of water where they were caught." Additional sampling and research projects concerning these aquatic nuisance species will continue on a long-term basis.

Geology and Geothermal Resources

With the tragic death of the park geologist, Rick Hutchinson, on March 3, 1997, Yellowstone lost a tremendous amount of geologic knowledge and expertise. In July, park managers invited scientists from the NPS, the U.S. Geological Survey (USGS), and academia to the park to evaluate its geologic and hydrologic program needs, discuss priorities, and recommend strategies. The group recommended that, in addition to filling the vacant geothermal geologist position, the park should hire a hydrologist to address water issues and mandates, and to help monitor hydrothermal discharges; and a geologist specializing in surficial processes to address what is occurring in streams and on the landscape, and assess how they are affected by park activities. As of year end, these recommendations were still under review by park management.

In September, park staff hosted a conference to discuss the earth science research being conducted throughout the park. USGS and university scientists as well as park staff gave presentations on geological, geochemical, geophysical, geothermal, hydrological, and microbial topics. Most of the data compiled below on seismic and geyser activity in the park during 1997 was obtained and analyzed by a seasonal technician and a naturalist stationed at Old Faithful.

Seismic Events

Earthquakes felt by park employees or visitors were documented on 16 days in 1997. On the modified mercalli scale (I to XII), which is based on perceived intensity, the quakes ranged from Level II, reported at Old Faithful and Grant Village, to Level IV, reported at Old Faithful, Madison, and West Yellowstone. On the Richter scale, a magnitude 4.2 earthquake rocked the Pitchstone Plateau on June 28th.

Seismic swarms occurred at various points within the park, with major swarms in the Norris and Mt. Holmes areas. Of particular interest were those reported three to five miles west of Norris Basin in an area of surface hot springs.

Long-Term Geyser Monitoring

To generate baseline trends for annual comparative studies and document changes in thermal activity due to natural and human activity, long-term monitoring of geysers in the park was begun in 1993 with the purchase of electronic sensing equipment. In 1997, the use of remote sensing data loggers was expanded to included additional geysers. Preparation of detailed comparative reports for the years 1993 to 1997, documenting the state of the major thermal systems as recorded through surface activity, began in late August, with publication expected in the summer of 1998.

The acronym IBE has been adopted to represent the interval of time between consecutive events or eruptions of thermal features. This interval is measured from the beginning of one event to the beginning of the next event. It is understood that upon initiation of an event, a system immediately begins a recharge process;

energy sources continue to feed the system as energy stores are depleted.

Upper Geyser Basin. Surface features in the Upper Geyser Basin continued to respond to an increased flow of energy during 1997. The driving force behind the major changes that have been taking place in the basin appears to be a large injection of super-heated waters. To explain this phenomenon, several hypotheses are under consideration. A buildup in local strain may have led to increased seismic activity during the past two years, opening up seams and fractures that have allowed larger volumes of super-heated waters to enter near-surface thermal systems, and thermal features that were dormant or at a low energy level acted as release valves to vent the additional energy. Or, the caldera may be undergoing a subsidence of a deep magmatic plume that has resulted in a loss of support of the caldera floor, causing slips in local faults, and the strain has been released through adjustment of local faults and the opening of energy conduits. Or, the caldera and local faults may be adjusting to regional strains.

In recent years, Giant Geyser had been averaging one eruption a year, usually occurring in the fall. Then the platform activated in mid-1996, attaining a level of activity not observed in decades. During 1997, a total of 47 eruptions were recorded, and eruptions could be predicted within a few days. This has resulted in the introduction of a new generation of visitors to one of the greatest geysers in the world.

Giantess Geyser also become far more active, erupting six times in 1997, beginning in late summer. Although in recent years, an eruption of Giantess Geyser led to a dramatic decrease in Plume Geyser's IBE, its eruptions in 1997 were accompanied by only a slight and temporary change in Plume's activity, indicating sufficient heat and thermal waters were available for system recharge. The response of Plume was more typical of responses reported in the early 1980s.

Splendid Geyser, which activated in mid-1996, displayed many powerful eruptions, series of eruptions, and an occasional dual eruption with its neighbor, Daisy Geyser. Eruptions of Splendid tend to drain energy resources from Daisy Geyser, resulting in longer recharge times for Daisy, with a mean IBE of 113 minutes for 1997. There was some indication that an eruption of the Giant Geyser complex reduced energy available to the Daisy/Splendid complex. Following an eruption of Giant, Splendid would often cease its activity, and Daisy IBE would return to its more typical range of 85 to 110 minutes.

Oblong Geyser reactivated early in the year. Although in the past, Giant Geyser eruptions appeared to result in a decrease in activity and annual dormancy of Oblong, in 1997 there was sufficient energy to maintain both geyser systems.

At Grand Geyser, one of the largest predictable geysers in the park, 829 IBE were recorded, resulting in a mean of 583 minutes and a median of 576 minutes. This indicates increased activity compared with the previous two years, but the eruption recovery time is still loner than that reported in 1993.

At Castle Geyser, 387 IBE were recorded in 1997, 367 following "major" eruptions and 20 following "minor" eruptions. The mechanism that might account for the minor eruptions is not known. Several times during the summer, eruptions aborted after a few minutes of heavy water play, followed by a quiet phase lasting 12 to 20 minutes, then a major eruption would begin. It appeared that Castle's system was prematurely driven to a critical eruption threshold, suggesting additional venting of energy was necessary to relieve pressure buildup.

The IBE at Old Faithful are bi-modal, indicating that two different states of the system lead to eruptions. Its 1997 annual mean of 75.3 minutes, which has increased approximately 8 minutes during the last 22

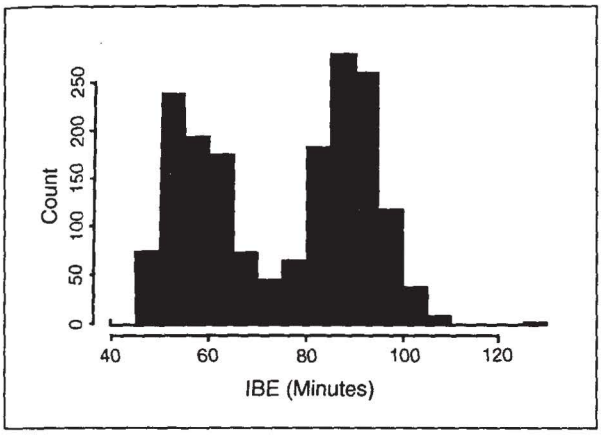


Figure 8. Old Faithful Geyser interval between eruptions, May–December 1997.

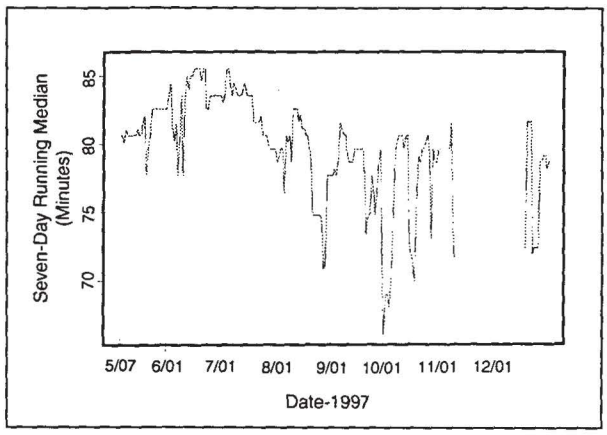


Figure 9. Old Faithful Geyser 7-day running median interval between eruption, May–December 1997.

years, does not therefore represent a measure of the actual recharge time between consecutive eruptions (Fig. 8). The increase in annual mean IBE could indicate that the system operates more often from the longer mode, or that both modes have shifted. A general shift within the distribution between the two modes might occur in response to annual aquifer loads, seasonal groundwater runoff, or local seismic events that open or seal below-surface conduits of energy. The entire distribution of the system state might shift in response to regional tectonic strains, caldera events, basin-wide events, or human activity.

In 1997, Old Faithful's IBE tended to be consistently longer from May to mid-July than during the remainder of the year (Fig. 9). Recent research suggests a possible hydraulic relationship between the Firehole River and Old Faithful Geyser. Although the Firehole River does not directly recharge the geyser system, groundwater circulation in the spring and early summer may account for the longer recovery time between eruptions. While circulating cooler waters may enter the system, they would also absorb heat from nearby thermal conduits.

Future research into Old Faithful eruption activity will look at the historical record in an effort to account for types of shift and interpretation of shifts. Bivariate modeling will incorporate both states of the system in a single model that could be tested for fit on an annual or bi-annual basis.

Midway Geyser Basin. Flood Geyser was the only feature in the Midway Geyser Basin that was monitored continuously for an extended period of time, from June 18 to September 13. It exhibited a single mode of activity through August 18, then changed to a bimodal pattern characterized by alternating short and long IBEs. It has been proposed that the Firehole River also exerts a seasonal influence on Flood Geyser.

The steep embankment from the old roadbed down to Flood Geyser and Circle Pool, which is about five meters downriver from the geyser, has been eroding since 1995, when the road near Flood Geyser was relocated as part of the road reconstruction work. But constant monitoring of the erosion barriers has kept washed silts out of the spring.

Lower Geyser Basin. The 366 IBE recorded at Great Fountain Geyser ranged from a minimum of 432 minutes to a maximum of 1,021 minutes, making predictions of eruption

times difficult.

At Fountain Geyser, instrumentation was set up in late July to record baseline activity for future reference, and 253 IBE were obtained with a mean of 425.8 minutes and median of 422 minutes. The prediction window length of 127 minutes is relatively short when compared to other geysers exhibiting the same force of eruptions. Continued part-time instrumentation and occasional staffing of the Lower Geyser Basin would improve prediction estimates and introduce more of the geothermal phenomena to park visitors.

Norris Geyser Basin. The seismic swarms that were reported west of Norris Basin this year pointed up the need for research and monitoring in this area of surface hot springs. It is not known if this small thermal area has undergone a disturbance, but the annual disturbance that had been occurring each fall in the Norris Basin ceased after 1995. The U.S. Geological Survey has continued to improve the monitoring capabilities at the Tantalus Creek weir to measure the total Norris discharge. Data on changes in discharge may offer some insight into the dynamics of the Norris geothermal system.

Eruption activity of Echinus Geyser reflected the lack of any major disturbances, and seismic events may have been responsible for maintaining open conduits for fluid and thermal flows. No "supers" (eruptions exceeding 30 minutes in duration) were recorded during 1997.

Monitoring Proposed and Existing Mining Impacts

New World Mine. Since the permit application process for the proposed New World Mine, a gold mine to be located less than three miles from the park's northeast corner, ceased in 1996 as a result of an agreement that provided for acquisition (by exchange) of property interests held by Crown Butte Mines, Inc., the staff time spent on this issue has been greatly reduced. Congress has appropriated money, the legal details are being worked out, and it is hoped that the agreement can be finalized in spring 1998.

Mineral Hill Gold Mine. Except for water management operations and the removal of hazardous chemicals as required by its mining permit, TVX Gold, Inc., suspended operations at this mine, located just north of Yellowstone near Jardine, Montana, in September 1996 pending the assay results from exploration in the headwaters area of Crevice Creek, which flows across the park's northern boundary. YCR staff continued to monitor the project and attend community task force meetings. Because TVX does not intend to continue operations, efforts were underway to locate a buyer for the mine property.

McLaren Mine Tailings. Park staff continued to work with NPS Water Resources staff to explore options for treatment and removal of the McLaren mine tailings located upstream and just outside the park's northeast boundary. Leaching from these tailings has historically caused pollution into Soda Butte Creek, which runs into Yellowstone National Park.

Land and Water

Disturbed Lands Reclamation

The resource management specialist also served as the primary coordinator for the park in carrying out these reclamation projects.

Little Thumb and Dry Creek Quarries. Both the Little Thumb and Dry Creek quarry pits, which produced gravel for use on park roads in the 1920s and 1930s, posed safety hazards and threats to the park's natural resources. With funding provided by the Wyoming Department of Environmental Quality's Abandoned Mine Land Division (WY AML), reclamation of the quarries and associated roads was completed in 1997. The heavy equipment work was done by the G.M. Stewart Corporation of Evanston, Wyoming, and

supervised by WY AML's contract engineer, Nelson Engineering of Jackson, Wyoming. Afterward, park hand crews mulched and revegetated the sites.

Reclamation at the five-acre Dry Creek quarry allowed the removal of the 4.3 mile long access road and reclamation of about 1.6 acres of wetland.

Gravel eroding from the 11.5-acre Little Thumb quarry had raised the bed of the creek, causing it to dry out during trout spawning runs and reducing the effective habitat for both spawning trout and associated grizzly bear fishing by an estimated 50 percent. The reclamation work involved recontouring the quarry to prevent additional erosion and deepening the creek channel. After the channel restoration had begun, the park's aquatic resources staff was consulted for technical assistance. Because of its impact on the integrity of the subterranean biotic environment, biologists were extremely concerned about the use of a fabric liner as a soil stabilizer on a significant portion of the stream channel in order to permit heavy equipment access. Complete elimination of the fabric was not feasible, as the channel had already been significantly altered and heavy equipment was needed to complete the work. However, where the fabric was necessary resource specialists recommended that frequent perforations be made to allow at least some biotic migration across the barrier.

Photos taken to document the condition of the altered Little Thumb channel areas will be used along with visual surveys to monitor changes in the form and function of the stream channel, including movement of substrate materials and cutthroat trout use of the channel reaches, and to determine the efficacy of the channel modifications.

Turbid Lake Road. When the East Entrance road under went a major reconstruction in the 1930s, a portion of the road was relocated to follow the north shore of Yellowstone Lake. The old segment, which was located further north along a pond created by a hydrothermal explosion and has long been referred to as the Turbid Lake road, was not closed to vehicular traffic until 1988. Although planning has been underway for several previous years, reclamation of the roadbed began this year, when park crews loosened about a half mile of the roadbed to promote revegetation; excavated stream crossings and reshaped road cuts to restore original drainage; and mulched, transplanted, and seeded the area with native plant species. A grant from the Canon Corporation was used to begin the project; additional funds are being sought to complete it in 1998.

Water Resources

Park staff continue to work with NPS Water Resource Division staff in implementing the Reserved Water Rights Compact that the NPS has signed with the state of Montana. Stream flow, pH, and conductivity were monitored at the gauging station on Soda Butte Creek near the park's northeast boundary.

Under the terms of the Water Rights Compact, the Montana Department of Natural Resources and Conservation is required to notify the NPS of all well permit applications within the Yellowstone Controlled Groundwater area. Of the 29 applications that were received by the state of Montana in 1997, the NPS objected to only one. That application for a change in place of use and the purpose of use of a warm water well constituted a new use and therefore required that the applicant seek a new water right permit. The matter remained unresolved at year's end.

The NPS determined that none of the groundwater withdrawals proposed by the other 28 applications would result in a calculable reduction in the surface water flow of a Category 3 or 4 stream or its tributary, and that the water did not meet the criterion to be classified as hydrothermal, for which restrictions apply.

Wetlands

As part of the road reconstruction program, wetlands along the Dunraven Road between Tower and Canyon were mapped and described by YCR staff. Mapping was also done in the Slough Creek Campground, East Entrance, Sedge Creek, and Lake housing areas to ensure that proposed activities would avoid impact to wetlands.

Through an interagency agreement with the NPS, the U.S. Fish and Wildlife Service completed draft National Wetland Inventory Maps for the entire park. Each 1:24,000 scale map shows wetland delineations and classifications on a 7.5 minute U.S.G.S. topographic quadrangle base. Completion of the final maps and digital information was expected by the summer of 1998.

In conjunction with the 18th Annual Meeting of the Society of Wetland Scientists, which was held in Bozeman, Montana, last summer, YCR staff hosted two field trips for more than 120 people and prepared a field-trip guide to the wetlands of the greater Yellowstone ecosystem.

VEGETATION

Plant Inventories

Two species of native vascular plants were reported for the first time in the park this year. *Dryopteris expansa* (C. Presl) Fraser-Jenkins & Jermy, northern wood fern, was brought to the attention of park staff by a visitor. *Polygonum sawatchense* Small, sawatch knotweed, was located on Dunraven Pass during surveys for "species of special concern" in conjunction with the parkwide road reconstruction program. Although previously overlooked, both of these species are presumed to be a long-term component of Yellowstone's flora.

In addition to the survey of vascular plants along the Dunraven Pass road from Tower Junction to the Chittenden road, possible trail reroutes were surveyed to prevent inadvertent impacts to species of special concern near Bechler Falls, Artist Paint Pots, a section of Fawn Pass, along Mountain Creek and near Eagle Pass. As a result of this field work, several additional populations of rare plants were located during the summer.

In striking contrast to the last few years, no new exotic species were located in the park in 1997. Although it is hoped this is the start of a new trend, the number of exotic vascular plants reported in the park has increased tremendously in the last decade. Part of this increase can be attributed to increased awareness and aggressive surveys to document the presence of exotic plants, but the rate of arrivals may also have increased.

Vegetation Research

Aspen. Long-term monitoring and hypothesis testing continues in response to questions about the role that elk browsing and/or fire suppression may have played in the decline in aspen in the park. The vegetation management biologist resampled 15 post-burn aspen seedling plots to determine trends in mortality, ungulate utilization, height growth, and competition with conifer seedlings; clipped the Junction Butte aspen subplot to determine annual biomass production; sampled an experimental aspen exclosure that failed during the winter to describe elk utilization patterns there after eight years of exclosure; and collaborated with Dr. William Ripple of Oregon State University, who

has begun a study of changes in aspen canopy coverage on the northern range using aerial photo series taken sporadically from the 1940s to 1992.

Vegetation Community Dynamics. As part of a revegetation study sponsored by the landscape architecture division, under the auspices of Dr. Terry McLendon of the University of Texas-El Paso, the vegetation management biologist supervised the establishment and sampling of vegetation plots in the Lamar exclosure to model vegetation community dynamics over time under different scenarios of changing environmental parameters.

Forest Health. As part of a nationwide effort by the U.S. Department of Agriculture to assess overall forest health, the vegetation management biologist served as a liaison with the Forest Health Monitoring Group of the Intermountain Forest and Range Experiment Station in Ogden, Utah, to assist in the logistics involved in establishing and sampling ten monitoring plots in Yellowstone.

Vegetation Management

Exotic Plants. YCR staff participated in updating the *Exotic Vegetation Management Plan* and compiling the related Environmental Assessment by providing data on chemical controls used during the past nine years and information on the effects of control on the soil resource, and initiated analysis of the existing exotic plant database to provide spatial and temporal baseline statistics.

Fire Management. The 1997 fire season was exceptionally light. Of the 13 recorded fires, 12 were lightning-caused and managed as prescribed natural fires; the other fire, which was caused by human activity, was suppressed. Less than one acre was burned by all of the fires combined.

In addition to serving as an instructor for fire behavior training courses, the vegetation management biologist assisted the fire effects technicians in sampling 15 long-term vegetation plots according to the original Daubenmire cover classes, and resampling them using the point-intercept methodology accepted by the Western Region Fire Monitoring Group. Both sampling methods will continue to be used in the future; although the Daubenmire method provides more accurate data on less common species, data from the point-intercept method can be used for comparison purposes with other wildland areas.

Hazard Trees. The vegetation management biologist helped to identify trees in developed areas that posed a threat to human safety, and in training district and maintenance crews to remove them. Two-hundred and seventy lodgepole pine seedlings were transplanted to the Madison Campground to replace trees that had been removed. Removal was accomplished in cooperation with district resource staff and fire cache personnel.

Wildlife Management in Developed Areas

On Roads

Large Mammals. In 1997, 80 large mammals were hit and killed by vehicles within the park, the lowest number since the park began keeping records in 1989. Mule deer (25) and elk (24) were the most frequent road mortalities. Other species killed by vehicles included 15 bison, 6 moose, 5 coyotes, 2 antelope, 2 wolves, and 1 raccoon.

Birds. Although a protocol for handling injured and road-killed birds was introduced in 1996 to standardize the procedure for park personnel, problems continued in 1997, generally as a result of staff not following the protocol, inadequate communication, or turning injured birds over to unqualified rehabilitators. Big Sky Wild Care of Bozeman, Montana, has been designated as the rehabilitator for injured birds found in the park and, if possible, the park ornithologist should be contacted before

sending a bird anywhere. Owls seem to be the most frequent avian victims of vehicle collisions.

In Buildings

As the park's Integrated Pest Management (IPM) Coordinator, the vegetation management biologist responded to 28 complaints during 1997, about average for the last 3 years.

Bats. Two little brown bats (*Myotis lucifugus*) in the attic of the Hamilton Stores' employee dorm at Fishing Bridge fell onto a sleeping employee who awoke and killed them. Both bats, which were sent to the Veterinary Diagnostic Laboratory in Bozeman, tested negative for rabies. As part of a long history of roosting bats in the attic, this incident led to an effort to bat-proof the facility by Hamilton Stores employees in the fall. The building will be inspected in 1998 to assess the effectiveness of efforts.

A silver-haired bat (*Lasionycteris noctivagans*), the first to be found in the park, was collected at the Norris housing area and tested negative for rabies. Although the bat did not have direct human contact, an employee present in the vehicle during specimen transport to Mammoth expressed concern about the possibility of airborne transmission of the rabies virus.

To address the problem of copious bat droppings in the lounge area at Lake Lodge and the potential for bat-human encounters on the front porch when bats emerge in the evening, Amfac hired an independent contractor to make recommendations. As a result, the park concessioner, Amfac, has undertaken a bat monitoring and exclusion project in cooperation with the park sanitarian and IPM coordinator, to be completed in the spring of 1998 before bat arrival. During an emergence survey that was conducted to identify entry and exit points, a total of 453 bats were counted using 6 different entry or exit points. Assessment surveys will be conducted in the summer of 1998 to assess the efficiency of the exclusion efforts, and the relocation, if any, of the bat colony.

Insects. A major sanitation/fumigation/habitat modification effort was made to address an ant infestation in a YCC housing area trailer.

Reports of insect damage to structural pillars in the Roosevelt Lodge dining room appeared to be a case of advanced dry rot. Attempts to collect insect larva or emerging adults were futile, and the apparent cause of the problem (i.e., water) has been rectified by raising and resting the pillars off the ground. Pressure filling the dry rot area has been proposed to maintain the integrity of the pillar while camouflaging the visible damage.

Swallows, Northern Flickers, and Ravens. Swallows, northern flickers, and common ravens continue to create difficulties in managing park buildings that call for annual training of park staff and concessions personnel by the park ornithologist. All of these birds are protected by law under the Migratory Bird Treaty Act. Many alternatives have been tried, but plastic netting appears to be the only effective way to displace swallows from nesting under the eaves of park buildings, and only if it is installed properly. Netting does not always work and can backfire if not installed properly. Ravens are more of a nuisance for managers responsible for building maintenance because of the mess they create, whereas the northern flicker problems are associated with drilling damage to wooden buildings. The key to managing these species that cause problems for people is through preventative maintenance, which is assessed on a case-by-case basis. Action was taken in about half of the cases, mainly through the installation of netting.

Other Wildlife Capture and Handling

In three entanglement cases involving an extension cord, a hammock, and a coil of thick gauge wire, three bull elk had to be immobi-

lized so the object could be removed.

On July 10, after a subadult male red fox began frequenting the area around the Tower Falls store, where visitors were approaching and attempting to pet and feed it, the animal was trapped, ear-tagged, and transported to Blacktail Plateau Drive, a straight-line distance of about seven miles. The fox returned to the store within six days, was trapped again and transported to Stephen's Creek, nearly 21 miles away. Within four days, the fox had returned to the Tower Falls area, where it was trapped and relocated in the southern end of the park, almost 52 miles away. Six weeks later, on October 1, a woman staying at the Mammoth cabins reported being bitten while feeding M&M candies to a red fox with a silver ear-tag in its left ear. After reports were made of a red fox getting into garbage and panhandling for food at the Bear Country Cafe in Gardiner, the animal was trapped at the Roosevelt Arch and chemically euthanized. Rabies tests conducted on the fox were negative.

Wildlife Surveys and Sampling

Northern Range Ungulates

Park staff shared costs and time with the Northern Yellowstone Cooperative Wildlife Working Group to complete counts of ungulate herds on the northern range.

Elk. Because of poor flying conditions and mild winter weather, the early winter elk count was not completed until January 1998. Although one flight outside the park was completed on December 30 and another was done on January 27, the park sections were surveyed on January 18, when 9,708 elk were counted. Potential difficulties in estimating the total number of wintering elk occurred because some animals may have migrated out of the park between the flights, and because the latter flights occurred during a legal late-season hunt that takes place north of the park boundary each year in January and mid-February.

Mule Deer. In a helicopter survey on May 6, 1997, a total of 1,748 mule deer were counted on the northern range.

Pronghorn. A count of pronghorn on April 21 found only 210 animals. Because of continued concerns for the long-term viability of this population, park staff increased their efforts to survey the herd in winter and on a November 22 flight, counted 251 pronghorn. Two park volunteers, Dr. Jim and Edna Caslick, conducted ground surveys for the third consecutive year to assess pronghorn distribution and evaluate the effects of bison management activities on pronghorn.

Bighorn Sheep. In March, 16 bighorn sheep were captured and radio-collared for a study supervised by Dr. Lynn Irby at Montana State University to learn about sheep movements and behavior in relation to road traffic and human activity. On May 6 and 12, an aerial survey located 199 bighorn sheep, of which 95 were inside the park. The annual December ground count found 97 bighorn (38 rams, 52 ewes, and 7 lambs) with ratios of 13 lambs and 73 rams per 100 ewes. During 1997, known sheep mortalities in the park included five adult ewes and two adult rams. One ewe died as a result of capture and collaring activities in March, and another ewe was killed by a mountain lion in July; causes of the other deaths are unknown.

Wildlife Health Sampling

Tissue Banking. As staff time permits, the park has been collecting DNA samples from wildlife since 1991 to establish a baseline DNA tissue bank. Ideally, at least 50 samples will be obtained for each large mammal species inhabiting the park. During 1997, samples were collected from 2 antelope, 2 bighorn sheep, 1 moose, and 1 mountain lion, bringing the total collection to 11 antelope, 6 bighorn sheep, 60 bison, 2 black bear, 16 coyotes, 50 elk, 2 grizzly bear, 27 moose, 1 mountain lion, 54 mule deer, and 1 white-tailed deer. Samples

are being stored at the Wyoming State Crime Laboratory until funding is acquired for DNA extraction and sequencing.

Grizzly Bear Hair. To develop a method for making accurate grizzly bear population and density estimates, the park is also participating in a project to extract DNA from bear hair or scats in cooperation with the Interagency Grizzly Bear Study Team. This year the study concentrated on collecting bear hair from tributary streams around Yellowstone Lake in order to estimate the number of bears that may be impacted by the potential reduction in the cutthroat trout population as a result of the introduction of lake trout. DNA from the 360 bear hair samples collected is currently being extracted and sequenced at the University of Idaho. Lab results are expected during the summer of 1998.

Rabies Testing. Four animals that had contact with park employees or visitors (two little brown bats, one silver haired bat, and one red fox) were collected and tested negative for rabies.

Other Diseases. Three dead coyote pups were collected and necropsied; two were diagnosed with parvo virus infection.

Wolf Restoration

Introduction

The goal of the wolf restoration program, which began in 1995, is to restore to the greater Yellowstone recovery area a population of gray wolves that includes at least 10 packs that produce pups for three seccessive years. When this is achieved and similar populations are present in the central Idaho and northwestern Montana recovery areas, the gray wolf will be removed from the Endangered Species List and managed as a resident species by the respective states.

During the first two years of the program, 31 Canadian wolves were brought to the park and released in early spring. In the late summer of 1996, an additional 10 pups were sent from northwest Montana, where they had been part of the Sawtooth pack, which was split up after preying upon livestock. Although the original plan called for annual translocations of Canadian wolves for three to five years, the reintroductions ceased after 1996 due to early success with transplanted wolves' reproduction and survivorship.

Despite this biological success, the recovery effort was dealt a legal setback on December 12, 1997, when U.S. District Court Judge William Downes ruled against it in three combined lawsuits. He found that the lack of geographic separation between fully protected "endangered" wolves already present in the northwestern Montana recovery area and the reintroduction areas, in which special rules for managing wolves as "non-essential, experimental" apply, violated the intent of the Endangered Species Act. He ordered the removal of all reintroduced wolves from Idaho and greater Yellowstone, but stayed that order pending anticipated appeal of his ruling. As of the end of the year, no appeal had yet been filed. Until a final court order is issued, wolves in Yellowstone will continued to managed and monitored as they have been.

With the departure of project leader Mike Phillips in June 1997, biologist Doug Smith

Because of the program success, no wolves were reintroduced in 1997. Photo courtesy William Campbell.

was the only full-time park employee assigned to the wolf project. Consequently, park staff depended on the considerable assistance provided by volunteers and a new student intern program.

Current Status

About 86 wolves (82 free-ranging and 4 captives) were believed to inhabit the GYA at the end of 1997, up from 52 wolves (40 free-ranging and 12 captives) reported at the end of 1996 (Table 11, Fig. 10). The 1997 year-end total included 62 wolves in 6 packs that had breeding pairs, 2 groups that were known to be lacking a known alpha animal (Washakie and Soda Butte), 1 that had animals of unknown breeding status (Nez Perce), and 11 wolves that were not clearly affiliated with one of the known packs. The whereabouts and fate of eight wolves previously documented were unknown. Although all the originally transplanted wolves were radio-collared prior to their release, about half of the free-ranging wolves, including most of those born in the GYA, were not marked, so tracking the movements of all wolves was not possible. Four wolves from the Nez Perce pack were being held in an acclimation pen and were expected to be released in late spring 1998.

In the spring of 1997, nine packs produced 13 litters ranging in size from 4 to 11 pups, with an average litter size of 5.2 pups, for a total of 67. The Rose Creek pack had three litters; the Druid Peak and Chief Joseph packs both had two litters; and six other packs each had one litter. This exceptionally high rate of reproduction was probably related to the high availability of prey.

Of the 32 wolves that were known to have died in 1997, 17 were pups. Except for one pup that was hit by a vehicle on Highway 191 in September, all of the pup mortalities were due to natural causes. In the first few months of the wolves' lives, survival is typically difficult, and pup mortality is not unexpected.

Table 11. Wolves in the GYA as of December 31, 1997.

Pack or Group	Pups	Yearlings	Adults	Total
Crystal Creek	6	0	2	8
Soda Butte	4	2	2	8
Rose Creek	9	3	3	15
Leopold	5	2	2	9
Chief Joseph	5	0	3	8
Druid Peak	5	0	3	8
Thorofare	6	0	2	8
Washakie	5	0	1	6
Nez Perce	1	3	1	5
Others	3	5	3	11
Total	49	15	22	86

Although pup counts were made by observing dens at a discreet distance within two weeks of the pups birth, it is possible that additional pups were born and not seen.

Of the 15 adults and yearlings that died, 7 were killed because of livestock depredation; 3 were illegally shot; 3 died of natural causes; 1 was hit by a vehicle; and 1 was inadvertently killed in a trap set for coyotes.

Population Movements

Except for the Nez Perce pack, which traveled to near Dillon, Montana, and one of the Sawtooth yearlings, which dispersed to Leadore, Idaho, and was shot for livestock depredation, the wolves restored to and born in greater Yellowstone remained with the recovery area in 1997.

Crystal Creek Pack. This pack was one of the founder packs released on Yellowstone's northern range in 1995. They were displaced southward by other wolves after an interpack interaction killed their original alpha male, and

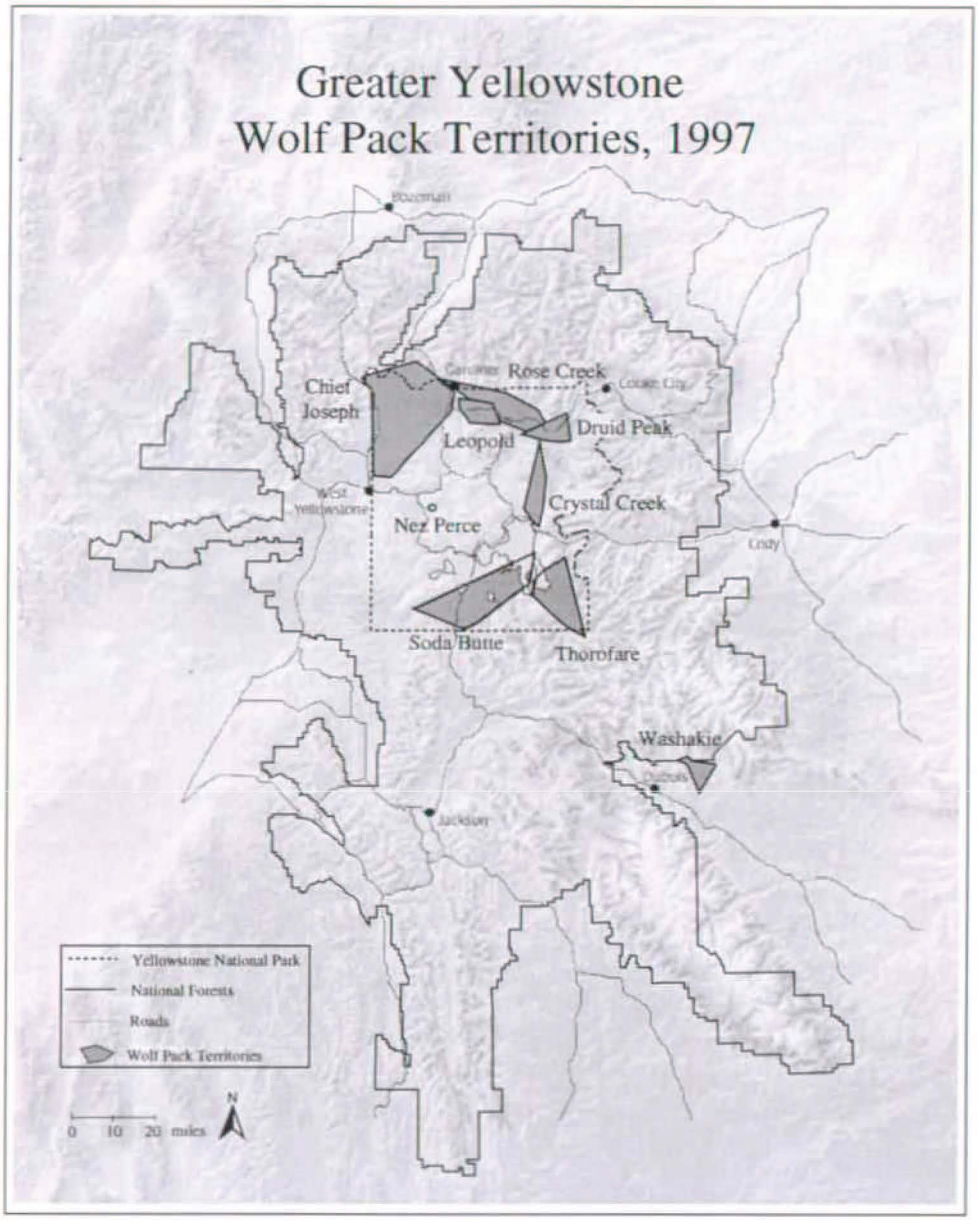


Figure 10. Wolf pack territories, 1997.

have since centered their activity in Pelican Valley, just north of Yellowstone Lake. In 1997 they numbered eight wolves, two adults and six pups and made the first documented bison kill since wolves were reintroduced.

Soda Butte Pack. This pack, also originally released in 1995, were relocated to southern Yellowstone in 1996 and have since lived in the Heart Lake area. The alpha male, #13, was the oldest wolf brought from Canada. He died, presumably of old age in March, although his pack remained near the site at which he died until late summer and thus, biologists did not search the area until September, when only his well-chewed collar was found. As of the end of the year, his mate had yet to find another partner, and the pack consisted of the alpha female, a two-year-old female, two yearlings, and four pups born in 1997.

Linda Thurston, a graduate student working on the denning ecology of wolves, radio tracks wolves in Lamar Valley. Photo by Joel Sartore.

Rose Creek Pack. With three adults, three yearlings, and nine pups born in 1997, this pack, also part of the original 1995 release, is the largest in the GYA. Their territory ranged from the Lamar Valley down the Yellowstone River to near Gardiner, Montana. Three of the pack's females bred in 1997, producing 22 known pups, but #19F was killed at her den when the Druid Peak pack trespassed onto Rose Creek territory. Her four pups subsequently died, probably from exposure and/or starvation. Nine other pups died of presumed natural causes in their first six months of life.

Leopold Pack. This pack in 1996 became the first naturally forming wolf pack to form in Yellowstone in more than 60 years. At the end of 1997 they numbered 10: 2 adults, 3 yearlings, and 5 pups. In the autumn of 1997, their territory on the Blacktail Deer Plateau, which was the smallest of any pack in the GYA, expanded to include Swan Lake Flats and Gardner's Hole.

Chief Joseph Pack. The territory of this pack, one male (#34) and three females (#16, #17, and #33), ranged from the northwest corner of Yellowstone National Park and into the Gallatin National Forest. Two of the females, #16 and #17, bred with #34 in 1997; #16 raised five pups on her own, while #34 assisted #17 with her litter of five pups.

In July, #17 was gored by a stick, probably while chasing elk. Shortly after her death, #34 took the five pups to the den where #16 had her pups, about 20 miles (33 km) away, and remained there with both litters. In August, #16 was injured when hit by a car on Highway 191 and could not return to the pups. Female #33, who had been wandering alone for some months, rejoined #34, and the two adult wolves began traveling with #17's five pups. Except for one of these pups which died of unknown and presumably natural causes, this group was still in typical Chief Joseph territory at the end of 1997.

The five pups born to #16F that had been left at the den were too young to fend for themselves and began foraging along the Highway 191 corridor in early September. Biologists, working with West District ranger staff, hazed the pups away from the road for about three weeks and radiocollared two of them to assist in keeping track of the group. One collared pup was hit by a car; the other four pups eventually left the area, and two probably starved to death. The pups mother, #16, eventually recovered, and although she

Visiting scholar Todd Fuller, and wolf project staff Deb Guernsey, Douglas Smith, and Alex Krevitz fit a Soda Butte wolf pup with a radio collar. Photo by William Campbell.

had a slight limp, she reunited with two of the surviving pups and was traveling with them at the end of 1997 in a separate group from the rest of the Chief Joseph pack, but within their range.

Druid Peak Pack. Since their release in 1996, this pack has ranged the eastern end of the Lamar Valley, Soda Butte, and Cache Creek areas, and been the most publicly visible group of wolves. In 1997, two females had litters totalling at least five pups, both presumably fathered by #38. After both of the pack's adult males (#31 and #38) were illegally shot east of the park on Crandall Creek in December, a young male disperser from the Rose Creek Pack, #21, joined the two remaining females and the five pups.

Thorofare Pack. This pack formed when two dispersing wolves from other packs paired in late 1996 and took up residence in the Thorofare region south and east of Yellowstone Lake. In 1997, they had at least six pups; at year's end the two adults (#30 and #35) and six pups remained.

Washakie Pack. Another pack created when two dispersers paired in 1996, this pack established its home range in the DuNoir Valley northwest of Dubois, Wyoming, and had five pups in the spring of 1997. The adult male, #15, was shot by federal agents in late October after killing two cows in his second act of livestock depredation. His mate, #26, and the five pups remained together in the area at the end of the year.

Nez Perce Pack. At the beginning of 1997, two siblings (#29 and #37), originally released from the Nez Perce pen in the Firehole Valley in 1996, were being held again in their pen after killing livestock west of Yellowstone National Park. With them were 10 pups that had been brought to Yellowstone in 1996 from Augusta, Montana, on the Rocky Mountain Front. Managers hoped that the wolves would become socialized to each other in the pen and form a cohesive pack after their release. At least three other Nez Perce wolves were believed to be alive: the original alpha male, #28, who ranged alone; and the alpha female, #27, who traveled with #48, a yearling female. The adult female was known to have killed at least eight domestic sheep near Fishtail, Montana, and the young female at least two sheep in February of 1997, but attempts to capture these wolves had been unsuccessful.

In January, #28, who had been wandering widely throughout the northwestern portion of

Wolf #95F, captured for radio collaring, was born to the Leopold Pack in 1997. Photo courtesy William Campbell.

the recovery area, was illegally shot west of Bozeman. In February, the two female Nez Perce wolves were captured and brought to the Nez Perce pen, but the yearling soon escaped; she roamed widely for the rest of the year.

In April, the penned siblings, #29M and #37F, produced a litter of four pups, one of which soon died. The surviving family of five, #27, and the 10 Sawtooth pups, were released, half in April and half in June. This was done in the hope that the first group would begin to establish a territory near the pen in order to remain near the confined wolves, and that they would all stay in the valley after release.

But the wolves traveled widely and were responsible for most of the wolf predation on livestock that occurred in greater Yellowstone in 1997. From June through October, four other pack members, not believed to have been involved in livestock killing but trapped when their pack mates had been removed by Wildlife Services' agents, had been penned. Male #29 escaped the pen by climbing over the top—a feat not accomplished by any other penned wolf—and subsequently dug a hole beneath the pen, freeing the other penned pack members. They returned to the Dillon area, then were recaptured and returned to a fortified pen, by which time the deaths of three sheep had been discovered and attributed to them. A decision was made to release the five wolves in 1998, but if they traveled west of Highway 287 or Highway 20, they would be removed permanently. In November #29M had again vaulted the fence. By the end of November, in addition to the early-year mortalities, six of the Nez Perce/Sawtooth wolves had been killed because of livestock predation—including #37 and the pack's alpha female, #27; another had been accidentally killed in a coyote trap; and one had been struck and killed by a vehicle.

In December, #29M returned to the Nez Perce pen and continued to stay outside the fence that, this time, successfully held four of his pack mates. The fate of one of the Nez Perce/Sawtooth wolves was unknown at the end of the year.

Denning Ecology Studies

Intensive monitoring of dens, begun in 1996, continued in 1997. Volunteers, situated at observation points a safe distance from dens (usually >1 mile), watched and recorded numbers and behavior of pups, den attendance by different pack members, and food-delivery rates. Interactions with other wildlife were also recorded.

Through a combination of aerial and ground observation, the most accurate birthing dates were obtained for wolves residing on the more monitorable northern range. The first female to give birth in 1997 was #18F of the Rose Creek pack, who gave birth on April 6; births continued through May 3. Wolf #18 used a den dug under a boulder that had been occupied by her mother, #9F, in 1996. Interestingly, three of #9's other female offspring used dens constructed under or around a rock; the den of another daughter was not examined. Sites used by four other denning females (including #9F) in 1997 were holes; two wolf dens were dug into the side of a hill; two were dug under the root systems of trees; and the Soda Butte female's den was in a cave near a

thermal area. The Thorofare female's den was flooded out so it was not examined.

Wolf Kills

During 1997, project staff detected 257 known and probable wolf kills, including 234 elk (91% of the animals killed), 8 moose, 6 mule deer, 2 bison, 1 beaver, and 6 unidentified prey. In March and again in November and December, wolf project staff intensively monitored wolf packs to estimate wolf predation parameters, including wolf kill rates during the late winter of 1996–97 and the early winter of 1997–98. Wolf kill rates were highly variable by season (range 1 to 8 days between kills), but because 1996–97 was an extremely hard winter, these rates were very high during the late winter study period, especially for packs living on the northern range. Data that has been collected over two winters suggests a lower kill rate (more days between wolf kills) for wolf packs that reside elsewhere in greater Yellowstone.

Wolf Management Activities

As described under *Nez Perce pack*, above, the year began with 12 wolves being held in captivity due to management captures. There were 10 incidents of livestock predation attributed to wolves in the GYA during 1997, resulting in the deaths of 68 sheep and 6 cattle. One yearling female wolf was responsible for 56 of the sheep depredations, and all but one of the livestock incidents were attributed to Nez Perce/Sawtooth wolves. As a result of the depredations, 7 wolves were removed from the population including 2 that were legally shot by ranchers and 5 that were removed by federal Wildlife Services' agents.

1) *February 1997.* Nez Perce yearling #48F killed two sheep on private property near Fishtail, Montana. She was captured by Wildlife Services and placed with her mother and 11 other wolves in the Nez Perce pen. She escaped shortly thereafter and roamed the GYA widely for the rest of 1997.

The presence of wolves once again in Yellowstone has great potential to reshape the ecosystem.

2) *June 1997.* Sawtooth yearling #64F was legally shot by a rancher for killing two sheep near Big Timber, Montana.

3) *July 1997.* Sawtooth yearling #69M dispersed from the GYA to Leadore, Idaho, where he killed one cow and one sheep and was legally shot by the rancher.

4) *August 1997.* Sawtooth yearling #68F killed 41 sheep on a grazing allotment on the Bridger-Teton National Forest near Pinedale, Wyoming. She was captured and

released in the center of Yellowstone National Park.

5) *August/September 1997.* Wolf #68F returned to the Pinedale area and preyed upon 15 more sheep; she was shot by Wildlife Services' agents in the sheep band.

6) *September-early October 1997.* Eight of the Sawtooth/Nez Perce wolves traveled west of Yellowstone National Park and killed three calves by early October near Dillon, Montana. As this was #27F's second livestock-killing offense (the first had occurred in 1996), she was removed and six others were relocated back to the Nez Perce pen.

7) *Mid- to late-October 1997.* Nez Perce wolf #29M and four other Nez Perce/ Sawtooth wolves escaped their pen and traveled back to the Dillon area, where they were again captured again and returned to captivity. Later, three sheep were found dead and attributed to these wolves. Managers decided that if the wolves moved west of the park or again killed livestock, they would be removed from the wild.

8) *October 1997.* Sawtooth yearling #63F killed three sheep on private land north of the GYA. She was captured and released in the Hayden Valley in the center of Yellowstone National Park.

9) *Late October 1997.* Wolf #63F returned to the same ranch within one week of her translocation; she killed another sheep and was shot by a Wildlife Services' agent.

10) *October 1997.* Washakie adult #15M killed two cattle near Dubois, Wyoming. Since he had also killed sheep in 1996, he was killed. The adult female and pups were believed to have been involved, thus marking their first strike.

Other Activities

Wolf fieldwork continued to be powered by volunteers, whose housing and food stipends were supported by generous contributions to the Yellowstone Foundation. Positions were highly competitive; 17 volunteers in 1997 contributed a total of 12,160 hours, worth $127,680 of GS-5 level work.

A Visiting Scholar program, begun in 1995 to allow the exchange of ideas and expertise about wolf recovery, ecology, or related topics, also continued in 1997. This year's visiting scholar was Dr. Thomas Drummer, a statistician from Michigan Technological University, who has been involved with the wolf-moose study on Isle Royale since 1985. His contribution to Yellowstone wolves involved a rigorous evaluation of the park's sampling and analytical procedures, such as those used to calculate wolf-kill rates and estimate moose populations inside Yellowstone National Park.

Part V. Yellowstone Center for Resources and Parkwide Support

This section describes work accomplished or coordinated by the YCR staff who are responsible for providing services for other YCR branches and other offices throughout the park. It includes the Spatial Analysis Center; Resource Information; Research Support; and Fiscal Operations and Personnel. Planning and Compliance staff were assigned to the YCR from 1994 until early 1997, when they began a transition to their reassignment as a branch of the Superintendent's Office.

Planning and Compliance

Planning and compliance staff worked on numerous projects, especially those related to road reconstruction, commercial services, and winter use management. In February 1997, the Branch of Planning and Compliance began an organizational transition, moving from the Center for Resources to the Superintendent's Office. Although their budget was carried on the YCR books throughout the fiscal year, their activities for 1997 are reported in the park's *Superintendent's Annual Report* for 1997.

Spatial Analysis Center

The Spatial Analysis Center (SAC) is the home for the park's geographic information system (GIS), soil information support, and the beginnings of a park resource database system. Its main business is the acquisition, analysis, organization, presentation, and storage of information, especially that concerning the cultural and natural resources of the park and the greater Yellowstone area. Its goals are to provide the information and technical support that park staff need to effectively do their jobs, and to make information available to outside agencies and the public.

Spatial analysis staff supported or initiated the following projects during 1997:

- Development of Yellowstone's *Avalanche Management Plan*
- Yellowstone's *Paleontological Survey*
- Field maps for wolf and bison projects
- Road kill analysis
- Support of several park researchers' projects
- Support of Yellowstone Foundation programs
- An Earth Day presentation in Gardiner
- A study of building history in Mammoth
- Support for Northern Range Cooperative Wildlife Working Group ungulate projects
- Inventory and monitoring of thermal areas
- Maps and displays for road construction analysis
- Assisting Gallatin County with data sharing
- Exotic vegetation surveys

New Data Sets

As a result of a Department of Interior focus on the Yellowstone ecosystem, SAC received data from the NPS and a variety of other Federal agencies, including the USGS and the Department of Defense, at very little cost to the park.

- ***DRGs:*** Digital Raster Graphics (DRGs) are scanned USGS topographic maps of all scales. By the end of 1997, SAC had on file 1:24,000; 1:62,500; 1:100,000; 1:125,000, and 1:250,000-scale DRGs for the park and most of the ecosystem. More than 20 CD-ROMs containing all the 1:24,000 scale (7.5-minute) maps for the park had been distributed to park staff in all divisions.
- ***DOQQs:*** Digital Orthophoto Quarter Quadrangles are digital, orthorectified (corrected for the distortions in the photograph due to elevation), geo-referenced aerial photographs at a one-meter ground resolution. This year, SAC received and processed black and white images for the park and much of the ecosystem using aerial photography that was done in about 1994. This highly sought-after digital product is worth more than a million dollars.
- ***10m DEMs:*** Yellowstone became one of the few places in the country to have Digital Elevation Models (DEMs) at 10-meter grid spacing, which forms the basis for most spatial analysis by providing many topographic characteristics such as elevation, slope, and aspect. The DEMs enable SAC to create detailed 3D models of the surface and surface phenomena.
- ***Hydrography:*** The park received a complete hydrography layer for the park at a 1:24,000 scale, including all streams, rivers, ponds, marshes, and human-created water features that are shown on the USGS topographic maps. SAC staff added value to this layer by attaching SONYEW numbers (the numbering system used by the park's Aquatic Resource Center) and official stream names. The streams and rivers were connected into a hydrologic network that can be used to model fish movement, create stream orders, and delineate watersheds.
- ***Imagery:*** Hyper-spectral instruments, a new, experimental method of remote

Digital Orthophoto Quarter Quadrangles for Mammoth Hot Springs. Digital Orthophoto Quarter Quadrangles are digital, orthorectified (corrected for the distortions in the photograph due to elevation), geo-referenced aerial photographs at a one-meter ground resolution.

sensing that records 300 narrow bands of spectral data at 17-meter ground resolution, have been flown over Yellowstone twice between 1996 and 1997. This technology, which USGS scientists have used to detect and differentiate forest cover types, plant species, mineralogy, and thermal algae types, may provide the next generation park vegetation layer for the park, along with maps of thermal area mineralogy and biota. The park also began a pilot program to use high-tech imagery provided by the Department of Defense, with initial efforts focused on thermal features and exotic vegetation. The data remains classified, but the products, when available, will increase our knowledge about the location of exotic plants away from roads, the extent of the park's thermal resources, and thermophile habitat.

New Technologies

Newer computer systems and software used in the Spatial Analysis Center made much of the work done by park staff and cooperators easier and faster. SAC began running its traditional Arc/Info software on Windows NT instead of the UNIX operating system, and point-and-click software allowed users to quickly create and manipulate 3D perspectives of GIS data.

Resource Database Development

Yellowstone has a tremendous need for a well-integrated database with the capacity to handle the huge amount of information gathered about the park in the last 125 years. In 1997, SAC staff undertook the essential first step to identify actual data sets that exist, describe them (including where and how to get them), and enter that information into a searchable database called the Dataset Catalog. They documented more than 150 data sets from a wide range of subject areas such as aquatic ecology, archeology, entomology, fire, geothermal systems, history, herpetology, mammalogy, ornithology, paleontology, soil science, water quality, and wildlife management.

Along with detailed information about each available data set, they also created a linked GIS layer of study site locations. Documentation of data sets was expected to continue in 1998, concentrating on geothermal systems, microbiology, and wildlife diseases.

SAC staff began creating documentation, termed *metadata*, for park data sets. Metadata, for which there is an official national standard, increases the utility of data sets by identifying how the data set was created and the level of error inherent in it. Providing metadata also reduced the number of questions the staff received about the appropriate use and creation

of data sets. Both the metadata and data sets themselves are available over the Internet at *http://www.nps.gov/yell/gis.*

Outreach

As part of its goal to put GIS and the huge investment in park data sets into the hands of more users, in 1997 SAC staff made GIS data sets and software directly available to park employees either through equipment in the lab or over the park's computer network. Five copies of the ArcView software were available in the GIS lab at park headquarters, and additional licenses were purchased by the Wolf Project and the Planning Office. In the Interior, copies of ArcView were installed on computers at Old Faithful, Canyon, and Lake. With some training and a little personal initiative, staff are able to make maps, query data, and even create their own data on a personal computer. In 1998, SAC staff hope to provide ArcExplorer (free software that enables the user to view GIS layers and print maps) to any interested employees.

In 1997, the Spatial Analysis Center provided information for the park's internal "Intranet" web site about their services and products. They began testing the potential for updating and providing access to park databases using the Intranet. The Internet is being used to provide basic information and data sets.

Resource Information

The resource information group was led by a resource naturalist (writer-editor), with a technical writer-editor and a visual information specialist on the paid staff. High-quality professional work was also performed by a six-month volunteer writer and 2 four-month volunteers, a retired wildlife biologist and his wife, who was an executive secretary during her previous career.

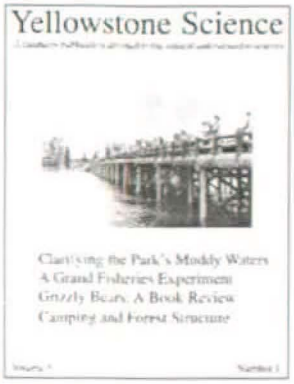
The resource information staff assisted in planning and conducting the Fourth Biennial Scientific Conference on the Greater Yellowstone Ecosystem on "People and Place: The Human Experience in Greater Yellowstone," held October 12–15, 1997, in Mammoth Hot Springs. This included producing calls for papers, registration forms, a program with a conference agenda and abstracts, and special programs on each evening or luncheon keynote speech. Montana State University's conference services department handled registration for the event, which appeared to produce better budgetary results, smoother logistical arrangements, and less work for YCR staff than occurred during previous conferences that were handled entirely by park and concessioner staff.

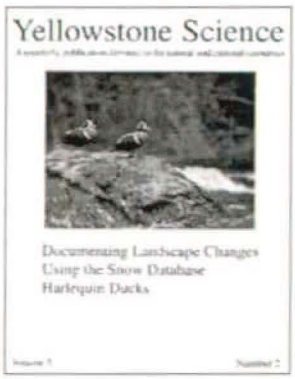
In mid-October, the technical writer-editor was detailed to San Diego, California, to assist on laboratory work and report production for a DNA analysis and lineage of wolves and other canids. This project resulted from a new "bioprospecting" arrangement reached between Yellowstone National Park and Diversa Corporation and was part of Diversa's commitment of services back to Yellowstone. While not working in the lab, the writer-editor continued editing and pre-production work on two other technical reports planned for early 1998 publication.

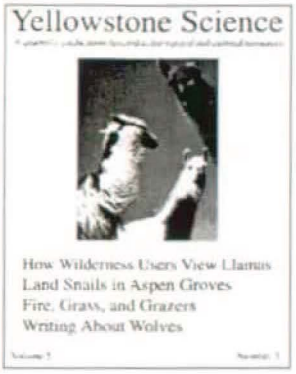
Publications

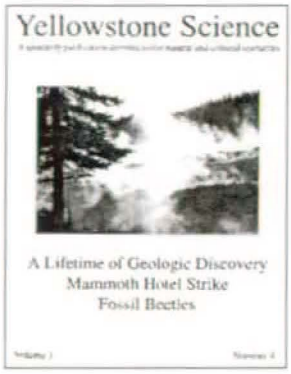
The resource information group produced a variety of publications to improve the documentation and availability of information about resource management and research activities throughout the park.

Topics covered by articles in the quarterly magazine *Yellowstone Science*, in its fifth year, included harlequin ducks, land snails, campsite impacts on forest structure, user attitudes about llamas in the backcountry, the snow database, suspended sediment in northern Yellowstone rivers, fire effects in grasslands, an early labor









strike during the building of the Mammoth Hotel, and reconstructing climate history by studying fossil beetle assemblages. The magazine featured interviews with biologist Mary Meagher, who discussed bison, winter use, and using comparative historic photographs to assess landscape changes; and geologist Irving Friedman, who developed a technique to date obsidian, benefiting both geologic and archeologic fields, and discussed long-term monitoring of thermal features. Books reviewed included *The Grizzly Bears of Yellowstone: Their Ecology in the Yellowstone Ecosystem, 1959–1992; Yellowstone's Ski Pioneers, Wolf Wars, The Wolves of Yellowstone, Yellowstone Wolves: A Guide and Sourcebook;* and *Discovering Yellowstone Wolves: Watchers' Guide.* Donations continued to support approximately 25 percent of the annual printing costs of *Yellowstone Science,* the rest of which were paid through a grant from the Yellowstone Association.

Other publications produced in 1997:

- a 150-page book on *Yellowstone's Northern Range: Complexity and Change in a Wildland Ecosystem,* which summarized the history, management issues, and research related to this critical resource
- a report on results of a 1996 parkwide aerial beaver survey
- a geologic bibliography and a report on geothermal resources
- a biennial report on the *Yellowstone Wolf Project, 1995–1996*
- the third annual report for the Yellowstone Center for Resources' activities in calendar year 1996
- five issues of the park's resource management newsletter, *The Buffalo Chip*
- a four-page insert on *Yellowstone's Northern Range* that appeared in newspapers around the ecosystem in June
- articles for the quarterly park newspapers and a "top ten issues" supplement to be handed out to all visitors entering Yellowstone's entrances
- a four-page insert on *Grizzly Bears: On the Road to Recovery in the Greater Yellowstone Ecosystem,* which was distributed to regional newspapers in December. Features were written by national park, national forest, and state game agency staff; Yellowstone did master editing, design, and layout of the insert and contributed $1,500 toward the final production cost.

At the request of the park superintendent, the resource information staff began work on a major document to be entitled *The State of the Park.* Text was written largely by a volunteer writer/editor and was still in the editing and pre-production stage at the end of 1997.

Assistance to Other Divisions

The resource information staff provides assistance to other park specialists and divisions in writing, editing, design, and/or produc-

tion of professional quality publications and educational programs. During 1997, such projects included a draft report and public newsletter about winter use planning and management; a newsletter about "The Greening of Yellowstone" conference held in September in West Yellowstone, Montana; slides and graphics to help subject-matter experts illustrate oral and written presentations; and artwork for approved cooperative ventures in fundraising by the Yellowstone Foundation.

A color printer, slide scanner, and Polaroid slide maker purchased in 1997 immediately began to simplify and improve the cost-effectiveness of producing products. Resource information staff also purchased the software needed to make written material suitable for use on the internet, and began experimenting with its use. Equipment and wiring limitations that limited the staff's ability to provide more of this assistance to park staff should be corrected in 1998.

Presentations, Field Trips, and General Information

After a full-time resources interpreter, who for ten years fielded many inquiries about park research and resource management activities, retired in February 1997, the resource naturalist (writer-editor) attempted to fill the gap by responding to written requests, phone calls, and email inquiries about various topics, especially wolf restoration, wildland fire, park and greater Yellowstone area management, grizzly bear recovery, other threatened or endangered species, elk and northern range management, bison management, ecology, fisheries, geology and geothermal activity, bison management, economics and sociology, human-wildlife interactions, exotic species, boating on park rivers, and finding employment in Yellowstone or other national parks.

The resource naturalist presented illustrated programs on wolf restoration (9), grizzly bears (6), both threatened and endangered mammals (2), the northern range (3), general park issues (4), and bison (2) in and outside the park to school and organizational groups. She arranged talks by other YCR staff and cooperative researchers for park staff and visiting student groups on topics including those mentioned above as well as the lake trout invasion, microbes, wilderness management and economics, cultural resource management issues, and park geology. Resource seminars presented to park staff covered the natural history of bats, mine waste and flooding in Soda Butte Creek, and the life history of whirling disease. Staff from the YCR also taught or assisted with *Yellowstone Institute* courses on grizzly bear ecology and management, wolves, carnivores, greater Yellowstone, and small mammals. They gave dozens of interviews on resource topics and hosted national and international visitors, providing special tours in the field for many of these guests.

Volunteers updated a series of resource briefs, used primarily as enclosures to answer staff and public inquiries about a variety of park issues, species, and topics. The resource naturalist provided updated information in written and oral form to the park's interpretive staff and to the annual resource management workshop attended by park rangers, maintenance, and administrative employees.

Research Support

Each year members of the park staff as well as independent researchers participate in short- and long-term studies in a wide range of topics, including archeology, botany, entomology, geology, microbiology, ornithology, paleontology, park history, and wildlife ecology. All persons conducting research in the park are required to obtain an annual permit by submitting an application and study plan, with peer reviews, for consideration by the park.

In addition to facilitating the application and review process, the park's research coordinator provided logistical support for researchers to the extent feasible. He maintained a computerized record of research permits and compiled an annual summary of reports submitted by the investigators. Of the 280 research projects active during 1997, 89 were newly initiated. Much of the funding for these projects was provided by other federal and state agencies, academic or non-profit institutions, and individuals. More information on specific research projects can be found in the *Investigators' Annual Reports* on file at the Yellowstone Center for Resources.

Funding and Personnel

Yellowstone Center for Resources (YCR) park base funds were authorized at $1,475,600 in fiscal year (FY) 97. Because this amount was inadequate to support even permanent salaries for the division, resource operations were supplemented by $90,000 of regional contingency funds for the *Bison Management Plan and EIS*, $35,000 of park funds in a no-year account (which can be carried over from one year to the next), and $8,500 of regional contingency for GIS equipment. The YCR obligated $710,500 from all sources for contracts, primarily to accomplish three projects: bison/brucellosis research, cultural resource surveys and compliance, and work related to the Montana Water Rights Compact.

The remainder of the division's budget supported 42.89 full-time equivalent staff who conducted work in cultural and natural resource management, research, and support.

Special NPS Funding

- ***Fee Demonstration Program:*** The YCR was allocated $250,000 of funds from the new Fee Demonstration program to apply toward projects described as "resource protection backlog," which in 1997 meant mostly infrastructure in need of repair. Because of restrictions placed on the use of Fee Demonstration funds, YCR "traded" $100,000 to the Maintenance Division for an equal amount of their base funds that could be used for basic resource operations. Projects such as archeologic surveys, seismic monitoring, and equipment improvements were funded from the remaining $150,000 of the Fee Demonstration funds. An additional $65,000 in Fee Demonstration funds was authorized to purchase equipment for the fisheries program (see below).
- ***Fisheries Fee Program:*** Based on projections of income from fishing permit fees, the YCR received authorization to use $334,500 to cover the cost of the fisheries management program, which was transferred from the U.S. Fish & Wildlife Service (USFWS) to the National Park Service in FY96. The $65,000 authorization provided from the Fee Demonstration program was used to pay for equipment needed after the withdrawal of the USFWS, and for the lake trout control program in Yellowstone Lake. In FY97, when the fishing permit fee allocation was reduced to $213,400 because fewer permits were sold, the Fee Demonstration authorization for fisheries was increased to $190,600 to cover the shortfall.
- ***Federal Lands Highways Program:*** In conjunction with the parkwide roads improvement projects, the Federal Highways Administration provided $433,700 for natural resource inventories, archeological/cultural resource compliance, and planning assistance done by YCR staff in FY97.
- ***Natural Resource Preservation Program:*** Yellowstone received $124,000 for the second of a three-year joint Yellowstone-Grand Teton bison/brucellosis study. An $80,000 advance for the third year was

authorized late in the fiscal year, bringing the total obligated for research contracts and equipment in FY97 to $204,000.

- ***Cultural Resource Preservation Program:*** The Branch of Cultural Resources successfully competed for $228,400 in funds that were used for cataloging backlog museum acquisitions, National Register evaluations and nominations, archeological monitoring, museum collections maintenance, and a historic resource study.
- ***Regional Natural Resource Program:*** The Branch of Natural Resources received $7,700 in special funds to purchase and install bear-proof food storage containers in park campgrounds.

Interagency Funding

The YCR administered several interagency projects in 1997 for which funding was provided by other federal or state agencies:

- The U.S. Geological Survey funded $300,000 in preliminary data-gathering for a national spatial data infrastructure information center, the intent of which is to share geographic information systems technology and data between local, state, and federal governments within the greater Yellowstone area. This project is known as the Greater Yellowstone Area Data Clearinghouse.
- The USGS Biological Resources Division reimbursed the park $61,300 for services and supplies provided for research projects performed by their employees.
- The USGS also provided $35,000 under the Technology Maturation program for Yellowstone to continue the biodiversity and bioprospecting initiative with the World Foundation for Environment and Development (WFED).
- The Bridger-Teton National Forest contributed $2,000 for a cumulative effects analysis of grizzly bear habitat prepared by the YCR.
- In addition to the annual $153,000 of base funding Yellowstone applied to the Montana Water Compact, the NPS Water Resources Division supplied $7,400 to support the water gauging station at Soda Butte Creek, which was paid directly to the USGS office in Helena for maintenance and data analysis.

Donations

A total of $48,000 donated to the park by private organizations and individuals was used primarily to support the wolf recovery program, the bioprospecting initiative, the printing of resource publications, and other natural resource programs.

Personnel

The YCR lost two long-time employees in early March of 1997. Norman A. "Norm" Bishop, Resource Interpreter, retired with more than 40 years of government service, the last 17 spent in Yellowstone educating employees, students, and the general public on natural resource issues. Roderick A. "Rick" Hutchinson, a veteran employee of Yellowstone and leading geothermal expert for more than 20 years, was killed in a backcountry avalanche near the Heart Lake Geyser Basin.

In June of 1997, with the reintroduction phase of the wolf recovery program complete and a monitoring plan in place, the Wolf Project Leader position was phased out when Mike Phillips resigned from government service to take a position with Turner Enterprises in Gallatin Gateway, Montana.

The YCR continued rebuilding the aquatic resources program, in the wake of the departure of the long-term U.S. Fish & Wildlife Service Yellowstone Fisheries Assistance Office, by adding a term fisheries biologist and two fisheries technicians to the staff.

The complete personnel roster for the Yellowstone Center for Resources in 1997 follows in Appendix I.

Table 12. YCR distribution of FY97 funds.

Program	Park Base	CRPP	NRPP	Fish Fee	FLHP	Fee Demo	Federal	Other Private	Total	Funding	% of Total
Center Support		406,500	0	0	0	0	34,600	35,000	8,200	484,300	13.5%
Natural Resources		458,300	0	0	213,400	182,600	257,300	7,700	12,700	1,132,000	31.6%
Cultural Resources		197,000	228,400	0	0	166,100	48,700	0	0	640,200	17.9%
Planning & Compliance		180,000	0	0	0	53,100	0	0	0	233,100	6.5%
Resource Technology		48,300	0	0	0	31,900	0	8,500	0	88,700	2.5%
Wolf Recovery		201,000	0	0	0	0	0	0	27,100	228,100	6.4%
Bison Management EIS		84,500	0	204,000	0	0	0	90,000	0	378,500	10.6%
Interagency Projects		0	0	0	0	0	0	398,300	0	398,300	11.1%
Total		1,575,600	228,400	204,000	213,400	433,700	340,600	539,500	48,000	3,583,200	100.0%

Table 13. Funding history (FY 1983-97), Research Division/Center for Resources, Yellowstone National Park.

	National Park Service Funds									Other			
FY	ONPS	Fee	PFRP	NRPP	CRPP	WRD	FLHP	Fee Demo	Other	USFWS	Federal	Private	Total
83	165,500	0	0	0	0	0	0	0	0	104,000	0	0	269,500
84	501,300	0	0	0	0	161,400	0	0	0	104,000	0	0	766,700
85	588,400	0	0	0	0	133,000	0	0	0	104,000	0	3,512	828,912
86	607,400	0	0	150,000	0	112,000	0	0	0	136,550	0	9,310	1,015,260
87	719,300	0	0	200,000	0	108,000	0	0	0	115,000	0	6,758	1,149,058
88	767,000	170,000	0	250,000	0	172,000	0	0	0	104,000	5,400	2,824	1,471,224
89	793,400	406,000	1,863,000	56,000	0	108,000	0	0	0	133,000	4,000	3,017	3,366,417
90	847,400	0	755,000	56,000	0	75,000	0	0	0	111,650	12,000	2,157	1,859,207
91	916,300	0	785,200	56,000	0	0	0	0	0	148,123	15,000	55,101	1,975,724
92	1,025,660	0	685,000	25,000	0	0	0	0	0	182,050	10,000	10,100	1,937,810
93	1,004,600	0	785,000	16,000	0	0	0	0	0	188,000	0	20,000	2,013,600
94	1,250,000	65,000	0	260,000	33,200	156,000	43,300	0	164,600	55,000	24,600	10,000	2,061,700
95	1,500,000	65,000	0	420,000	45,000	6,800	303,600	0	53,000	20,000	0	5,300	2,418,700
96	1,544,100	274,500	0	404,000	201,100	119,800	626,700	0	38,000	0	64,958	31,504	3,304,662
97	1,674,100	213,400	0	204,000	228,400	0	433,700	340,600	42,700	0	398,300	48,000	3,583,200

Appendix I. Personnel Roster, 1997

Name by Branch	Title	FTE	Borrowed FTE
Directors/Professional Support			
Norm Bishop	Resources Interpreter	0.42	
Wayne Brewster	Deputy Director	1.00	
Sarah Broadbent	Technical Writer-Editor	1.00	
Wendy Clark	Wildlife Biologist	1.00	
Sue Consolo-Murphy	Resource Naturalist	1.00	
Renee Evanoff	Visual Information Specialist	0.96	
Gregg Kurz	Biological Science Technician	0.15	
Bob Lindstrom	Management Assistant	1.00	
John Mack	Wildlife Biologist	1.00	
Melissa McAdam	Budget Analyst	1.00	
Joy Perius	Administrative Assistant	1.00	
Julie Rehmer	Editorial Aide	0.85	
Paul Schullery	Resource Naturalist	0.40	
Holli Traucht	Center Clerk	1.00	
John Varley	Director	1.00	
Cultural Resources			
George Briggs	Museum Technician	0.62	
Sean Cahill	Museum Technician	0.49	
Vanessa Christopher	Museum Technician	0.88	
John Dahlheim	Management Assistant		0.01
Linnea Despain	Museum Clerk	0.26	
Elaine Hale	Cultural Resource Assistant	0.50	
Holly Hampton	Archeological Technician		0.02
Laura Joss	Branch Chief	1.00	
Susan Kraft	Supervisory Museum Curator	1.00	
Catherine Lentz	Cultural Resource Specialist	1.00	
Anne Lewellen	Museum Technician	0.48	
Loretta Lindstrom	Cultural Resource Assistant	0.11	
Beth Raz	Budget Clerk		0.04
Charissa Reid	Cultural Resource Assistant	0.22	
Freya Ross	Park Ranger		0.04
James Thompson	Cultural Resource Assistant	0.23	
Jennifer Whipple	Botanist	0.73	
Lee Whittlesey	Archivist	1.00	
Natural Resources			
Mark Biel	Biological Science Technician	0.90	
Meredith Burnett	Biological Science Technician	0.35	
Tami Blackford	Secretary	1.00	
Ken Coffin	Biological Science Technician	0.31	
Stu Coleman	Branch Chief	1.00	

Brian Ertel	Biological Science Technician	0.54	
Kerry Gunther	Wildlife Biologist	1.00	
Mary Hektner	Resource Management Specialist	1.00	
Roderick Hutchinson	Research Geologist	0.43	
Gregg Kurz	Biological Science Technician	0.04	
Jeff Lutch	Biological Science Technician	0.95	
Daniel Mahony	Fisheries Biologist	1.00	
Terry McEneaney	Wildlife Biologist	1.00	
James McGrath	Biological Science Technician	0.37	
Amy Pederson	Biological Science Technician	0.13	
Mike Phillips	Wolf Project Leader	0.67	
Karen Reinhart	Park Ranger		0.08
Roy Renkin	Vegetation Management Specialist	1.00	
Dave Richards	Biological Science Technician	0.03	
Hillary Robison	Biological Science Technician	0.44	
Jim Ruzycki	Fisheries Biologist	0.33	
James Schaffer	Biological Science Technician	0.35	
Douglas Smith	Wildlife Biologist	1.00	
Tim Thompson	Physical Science Technician	0.25	
Debra Tirmenstein	Biological Science Technician	0.33	
Shannon Troop	Biological Science Technician	0.03	
Planning and Compliance			
Kris Churchill	Planning Assistant	0.39	
John Dahlheim	Management Assistant	0.36	
Melissa Frost	Planning Assistant	0.29	
Amanda Hardy	Planning Assistant	0.20	
Kristen Legg	Park Ranger	0.73	
John Sacklin	Branch Chief	1.00	
Bill Schneider	Outdoor Recreation Planner	1.00	
Spatial Analysis Center			
Michael Heiner	Computer Operator	0.10	
Linda Phillips	Computer Operator	0.10	
Skip Repetto	GIS Operator	0.45	
Ann Rodman	Soils Scientist	0.96	
Henry Shovic	Branch Chief		0.40
Lurleen Smith	Computer Operator	0.21	
IGBST and USGS/BRD			
Lisa Baracz	Park Ranger		0.30
Chad Dickenson	Biological Science Technician	0.46	
Christie Hendrix	Forestry Technician		0.05
Ed Olexa	Biological Science Technician	0.96	
		42.89	**0.94**

Appendix II. Publications, Administrative Reports, and Information Papers

Professional Publications

Biel, M. J., K. A. Gunther, and H. E. Hoekstra. 1997. Yellowstone Park bear attractant study with biodiesel. Pages 127–135 *in* Conference Proceedings, Commercialization of Biodiesel: Environmental and Health Benefits. Univ. of Idaho, Moscow. 218pp.

Administrative Reports

Gunther, K. A., M. T. Bruscino, S. Cain, T. Chu, K. Frey, and R. R. Knight. 1997. Grizzly bear-human conflicts, confrontations, and management actions in the Yellowstone ecosystem, 1996. Interagency Grizzly Bear Committee, Yellowstone Ecosystem Subcommittee Report. 43pp.

_____, and M. A. Haroldson. 1997. Comments on the importance of bison to grizzly bears in the Yellowstone ecosystem. Natl. Park Serv., Yellowstone National Park, Wyo. 21pp.

_____, M. J. Biel, H. L. Robison, and H. Zachary. 1997. Bear management office administrative annual report for calendar year 1996. Natl. Park Serv., Yellowstone National Park, Wyo. 50pp.

Hutchinson, R. A. 1997. Geologic publications and articles related to Yellowstone National Park: an annotated bibliography. Natl. Park Serv., Yellowstone National Park, Wyo. YCR-NR-97-3. 44pp.

McEneaney, T. 1997. The Yellowstone bird report, 1996. Natl. Park Serv., Yellowstone National Park, Wyo. 22 pp.

Phillips, M. K. and D. W. Smith. 1997. Yellowstone wolf project, biennial report 1995–1996. Natl. Park Serv., Yellowstone National Park, Wyo. YCR-NR-97-4. 24pp.

Robison, H. L., M. J. Biel, and K. A. Gunther. 1997. Biological assessment of rare mammal activity near the proposed Canyon contractor camp in Yellowstone National Park. Natl. Park Serv., Yellowstone National Park, Wyo. 22pp.

Smith, D. W., S. Consolo Murphy, M. K. Phillips, and R. Crabtree. Beaver survey, Yellowstone National Park 1996. Natl. Park Serv., Yellowstone National Park, Wyo. YCR-NR-97-1. 8pp.

Thompson, T. and R. A. Hutchinson. 1997. Geothermal resources of Yellowstone National Park, 1993–95. Natl. Park Serv., Yellowstone National Park, Wyo. YCR-NR-97-2. 54pp.

Yellowstone National Park. 1997. Annual report: Yellowstone Center for Resources 1996. Natl. Park Serv., Yellowstone National Park, Wyo. YCR-AR-96. 75pp.

Yellowstone National Park. 1997. Investigators' annual report: Yellowstone National Park 1996. Natl. Park Serv., Yellowstone National Park, Wyo. YCR-IAR-96. 120pp.

Yellowstone National Park. 1997. Yellowstone's northern range: complexity and change in a wildland ecosystem. Natl. Park Serv., Yellowstone National Park, Wyo. 148pp.

Information Papers

Gunther, K. A. 1997. Yellowstone National Park bear-related injuries/fatalities. Info. Paper BMO-1. Natl. Park Serv., Yellowstone National Park, Wyo. 2pp.

_____. 1997. Characteristics of black bears and grizzly bears in Yellowstone National Park. Info. Paper BMO-2. Natl. Park Serv., Yellowstone National Park, Wyo. 2pp.

_____. 1997. Where are all the bears? Info. Paper BMO-4. Natl. Park Serv., Yellowstone National Park, Wyo. 2pp.

_____. 1997. Bear management area program, Yellowstone National Park. Info.

Paper BMO-5. Natl. Park Serv., Yellowstone National Park, Wyo. 4pp.

_____. 1997. Recovery parameters for grizzly bears in the Yellowstone ecosystem. Info. Paper BMO-6. Natl. Park Serv., Yellowstone National Park, Wyo. 4pp.

_____. 1997. Bears and menstruating women. Info. Paper BMO-7. Natl. Park Serv., Yellowstone National Park, Wyo. 2pp.

_____, and M. J. Biel. 1997. Yellowstone National Park bear information book. Natl. Park Serv., Yellowstone National Park, Wyo. 128pp.

Papers Presented at the 1997 Biennial Conference

Davis, L., Johnson, A., and Davis, C. Archeology and prehistory of the northern Rocky Mountain Sheepeater Indians.

Kraft, S. Wonderland indoors: a history of museums in Yellowstone National Park.

Joss, L. and Olliff, T. A delicate balance: front and backcountry management of Yellowstone's cultural resources.

Schullery, P. and Whittlesey, L. The Madison campfire story: Yellowstone's creation myth and its legacy.

Yellowstone Center For Resources

ANNUAL REPORT 1997