# YELLOWSTONE CENTER FOR RESOURCES

# 2000 ANNUAL REPORT

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*Trumpeter swans. Photo by Jennifer Whipple.*

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

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# Introduction

On May 2, 2000, the world's tallest active geyser, Steamboat, erupted for the first time since October 2, 1991. An eruption of Steamboat is always an exciting and historic event and seems a fitting way to celebrate the first year of the new millennium for the Yellowstone Center for Resources (YCR).

The YCR experienced some major changes in leadership this year. Laura Joss accepted the position as superintendent at Fort McHenry National Monument. Laura made great strides toward increasing the awareness and preservation of cultural resources in Yellowstone, and we acknowledge the important legacy she leaves. The Branch of Cultural Resources is left in the capable hands of Sue Consolo Murphy, who will keep the momentum going to fulfill this important part of the national park mission. Tom Olliff takes the helm as the branch chief of natural resources. Tom's longevity in the park, his depth of experience, and his dedication to preserving park resources leave him well prepared to lead this branch.

Park archeologist Ann Johnson did a laudable job as acting branch chief of cultural resources, in addition to overseeing the archeological inventory of 1,441 acres and the recording of 64 new sites this year. Cultural anthropologist Rosemary Sucec was reassigned from the regional office to be the liaison with the 24 Native American tribes affiliated with the park, highlighting the park's commitment to the cultural aspect of the Yellowstone story. In addition to this ethnographic work, several significant Euro-American oral histories were completed. Park staff interviewed park rangers and scientists involved in ungulate management during the 1960s, when a major elk reduction program brought about the natural regulation experiment. Excerpts from these interviews were published in two issues of the park's quarterly magazine, *Yellowstone Science*. The park archivist conducted an interview with former President Gerald S. Ford about his experience as a park ranger in 1936.

It was a good year in court for Yellowstone. Judges from the Tenth Circuit U.S. Court of Appeals reversed the Wyoming District Court's decision ordering wolves to be removed from the reintroduction area. In April, the U.S. District Court for the District of Columbia dismissed with prejudice a legal challenge to Yellowstone's "bioprospecting" benefits-sharing agreement with the Diversa Corporation. The NPS is initiating a study to determine the environmental impacts of entering into such agreements in national parks throughout the U.S. After more than eight years of negotiations and seven months of mediation between federal agencies and the State of Montana, a joint management plan for bison was agreed to in December. By allowing bison the opportunity to seek winter range outside the park, the plan reflects a commitment to end the unnecessary killing of bison.

The year 2000 was another year of great successes and further challenges in preserving the natural and cultural resources of the park. Five new native plant species were discovered, as well as six more exotic ones. A 16-year-old whooping crane that had been nesting in Yellowstone died in March after colliding with a power line in Colorado. By the end of the year, only two whooping cranes remained in the Rocky Mountains. Yellowstone is a stronghold for the peregrine falcon, a species of special concern. Two new eyries were found this year, bringing the total to 16 and the number of fledglings to 29, the most ever recorded in the park. In addition, a new species was added to the park's Field Checklist of Birds, the glossy ibis. This year, the lynx was listed as a threatened species. Despite evidence that lynx have been present in Yellowstone, historically and currently, little has been done to document their numbers and distribution. The Yellowstone Park Foundation provided a grant to assist a lynx survey and fieldwork will begin in January 2001. As the year comes to a close, it is clear that the search for species, and the search for knowledge in general, will continue at the Yellowstone Center for Resources. From the beginning, Yellowstone has always represented the spirit of discovery, and it always will.

John D. Varley
Director, Yellowstone Center for Resources

*Tom Besom and Doug Mitchell from the Museum of the Rockies working at the Osprey Beach site.*

# Part I. Resource Highlights

## Archeologists Document 9,300-Year-Old Site

In 2000, an archeological site documented in 1958 but not revisited by archeologists since revealed new information about old uses of the park. This summer, a volunteer crew from Wichita State University, under the direction of Dr. Donald Blakeslee, re-identified a major site eroding on the shore of Yellowstone Lake. Following this initial work, a crew from the Museum of the Rockies spent four days at the newly dubbed Osprey Beach.

The single cultural horizon, 60 cm (two feet) below the present ground surface, was radiocarbon dated at 7350±50 B.C. Drs. Ken Pierce of the U.S. Geological Survey and Paul Doss from Yellowstone interpreted the soil profile as showing that early people camped on the then-extant shoreline of the lake. Archeologists unearthed chipped obsidian tools and two "Cody knives," named for a culture known as the Cody Complex. The knives are made of a dark green chert whose origin is the Absaroka volcanic rocks that line the park's eastern boundary across the lake. Obsidian tools found in the lakeshore site come from at least four places—Obsidian Cliff, a natural National Historic Landmark within the park; Teton Pass west of Jackson Hole; and two places in southeastern Idaho, indicating to park archeologist Dr. Ann Johnson that the people who camped on the lakeshore moved or traded across the region.

Of particular interest was the immunological analysis of eight artifacts (seven points and one abrader) for blood residue. Artifacts yielded blood residue from rabbits, sheep, deer, and an unidentified canid, a member of the dog family. Though there is as of yet no clear evidence to prove it, archeologists believe the Cody Complex people hunted the now-extinct *Bison antiquus*, a species similar to the bison commonly observed in the park today.

The Osprey Beach site contains important information about early human use of the park and has the potential to add to our understanding of the local environment some 9,300 years before present (B.P.). In 2001, archeologists hope to put in several additional test units to better understand how much of the site remains away from the lakeshore.

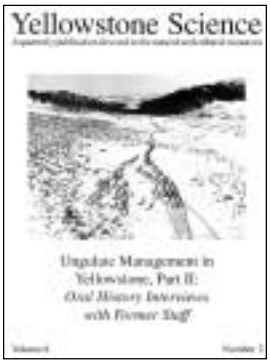
## World's Tallest Geyser Spouts Again

Around 6 A.M. on May 2, 2000, Steamboat, the world's tallest active geyser, erupted for the first time since October 2, 1991. At around 7 A.M., a park employee spotted a tall vapor column as he neared the Norris Geyser Basin and, suspecting a possible eruption, stopped to investigate. Two visitors who had been sleeping in their truck at the Norris parking area stated that they were abruptly awakened by what they thought was an earthquake. By the time the employee arrived, a heavy, wet mist enveloped most of the area, and Steamboat was in full steam phase—emitting a tremendous roar, with a huge, visible vapor plume approximately 500 feet tall. During a major eruption, Steamboat's water phase can reach heights of over 300 feet, lasting three to 40 minutes, and for 12 or more hours after, Steamboat thunders with powerful jets of steam. In the twentieth century, eruption intervals of Steamboat varied from three days (in 1989) to 50 years (between 1911 and 1961).

*Steamboat Geyser, May 2, 2000.*

## Additions to Park Collections

In 2000, park staff completed an oral history project focussing on ungulate management in Yellowstone. Project leader Charissa Reid and assistant Sally Plumb interviewed dozens of former park rangers and scientists who had been actively involved in ungulate management, particularly during the 1960s when a major elk reduction program gave way to implementation of the so-called "natural regulation" experiment. The project, funded through the park's Recreation Fee Demonstration Program, wrapped up with a luncheon honoring former park biologists Glen Cole and Douglas A. Houston, and with the publication of two issues of the park's *Yellowstone Science* magazine that included several features and excerpts from the oral history interviews. Publication of that and an article in *Cultural Resources Magazine* brought positive feedback from participants, Yellowstone Park staff, and employees in other NPS areas. In May, park archivist Lee Whittlesey conducted an interview with former President Gerald S. Ford about his experiences as a park ranger in 1937. The oral history interviews have been transcribed and placed in the park archives collection for use by present and future researchers.




Several notable museum objects were acquired during the year. A bronze sculpture, "*Buffalo Charging,*" made by Avard Tennyson Fairbanks in 1911, was presented as a gift to the White House, from where it was transferred to Yellowstone. Using funds raised by the Yellowstone Park Foundation, the park acquired the original stagecoach ledger kept by the Yellowstone National Park Transportation Company from 1892 to 1906. The ledger is an important volume long missing from the set of ledgers already in the park archives. The curator successfully bid more than $3,700 for the ledger on the eBay online auction service. Yellowstone Park Foundation funds also made possible the purchase of several diaries for the archives and an 1884 photo album from an east coast collector documenting a guided horseback trip through Yellowstone. The archives gained through donation several valuable old volumes, and purchased buffalo keeper David W. Pierson's collection, including his diary, letters, awards, and photographs.

## 10th Circuit Court Overturns Order to Remove Wolves

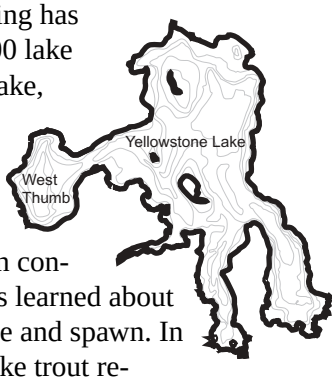
On January 13, 2000, the Tenth Circuit of the U.S. Court of Appeals in Denver, Colorado, issued its ruling on multiple appeals filed by parties concerned with the reintroduction and management of gray wolves. The original plaintiffs—including the Idaho, Montana, Wyoming, and American Farm Bureau Federations and Cat and James Urbigkit—challenged how the U.S. Department of the Interior, U.S. Fish and Wildlife Service, and other agencies used section 10(j) of the Endangered Species Act (ESA), regarding a "nonessential, experimental" population of wolves in Yellowstone National Park and central Idaho. In December 1997, the District Court for Wyoming held that wolf reintroduction rules lessened protection for naturally occurring wolves (such as those migrating south from Canada, or born in the Glacier National Park area) in the experimental population areas. The lower court judge ordered that wolves be removed from the reintroduction areas, but he immediately stayed his order pending appeal.

The three court of appeals judges found no conflict between the challenged experimental population rules and the ESA, and unanimously reversed the district court's order and judgment. The court acknowledged that occasional disperser wolves from another geographic area might enter areas in which wolves designated as experimental populations exist, but determined that "the paramount objective of the Endangered Species Act [is] to conserve and recover species, not just individual animals." The opinion also said that "the rules did not present complicated law enforcement obstacles...the legal protection afforded any particular wolf is clearly known, depending entirely on where the wolf is, not where it might once have been."

The court found that the Urbigkits' claims that wolf reintroduction influenced an existing population of a distinct subspecies "boil down to a disagreement over scientific opinions and conclusions...[but] simply does not constitute a National Environmental Policy Act violation.... Agencies are entitled to rely on their own experts so long as their decisions are not arbitrary and capricious."

## Lake Trout Removal

Although lake trout may have been illegally planted in Yellowstone Lake as long as 20 years ago, their presence was not confirmed until 1994, by which time they had become well-established in the West Thumb area of the lake. Each mature lake trout can consume 50 to 90 Yellowstone cutthroat trout a year, and cutthroat trout numbers have been lower in recent years than at any time during the 25-year monitoring effort. This could ultimately affect 42 species of mammals and birds that feed on the cutthroat trout.




Since 1995, gillnetting has removed more than 27,000 lake trout from Yellowstone Lake, and the strategy for removing as many lake trout as possible while minimizing the by-catch of cutthroat trout has been continually refined as more is learned about where the lake trout reside and spawn. In terms of the number of lake trout removed, the 2000 field season was the most successful yet, with 12,792 lake trout captured by gillnetting and about 250 by anglers. The catch rate (number of fish caught per unit of effort) remained about the same, indicating that the netting effort may be preventing the lake trout population from increasing. The average size (and potential reproductive capacity) of spawning lake trout has continued to decrease at known spawning locations, and the lake trout mortality goal of 50 percent appears to be nearly met in the West Thumb/Breeze Channel portion of Yellowstone Lake, where all of the known spawning grounds are and most of the adult lake trout reside. However, the gillnetting program will need to be expanded, because juvenile lake trout have been found throughout the lake, and it is expected that new spawning grounds will be established at other sites.

## Cultural Anthropologist Comes to Yellowstone

In March 2000, Rosemary Sucec was reassigned to Yellowstone from the NPS regional office in Denver, although she was still on a temporary appointment. Her skills as a cultural anthropologist were immediately put to use as she assumed responsibilities for being the park's primary liaison with 24

*Coeur d'Alene biologist Richard Allen with a cutthroat.*

affiliated Native American tribes. She coordinated government-to-government consultations; took opportunities to obtain information about park ethnographic resources for planning, resource management, and visitor education purposes; and created training opportunities for park staff.

In June, an interdisciplinary team of park staff including the cultural anthropologist visited a sample of Nez Perce sites associated with their 1877 flight through Yellowstone. These sites have the potential for wayside interpretation. In September, in conjunction with the annual meeting of the Nez Perce National Historic Trail Foundation meeting in Cody, Nez Perce tribal members from Colville, Lapwai, and Umatilla visited four sites in the park: the Lower Geyser Basin at the Nez Perce Creek pullout, Otter Creek, Nez Perce Ford (formerly called Buffalo Ford), and Indian Pond. At each site, Nez Perce historians and elders relayed oral accounts of the flight and of customary use of the area by Nez Perce bands. The Nez Perce-interpreted tour was video-recorded and is available upon request.

Also in June, members of the Coeur d'Alene Tribe in Idaho visited Yellowstone Lake and its tributaries. The Coeur d'Alene have oral accounts of merchant families who traveled to Yellowstone to harvest rare materials subsequently used in trade and for other purposes upon their return home. They acquired stone such as obsidian and items harvested during bison hunts. Tribal biologists and fisheries technicians came to observe spawning cutthroat trout in their native habitat. They gleaned technical knowledge from park biologists that they hope will help the tribe sustain a viable population of western cutthroat trout on reservation lands (including Coeur d'Alene Lake) and renew their tradition of subsistence fishing.

## Bioprospecting Agreement Upheld

On April 12, 2000, the U.S. District Court for the District of Columbia dismissed with prejudice a legal challenge to Yellowstone's "bioprospecting" benefits-sharing agreement with the Diversa Corporation of San Diego, California. The suit had been brought by the Edmonds Institute, the International Center for Technology Assessment, the Alliance for the Wild Rockies, and a Bozeman, Montana, citizen. The 1997 agreement provided that Diversa would share with Yellowstone specified economic and scientific benefits that might result from its research activities involved with microbes sampled from the park's geothermal features. Although collection of biological specimens from Yellowstone for research purposes dates to the 1890s, the Yellowstone-Diversa agreement (known as a Cooperative Research and Development Agreement or CRADA) marked the first time that researchers agreed to share any resulting benefits with the park for conservation purposes.

Judge Royce C. Lamberth ruled that the CRADA was "consistent with the governing statutes because it would produce direct concrete benefits to the park's conservation efforts by affording greater scientific understanding of Yellowstone's wildlife, as well as monetary support for park programs." The opinion rejected the plaintiffs' allegations that the agreement violated several park-related laws and regulations, and found that the CRADA "plainly constitutes an equitable, efficient benefits-sharing arrangement."

As a result of a prior order from the same court, the NPS is initiating a study to determine the environmental impacts of establishing additional research-related benefits-sharing arrangements in national parks throughout the U.S.

*Duncan Foley sampling hot spring temperatures.*

## Historic Properties Recognized

Yellowstone evaluated several historic properties for the National Register of Historic Places in 2000. After the National Park Service took over the administration of Yellowstone from the U.S. Cavalry in 1917, it continued to use a system of backcountry cabins built by the Army to patrol for poachers. In 1920, the NPS began constructing its own cabins, carefully designing them to harmonize with their surroundings. In 1930, the park adopted a standardized cabin design, which was used until World War II. A multi-year inventory of snowshoe or backcountry patrol cabins resulted in the determination that 15 of the park's 38 cabins were eligible for listing on the National Register.

In 1956, the National Park Service undertook a ten-year development program to upgrade visitor services across the nation. The plan, called "Mission 66," was designed to serve the needs of automobile tourists and bring facilities up to contemporary standards. NPS architects abandoned the traditional rustic park architecture and embraced a more modern building style. Canyon Village was the first development constructed under the Mission 66 program and it was intended to showcase the program to the American public. While planning a major rehabilitation of the Canyon Visitor Center, the park researched the history of Canyon Village and determined that it was eligible for listing in the National Register. The park also requested and received consensus determinations of eligibility from the Wyoming State Historic Preservation Officer for former U.S. Bureau of Fisheries cabins at Peale Island and Clear Creek, historic road bridges over Otter Creek and Tower Creek on the Grand Loop Road, the Mammoth Hot Springs Campground, and the Canyon Service Area Historic District.

## Agreement Reached on Joint Management Plan for Bison

After more than eight years of negotiation and seven months of mediation between three federal agencies and the State of Montana, a joint management plan for bison in Yellowstone was agreed to in December. The controversy over bison that migrate out of the park in the winter goes back more than three decades, when culling ended and more bison began seeking winter range at lower elevations outside the park. This land is part of the bison's traditional range, but it includes national forest and private property where the animals may come in contact with domestic cattle. Bison entering Montana have been shipped to slaughter or shot because they may carry brucellosis, which could be transmitted to cattle. In the severe winter of 1996–97, when an unusually large number of bison left the park in search of forage, more than 1,000 were killed.

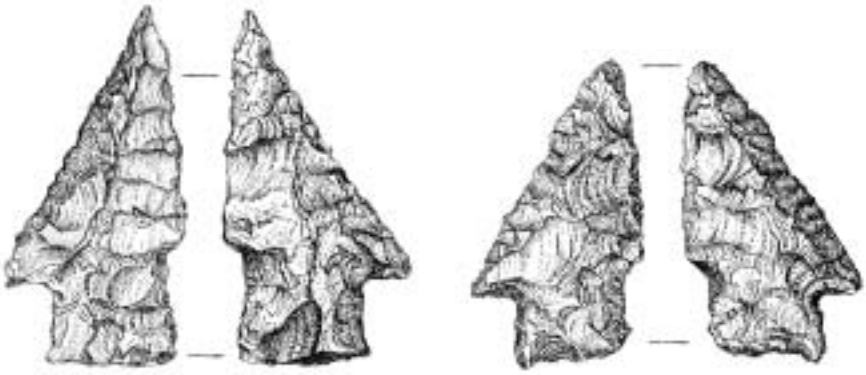
An interagency effort involving the National Park Service and the USDA Forest Service and Animal and Plant Health Inspection Service resulted in the release of a plan and Environmental Impact Statement (EIS) for long-term bison management in YNP and Montana in June 1998. About 67,500 public comments were received and analyzed in the final EIS released in August 2000. On December 20, the federal agencies agreed on a joint management plan

*Bison at thermal pool on Geyser Hill. Photo by Jennifer Whipple.*

that is a slightly altered version of the plan presented in the FEIS. The State of Montana incorporated the FEIS into its own FEIS for bison management and signed their Record of Decision on December 22, which implements the same joint management plan as that agreed to by the federal agencies. By allowing bison the opportunity to seek winter range outside the park, the plan reflects a commitment on the part of the agencies to end the unnecessary killing of bison outside the park. The agencies also agreed to increase implementation of non-lethal management measures should severe winter conditions result in a large management removal or natural winter die off. Bison will not be allowed to intermingle with cattle and will be hazed back into the park when winter weather typically moderates in the spring.

## Greater Yellowstone Area Parks Begin Inventory Effort

Yellowstone and Grand Teton national parks and Bighorn Canyon National Recreation Area will soon benefit from a servicewide initiative to improve baseline inventories of natural resources. The three parks, combined as the greater Yellowstone network, submitted a plan to complete priority inventory work for vertebrates and vascular plants in the region. An inventory coordinator will be hired and, though stationed in Yellowstone, will oversee projects in all three parks, including efforts to improve baseline knowledge of exotic and native plant distributions, reptiles, bats, and fishes in alpine lakes. The network expects to receive approximately $700,000 for projects to be completed in three to four years.



48YE409
Specimen A

48YE409
Specimen B

*Two Cody knives from the Osprey Beach site (both surfaces of each knife are shown). The artifacts are manufactured from a dark green chert believed to be derived from the Absaroka volcanics on the park's east boundary.*

# Part II. Cultural Resource Programs

During 2000, the Branch of Cultural Resources continued to add to the professionalism and permanence of its staff. Lon Johnson, a term employee focusing on historic structures and Section 106 compliance, was converted to a permanent full-time position. Still, despite the dedicated work done by professionals in temporary and term appointments, several major programs lacked permanent staff to provide strategic planning and tend to their long-term program needs. To supplement the branch's base budget of $402,000 and support specific projects, an additional $101,000 was obtained from special emphasis project funding sources, $205,000 from the park's Recreation Fee Demonstration program, and $115,600 from the Federal Lands Highway Program. The Yellowstone Association and the Yellowstone Park Foundation also continued to support cultural resource programs, particularly in the operations of and new acquisitions for the museum, library, and archives.

Laura Joss, who had been the branch chief of cultural resources since 1994, was appointed superintendent of Fort McHenry and Hampton House national historic sites and left the YCR in March. In her wake, archeologist Ann Johnson did noble duty as acting branch chief until October of 2000, when Sue Consolo Murphy, former senior writer-editor and head of the center's resource information group, was appointed branch chief.

Park managers and cultural resource staff noticed increased interest in the ethnographic program, partly related to the long-range bison management planning efforts, in which more than 100 American Indian tribes across the nation exhibited significant interest. Working with park managers, the Yellowstone Center for Resources is continuing to spend more time consulting with Native Americans to identify traditional cultural properties, issues of interest, and appropriate ways to handle the protection, interpretation, and research of ethnographic resources.

The paleontology program is covered under Natural Resource Programs this year (see page 37).

## ARCHEOLOGY

In 2000, park archeologist Dr. Ann Johnson, cooperators, temporary staff, and volunteers were busy conducting site inventories and advising staff from other divisions as to whether their projects affected archeological resources. Parkwide, 1,441 acres were intensively inventoried and 64 new sites recorded. Volunteers donated 2,032 hours to park archeology and significantly reduced the cataloging backlog of incoming materials.

### *New Acquisitions*

A large collection of prehistoric artifacts from the park was returned in July 2000 by someone who had been a park ranger between the 1930s and the 1950s. The collection is notable because it contains more than 700 tools and projectile points, and its value is tremendously enhanced because the collector made extensive notes identifying the date and location of each collection and included many maps showing the specific sites where artifacts were found. Some of the sites were already known, but the archeological staff are eager to visit and record the others.

### *Field Inventories*

Field work was accomplished by several crews of professional and student archeologists, particularly those from the Museum of the Rockies (MOR) in Bozeman, Montana, and the Office of the Wyoming State Archaeologist (OWSA). Much work was done to record sites and test them to determine their eligibility for listing on the National Register of Historic Places. Due to workload limitations, archeological investigations often focussed on areas for which other work—such as trail rehabilitation or road reconstruction—was planned or underway.

**Yellowstone Lake shore.** A volunteer crew from Wichita State University under the direction of Dr. Donald Blakeslee re-identified a Cody Complex site that is eroding on the shore of Yellowstone Lake. The site had been documented in 1958 by researchers from Montana State University but not revisited by archeologists since then.

MOR crews devoted four days to clarifying the cultural component at the Cody Complex site (48YE409) recorded by the Wichita State volunteers. This site was named Osprey Beach. The single cultural horizon was 60 cm (two feet) below the present ground surface and was radiocarbon dated at 7350±50 B.C. (Beta-148567). Drs. Ken Pierce (USGS) and Paul Doss interpreted the soil profile as showing these early people were camping on the then-extant shoreline of the lake. Of particular interest was the immunological analysis of eight artifacts (seven points/knives and one abrader) for blood residue. The blade and haft areas of the points/knives were analyzed separately and four produced positive results. Two haft elements were positive for rabbit, suggesting that rabbit sinew/blood had been used to attach the artifacts to shafts. One of the artifacts with rabbit on the hafting element also tested positive for sheep on the blade. Two additional point blades were positive for canid and deer, respectively.

This site clearly contains important information about early human use of the park and has the potential to add to our understanding of the local environment at that time. As a result of this fieldwork, we now have a reasonable understanding of the part of the site that is eroding along the lake. In 2001, archeologists hope to put in several additional test units to better understand how much of the site remains away from the lakeshore.

**Backcountry investigations.** MOR crews inventoried around Heart Lake, including locations potentially affected by the Red Creek trail reroute and the trail crew campsite, the trail to Basin Creek Lake and Sheridan Lake, the Beaver Creek trail reroute, and several backcountry campsites around Heart Lake.

The Jones Pass trail was inventoried from the park's east boundary to Turbid Lake. Given that the Jones Pass trail has been well-documented from historic records, archeologists were surprised that only a few sites were identified and that these were very small. A possible interpretation is that the trail in the park was used only for movement between camps on the east side of the park boundary and areas down near Yellowstone Lake.

The Hellroaring Creek trail was partially inventoried; of interest was the identification of tool-quality rock that had been quarried prehistorically. The rock is multi-colored with reds, gold, white, browns, and purples. Some are opaque and others are translucent; these would ordinarily be classified as cherts and chalcedonies, respectively. In this case, however, a chunk may contain both varieties, which demonstrates the artificiality of the classification scheme. It appears that quarries in the Hellroaring Creek drainage may have been the source for many of the stone tools found in the Black Canyon sites and in the greater Yellowstone area.

*Archeological crew and volunteers at the Osprey Beach site.*

Finally, MOR inventoried the trail loop connecting the Warm Springs trailhead to the Pebble Creek campground.

In the Black Canyon of the Yellowstone, two known sites were tested for National Register significance. Results showed that site 24YE9 did not contain significant subsurface cultural deposits, while 24YE26 contains four buried, stratified campsites. One is in the grass roots, close to the surface, which suggests it is a fairly recent site, although its age and cultural affiliation are not yet known. Pelican Lake points were identified in the third cultural level below the surface with large corner-notched knives. It is possible that because a positive association with the Pelican Lake culture has been made for these knives, they will allow assignment of cultural identification at sites that lack projectile points.

Archeological crews also documented a site near Trail Creek, reported by Tom Murphy of Livingston (48YE252). The site contained diagnostic projectile points that range in age from Late PaleoIndian (~8000 B.C.) through Late Prehistoric (possibly as late as A.D. 1450). Pelican Lake (A.D. 200–1000 B.C.) is the most commonly recovered point at this site, as it is throughout the park. An eroding hearth was salvaged and produced a radiocarbon date of A.D. 140–100 B.C. (cal) (Beta-150250). This is a good date for the Pelican Lake use of the area. Floral analysis of the hearth contents identified dwarf mistletoe, pine, maple, juniper, spruce, and willow pollen, and pine, fir, and willow charcoal.

**Roadside investigations.** The crew from Wichita State University worked for a week on the west side of the Gibbon River and documented five prehistoric campsites. Mack Shortt led a MOR crew in evaluating nine prehistoric sites by testing on the Mammoth-to-Gardiner highway corridor. Reports of final results on these sites' eligibility were still underway at year's end.

OWSA archeologists completed National Register testing and documentation of eight prehistoric and two historic archeological sites along the Canyon-to-Fishing Bridge road. Five prehistoric sites were found to contain limited remains and were recommended as not eligible for the National Register of Historic Places. Both historic archeological sites lacked integrity due to demolition and "clean-up" that had occurred in the past. Prehistoric site 48YE545 produced a radiocarbon date (Beta-145818) of A.D. 880±50 on wood from a buried fire-cracked rock feature (interpreted as a hearth), while a non-cultural organic layer in the lower sediments of prehistoric site 48YE241 had a radiocarbon date (Beta-145819) of 4510±50 B.C.

The Yellowstone River corridor was used intensively in the past, as it is today. The sum of inventories and site testing along the river through Hayden Valley has shown use by the Cody Complex (Scottsbluff point) between 7,000 and 8,000 B.C. and by other peoples up through the past several hundred years.

The North and South Rim drives around Canyon were inventoried, resulting in documentation of historic archeological sites. No prehistoric sites were identified, although historic water works, historic trash scatters, and the remains of an historic hotel were located. These were determined to be ineligible for listing on the National Register.

Inventory was conducted at limited locations along the East Entrance Road east of Sylvan Pass to identify several historic sites and determine if they were within the area of potential effect of the reconstruction and widening of this road segment. One historic road camp was located within 100 meters of the road corridor. For one site located within the corridor, field documentation was completed. Three

additional sites were found to be outside the road corridor and area of potential effect.

**Quarries and staging areas.** Archeological inventory was also conducted at three quarry sites: the Natural Bridge quarry and staging site, the Sedge Creek pit, and the Lone Star pit. This work was done in conjunction with the Wyoming Abandoned Mine Lands program, which intends to use the excess excavated materials being stored at Fishing Bridge to fill in the Natural Bridge pit. The program would also make reclamation of the Sedge Creek pit possible using the excess materials that are likely to be available from the Pelican Creek viaduct and the Sylvan Pass-to-East Entrance road projects.

**Eligibility for the National Register.** The count of the archeological sites associated with the Federal Highway Administration program improvements for which Yellowstone National Park requested determination of eligibility for inclusion to the National Register of Historic Places in 2000 includes:

**93 prehistoric sites, of which:**
30 were determined eligible,
19 were determined ineligible, and
44 remain unevaluated or their eligibility was undetermined.

**10 historic sites, of which:**
1 was determined eligible,
4 were determined ineligible, and
5 remain unevaluated.

**4 multi-component sites, of which**
1 with both prehistoric and historic components was determined eligible;
2 were determined to have prehistoric components eligible, historic components ineligible; and
1 with both components was unevaluated.

### *Archeological Research and Management*

The park archeologist participated in a five-day, 70-mile backcountry trip on the eastern park boundary and upper Lamar area. This trip provided an unparalleled opportunity to observe the country through which the U.S. Army chased the Nez Perce in 1877. Primary among the sites that were observed were the prehistoric and historic campsites documented by Superintendent Norris in 1879 near Parker Peak and the Parker Peak obsidian source. So far, Parker Peak obsidian has not been identified beyond its immediate area, but archeologists expect to clarify this as they obtain additional samples on the eastern park border and possibly to the east outside the park.

An ongoing obsidian sourcing project continues, and this year two obsidian sources were identified for the first time in park specimens. Specimens from the south shore of Yellowstone Lake and around Heart Lake were identified as coming from Crescent H (south of Wilson in southern Jackson Hole) and Conant Creek (south of Grassy Lake Reservoir).

General patterns of prehistoric obsidian usage in the park are gradually beginning to emerge. In all areas, Obsidian Cliff obsidian dominates, and Bear Gulch obsidian (imported from northeastern Idaho) is the next highest in percentage of specimens sourced. In the Mammoth/Black Canyon area, about 92 percent of the source specimens are Obsidian Cliff obsidian, while perhaps 7 percent are from Bear Gulch in northeastern Idaho. Around Madison Junction to the West Entrance there is significant diversity, including Obsidian Cliff, Gibbon River, and Cougar Creek (from in the park), and Grassy Lake Reservoir, Malad, Teton Pass, and Bear Gulch (from outside the park). Around Yellowstone Lake, Hayden Valley, and the center of the park, Park Point obsidian has local use. The southern park of the park contains more obsidians derived from outside the park such as Teton Pass, Crescent H, Conant Creek (all south of Yellowstone in the Jackson Hole area), and Packsaddle Creek and Malad (southeast-central Idaho).

About 3 percent of the obsidian artifacts are from sources that have not yet been identified. Future work is planned to provide more details, clarify the above observations, and fill in some blank areas including the eastern park border, the northeastern quarter, and the southwestern corner of the park. As spatial patterning is becoming clearer, it is becoming more urgent that we look at what the temporal patterning for the use of different obsidian sources might be.

## ETHNOGRAPHY

Ethnographic resources are the natural and cultural resources that a traditionally associated community identifies as significant to its present way of life. Such resources help to maintain community identity, including cultural traditions. A “traditionally associated community” is one whose relationship with resources endures at least two generations or began prior to the park’s establishment. At Yellowstone, that includes 24 American Indian tribes with histories of using what is now park land. The National Park Service devotes attention to ethnographic resources

because of various laws, executive memoranda and orders, and administrative policies that require consultation, particularly with Indian tribes.

In March 2000, cultural anthropologist Rosemary Sucec assumed the responsibilities of acting as liaison with tribes, coordinating government-to-government consultation with tribes; overseeing opportunities to obtain information about park ethnographic resources for planning, resource management, and visitor education purposes; and creating training opportunities for park staff.

### *Intergovernmental Consultations*

The United States government recognizes tribal sovereignty—the right of an Indian tribe to be independent and self-governing. Essential principles have been established by which the federal government interacts with Indian tribes. One of these, the "trust responsibility," speaks to the obligation the federal government has to advance tribal interests. The relationship has been likened to that of a ward to a guardian engendering legal and moral duties. The NPS affirms tribal sovereignty and provides guidelines for how parks should interact with Indian governments. Parks and tribal governments should work collaboratively and cooperatively in arriving at mutually acceptable protocols to guide park actions concerning land and resources with which tribes have religious and cultural ties.

**General consultation meetings.** In partial fulfillment of these requirements, YNP conducted two general consultation meetings in fiscal year 2000. Fourteen tribes and organizations were represented at one or both meetings: Eastern Shoshone; Shoshone-Bannock; Nez Perce Tribe of Lapwai; Prairie Band of Potawatomi; Lower Brule, Oglala, Rosebud, and Yankton Sioux; Confederated Salish and Kootenai; Winnebago Tribe of Nebraska; Gros Ventre and Assiniboine of Fort Belknap; Crow; Northern Cheyenne; and Intertribal Bison Cooperative.

*A visit to a bison capture facility during a general consultation meeting in October 2000.*

On April 9–10, nine tribes and Native American organizations sent 13 representatives to a general meeting at which major environmental planning efforts were discussed. These included the *Draft Environmental Impact Statement (EIS) for the Interagency Bison Management Plan for the State of Montana and Yellowstone National Park;* the *Draft Winter Use Plan EIS for Yellowstone and Grand Teton National Parks and the John D. Rockefeller, Jr., Memorial Parkway;* the *Draft EIS for the Jackson Bison/Elk Management Plan;* and the *Grizzly Bear Conservation Strategy.* Other Yellowstone wildlife issues discussed included lynx listing and wolf reclassification and management. Updates were provided on activities within the cultural resources program. The chief of interpretation, Diane Chalfant, discussed future plans including the construction of new visitor centers.

Eleven tribes and Native American organizations sent 19 representatives on October 11–12. Again, major planning efforts were discussed, including bison management and the final winter use plan. Other planning issues such as road improvements were discussed, and updates were given on cultural resource projects. An overview was given on the summer fire season. Tours were taken of the bison capture facilities at Stephens Creek and of the buffalo herds at Lamar Valley. Transcripts of both meetings are available upon request.

**Community potlucks.** Potluck dinners held on the first night of the general consultation meetings became a tradition this year. These events enabled park staff, community members, and affiliated tribal members to become acquainted with each another. Yellowstone employees and the Bear Creek Council co-sponsored the events on behalf of tribal guests. The community of Gardiner was also invited. An after-dinner program was initiated at the spring potluck. Representatives from the Confederated Tribes of Salish and Kootenai (Dale Becker) and the Gros Ventre and Assiniboine Tribes of Fort Belknap (Mike Fox) spoke about "Wildlife Management on Tribal Lands."

**Bison management issues.** When the Record of Decision for the *Final Environmental Impact*

*Statement and Bison Management Plan for the State of Montana and Yellowstone National Park* was signed on December 20, copies were sent to the park's 24 affiliated American Indian tribes and to 72 other tribes interested in bison. It included a summary table prepared by the park anthropologist that identified tribal comments from the planning process and how they were incorporated into the Record of Decision. Copies of the table can be obtained from the Branch of Cultural Resources.

### *Resource Management and Research*

**Ethnographic overview and assessment.** Park staff completed their review of a report entitled *American Indians and Yellowstone National Park: Restoring a Presence, A Documentary Overview* by researchers Peter Nabokov and Larry Loendorf. Based on documentary sources and limited interviews, the report identifies American Indian tribes historically associated with what is now the park and provides a foundation for beginning to identify significant ethnographic resources associated with nine tribes. The report will be published by the YCR.

**Affiliated tribes.** "Affiliation" carries with it certain privileges as authorized by laws, regulations, and policies. Consultation with affiliated tribes helps the park to become more knowledgeable about its resources, including the values placed upon them, and to manage and interpret them in a culturally informed, sensitive manner. Methods for determining affiliation include documentary evidence and evidence from the oral tradition of tribes themselves.

In 2000, three tribes were added to the list of those that have been identified as having histories affiliated with Yellowstone. The Coeur d'Alene Tribe, who visited the park's native trout spawning habitat, relayed accounts from their oral tradition of coming to Yellowstone country to harvest certain resources. The Confederated Tribes of the Colville Indian Reservation and the Confederated Tribes of the Umatilla Reservation were added because descendants of Nez Perce bands reside at those reservations. Some of their ancestors participated in the 1877 flight through the park.

The total list of 24 affiliated tribes includes 11 Sioux tribes that were added in 1999: Cheyenne River, Crow Creek, Flandreau Santee, Lower Brule, Oglala, Rosebud, Sisseton-Wahpeton, Spirit Lake, Standing Rock, Yankton, and Assiniboine and Sioux Tribes of Fort Peck. The other 13 affiliated tribes are: Blackfeet, Coeur d'Alene, Confederated Tribes of the Colville Indian Reservation, Confederated Tribes of the Umatilla Reservation, Confederated Tribes of Salish and Kootenai, Crow, Eastern Shoshone, Gros Ventre and Assiniboine, Kiowa, Nez Perce of Lapwai, Northern Arapaho, Northern Cheyenne, and Shoshone-Bannock.

**The Nez Perce National Historic Trail.** Yellowstone was already a national park when 800 Nez Perce and 2,000 horses fled to it after the battle at Big Hole in 1877. Led by Chiefs Joseph, White Bird, Looking Glass, Too-hool-hool-zote, and Hahtelekin, this entourage chose a difficult route through the park to avoid detection by the U.S. Army. That route is part of the 1,170-mile Nez Perce National Historic Trail established by Congress in 1986 to memorialize the Nez Perce's journey and focus attention on a cultural collision that continues to shape the American West. The Nez Perce's route through the park is regarded as a precious resource to contemporary Nez Perce that represents both profound suffering and heroic achievement in the face of overwhelming hardship. It is a critical piece of history for the Nez Perce people, unifying them and contributing to who they are. It was near the end of the trail that Chief Joseph famously declared, "I will fight no more forever."

In June, an interdisciplinary team of park staff, including the cultural anthropologist, visited a sample of Nez Perce sites associated with the 1877 flight that have potential for wayside interpretation, and discussed plans for arranging a visit to the park by Nez Perce historians and elders. In September, in conjunction with the annual meeting of the Nez Perce National Historic Trail Foundation meeting in Cody,

*Nez Perce tribal representatives at Nez Perce Ford of the Yellowstone River, where five bands of Nez Perce crossed in 1877.*

Wyoming, Nez Perce tribal members from Colville, Lapwai, and Umatilla visited four sites in the park: the Lower Geyser Basin at the Nez Perce Creek pullout, Otter Creek, Nez Perce Ford (formerly called Buffalo Ford), and Indian Pond. At each site, Nez Perce historians and elders relayed oral accounts of the flight and of customary use of the area by Nez Perce bands. The Nez Perce-interpreted tour was video-recorded and is available upon request.

**Yellowstone history of the Coeur d'Alenes.** Members of the Coeur d'Alene Tribe in Idaho visited Yellowstone Lake and its tributaries in June. Called "pointed hearts" by the French for the exactness with which they traded, the Coeur d'Alene have oral accounts of merchant families who traveled outside their aboriginal territory to Yellowstone to harvest rare materials subsequently used in trade and for other purposes upon their return home. They acquired stone such as obsidian and items harvested during bison hunts. Tribal biologists and fisheries technicians came to Yellowstone to observe spawning cutthroat trout in their native habitat. They gleaned technical knowledge from park staff that will enable abundant numbers of western cutthroat trout to survive on reservation lands (including Coeur d'Alene Lake). The potential exists for the tribe to sustain a viable population of cutthroat and renew the tradition of subsistence fishing.

**Youth of affiliated tribes.** In August, geologist Nancy Hinman led a tour of the park's thermal areas for 14 Indian high school students who were selected to participate in the American Indian Research Opportunities (AIRO) Program at Montana State University. AIRO's mission is to provide learning and career opportunities for Indian students in science, engineering, and mathematics. Most of the participants were enrolled members of affiliated tribes who conveyed traditional knowledge about the park received from their elders. They provided place names and stories about their ancestors trading with the Tukudika or Sheep Eater Indians, residents of the Yellowstone area plateaus and valleys at time of contact.

### *Educational Opportunities for Park Staff*

**Native cultures of the GYA.** In April, Dr. Larry Loendorf taught a week-long class for 22 park employees from three divisions. Affiliated tribes were invited to attend and two sent representatives. Lawrence Flat Lip, from the Crow (Apsaalooke) Tribe, also gave a presentation.

**Anthropogenic fire history.** In October, Dr. Henry T. "Hank" Lewis, an internationally recognized expert on indigenous fire management practices, visited the park for a week-long series of presentations, discussions, and meetings with individuals and work groups. Based on his cross-cultural experience, Hank was able to help staff from interpretation, fire management, and the Yellowstone Center for Resources sort out appropriate research questions about indigenous fire history in the park and the greater Yellowstone area. Knowing how Indians used fire contributes to our understanding of the integration of ecological and human history in Yellowstone. Research projects and a symposium are being discussed for the future.

## HISTORY

As the park continued to function without a full-time historian in 2000, the park archivist performed part-time duties for this program.

Kamiah DuMontier, an English major at Montana State University-Billings, was hired as a cultural resource clerk during the summer. Kamiah undertook historical research on several buildings and structures being considered for National Register listing and provided general assistance to cultural resource staff.

The oral history project focussing on ungulate management in Yellowstone was completed. An issue of the park's *Yellowstone Science* magazine that described the purpose and process of the oral history project and included several features and excerpts from the interviews brought positive feedback from participants, park staff, and other NPS areas. By the end of the year, staff had either completed or were in the final stages of reviewing all transcriptions from this project. Interviews, including both a hard copy of all the transcripts and a CD-ROM wav file of the audio recordings, had been placed in the park archives. The project lead, Charissa Reid, was upgraded to a GS-7 park anthropologist.

### *National Historic Landmarks*

**Museums.** As noted in last year's annual report, the Secretary of the Interior included three of Yellowstone's five National Historic Landmarks in his America's "Landmarks at Risk" report to the U.S. Congress: the Norris Geyser Basin, Madison, and Fishing Bridge trailside museums. The report cited physical deterioration stemming from the effects of weather and deferred maintenance, extensive rodent

problems, and thermal activity at Norris as reasons for the listing, and recommended that the park prepare condition assessment reports to better understand the condition of these buildings. The park is actively seeking means to address these recommendations. A special funding request competed successfully for exterior maintenance work and pest management at the Norris Geyser Basin Trailside Museum. The work will be undertaken in FY2001.

**Fort Yellowstone.** The importance of Fort Yellowstone as a representation of the U.S. Army's role in the history of our national parks has long been recognized. As park administrators from 1886 until 1918, the U.S. Army constructed a military post that eventually housed four cavalry troops. About 35 army buildings, dating from three main construction periods (1891, 1897, 1908), present an almost complete "picture of an extraordinarily handsome Western Army post at the turn of the century" (David G. Battle and Erwin N. Thompson, Fort Yellowstone Historic Structure Report, 1972). In the fall of 1999, the National Trust for Historic Preservation contracted with Front Range Research Associates, Inc., of Denver, Colorado, to prepare a National Historic Landmark nomination for the fort and other U.S. Army-constructed buildings in the park, including the Bechler River and Norris soldier stations, the Buffalo Lake Snowshoe Cabin, and the Roosevelt Arch.

The National Trust for Historic Preservation delivered the Fort Yellowstone National Historic Landmark nomination to the park in June 2000. The nomination documents the significance of the army's protection policies and the impact those policies had on the emerging conservation and national park movements in the late nineteenth and early twentieth centuries. The park plans to submit the Fort Yellowstone National Historic Landmark nomination to the National Park System Advisory Board in 2001. The Secretary of the Interior designates landmarks based on the board's recommendations.

### *National Register of Historic Places*

Under National Park Service management guidelines and Section 110 of the National Historic Preservation Act, the park is required to identify, evaluate, and nominate to the National Register historic properties under its stewardship. Such properties listed in or determined eligible for listing in the National Register are managed and maintained in a way that considers the preservation of their National Register qualities. (The following list does not include archeological properties.)

*The Mammoth Campground, the first "planned" campground in Yellowstone, 1939.*

**Nominations to the register.** The contractor for the Fort Yellowstone National Historic Landmark nomination also prepared a nomination for the Mammoth Hot Springs Historic District. This district overlays the Landmark District and, in addition to the U.S. Army buildings, includes the historic concessioner buildings, National Park Service administrative and residential buildings, and the Mammoth Campground. The contractor found the historic district eligible for listing because of its architecture and its association with the development of administrative and concession policies in the national park system. The park plans to submit the nomination to the National Register in 2001.

Historic properties sharing the same significance can be nominated to the National Register of Historic Places using a Multiple Property Documentation form. Common information like the historic context, bibliography, and methodology are documented once, and then individual nomination forms are prepared referencing the information.

In 1999, a Multiple Property Documentation form for Yellowstone's historic administrative and concessions buildings was submitted to the National Register. It was returned for substantial changes. The National Trust for Historic Preservation contracted with Allan Mathews, a Missoula, Montana, historian, to begin revisions to the form.

**Determinations of eligibility.** To meet its ongoing responsibilities under the National Historic Preservation Act, Yellowstone evaluated several historic properties for the National Register of Historic Places this year. The park requested consensus determinations of eligibility (DOE) from the Wyoming State Historic Preservation Officer for the "snowshoe cabins" and Canyon Village.

After the National Park Service took over administration of Yellowstone in 1917, it continued to use a system of backcountry cabins built by the U.S. Army to patrol for poachers. In 1920, it began constructing its own cabins, carefully designing them to harmonize with their surroundings. In 1930, the park adopted a standardized cabin design, which was used until World War II. A multi-year inventory of snowshoe (backcountry patrol) cabins resulted in determinations of eligibility for 15 cabins.

In 1956, the National Park Service undertook a 10-year development program to upgrade visitor services nationwide. The plan, called "Mission 66," was designed to serve the needs of automobile tourists and bring facilities up to contemporary standards. NPS architects abandoned the traditional rustic park architecture and embraced modern architecture. Canyon Village was the first development constructed under the Mission 66 program, and was intended to showcase the program to the American public. The Division of Interpretation has proposed a major rehabilitation of the Canyon Visitor Center. As part of the project planning process, cultural resources and interpretation employees researched the history of Canyon Village and determined that it was eligible for listing in the National Register. The Wyoming State Historic Preservation Officer concurred.

Determinations of eligibility were also completed for the former U.S. Bureau of Fisheries' Peale Island and Clear Creek cabins, the Canyon Service Area Historic District, the Mammoth Campground, and the Tower Creek and Otter Creek bridges.

### *List of Classified Structures*

The List of Classified Structures (LCS) is the nationwide computerized database containing information about National Park Service-owned historic buildings and structures. The LCS shows Yellowstone has 912 buildings and structures eligible for listing in the National Register of Historic Places. Much of the information on Yellowstone's buildings dates from the 1980s and does not include more recent research and building inventory information. The Intermountain Regional Office is making a concerted effort to update the Yellowstone forms. Sayre Hutchison and Pam Holtman of the Intermountain Regional Office and Lon Johnson, Yellowstone's historical architect, spent several days verifying building-specific information at the Lamar Buffalo Ranch, Roosevelt Lodge, Yellowstone Park Transportation Company (Gardiner), and Mammoth Hot Springs historic districts. The goal is to have 500 building forms current by the end of FY01.

### *Compliance with NHPA*

As required under the National Historic Preservation Act, each park division is responsible for initiating and completing Section 106 review, under the guidance of and assistance from cultural resource staff, for projects that could potentially affect National Register-eligible or listed properties. Lon Johnson coordinated this compliance, addressed other regulatory and NPS cultural resource requirements, and provided technical assistance to help properly manage and care for the park's historic properties.

The National Park Service has a programmatic agreement with the National Council of State Historic Preservation Officers and the Advisory Council on Historic Preservation exempting specified work items from Section 106 compliance. Lon developed a form to document exempted projects in the park that was approved by the Wyoming State Historic Preservation Officer. A letter implementing use of the form in Yellowstone was sent to the superintendent in December.

Lon represented historic preservation concerns to the sponsoring divisions regarding several buildings proposed for construction in Yellowstone: a new visitor center in the Old Faithful Historic District, rehabilitation of the Canyon Visitor Center, a new Yellowstone Heritage and Research Center near the North Entrance or in the Mammoth Hot Springs Historic District, and a new public restroom building in the Mammoth District.

In 2000, Yellowstone National Park submitted 11 projects to the Wyoming State Historic Preservation Officer for formal review and comment under Section 106 of the National Historic Preservation Act. Findings of no effect or no adverse effect were reached for 10 undertakings: interior rehabilitation of the U.S. Commissioner's (Judge's) House; moving the West Thumb Comfort Station to the Mammoth Campground; constructing a vault toilet at West Thumb; demolition of two non-contributing cabins in both the Canyon Service Area and the Lake historic districts; rehabilitation of Peale Island cabin; installation of a webcam on Old Faithful Inn; an addition to a building adjacent to the Tower Ranger Station Historic District; and construction of a fireplace in the Mammoth Hotel lobby. One project, the re-routing of a portion of the Grand Loop Road at

Tanker Curve due to annual debris and mud slides, was found to have an adverse effect on the road, since a portion of a National Register-eligible road will be isolated and removed. This will be mitigated by providing some roadside interpretation.

**Historic roads and bridges.** A programmatic agreement provides the mechanism to complete Section 106 requirements for the park's principal park road system improvements. This document was signed in January 1993 by the National Park Service, the Advisory Council on Historic Preservation, the Wyoming State Historic Preservation Officer (WYSHPO), and the Montana State Historic Preservation Officer (MTSHPO). In 2000, the Council issued notice that consultation agreements developed prior to the new regulations would be grandfathered with no new provisions being required. The park has an interdisciplinary road team that provides primary planning and compliance work for road projects and monitors on-site construction impacts. The position held by the cultural resources representative to the road team, Elaine Hale, was funded by the Federal Lands Highway Program.

In an annual on-site review with WYSHPO and Yellowstone staff, conducted October 10–12, participants discussed various aspects of the Canyon-to-Tower (Dunraven) road reconstruction, improvements to the Artist Point and Grandview Point viewing areas, the North Rim Drive road rehabilitation, and the new bridge to be constructed across the Gibbon River above Gibbon Falls. The semi-annual tribal consultations were taking place in the park at the same time, which gave WYSHPO staff the opportunity to join the affiliated Native Americans at a community potluck and resource management program on October 11. Native cultural representatives voiced strong support for the repair and widening of the existing road system in the park.

***Fishing Bridge-to-Indian Pond.—***Redesign of the parking area west of Fishing Bridge was completed. The historic stone curbing was liberated, cleaned, and repaired (or replaced), and vegetation planted to provide a more natural pedestrian area between the west parking lot and Fishing Bridge. Stone curbing transitions the pedestrian viewing area onto the wood bridge structure and the repaired stairway to the river.

Excavation of the west bridge abutment was necessary to reset the bridge deck on the abutment, repairing damage probably caused by the 1959 Hebgen Lake earthquake. Repairs to the cross bracing under the bridge were completed and metal sleeves were placed around some piers from ground level to the high water mark to protect the wood from ice damage.

Difficulty was encountered laying the asphalt tiles on the bridge deck. Original specifications for the asphalt deck tiles were located and, although the replacement tiles were made as closely as possible to those specifications, the asbestos used in the original formula was omitted due to current legal constraints. This resulted in the new tiles being less pliable than the original tiles. Chip sealing of the asphalt tiles was completed in mid-October.

Consultation on the removal of excess excavated material currently stockpiled behind the Hamilton Store east of Fishing Bridge continued. The park hopes to use the excess material to reclaim abandoned open pits located in Yellowstone. Three pits were identified as candidates: Natural Bridge, Sedge Creek, and Lone Star pits. In conjunction with the Wyoming Abandoned Mine Lands (AML) reclamation program, an archeological inventory report and an environmental assessment were begun for this action. All of the material currently stored at Fishing Bridge will probably be used in reclamation of the Natural Bridge pit. Excess material generated on future East Entrance Road projects will be used to reclaim the Sedge Creek pit. Correspondence from WYSHPO confirmed their support for the project.

***Indian Pond-to-Lake Butte.—***The remaining repairs to this section of road, which was damaged during a washout due to high water in 1997–98, were completed. The road was paved to the full 30-foot width along the north side of Mary Bay, where it joins the previously reconstructed segment of the East Entrance Road. Repairs were also completed to the stone masonry guard wall at Steamboat Point that was damaged after it was struck by a construction vehicle.

***Sylvan Pass-to-East Entrance.—***Reconstruction and widening of this road was the subject of numerous on-site planning sessions for park staff, Federal Highway Administration (FHWA) engineers, and geo-technical experts. The road team and FHWA design engineers spent time on the site of the Sylvan Pass material source to discuss the final landscape design of the area.

Research was being conducted to find the most appropriate protection for the problematic rockfall/avalanche area known as Brown Drift. A fill-slope retaining wall located partially up the slope was

being considered to provide protection for the abandoned historic Corkscrew Bridge (Loop Bridge) area. A new pullout viewing area was also being designed for the Corkscrew Bridge area. Design of the widened road was planned with care to retain most of the curves in the road and the natural character of the rock cuts. The masonry guard walls constructed in the 1970s were of poor quality and will need to be repaired, although the masonry retaining walls appear to be in good repair.

***Arnica Creek-to-Little Thumb Creek/Bridge Bay-to-Lake access.—***Reconstruction of this Grand Loop Road segment was completed to a 30-foot road width between Arnica Creek and Little Thumb Creek. Resurfacing of the Bridge Bay to Lake access segment was also completed. Staff monitored work associated with the center island removal and drainage sub-excavation and repair of the road at the Bridge Bay Marina to ensure that no new impact to archeological resources occurred. Stone masonry was placed over the four concrete abutments of the modern bridge at Bridge Bay, creating a more historic appearance for both motorists and boaters.

***Madison-to-Gibbon Falls/Tanker Curve-to-Gibbon Meadow.—***Final road designs for Tanker Curve-to-Gibbon Meadow (segment C) were combined with the previously completed design package for Madison-to-Gibbon Falls (segment A). A modified bid process was adopted to allow review and discussion of sensitive areas such as the rebuilding of historic bridges. The park road team brought in a consultant to assist in the design of a new bridge over the Gibbon River, connecting the Tanker Curve reroute section of road to the historic alignment just north of Gibbon Falls. Architect Kevin Peterson of the Seattle-based design firm of Parsons Brinckerhoff, Quade, & Douglas, Inc., met with the road team to view the Madison-to-Norris road and its historic bridges and culverts. A survey of the new bridge site was conducted in November 2000.

***Tower-to-Canyon (Dunraven Road).—***Reconstruction and widening of this segment of the Grand Loop Road is scheduled to begin in spring 2002. Due to delicate geologic resource issues at and near Overhanging Cliff, as well as the park's goal of minimizing the overall impacts of road reconstruction on cultural and natural resources, this segment will be completed to a 24-foot rather than the standard 30-foot width. Geologists identified a large landslide slump between Tower Junction and Calcite Springs. During the 2000 field season, alternatives were explored in an effort to identify possible repair options for the fault at Overhanging Cliff. The feasibility of constructing a retaining wall to check the slumping was looked into but considered too expensive. Rerouting the road away from the area was also considered, but no good location for a new bridge over Tower Creek was found. The historic Tower Creek Bridge is wide enough to accommodate the 24-foot roadway and is in good repair. The dry-laid stone retaining wall connecting to the north abutment of the bridge is unraveling due to high water during spring run-off and will need repair. Parking lots at the Dunraven trailhead and at Calcite Springs will be reconfigured to provide safer access and a more aesthetic appearance, similar to what has been done in other parking areas along the Grand Loop and entrance roads. Resource information was being compiled for the environmental assessment, and initial road designs were being generated.

*Overhanging Cliff on the Tower-to-Canyon road. Aerial photo by Lee Snapp.*

A completed inventory of historic structures located on the Dunraven Road was submitted to WYSHPO in June. An archeological inventory of part of the Chittenden Road corridor (off the Grand Loop) and several abandoned road segments was completed in 1999. Tower Creek Bridge and Chittenden Road were eligible for the National Register, and unnamed features contributed to the eligibility of the Tower-to-Canyon segment.

After several attempts to avoid impacts to the Tower Soldier Station archeological site, staff determined that data recovery would be necessary for a small portion of the site. Correspondence discussing the intended data recovery of this military ruin was sent to the park's affiliated tribes, but by the end of the year no tribes had expressed concern about the proposed archeological work.

***Fishing Bridge-to-Canyon.—***National Register testing of eight prehistoric sites and two historic sites adjacent to this 15-mile segment of the Grand Loop Road was completed during summer 2000. A total of 27 archeological sites located within the area of potential effect of this overlay have been tested for National Register eligibility. Documentation of the Otter Creek bridge and the historic road features was prepared and provided to WYSHPO.

Road team/FHWA evaluation of the road's condition revealed several areas of road slump and drainage damage that will need to be repaired. Geologic drilling was conducted in several slump/landslide areas just south of Canyon to ascertain appropriate corrective measures. Inadequate drainage of an ancient wetland area near the Nez Perce Ford (formerly called Buffalo Ford) picnic area has caused major road degradation. Additional drilling at a National Register-eligible prehistoric site was conducted within the road corridor at Nez Perce Ford to reveal whether buried cultural deposits existed at the "dig-out" depth necessary to make repairs. No cultural materials were found.

Staff continued to study the thermal feature emerging in the Mud Volcano parking area, which was re-surveyed to ascertain if a slight dome pavement structure would correct drainage problems.

***North and South Rim drives.—***On-site scoping for the rehabilitation of the North Rim Drive's current road alignment was conducted in 2000. Archeological inventory of the road corridor was completed, and road features documentation was done for this segment and the South Rim Drive segment known as Artist Point road. Research was completed to document the history of the North and South Rim segments in preparation for determining their eligibility to the National Register.

***North Entrance Road.—***The current alignment is unstable, and occasional minor rockslides occurred. National Register testing was conducted during the 2000 field season on sites within the road corridor along the current alignment and along the previously used Gardiner High Road.

***Northeast Entrance-to-park boundary.—***A 0.4-mile section of road from the Northeast Entrance Station to the park boundary was included in the Montana Forest Highway Program/FHWA reconstruction of an 8.34-mile segment of the Beartooth Highway. Fieldwork was conducted in 2000 to document two historic type-A masonry culverts. This information was combined with the recently completed road features documentation for the remaining 29+ miles of Northeast Entrance Road, and provided to MTSHPO.

***Monitoring.—***To ensure that park resources would not suffer adverse impacts, cultural resource staff monitored the structural repairs completed on Fishing Bridge, the drainage repair sub-excavation of the road as it passed through a prehistoric occupation site near Bridge Bay, the sub-excavation and repair of a utility line running through a prehistoric site near Fishing Bridge, and construction activities at the excess material stockpile in the Fishing Bridge developed area.

## Museum Collections

In 2000, Yellowstone's museum staff consisted of Susan Kraft, the supervisory museum curator; Beth Raz, a museum aide; and museum technicians Sean Cahill, Vanessa Christopher, Jon Dahlheim, and Kirk Dietz (on detail from the Presidio). Most of the museum technicians' salaries and a portion of the museum aide's salary were funded using project monies raised from NPS sources.

### *Preservation and Access*

A variety of projects contributed to the preservation of important components of the museum collection and to the accessibility of these collections for research, education, and other purposes.

**Works of art.** Private Charles Moore, an amateur artist on the Washburn-Langford-Doane expedition of 1870, made the first known sketches of what would become Yellowstone National Park. Five of these drawings are in the park's custody, but they were soiled and had residues of tape and labels applied to them decades ago, before their fragility and historic significance were fully appreciated. The drawings were transported by courier to a paper conservation lab in Denver, where they were treated and placed in archival mounts that will allow them to be handled and shown in moderation without damage. In 2001, the drawings will be professionally photographed and digitized for use on the park's web site.

**Photographs.** Approximately 12,000 images in the park collection previously remained only in the form of cellulose nitrate negatives, which are highly flammable and must be stored in freezers. The curator estimated that it would take at least 10 years to complete reformatting of all the park's nitrate film, at a cost of more than $100,000 in contract lab fees.

However, special funding that began in 1999 is being used to copy all of the negatives onto safety film. This project will enable reformatting to be completed by 2002, at no direct cost to Yellowstone, and at a savings to the NPS of more than $30,000.

Yellowstone shipped its first batch of nitrates to the Northeast Document Conservation Center in Massachusetts in September. Safety negatives of thousands of images that have been inaccessible since their creation between the 1930s and the 1950s are now available to researchers. A large portion of the museum aide's time was devoted to this project in 2000, organizing the nitrates into batches; documenting and tracking outgoing and incoming batches; and labeling, sleeving, boxing, and shelving the resulting safety negatives and interpositives (an intermediate step between original negatives and safety negatives).

The museum staff also began a two-year project, funded by the NPS Museum Collections Preservation and Protection (MCPP) program, to properly re-house several thousand other photographs and objects using archival enclosures and museum-quality storage trays, boxes, cabinetry, and shelving. Unframed works of art and glass negatives are among the types of collections benefiting from this project.

**Cataloging.** Yellowstone had two NPS backlog cataloging projects funded—the most for which a single park can receive funding. One of the projects, planned with the NPS Midwest Archeological Center (MWAC) in Lincoln, Nebraska, allowed MWAC to catalog the Chittenden Bridge archeology collection. This collection, housed at MWAC and consisting of approximately 700 artifacts important for their research value, had been left in a state of disorder by its collector. Items were mixed up and mislabeled, while some artifacts and field notes had suffered from water damage and were in need of professional conservation. MWAC was able to leverage the catalog funding secured by Yellowstone to access funds sufficient to contract for the conservation treatment.

Yellowstone also received NPS backlog cataloging funds to catalog 3,070 historic objects and photographs. Museum technicians were able to catalog 3,419 objects with this funding by processing some materials, such as aerial photographs, in bulk. This cataloging has made several thousand photographs accessible for research, publications, exhibits, and other purposes. It also enabled museum staff, with the assistance of a blacksmith from Bozeman, Montana, to identify and catalog the historic tools in the Mammoth blacksmith shop.

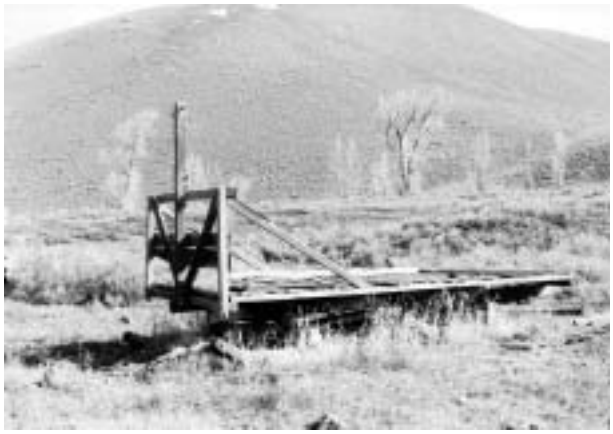
A significant number of archeological artifacts (8,940) were cataloged during the year under the terms of contracts that generated them. With funding associated with the NPS Inventory and Monitoring program, 529 vertebrate biological specimens were cataloged.

**Digitization.** The Yellowstone Park Foundation found a donor for a project that will enable documents associated with the Hayden Survey and other early exploration parties to be professionally photographed, scanned for web site use, and transcribed for researchers. During the summer, a volunteer began transcribing Thomas Moran's autobiography and part of his diary.

In a separate project funded by the Recreation Fee Demonstration program, the park's most frequently requested historic images were identified, retrieved from storage, scanned, and organized by topic in preparation for their placement on the park's web site. Captions, copyright information, and citations for these images will be prepared in 2001, using data from the museum collections cataloging database.

**Historic vehicles.** Preservation of the park's collection of historic vehicles also continued in 2000, thanks to another Fee Demonstration project. The project, which will continue through fiscal year 2001, funds preservation and maintenance of the park's stagecoaches, wagons, buses, touring cars, and other historic vehicles, as well as repairs and safety improvements to the warehouse in which they are stored. While much of the focus in 2000 was on the

*MSU farrier Tom Wolfe (right) and NPS Yellowstone horseshoer George Altenbriete (left) demonstrating the use of historic blacksmith tools prior to cataloging for the museum collection.*



*A haying sled, the last significant horsedrawn oversnow vehicle in the park.*

motorized vehicles, the last major significant horsedrawn oversnow vehicle in the park, a haying sled, was also preserved *in situ* at the Lamar Buffalo Ranch and covered to protect it from the elements. Conservators who specialize in historic vehicle conservation were brought in to perform a collection condition survey, and park staff have begun to implement their recommendations. The conservators' reports have also served as the basis for other funding proposals aimed at preservation of this important collection.

**Field collections.** Collections of natural science specimens and cultural artifacts made under approved collecting permits were, as usual, a significant source of new museum items. The number of specimens in natural science collections (including biological, paleontological, and geological specimens) that are either physically in the park or have been reported to the park by outside collectors has more than doubled in the last two years, reaching 46,042. The archeology collection grew to 107,762 items, with more than 95,000 artifacts from Yellowstone housed at the NPS's Midwest Archeological Center in Lincoln, Nebraska.

Most natural science specimens collected in the park are, under the terms of their permits, removed from the park for research and storage. In 2000, the park issued 125 permits authorizing the collection of specimens. Federal regulations governing collecting permits stipulate that materials collected under research permits and retained in any repository remain the property of the United States. Such materials are managed as part of the park's museum collection. Although collectors are requested to contact the curator's office for an accession number (establishing federal ownership) before they leave the park, by the end of the year only six collectors, approximately 5 percent of the total, had contacted the curator's office.

**Herbarium.** The park herbarium, which is managed as a separate collection, contains approximately 7,600 specimens of vascular and non-vascular plants that are identified and mounted. More than 6,100 specimens of vascular plants are also cataloged, and cataloging data have been entered into the NPS Automated National Cataloging System (ANCS+). During the 2000 field season, 171 specimens were collected for the herbarium. A backlog of approximately 2,500 specimens remains to be identified, labeled, mounted, and cataloged. Fiscal year 2001 NPS backlog cataloging funds were secured to begin cataloging 2,000 specimens, including lichens, fungi, and bryophytes.

### *Notable Acquisitions*

**The Yellowstone archives.** Museum collections in the National Park Service are managed on a fiscal year basis. The total size of Yellowstone National Park's collections, as reported on the NPS Collections Management Report (CMR), jumped from 306,439 in fiscal year 1999 to 5,111,291 by the end of fiscal year 2000. This increase resulted from accessioning the Yellowstone National Park archives, which comprise approximately 3,000 linear feet of records. (The archives profession uses a figure of 1,600 items per linear foot to estimate the number of individual items in an archive.) The Yellowstone archives are subject to a 1978 Memorandum of Agreement (MOA) with the National Archives and Records Administration (NARA) that allows records that would normally be shipped to a federal records center (such as the one in Denver) to remain in the park. However, until 2000, these records had never been accessioned in accordance with either the NARA or NPS requirements. As Yellowstone National Park is the first NPS affiliate of NARA, officials have not yet reached an agreement as to whether the records may still be considered NPS property or must be considered NARA property. If the records are ultimately determined to be NARA property, the accession will be considered a loan from NARA.

Regardless of the type of accession under which the records are documented, the act of accessioning them makes them eligible for crucial funding under

NPS museum collections preservation and backlog cataloging programs. The park's collection of government-produced photographs, managed by the curator but also subject to the MOA, was accessioned more than 15 years ago, and has regularly benefited from both backlog and MCPP funding.

The National Park Service considers archives one facet of a park's museum collection. The accessioning of Yellowstone's archival records has made archival materials the single largest component on the park's fiscal year 2000 CMR, reflecting an overall trend in the NPS. Traditionally, archeological collections outnumbered every other type of collection in the NPS. However, in recent years, as parks have conducted archival surveys and begun accounting for their archival records in a more professional manner, archival collections have, item for item, become the largest component of NPS museum collections. Yellowstone National Park has not yet conducted a formal archives survey. Such a survey would likely identify even more records, stored throughout the park, that should be formally added to the archives.

**Museum objects.** Other notable acquisitions made during the year included a bronze sculpture of a bison, "*Buffalo Charging*," made by Avard Tennyson Fairbanks in 1911, presented as a gift to the White House, from where it was transferred to Yellowstone. Using funds raised by the Yellowstone Park Foundation (YPF), the park acquired the original stagecoach ledger kept by the Yellowstone National Park Transportation Company from 1892 to 1906, an important volume long missing from the set of ledgers already in the park archives. The curator was the successful bidder on the ledger, which sold on the eBay online auction service for more than $3,700. YPF funds also made possible the purchase of an 1884 photo album from an east coast collector documenting a guided horseback trip through Yellowstone, and several diaries for the archives.

During the summer, the park received the painting "Old Faithful" as a loan from the artist, Ray "Paco" Young of Belgrade, Montana. The painting, made specifically to hang over the fireplace of the Old Faithful Inn dining room, will be donated to the park next year.

During the year, a YPF board member began raising funds to purchase the Susan and Jack Davis collection, the finest private assemblage of Yellowstone-related photographs, postcards, stereographs, souvenirs, poster art, and ephemera in the world. Appraisal of the collection is expected to be completed in the first quarter of 2001.

### *Research, Technical Assistance, and Outreach*

As in past years, demand for access to the museum collection was extremely heavy. More than 800 research and reference requests—about 30 percent from park staff and 70 percent from outside researchers—were met during the year, often consuming nearly 40 hours per week of staff time. Use of the museum collection by park staff doubled since last year, occupying more than 40 percent of the time the museum staff spent assisting researchers. The number of requests from outside researchers remained relatively constant. The curator and other members of the museum staff conducted 28 tours of the museum collection, averaging just over an hour apiece. During the year, research and reference requests, as well as requests for VIP tours or access to the collection for special projects, came from authors of books, magazine articles, dissertations, and theses about Yellowstone; filmmakers, videographers, and producers of CD-ROMs; park interpreters and resource managers; visiting scientists; environmental organizations; members of the media; members of American Indian tribes in the park for consultation meetings; Elderhostel groups; Yellowstone Association Institute classes; the Yellowstone Park Foundation; neighboring museums; and the general public. The greatest demand continued to be for historic images (including photographs, postcards, and stereographs); artwork; ephemera (such as historic brochures); and for access to the vehicle collection. Use of the herbarium also continued to be heavy, particularly during summer months.

During 2000, there were 31 active outgoing loans involving a total of 56,363 objects and specimens. The purposes of these loans included exhibits, analysis of archeological artifacts, identification of fossils, conservation of museum objects, educational uses of artifacts and specimens, reformatting of images from the photograph archive, and long-term curation and storage.

The curator delivered several talks on behalf of the park during the year, most notably a slide presentation at the Montana Historical Society's annual Montana History Conference. The talk, part of a panel focusing on Yellowstone photographs and films, highlighted Yellowstone's most important historic photographers and illustrated the importance of photographs in documenting and revealing changes

to the natural and cultural landscape and the visitor experience in Yellowstone.

The museum staff provided technical assistance and guidance on curatorial issues to staff at numerous other parks by telephone and electronic mail, as requested by regional curators and the parks themselves. The museum staff hosted a new curator from Dinosaur National Monument on a shadow assignment, and provided hands-on training in the use of the NPS cataloging system to collateral-duty museum staff from Bighorn Canyon National Recreation Area. The curator participated in a meeting of the NPS Museum Management Program Council (an organization of senior NPS curators) at Glacier National Park, where she was named to the NPS Archives Working Group in order to contribute expertise in the management of field records.

The curator participated in meetings of the Yellowstone Museum Partnership that resulted in assistance to several neighboring museums (such as the Livingston Depot Center) and the sharing of knowledge on disaster planning. Yellowstone's museum staff also provided technical assistance on curatorial matters to other non-NPS museums and agencies around the country, including the California state parks.

The curator participated in scoping and planning meetings on the proposed new exhibits at the Canyon Visitor Center and the proposed new Old Faithful Visitor Education Center, and provided written comments on concept plans and film scripts. The museum staff continued to work with the concessions division and park concessionaires to ensure preservation and appropriate care and maintenance of exhibits and specific museum objects at the Old Faithful Inn, Roosevelt Lodge, and Mammoth Hotel. At the end of the visitor season, the clock over the fireplace in the Old Faithful Inn lobby received repairs under the direction of a clockmaker from Bozeman, Montana. Historic components removed during the repairs, along with newer components that serve as evidence of previous repairs, are being documented and retained in the museum collection. Museum staff also worked with the park's historical architect and the ranger and maintenance divisions on a display for the Bechler River Ranger Station.

### *Yellowstone Heritage and Research Center*

The curator continued work on the park's proposed new museum, archives, and library facility, tentatively named the Yellowstone Heritage and Research Center (HRC). Museum, archives, and library staff, as well as staff from other divisions, reviewed schematic plans that would use a site on park land adjacent to the high school in Gardiner, Montana. The building program will be phased in because the available line-item construction funds of $6.1 million would cover some, but not all, long-range collections needs. Proposals to fund the remaining phases were revised and resubmitted to the Yellowstone Park Foundation and the Save America's Treasures program. The curator gathered and submitted all comments on the plans and participated in numerous meetings, including a review of the plans with representatives from the Wyoming State Historic Preservation Office. A team that included the regional curator from the NPS National Capital Region and one of the nation's top environmental engineers advised the park on its space needs and environmental requirements for the facility.

*Old Faithful Inn's clock received repairs by a clockmaker from Bozeman, Montana.*

As a temporary solution to the severe overcrowding in the museum and archives storage areas, the curator and archivist were granted permission to use the Scout House, a former Civilian Conservation Corps administration building in the YCC camp, as overflow storage. The building entrances were equipped with digital door locks for improved security, the locks on doors inside the building were rekeyed, and archives and museum staff began moving some collections into the building. More collections will be moved after the building's previous occupants have finished vacating the space.

## Research Library and Archives

The Yellowstone Research Library and Archives are jointly managed by park archivist Lee Whittlesey, who also functioned as defacto historian in 2000, as time allowed. Librarians Alissa Cherry, Kathryn Kirby, and Barb Zafft recorded a total of 1,467 patrons in 2000, an increase of more than 40 percent over 1999. The library, which includes a rare book collection among its more than 20,000 titles, obtained a computer terminal for public Internet access, which was very busy throughout the year, particularly in the summer months. The staff began the process of placing the library catalog on the Wyoming Libraries Database. When this project is completed and the library is online (anticipated in July 2001), the staff expects to see a great increase in the library's patronage.

Staff began cleaning, organizing, and securing the additional storage and work space made available at the historic Scout House to accommodate acquisitions that overflow the existing capacity of the library and archives space. Staff continued to work with architects and engineers to plan the new collections storage building, the Yellowstone Heritage and Research Center.

With funds provided by fee demonstration for a major multi-year preservation project, conservator Renee DeVille from the University of Texas provided training to library staff on appropriate conservation techniques and supplies. Park librarians identified items in need of conservation, made boxes and enclosures to house fragile items, and repaired a variety of books and printed materials.

Fee demonstration funds also made it possible to obtain copies of records from the National Archives in Kansas City that cover a wide range of Yellowstone topics, including roads, wildlife management (especially bison), snow removal, development and maintenance of park buildings, and thermal features. Processing these records and other archival documents, including administrative and natural resource records from the Yellowstone Center for Resources, was undertaken by archives specialist Harold Housley and archival intern Tara Cross. Harold and contract employee Frankie Collins continued work on converting records from a Microsoft Word archival system to a newer Re:discovery/ ANCS+ system, in compliance with NPS guidelines.

On May 23, 2000, a sewer-pipe from the public restrooms in the adjacent Albright Visitor Center backed up into the park archives vault room while a third-floor restroom simultaneously overflowed, causing water to cascade down the building's elevator shaft and onto the floor of the library's rare book room. Many days were spent cleaning up and disinfecting the collections, reporting on this event, and making plans to prevent its reoccurrence. Subsequently, two kinds of water alarms were installed in the library and archives, paper items were moved from the bottom map drawers, and other materials were placed on risers in the rare book room and archives room. Staff conducted frequent testing of alarms to ensure proper operation in the event of a leak.

Assisted by other library and archives staff who helped catalog maps in the collection, contract employee Cynthia Keller improved the organization and physical condition of the collection by enclosing many maps in Mylar, placing items in acid-free map folders, and identifying them on the computerized finding aid.

The librarians and the archives specialist attended a week-long training course at the National Archives in Washington, D.C., and College Park, Maryland. The archivist took two trips to southern California to tape five oral-history interviews with former park employees, including former President Gerald R. Ford, who worked as a park ranger during the summer of 1936. He also visited the photo collection at the University of California-Riverside to gather information on Yellowstone photographs held by that repository.

The archivist also completed a written history of landscaping in the Mammoth area, presented a paper to the annual Montana Historical Society conference with Paul Schullery on the history of large mammals in Yellowstone, and presented a paper on early Yellowstone photographers at the University

*Ranger Ford, circa 1936.*

of Wyoming symposium "Packaging Places and Imaging Landscapes." He presented a speech on bibliographical sources at a symposium at Cody, Wyoming, entitled "The Nez Perce in the Yellowstone Country," and gave a speech to the West Yellowstone Historical Society entitled "On the Grand Tour in Yellowstone." He and Frankie Collins transcribed the 1863 diary of gold prospector Cal C. Clawson, information from which should be useful in Schullery and Whittlesey's continuing efforts to produce a book about the history of large mammals of the Yellowstone region.

The archivist presented a field trip on the "Madison Campfire Myth" to 30 participants during the annual Greater Yellowstone Coalition meeting at West Yellowstone. He helped organize and attended a three-day reunion at Old Faithful of former concessioner bus drivers and tour guides that was attended by 128 people, some of whom gave many historic photos to the park archives. Lee also laid groundwork to conduct dozens of future oral history interviews with attendees. He taught two classes at the Yellowstone Institute: "Southern Yellowstone Roadside History" and "Yellowstone's Artists and Photographers." The latter was co-taught by Dr. Peter Hassrick of the University of Oklahoma, author of a forthcoming new book, *Drawn to Yellowstone: A History of Artists in the National Park.*

### *Notable Acquisitions*

The park archivist and curator attended the annual national park paper show at Billings, Montana, and purchased many items for the park library, archives, and museum collections. Some of the most significant items added to the archives in 2000 include an autographed copy of Eugene Burns 1953 *Advanced Fly Fishing* (donated); J.J. Aubertin's 1888 *A Flight with Distances: the States, the Hawaiian Islands, and Canada* (donated by Ron Lerner); E.H. Scott's 1925 *Panama, Yosemite, Yellowstone* (donated by Lee Silliman); buffalo keeper David W. Pierson's collection, including his diary, letters, awards, and photographs (purchased by the park); an anonymous gift of a collection of Bloom Brothers postcards; rare separates from Harper's Weekly, Frank Leslie's Weekly, and the New York Tribute; and Northern Pacific and Union Pacific railroad items.

## Other Projects

The Branches of Cultural Resources and Landscape Architecture, with the assistance of the North District rangers and the paint shop, jointly hosted an Elderhostel Service Program from September 5 to 9 at which Elderhostel volunteers donated about 200 hours of work to the park. Participants painted the fence surrounding the U.S. Army Cemetery near Mammoth Hot Springs and removed weeds from the cemetery. They also cleaned museum artifacts and spent 1.5 days gathering seeds for revegetation projects.

*The southeast arm of Yellowstone Lake. Photo by Jennifer Whipple.*

# Part III. Natural Resource Programs

## Air, Land, and Water

### *Air Quality*

Resource management specialist Mary Hektner continued to represent the park in the Greater Yellowstone Area Clean Air Partnership. The primary focus of the group's efforts was to prepare an assessment identifying GYA air quality issues and conditions, air pollution sources, and monitoring efforts. The assessment also summarized known information and identified monitoring needs with recommendations for future management actions.

Snowmobile emissions and air quality concerns remained in the news as the park's controversial winter use planning and compliance process continued. Mary assisted the NPS Air Resources Division with the compilation of a service-wide report on air quality concerns related to snowmobile use.

### *Disturbed Lands and Mining Impacts*

Reclamation of the 2.5-mile long segment of the Turbid Lake road between Turbid Lake and the Pelican Valley trailhead continued in 2000. Park and Montana Conservation Corps staff used Fee Demonstration funding to de-compact about 0.8 miles of the roadbed, excavate stream crossings, reshape road cuts to restore original drainage, and mulch, transplant, and seed the area with native plant species. Reclamation of the remaining 0.6 miles of road will be completed in 2001.

Mary Hektner helped prepare a general agreement that was signed with the Wyoming Department of Environmental Quality Abandoned Mine Lands (AML) Division to secure funding (currently budgeted at $828,000) for restoration of three abandoned park gravel pits (Lone Star Geyser, Natural Bridge/Bridge Bay, and Sedge Creek) totaling 23.6 acres. She also helped select an engineering firm that will prepare designs, specifications, and an environmental assessment, and met with Wyoming AML, the contract engineer, and park staff to develop a task directive that outlines project items and a schedule for restoration of the pits in 2001. She supervised the wetland and rare plant surveys and arranged for cultural resource surveys of the areas as needed for environmental compliance and permitting.

Mary Hektner continued to participate in planning meetings and to monitor reclamation projects associated with three mines located outside the park: the New World Mine, the Mineral Hill Gold Mine, and the McLaren Mine tailings. Reclamation of the Mineral Hill Gold Mine began in 2000. Park staff are working with staff from NPS Water Resources and the Wyoming Department of Environmental Quality to explore options for treatment and removal of tailings from the McLaren Mine that are located upstream and just outside the park's northeast boundary.

### *Greater Yellowstone Network Inventory Plan*

Park staff representing YNP participated on a team that developed a $665,000, four-year plan to inventory vascular plants and vertebrates in Yellowstone and Grand Teton national parks and Bighorn Canyon National Recreation Area. Inventories to begin in 2001 in YNP will include non-native and alpine plants, bats, amphibians and reptiles, and Yellowstone cutthroat trout.

### *Wetlands*

More than 130 wetlands were mapped and described along 12 miles of the Grand Loop Road between Mud Volcano and Fishing Bridge, and between Sylvan Pass and the East Entrance as part of the parkwide road reconstruction program. A semi-technical full color publication about the park's wetlands, *Wetland Resources of Yellowstone National Park,* was completed and 1,400 copies were printed for distribution by the park and the U.S. Fish and Wildlife Service.

More than 10 projects were reviewed to ensure that impacts to wetland resources would be avoided or minimized.

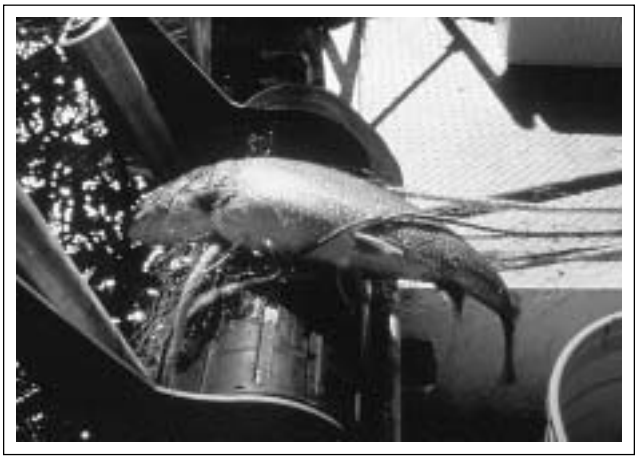
## Aquatic Resources

### *Lake Trout Removal*

The 2000 field season was the most successful yet for control of lake trout (*Salvelinus namaycush*) in Yellowstone Lake since the non-native species was documented there in 1994. The park fisheries staff continued to employ three gillnetting strategies: control, distribution, and spawner nets.

- Control nets continued to be the most effective method for removing lake trout. This effort primarily targeted smaller lake trout in water 50 to 75 meters deep to maximize the removal of lake trout and minimize the by-catch of Yellowstone cutthroat trout (*Onchorhynchus clarki bouvieri)*. Small-mesh, monofilament gillnets (19–44 mm bar measure) were used from May through October. Larger mesh nets (51–89 mm) were used from ice-off to the beginning of thermal stratification in an attempt to capture larger lake trout when they were found in shallower water five to 15 meters deep.
- Distribution nets were used to determine the vertical and spatial locations of lake trout in 16 randomly chosen sites over a two-week period in August. Pairs of nets containing 11 different mesh sizes were used for one night in water 15 to 40 meters deep at each site.
- Spawner nets targeted lake trout from mid-September through mid-October when they moved onto their spawning grounds. Monofilament gillnets (51–70 mm) were used at two known spawning locations in West Thumb and three possible spawning sites in Breeze Channel. Various other locations throughout the lake were also sampled in an attempt to locate additional spawning grounds.

By using different sizes of gillnets, the fisheries staff were able to target two of the lake trout's three life history stages: small non-predatory (<400 mm total length [TL]), and large predatory (>550 mm TL) fish. Mid-size lake trout (400–550 mm TL) tend to reside in the same areas of the lake as do the native Yellowstone cutthroat trout, so targeting them for gillnetting could result in large by-catch of cutthroat.



*Gillnets are being used extensively on Yellowstone Lake to remove the predaceous lake trout in order to protect Yellowstone cutthroat trout.*

**Control and Spawner Gillnetting Effort**

| Year | Effort | Lake Trout Caught | CPUE | Cutthroat: Lake Trout |
|---|---|---|---|---|
| 1994 | 39 | 2 | 0.05 | 252.00:1 |
| 1995 | 250 | 153 | 0.61 | 6.60:1 |
| 1996 | 401 | 580 | 1.45 | 1.70:1 |
| 1997 | 538 | 863 | 1.60 | 2.50:1 |
| 1998 | 1,415 | 7,792 | 5.51 | 0.13:1 |
| 1999 | 1,626 | 5,748 | 3.54 | 0.08:1 |
| 2000 | 3,354 | 12,792 | 3.81 | 0.10:1 |

*Table 1. Gillnetting effort (number of 100-m net-nights), number of lake trout caught, CPUE (catch per unit effort), and cutthroat trout-to-lake trout catch ratio.*

Refinement in gillnetting techniques and extended set duration resulted in more than doubling our 1999 netting effort. In 2000, 3,355 units of effort (control and spawner nets combined) netted 12,792 lake trout and 1,334 cutthroat trout (of which 642 were released back into the lake alive). Distribution netting obtained another 81 lake trout and 207 cutthroat trout (110 released). Most of the captured lake trout caught were juvenile fish netted in deep water, but spawner nets captured 861 fish, of which 765 (89%) were mature spawners. The cutthroat-to-lake trout catch ratio of 0.10:1 was similar to that of the previous two years (Table 1).

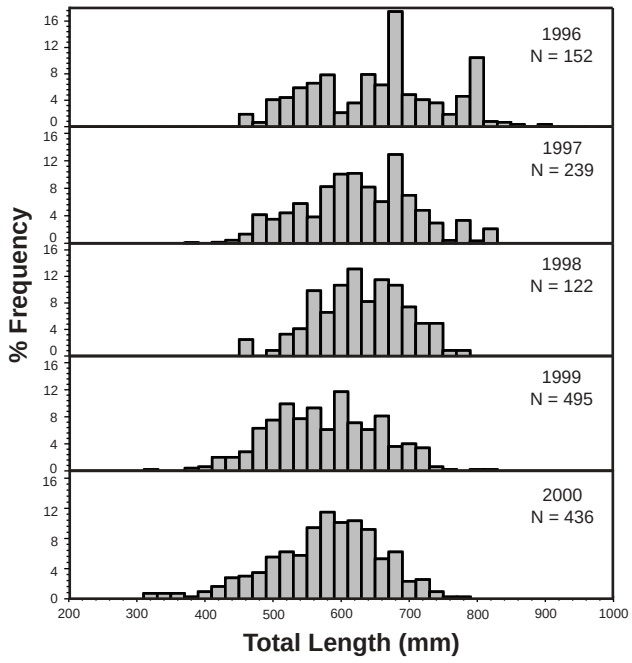



*Figure 1. Length frequency of mature lake trout caught at Carrington Island.*

**Lake Trout Caught in Spawner Nets**

| Year | Area | Lake Trout Caught | Mean TL (mm) | Median TL (mm) |
|---|---|---|---|---|
| 1996 | Carrington | 151 | 623.47 | 610 |
| 1997 | Carrington | 222 | 588.18 | 595 |
| 1998 | Carrington | 121 | 625.43 | 621 |
| 1999 | Carrington | 461 | 589.12 | 585 |
| 2000 | Carrington | 437 | 586.65 | 596 |
| 1997 | 27 | 144 | 612.80 | 605 |
| 1998 | 27 | 203 | 617.38 | 613 |
| 1999 | 27 | 271 | 611.85 | 607 |
| 2000 | 27 | 211 | 602.63 | 597 |
| 1999 | 24, 25, 26 | 72 | 577.13 | 570 |
| 2000 | 24, 25, 26 | 118 | 599.48 | 606 |

*Table 2. Spawner gillnet totals by area. Carrington Island and area #27 are in West Thumb; areas #24, #25, and #26 are suspected spawning sites in Breeze Channel.*

Although the number of lake trout captured increased by more than 50 percent from 1999 to 2000, the catch rate (CPUE in Table 1) remained about the same, indicating that the netting effort may be preventing the lake trout population from increasing. The average size (and potential reproductive capacity) of spawning lake trout continued to decrease at both confirmed spawning locations (Table 2, Figure 1).

**Angler catch.** Anglers were again encouraged to fish for lake trout during a two-week early season (June 1 to June 15) on Yellowstone Lake and to report their catches. Reports showed that the number of lake trout captured was not enough to offset the incidental mortality of cutthroat trout spawners caught during this period. The opening of angling season on Yellowstone Lake will therefore revert to the traditional June 15 date in 2001.

Anglers reported catching about 250 lake trout during the fishing season, which was consistent with the previous three years. Although angler lake trout removals are much lower than gillnet catch totals, they are important to the overall control program. Anglers primarily catch the medium-size life history stage of lake trout that cannot be targeted with gillnets due to the high by-catch of cutthroat trout.

**Long-term prospects.** Since 1995, gillnetting has removed more than 27,000 lake trout from Yellowstone Lake, most of them from West Thumb and Breeze Channel. Bioenergetics modeling (estimates of how many cutthroat trout a lake trout potentially consumes) suggests that a mature lake

trout can eat between 50 to 90 cutthroat trout per year, so the gillnetting effort has saved a large number of cutthroat trout. The gillnetting, telemetry, and hydroacoustic data collected since 1996 indicate that:

- Most lake trout reside in the West Thumb/ Breeze Channel portion of the lake.
- All known spawning grounds for lake trout are in the West Thumb/Breeze Channel area.
- Most adult lake trout reside in West Thumb.
- Juvenile lake trout are found throughout the lake.

The combination of intensive gillnetting and angler removals suggests that the program is approaching the lake trout mortality goal of 50 percent in the West Thumb/Breeze Channel portion of Yellowstone Lake, and that current removal efforts are adequate for this area. However, the gillnetting program will have to be expanded lake-wide in order to control population expansion throughout the lake basin. The data also suggest that over the long term, new spawning grounds will be established at other sites throughout the lake.

To address the long-term needs of the program, the NPS has acquired funding for a new commercial gillnetting boat that is expected to be fully operational during the 2001 field season. This vessel and its crew will be used solely for the lake trout removal program.

### *Westslope Cutthroat Trout Restoration*

Until 1997, only limited genetic information was available about selected populations of westslope cutthroat trout (*Onchorhynchus clarki lewisi*) in the park. The Aquatic Resources Center initiated research to gather information about the genetic status and population structure of this native subspecies that would lead to the protection and re-establishment of viable populations in the Gallatin and Madison river tributary streams where the trout was once abundant. This project includes:

- an extensive genetic survey to more accurately describe the distribution of pure versus hybridized populations;
- annual monitoring of changes in abundance, length and age structure, and collection of seasonal distribution information; and
- a pilot study at Canyon Creek to examine the feasibility of westslope cutthroat trout restoration by removing non-native fish and isolating the stream with a physical barrier.

From 1997 to 1999, non-lethal genetic samples (fin clips) were removed from westslope cutthroat trout at 20 different sites from 11 streams and sent to the Wild Trout and Salmon Genetics Laboratory in Missoula, Montana, for analysis. These analyses identified a genetically pure population in the North Fork of Fan Creek, and described the extent of hybridization with introduced trout among other streams. Length and age structure information and baseline abundance estimates collected from many of these populations will enable fishery biologists to monitor their status.

In 2000, preliminary data were collected on the westslope cutthroat trout distribution and reproductive status at seven sites in tributaries of Fan Creek: four evenly-spaced reaches of the North Fork; two sites in the first meadow of the East Fork; and Stellaria Creek nearly a mile upstream from its confluence with the East Fork. Trout were captured in each stream with electrofishing gear and measured for length and weight, and gonadal tissue was examined from a subsample. Otoliths (small bony structures that fish use for balance) were extracted from the heads to determine age because annual growth rings are often easier to see on them than on scales. A complete health assessment was made of fish from the North Fork to test for whirling disease and other diseases to which trout are susceptible.

Mature cutthroat trout in spawning condition were captured in June in the four North Fork sites, and were most abundant in its headwaters. The large percentage of spawning trout observed suggests that the peak of the spawn occurred around June 21. Mature trout averaged 174.3 mm in total length; the smallest mature fish was a 132-mm male. Spawning locations (redds) were found mainly near the middle of the drainage, and were more abundant at the lower end of a large meadow. Only one redd was observed at the other three sites.

At the two East Fork sites, most of the trout examined (63%) had completed spawning, but because these surveys were not finished until late June, the two forks were thought to have similar breeding periods. The mature trout had a mean total length of 281.6 mm, more than four inches longer than in the North Fork. The total length of the smallest mature fish was 160 mm. Specific breeding locations in the East Fork could not be determined

since trout redds and spawning activity were not observed at either site.

The breeding period of cutthroat trout in Stellaria Creek occurred about the same time as in the East Fork. Nearly 90 percent of the adults captured during the survey were classified as post-spawning, and no spawning or redds were observed. The mean length of the adult fish was 225 mm; the smallest mature fish was 183 mm.

The NPS is funding a graduate research project with the Cooperative Research Unit at Montana State University to examine seasonal movements of west-slope cutthroat trout in the Fan Creek drainage. Previous data on spawning activities and the length and age structure of cutthroat trout suggest that two different life forms may be present: fluvial, which typically use many areas within a drainage; and resident fish that remain in a single tributary. A combination of radio telemetry and Passive Integrated Transponder tags will determine if two different forms exist, and the data will be used to develop conservation strategies for protecting and restoring this subspecies of cutthroat trout in the park.

**Canyon Creek restoration site.** Park fishery staff continued to use electrofishing gear to remove introduced trout (brook trout *[Salvelinus fontinalis]*, brown trout *[Salmo trutta]*, and rainbow trout *[Oncorhynchus mykiss]*) from Canyon Creek while testing the effectiveness of a barrier constructed near the mouth of the creek to prevent upstream fish migration. From July through September, 659 trout were captured. Since 1997, a total of 13,768 non-native trout have been removed. However, length structure data indicate that 35 percent of the fish captured in 2000 were age 0, with a total length of less than 70 mm. Since it was estimated that 98 percent of the mature trout in the stream were removed in 1999, the few remaining adults were apparently able to sustain the current population. Consequently, other removal methods, such as chemical treatment, are being considered.

In 2000, 67 of the captured fish were marked with fin clips and released below the barrier, bringing the total number of marked and released fish since 1998 to more than 800. None of the marked fish have been found upstream of the barrier since improvements were made to it in 1998, indicating that upstream migration by non-native fish need not be a primary threat to the goal of re-establishing westslope cutthroat trout in Canyon Creek.

### *Arctic Grayling*

For the second year, the Gibbon River was sampled for Arctic grayling (*Thymallus arcticus)* to determine if a fluvial (river-dwelling) form exists anywhere in the drainage. Anglers frequently report catching grayling above and below Gibbon Falls, but these fish may have dispersed from the headwater lake-dwelling populations in Wolf and Grebe lakes. Crews using a 16-foot raft equipped with electrofishing gear sampled separate river sections in Gibbon Meadows, Gibbon Canyon, below Gibbon Falls at the mouth of Canyon Creek, and further downstream near Tuff Cliffs. A total of 11 grayling were captured in the Canyon Creek and Tuff Cliffs sample areas, but none above Gibbon Falls. The total length of the captured fish ranged from 254 to 363 mm and averaged 317 mm, with the mean length slightly larger at Tuff Cliffs (328 mm) than at Canyon Creek (312 mm). No young fish have been captured during the two years of study. Tissue samples from the fins will be analyzed to determine if they differ genetically from those of Grebe Lake grayling.

Previous Gibbon River studies have marked grayling captured near Wolf and Grebe lakes with elastomer tags to document downstream dispersal from these lakes. In 2000, however, low water and early snow melt resulted in unusually early spawning runs, preventing fishery staff from tagging a sufficient number of fish for the study. Adequate numbers of grayling will be tagged in spring 2001 before fishery surveys are completed in the Gibbon River during the summer.

### *Whirling Disease*

Whirling disease primarily affects young trout whose skeletal systems are not fully developed. Loss of equilibrium, skeletal deformities, changes in coloration, and an inability to avoid predators or feed normally may occur as the parasite that causes the disease *(Myxobolus cerebralis*) destroys cartilage in the head of the fish. The standard method for detecting the presence of *M. cerebralis* in a stream involves "sentinel exposure trials," in which young trout are placed in a stream cage for a 10–14 day period when they are most susceptible to infection. The exposed fish are then kept in an isolation facility until they reach six months of age, when they are microscopically examined for cranial parasite spores.

After *M. cerebralis* was verified in Yellowstone Lake cutthroat trout in 1998, the park fishery biologists initiated a program to test cutthroat fry as well

as larger cutthroat that are incidentally captured during lake trout gillnetting. When cutthroat fry were placed in sentinel cages at 14 sites (12 Yellowstone Lake tributaries plus Fishing Bridge and Nez Perce [formerly Buffalo] Ford) in the spring of 1999, the parasite spores were found only at Fishing Bridge, where they were detected in seven of the 50 exposed cutthroat fry. All of the exposed fry appeared normal both before testing and after parasite exposure. Disease severity was rated mild in all but one of the seven infected fish.

The small extent of infection found in 1999 may indicate a less than optimum environment for the infectious stage of the parasite. The most important variable affecting release of parasites during this stage appears to be water temperature. Recent research suggests that about 1,800 temperature units (average water temperature in ºC multiplied by the number of days >0ºC) are needed annually for completion of the parasite cycle. In colder high-elevation streams, the peak infection period may therefore occur in the fall rather than the spring.

Based on these temperature criteria, seven of the tributaries tested in 1999 were used again in 2000, when 10-day exposure tests were conducted with about 100 cutthroat fry in sentinel cages beginning September 10. At each of four other sites (Fishing Bridge, Bridge Creek, Clear Creek, and Pelican Creek), multiple exposure trials (three separate 10-day exposure tests) were conducted during the period from September 10 to mid-October as water temperatures declined. Because these exposure tests occurred later in the year, the test fry were 60–80 days post-hatch and could have developed some resistance to the parasite infection.

After 100 days, microscopic examination found that some of the fry from the Fishing Bridge and Pelican Creek sites were infected. Although detailed histological analyses are not yet complete, the whirling behavior exhibited by the fish at the Pelican Creek site suggested a more severe infection than was observed in 1999.

Examination of all 637 cutthroat trout gillnetted in 1999 yielded some preliminary observations about the lake-wide distribution of whirling disease and its potential effects.

- Older cutthroat trout from many locations in the lake had a low-level of whirling disease infection.
- If these older infected fish acquired the parasite when they were fry, it appears that some cutthroat trout in Yellowstone Lake are able to survive the infection without any obvious long-term effects.
- Prevalence of the disease is higher in samples from the northern portions of the lake (24.2%) than in the arms (6.5%) (Figure 2).
- The broad age range of infected cutthroat trout (3–8 years old) suggests that the parasite has probably been in the Yellowstone Lake basin for a number of years.

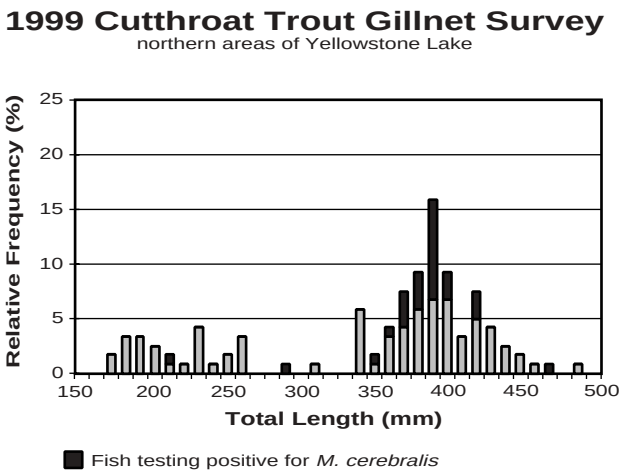



*Figure 2. Whirling disease-infected cutthroat trout captured in the northern Yellowstone Lake gillnetting sites.*

In 2000, only a stratified subsample of gillnetted cutthroat trout were examined for *M. cerebralis* spores. Again, none of the fish exhibited any clinical sign of the disease, and infection severity was rated mild. This finding is not unexpected, because more severe infections in cutthroat fry would likely reduce the fish's chances of long-term survival.

Although the level of infection appears to be low, expansion of the parasite to other sites in the Yellowstone Lake basin could have serious impacts on the cutthroat population. Park fishery biologists plan to expand the sentinel cage exposure studies in the next several years. Partitioning stream sites by annual temperature profiles or unique habitat should assist in describing focal points of parasite abundance. These studies and the ongoing examination of incidental cutthroat trout catch should yield information about the vulnerability of Yellowstone Lake cutthroat trout to whirling disease that park managers can use to develop protections for the preservation of this native fish.

### *Cutthroat Monitoring at LeHardy Rapids*

**Annual sampling.** The short section of the Yellowstone River known as LeHardy Rapids provides an excellent dipnetting site where mature Yellowstone cutthroat trout are accessible when they temporarily congregate in pools along the edges of the rapids as they move upstream to spawn. Since 1974, cutthroat have been collected at LeHardy Rapids to monitor size, age, sex ratios, and growth rates. In 2000, every Monday from May 31 to June 26, three-person crews placed the captured fish in large tubs, anesthetized them, measured each fish's length and weight, and visually identified sex and stage of maturity. Scales were collected from the first 20 mature fish captured each week to obtain length specific stratified age and growth data (10 fish samples of each sex in each 10-mm size class). All fish were marked with a caudal punch, revived, taken upstream of the rapids, and released.

A total of 228 mature cutthroat trout was netted at LeHardy Rapids during the 2000 field season. The largest sample (100 fish) was collected on June 5. Mature cutthroat averaged 403 mm in total length, slightly larger than the 25-year average of 392 mm. The mean length of males was typically larger (411 mm) than that of females (395 mm).

**Brood stock.** For the past several years, the Wyoming Game and Fish Department has dipnetted at LeHardy Rapids to collect wild gametes to supplement their Yellowstone cutthroat trout brood stock. In 2000, fish were captured weekly from June 8 to 29 and visually identified to sex and stage of maturity. Those fish that were expected to spawn within the week were transported to live cages and separated by sex; the others were released. At the end of each week, the brood fish were paired (a total of 150 pairs during the sampling period), and one ounce of eggs was taken from the female and fertilized with a small amount of milt from the male. The females were tested non-lethally for the infectious hematopoetic necrosis virus; all tested negative. After they were spawned, the fish were measured to total length, weighed, marked, and released upstream of the rapids.

*Yellowstone cutthroat trout can be seen ascending LeHardy Rapids from mid May to late June most years.*

### *Cutthroat Monitoring in Lake Tributaries*

To assess the current and potential impacts of the presence of lake trout in Yellowstone Lake, park fishery staff are monitoring the population structure of the cutthroat trout entering three tributaries of the lake to spawn.

**Clear Creek.** Data on spawning trout numbers and size has been collected at Clear Creek since the mid 1940s. In 2000, park fishery staff operated the fish trap from May through July and counted 11,453 trout migrating upstream. More fish (14,290) were counted passing downstream through the trap on their return to the lake, indicating a likely equipment malfunction; the upstream count probably measured only the portion of the run that occurred before and after peak runoff. The upstream and downstream counts for 2000 are comparable to those recorded from 1997 to 1999, indicating that this component of the population has remained relatively stable for the past few years. However, the upstream counts are significantly less than the highest counts recorded during the late 1970s and early 1980s (Figure 3).

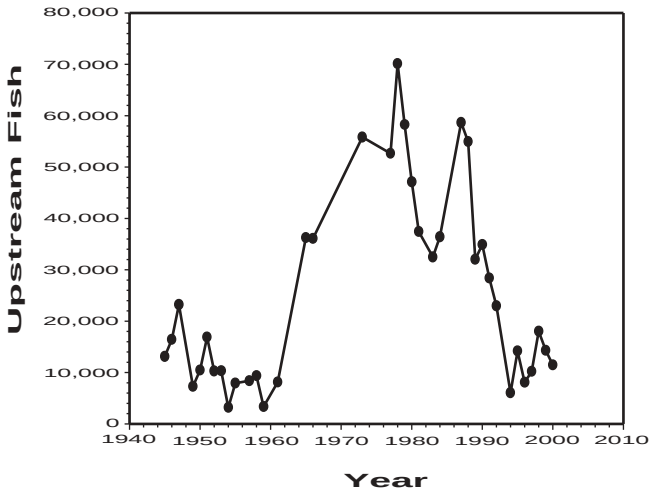



*Figure 3. Upstream spawner counts of cutthroat trout entering Clear Creek, 1945–2000.*

*Yellowstone cutthroat trout caught migrating up Clear Creek to spawn are subsampled to obtain length, age, and growth data.*

Beginning in 1995, several years of high water in Clear Creek eroded stream banks, degraded some of the trap structures, and compromised the biologists' ability to obtain accurate fish counts. Therefore, with assistance from the YCR's supervisory geologist, a rehabilitation project was completed in August that is expected to lead to more accurate counts in the future. All necessary permits were secured from the Wyoming Department of Environmental Quality and the U.S Army Corps of Engineers; project approval was obtained from the park's Resource Council. Six volunteers from the Montana Conservation Corps worked with fishery staff to stabilize the stream banks by planting trees angled in a downstream direction. The trap structures were reinforced with large rocks and concrete, and modifications were made to the weir to facilitate the flushing of gravel during high water. Fish counting chutes were repositioned in the weir so that high water and associated gravel will not affect their function.

**Arnica Creek.** In 1997, park fishery biologists expanded the number of monitoring streams by installing a fish trap in Arnica Creek, which historically contained one of the largest spawning migrations of cutthroat trout in an area of the lake where large predatory lake trout have become abundant. During 2000, 853 cutthroat trout were counted passing upstream through the fish trap and electronic fish counters, and 417 passed downstream to return to the lake. These estimates represent a more than 200 percent increase from the 1999 counts; spawner counts from 1997 to 1999 were lower than expected. Changes to the trap design and efficiency have occurred during the past several years that may have permitted more precise counts in 2000.

**Bridge Creek.** Beginning in 1998, park fishery biologists began to monitor a spawning run of cutthroat trout in Bridge Creek by installing a fish counter near the mouth of the stream. In addition to its close proximity to the Lake field office, Bridge Creek supports a large spawning run of Yellowstone cutthroat trout relative to the size of the stream. The fish counter was also used to test a design intended to reduce the amount of required maintenance so that it could be used to monitor small backcountry streams in remote areas of the lake. In 2000, upstream and downstream migrating trout were counted as they passed through an electronic fish counter, but no trap facility was used. In total, 1,250 fish were counted migrating upstream, and 696 trout passed downstream through the counter on their return to the lake. These estimates are lower than the previous year, when nearly 2,400 trout were counted. Thaws during April likely triggered an early spawning run before the counter was installed. For example, more than 350 fish had passed through the counter during the first four days of operation. A significant decline in the total spawning run for 2000 was not expected, although lower water levels may have been a factor.

### *Road Construction Inventories*

**Gibbon River.** For the past two years, aquatic resources staff have been collecting fishery and habitat data from the Gibbon River in connection with the Madison-to-Norris road reconstruction project. Most of the survey effort focused on determining the distribution of Arctic grayling in the Gibbon River watershed (see section on Arctic grayling, above), but mottled sculpin and brown, rainbow, and brook trout were commonly caught. Detailed abundance estimates and population structure analyses will be completed by the end of the road construction project.

This road project is unique because a portion of the road will be removed and an entirely new road segment will be constructed. Because it is unknown how these activities will affect the river resources, a cooperative study with the USGS was initiated in 2000 to monitor natural sediment loads and document changes in sedimentation rates during construction.

**Antelope Creek.** Electrofishing was used to determine species composition and relative abundance of fish in three sections of Antelope Creek, which flows adjacent to the Canyon-to-Tower road, in order to monitor impacts from proposed road reconstruction. The first section was located 25 yards below the confluence of an unnamed tributary and about two miles upstream from the outlet. The second section was a few hundred yards downstream from the first, and the third was in the canyon below

a waterfall barrier about a mile upstream from the outlet. Yellowstone cutthroat trout was the only species found in the creek. Relative abundance averaged 53 fish per 100 meters of stream or about 533 fish per kilometer. Fin clip samples taken from each fish to determine genetic composition have not yet been processed. Although there have been no official stocking activities in Antelope Creek, angler reports indicate cutthroat trout have been caught there since at least 1974.

### *Angler Surveys*

Visitors who purchase a fishing permit also receive a postal catch card requesting information on fishing effort (hours and days fished), catch, skill level, and satisfaction for specific waters that they fished. Fishery staff use data from these Volunteer Angler Report (VAR) cards to estimate angling pressure, landing and harvest rates, and mean lengths by species of fish landed and creeled.

Visitors purchased 67,687 fishing permits in 2000. Surveys of visitors as they leave the park showed that nearly 4 percent of those who had obtained a permit did not fish, reducing the estimated number of anglers to 65,990. Based on data from the 3,798 usable VAR cards that were returned, the park fishery staff estimated the number of fishing days at 264,250, the fishing effort at 712,642 hours, and that anglers landed 713,990 fish and creeled only 22,109, releasing more than 97 percent of all fish landed. Mean annual landing and creel rates were 1.00 and 0.03 fish/hour, respectively, with nearly 81 percent of single-day anglers landing one or more fish. Cutthroat trout were the most frequently captured fish (59%), followed by rainbow trout (16%), brook trout (9%), and brown trout (8%). Lake trout, Arctic grayling, mountain whitefish *(Prosopium williamsoni)*, and unidentified fishes made up the remaining 8 percent of landed fish.

The 33,465 landed fish reported on the VAR cards had an average length of 12.9 inches (328 mm). Nearly 59 percent of these fish were >12 inches (305 mm), and 47 percent were >14 inches (356 mm). Lake trout had the greatest average length (17.6 inches; 447 mm), followed by cutthroat trout (14.4 inches; 366 mm), mountain whitefish (12.4 inches; 315 mm), and brown trout (12.0 inches; 305 mm). The average angler skill level was “experienced” at 1.98 (1 = beginner, 2 = experienced, and 3 = expert), with an estimated 83 percent of park anglers reporting satisfaction with their overall fishing experience.

## Geology and Geothermal Resources

The year 2000 marked the arrival of two geologists at the YCR: Dr. Paul K. Doss from the University of Southern Indiana as supervisory geologist, and Dr. Nancy Hinman from the University of Montana as geothermal geologist. They quickly got involved in many aspects of park management.

Notable geological events during the year included the spectacular eruption of Steamboat Geyser in Norris Geyser Basin in the early hours of May 2 after a nine-year hiatus. Silex Spring in the Fountain Paint Pots group erupted in August after a 21-year eruption hiatus. While no catastrophic mass movements were reported in the park, minor rock falls in the Gardner Canyon and small mudflows in the Gibbon Canyon continued to require road clearing and monitoring by the Resource Management Operations and Visitor Protection, and Maintenance divisions. At least one earthquake out of nearly 1,900 in the park area during 2000 was reported as a felt earthquake that caused some minor damage.

### *Program Development and Scoping*

Efforts began in earnest to develop a formal structure for geological resources management in YNP that will include geological features and processes. Priorities will focus on:

- *hazard issues:* participation in the development of a comprehensive Volcano and Earthquake Hazards Plan by the U.S. Geological Survey that will identify large-magnitude seismic events and hydrothermal explosion structures and response plans.
- *geothermal monitoring:* development and implementation of a plan as mandated by the Geothermal Steam Act of 1970.
- *NPS-State of Montana Reserved Water Rights Compact:* reviewing applications for drilling in the Controlled Groundwater Area.
- *support for interpretation:* assisting in interpretive ranger training and preparation of audiovisual materials for the new Old Faithful and Canyon visitor centers.
- *protection of geological resources:* protecting features such as hydrothermal areas and lithologies (obsidian, sinter, travertine, petrified wood, etc.), and natural processes such as erosion, stream flow, and hydrothermal discharge.

Much time and effort was expended in 2000 documenting the need for applied geological input in various aspects of park management. In addition to providing assistance to park staff and research investigators, YCR geologists sought advisory input from park employees in all divisions, external researchers, and federal agency cooperators. In June 2000, the supervisory and geothermal geologists participated in a park field trip led by Lisa Morgan, Pat Shanks, Ken Pierce, Bob Christiansen, and other USGS scientists.

### *Working with Every Division*

During 2000, the geological resources management program was able to assist, in some capacity, every YNP division. Much of that assistance and collaboration dealt directly with geological resource management issues.

**Interpretation.** Major initiatives included the production of a hydrothermal video that will première at Old Faithful in the summer of 2001 and exhibits planning for the new Old Faithful Visitor Education Center. Many geologists from the USGS and academic institutions provided technical expertise in video script and exhibit development. The Canyon Visitor Center will undergo renovations and house completely new exhibits focusing on the large-scale geological setting of Yellowstone. Field trips on local geology provided exhibit specialists from Gallagher and Associates (visitor center consultants) and Harper's Ferry a firsthand look at the task at hand. Exhibit plans include interactive media, real-time seismic data retrieval, and scale models of the Yellowstone hotspot and geoecosystem. Reviews of exhibit plans and geological interpretive themes will be ongoing.

Nearly all park trail guides, the environmental education curricula, several wayside exhibits and interpretive signs, and the *Resources and Issues Handbook* were reviewed by staff geologists for technical accuracy and updating.

**Resource management operations.** On August 22, when a thermal accident and subsequent fatality occurred in the Lower Geyser Basin, staff geologists assisted in evidence collection and site documentation, including water temperatures, water depths, and sediment disruptions. Staff geologists also helped other resource management staff to assess the age of disturbance and wetland extent at a site in the Canyon area for possible restoration to mitigate for the construction of a contractor's camp in grizzly bear habitat. On July 3, about 100 gallons of diesel fuel were discharged 10 meters west of Grayling Creek as a result of a vehicular accident within park boundaries on Route 191 north of West Yellowstone. The contamination was contained and removed by maintenance personnel and outside contractors before it could migrate. One of the staff geologists visited the site twice and participated in plans to develop a protocol to follow in future incidents of this type. Assistance was also provided to resource management personnel involved in stream flow monitoring and water-rights allocations in Reese Creek along the northern park boundary.

*An accident within park boundaries on Route 191 resulted in the discharge of approximately 100 gallons of diesel fuel just 10 meters from Grayling Creek. The contamination was quickly contained by maintenance and State of Montana personnel.*

**Visitor protection.** At the request of the Visitor Services Office, the staff geologists responded to visitor inquiries on subjects ranging from specific geyser information to behavior of the Yellowstone caldera, seismic activity, and volcanism.

**Planning and compliance.** The staff geologists reviewed and provided input on the draft environmental assessment for the Mammoth public restroom.

**Public affairs.** At the request of the Public Affairs Office, the staff geologists assisted with media contacts pertaining to hydrothermal features, fossil forest resources, seismicity in the park, and Yellowstone Lake research, and accompanied film crews during location shots in sensitive thermal areas of the park.

**Maintenance.** Working with maintenance staff, the geothermal geologist examined the deteriorated Physical Sciences Laboratory trailer, organized and cleaned the facility, obtained the necessary furnishings for chemical and sample storage, and prepared a laboratory use protocol.

*A film crew conducting location shots in the Lower Geyser Basin, a sensitive thermal area of the park.*

The staff geologists also provided expertise used in the Beryl Spring Bridge design and refurbishing, Artist's Point construction and development, and site investigations related to the construction of the new Old Faithful Visitor Education Center. They participated in planning for site borings, and were onsite during drilling on November 7 for data-collection and observation.

**Concessions.** One of the staff geologists provided a training session on park geology for snowcoach drivers who give guided tours on routes between the South and West entrances and Old Faithful, and from Mammoth to Old Faithful and Canyon.

**Yellowstone Center for Resources.** The staff geologists conducted reviews of research permit applications and provided advice on proposed methodology and study-site access. For the resource information branch, they edited fact sheets relating to geology issues that are available to the public and other interested parties.

The staff geologists consulted with cultural resources staff on archeological sites. At a new Cody Complex site (approximately 9,300 years old) located on Yellowstone Lake near Grant Village, the supervisory geologist accompanied Dr. Ken Pierce (USGS) to describe sediment types, provide geomorphic (landscape) interpretations of lake terraces and sediment distributions, and collect samples for radiocarbon dating.

The supervisory geologist accompanied fisheries staff to the Clear Creek site where dynamic stream-channel processes have threatened the integrity of the fish weir, and documented sediment deposition and accumulation immediately upstream of the weir, channel migration, cutbank erosion, and undermining of the weir infrastructure.

### *Resource Monitoring*

The geothermal geologist initiated efforts to establish a conceptual model for a monitoring plan as called for under the Geothermal Steam Act of 1970 (30 U.S.C. 1001) to protect "significant thermal features" in the park. As envisioned, the plan will characterize the current status of the hydrothermal systems in the park and establish a baseline to document change in their behavior. The geothermal monitoring plan will incorporate existing efforts such as chloride flux measurements and external researcher investigations, and new initiatives to achieve comprehensive monitoring. Elements in the conceptual model include identification of data needs, database development, and sampling protocols and strategies.

*On-site drilling for geotechnical review at the proposed site for construction of the new Old Faithful Visitor Center.*

*Accumulation of sediment, and resultant channel modifications immediately upstream from the Clear Creek fish weir.*

**Water resources.** As part of the NPS-Montana Reserved Water Rights Compact that was established to protect water resources within the park from development pressures along its borders, staff geologists are responsible for reviewing permit applications for drilling in the Controlled Groundwater Area (CGA) that extends primarily along the northern and upper western boundary of the park, and includes parts of Paradise and Gallatin valleys. About five applications for water well drilling (primarily domestic use wells) were reviewed in 2000. The geological resources management program continued its support of water resources data collection by the USGS and NPS Water Resources Division, including the Lamar River gauging station, as well as of the gauging and water quality stations on Soda Butte Creek below the New World Mining District.

**Earthquakes.** The Yellowstone Seismograph Network of 22 stations in and around the park that is operated by the University of Utah recorded about 1,926 earthquakes in the YNP area during 2000. The epicenters of earthquakes recorded from October 1999 through September 2000 show typical concentrations in the West Yellowstone and Hebgen area, in the vicinity of Norris, and around the Mallard Lake and Sour Creek resurgent domes. The three largest earthquakes were two shocks of magnitude 3.9 on May 23 (19.7 miles WNW of Gardiner, MT) and August 7 (7.3 miles WNW of Norris Junction, WY), and a magnitude 4.3 quake on November 24 (1.1 miles north of Norris) that was the only "felt" earthquake reported. It caused some minor damage to supplies in the Norris apartment of maintenance employee Grant Gifford.

An earthquake swarm was recorded 7.5 miles northwest of Norris Geyser Basin from July to late August. Earthquake swarms, defined here as a concentration of earthquakes in time and space, are relatively common in the park, but the Norris swarm generated interest because of its coincidence with observed changes to the hydrothermal features in the northwest side of Norris Geyser Basin.

**Volcanic activity.** Plans to establish a Yellowstone Volcano Observatory (YVO) developed out of discussions with Marianne Guffanti, Coordinator of the USGS Volcano Hazards Program. Similar to the Alaska Volcano Observatory, the YVO will be a "virtual" observatory in that it will have no tangible infrastructure. Robert Christiansen (USGS-Menlo Park) will serve as Scientist-in-Charge, and Robert Smith (University of Utah) will act as Coordinating Scientist. In addition to formalizing the longstanding monitoring of seismic and volcanic activity in YNP by the University of Utah, the USGS, and the NPS, establishing the YVO will contribute to the development of an Earthquake and Volcanic Hazards Plan for the park.

**Unusual geyser eruptions.** Perhaps the most notable geothermal resource news for 2000 was the spectacular early morning eruption of Steamboat Geyser in the Norris Geyser Basin on May 2, 2000, the first major eruption documented since October 2, 1991. The steam-phase eruption that followed the water phase was reported to have continued for more than 24 hours. Steamboat Geyser is known as the tallest active geyser in the world, but it remains unpredictable.

Norris is regarded as the hottest and one of the most dynamic thermal basins in the park, and has historically displayed seasonal and annual changes in hydrothermal characteristics. West of the Porcelain Basin trail, a part of the Hundred Springs Plain known as "the Gap" showed a substantial change in hydrothermal activity during 2000: new and expanding hot spring features, boiling ground, irregular eruptive episodes, and extensive areas of vegetation die-off from thermal stress. While some of the changes coincided with the Norris earthquake swarm, no conclusions can be reached about a definitive relationship between the two events.

In the Lower Geyser Basin, Silex Spring in the Fountain Paint Pots group erupted in early August for several days, including bursts to nearly 30 feet, many of which broke and dislodged segments of the sinter platform built around the edges of the spring, and continued irregular eruptions through the fall. The last known eruption of Silex occurred on November 22, 1979.

**Electronic monitoring.** An increase in temperature in a geyser runoff-channel, as recorded by a remotely deployed thermal probe, is a direct surrogate for measuring eruption times and intervals. Continuous records of eruption intervals and durations provide baseline measurements that are a prerequisite for the development of a geothermal monitoring plan. Moreover, the ability to predict eruption times, which can be improved by having comprehensive data sets of eruption intervals, is necessary for the interpretive staff and visitor inquiries. Efforts were made during summer 2000 to increase the number of deployable continuous recorders on selected thermal features throughout the geyser basins to about 25. The instruments are visited regularly by thermal volunteers, interpretive staff, or

the geothermal geologist for retrieval of data that can be processed to provide eruption duration and interval information.

Interval data for Echinus Geyser in the Norris Basin show the irregularity of eruptions (Figure 4). For a 15-day period during July, eruption intervals ranged from about one hour, 20 minutes, to nearly four hours. Old Faithful Geyser has historically shown a strong bimodal tendency for eruption intervals. Long duration eruptions tended to generate a long interval of 80 to 90 minutes, and a short duration eruption generally led to a short interval of about 60 minutes. In recent years, Old Faithful has shown a strong trend towards displaying long intervals only. For a three-week period in November, only four intervals out of 362 were short (Figure 5). The current median eruption interval is 88 minutes with a standard deviation of only six minutes.

The expanded ability to remotely monitor thermal features will permit identification of change in the park's hydrothermal systems. The data may indicate long-term changes in system dynamics, help predict hydrothermal explosion hazards, and provide updates for the interpretive staff and visitor inquiries.

**Yellowstone Lake thermal features.** The supervisory geologist worked with geoscientists Lisa Morgan and Pat Shanks (USGS) as they continued their investigations into hydrothermal features in Yellowstone Lake. Bathymetric and video surveys of the West Thumb area expanded previous surveys (1999) in the northern part of the lake. Preliminary interpretations from the 2000 field season include the identification and mapping of previously undocumented hydrothermal explosion craters, extending the mapped leading edges of Yellowstone Plateau rhyolite flows (tentatively the Elephant Back, Aster Creek, West Thumb, and Dry Creek flows), and identification of small domal features, perhaps associated with hydrothermal fluids.

**Thermal volunteers.** Lynn Stephens contributed more than 1,000 hours to geothermal monitoring, primarily by compiling a database of geyser eruption times and intervals. Ralph Taylor spent nearly 1,000 hours on the deployment of continuous monitors on selected geysers and the protection and cleaning of thermal features throughout the park. Mary Beth Schwartz contributed over 700 hours making detailed observations of the Grand Geyser Group. James Grigg contributed his time for thermal monitoring and resource protection, particularly in Pott's Basin.

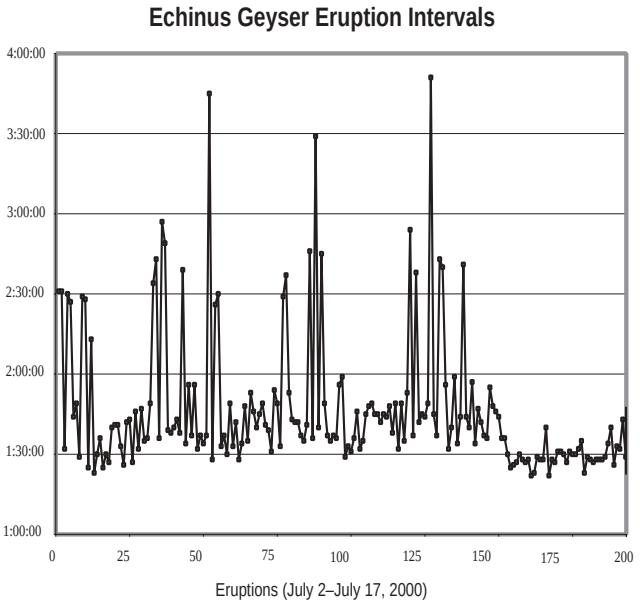



*Figure 4. Interval data for Echinus Geyser in the Norris Geyser Basin for a two-week period in July 2000 show the current level of irregularity of eruptions (data processed by Ralph Taylor, VIP).*

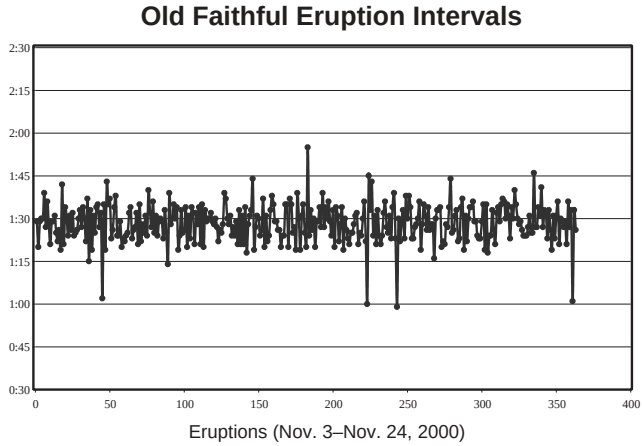



*Figure 5. Interval data for Old Faithful Geyser in the Upper Geyser Basin, for a three-week period in November 2000, show the current dominance of long intervals between eruptions (data processed by Tom Hougham).*

## *Paleontology*

During 2000, the park's cultural resource technician, Elaine Hale, continued to assist the Branch of Natural Resources with inventory and documentation of the park's fossil resources. Hale, NPS paleontologist Vince Santucci, and the supervisory geologist met to discuss the park's fossil resources and possible funding sources for development of a park paleontology program. A proposal for a two-year study of the Cenozoic and Mesozoic fossiliferous exposures and the stratigraphy on Mount Everts was submitted to the Intermountain Region

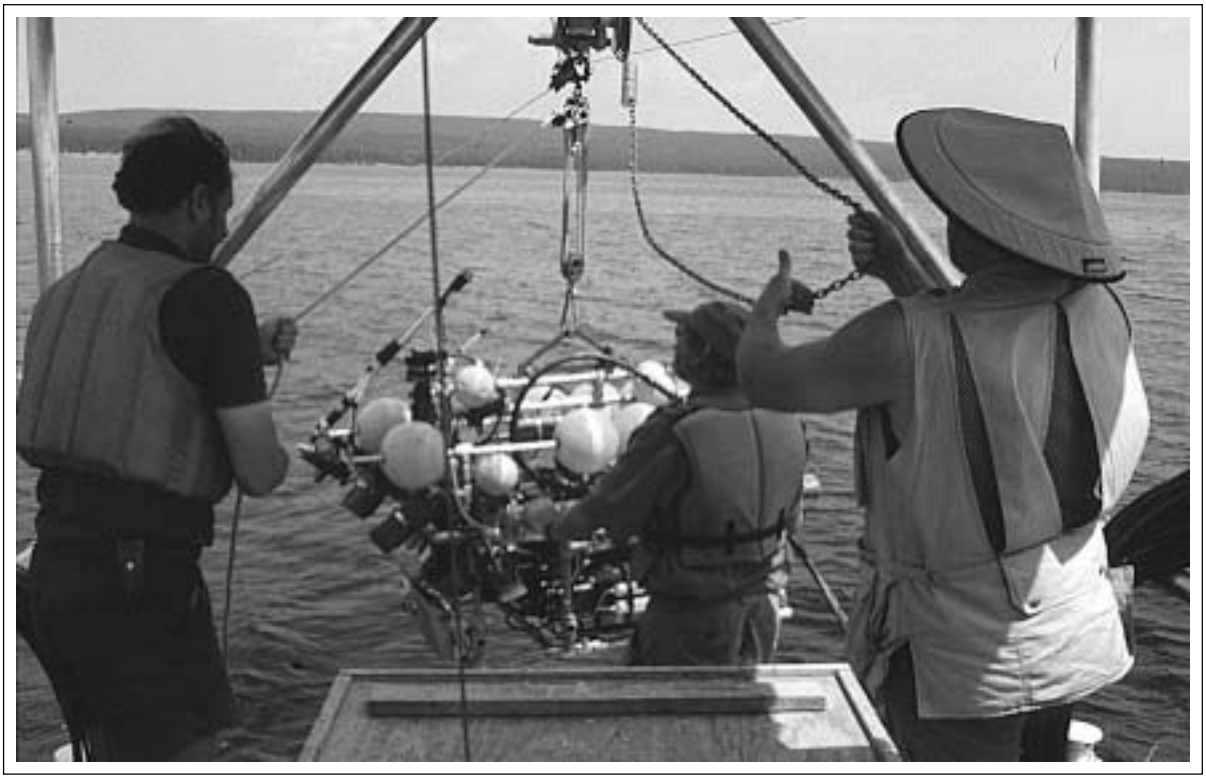
and was awarded $29,100 in funding for fiscal years 2001 and 2002. A funding request for paleontological resource surveys of known fossil localities was well-received by the Yellowstone Park Foundation early in 2000, and the foundation is soliciting funds to support the summer 2001 fieldwork.

**Volunteer efforts.** Dr. Thomas (Les) Reeves began a volunteer project in February to inventory fossils that have been collected in YNP and stored outside the park. Review of the park's research permit files identified the principal investigators, the specimens collected, the institution responsible for the collection, and any related reports that have been published. An updated bibliography expands on that previously included in *The Yellowstone Paleontological Survey*. Information concerning ongoing microbial fossil research is being separately collected and will be added to the database later. The project will be completed in 2001 when each institution holding a YNP fossil will be requested to provide information describing the specimen and locality from which it was collected. This will provide YNP with the information needed for museum record management, resource management and protection, and further research.

A proposal to relocate the trail at Daly Creek in the northwest region of the park provided an opportunity for volunteers Kamiah DeMarnier and Geneva Plumb to document the petrified sequoia forest, remnants of the Eocene epoch, located along it.

**Visiting investigators.** Nancy Ward, a park civil engineer, identified a fossil site at an eroding locality along the Yellowstone River while fishing in 1999 and led a YNP resource team there. In June of 2000, Vincent Santucci, the NPS paleontologist at Fossil Butte, assessed a representative sampling of fossil leaf specimens collected from the site. Preliminary identification of the leaves indicates the area is a Paleocene/Eocene flora site formed between 65 and 45 million years ago. The site provides important information about paleoclimates in the park and will be considered for documentation and further investigation. For three days, Santucci was joined by Ward, volunteer Les Reeves, and cultural resources staff members Elaine Hale and curator Susan Kraft in assessing the need for documentation and protection at other known fossil localities on Specimen Ridge, Pebble Creek, and Mt. Everts.

William P. Wall, a professor at Georgia College, and a group of graduate students inventoried the rock outcrops to be affected by the widening of the East Entrance Road, and an area in the Hoodoo Basin area on the east boundary of the park because fossils had been found in a similar geologic setting just east of

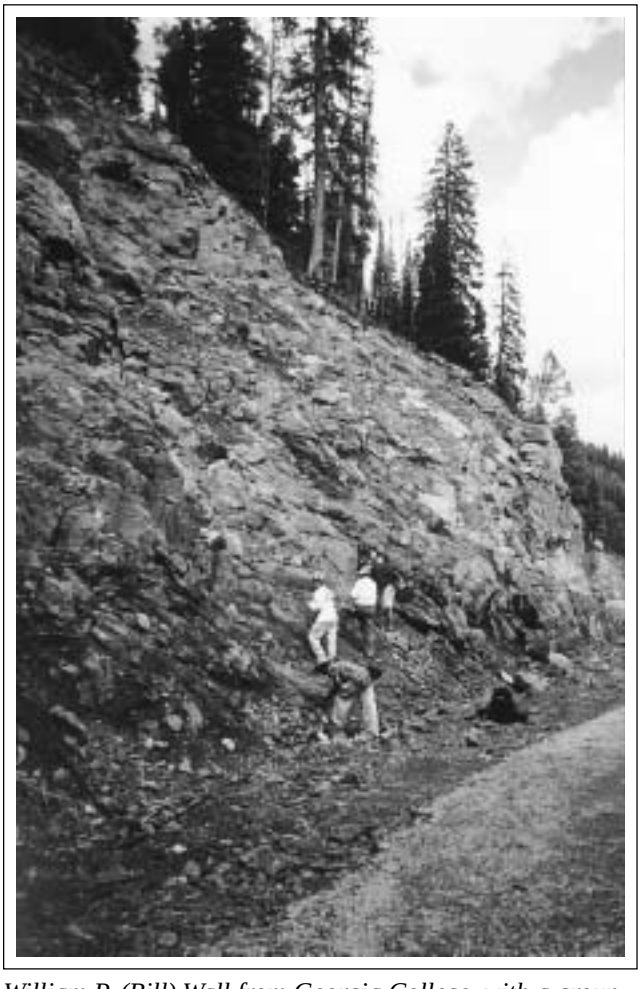


*USGS geoscientists during their summer 2000 investigations of lake-bottom hydrothermal features in Yellowstone Lake.*

the park in the Shoshone National Forest. Wall's group did not locate any fossils, but they did identify three low-energy volcanic mudflow areas along the East Entrance Road and reported them to the YNP road team and Federal Highway Administration personnel for monitoring during construction.

Lorin Amidon, a Ph.D. candidate at Dartmouth College, conducted research on fossil soils located in the Lamar River Formation in the Specimen Ridge area accompanied by YCR research technician Michelle LeBeau.

**New fossil localities.** Craig Whitman of the Interagency Grizzly Bear Study Team provided locations, photographs, and a written description of a fossil locality he identified on the Buffalo Plateau that contains fossil coral and the first ammonites recorded in the park. While removing debris from the road, a maintenance crew salvaged a fern-like imprint of a Metasequoia fossil. The previously unknown fossil occurrence also contained petrified wood. An interpretation staff member located a horn coral (Rugosa) fossil locality in a Paleozoic sedimentary unit north of the Pebble Creek area. This area will be revisited in 2001 to document the fossil locality and the fossil bearing geologic formation.



*William P. (Bill) Wall from Georgia College, with a group of graduate students, conducting a pedestrian inventory of the rock outcrops to be affected by the widening of the East Entrance Road.*

### *Presentations and Workshops*

The supervisory geologist made a keynote presentation at an interagency science meeting held in Mammoth in September 2000 and presented an invited talk at the national meeting of the Geological Society of America in Reno, Nevada. That presentation was intended as a form of peer review for the proposed structure of geological resource management in YNP.

The supervisory and geothermal geologists presented talks at a workshop held at Lassen Volcanic Park in California that tackled the problems of resource protection, interpretation, and research at national parks in volcanic terranes. The supervisory geologist represented YNP at the Plate Boundary Observatory workshop in Palm Springs, California, on large-scale initiatives to monitor seismic and volcanic activity in the West. Both geothermal geologists led educational activities in the park including school and college group tours.

## VEGETATION

### *Plant Inventories*

Summer fieldwork focused on rare plant surveys associated with construction projects, primarily the road from the East Entrance to Sylvan Pass. In addition, possible trail reroutes were surveyed to prevent inadvertent impacts on species of special concern. Trail sections examined included the proposed revegetation of the social trail from Bubbling Beach at Shoshone Geyser Basin, the trail to Tower Falls, the southern portion of the Red Creek trail, and a major reroute near Beaver Creek. During the summer field season, 19 new sites were located for "species of special concern" or rare plants, and about 15 known rare plant sites were examined opportunistically in order to determine the persistence of the species of special concern at those sites.

**New native plants.** As a result of new collections and clarifications, five new native vascular plant species were confirmed within the park.

- *Astragalus inflexus* Dougl. ex Hook. (bent milk-vetch), *Orogenia linearifolia* Wats.

(linear-leaved orogenia), and *Polygonum minimum* Wats. (broadleaf knotweed) were all located, apparently for the first time, in the park and are presumed to have been long-term components of Yellowstone's flora that have been previously overlooked.

- The presence of *Antennaria lanata* (Hook.) Greene (woolly pussy-toes) was confirmed after it was discovered that a previous report of the species was apparently based on a specimen in the park herbarium that had been collected outside the park on the Beartooth Plateau.
- *Townsendia condensata* Parry ex Gray var. *condensata* (cushion townsendia), whose presence in the park had previously been based on a misidentification of a different species of townsendia in the park herbarium, was located on the Absaroka Divide just inside the park boundary.

**New exotic plants.** Six new exotic vascular plant species were documented to occur in the park during the summer of 2000, primarily in developed areas and along the roadsides.

- West District resource management personnel found and eradicated one plant of *Ambrosia artemisiifolia* L. (annual ragweed) on the Grand Loop Road between Madison Junction and Norris.
- A mature specimen of *Arctium lappa* L. (great burdock) that was found flowering and with developing fruits along the road between Mammoth and Gardiner was eradicated before any seed dispersed. Until this discovery, it was assumed that any vegetative burdock material found in the park was *Arctium minus* (Hill) Bernh., the more common exotic species. But it is unknown whether *Arctium minus* is present in the park, since all other burdock plants have been eradicated as leaf rosettes, which are impossible to determine to species.
- A small patch of asparagus (*Asparagus officinalis* L.) was found growing in an area near Reese Creek that is associated with ranching/farming activities conducted before the boundary line area was added to the park. The asparagus apparently perpetuated itself either by long-term persistence (more than 60 years) or by reseeding.
- A patch of *Astragalus cicer* L. (chick-pea milk-vetch) about two meters square was located in scree near Sylvan Pass. The Wyoming Highway Department has apparently used this perennial species in revegetation seed mixes near the park. It has an extensive underground rhizome system, and casual observations outside of the park suggest that it may be highly invasive.
- Seasonal employees working on wetland delineation collected a new species of rush, *Juncus compressus* Jacq. (compressed rush) in a wetland on the east side of Sylvan Pass. However, the site where it was collected could not be relocated so continued vigilance will be needed to spot and eradicate this species.
- A small infestation of *Tamarix chinensis* Loureiro (tamarisk) was located by South District resource management personnel on an island in the Snake River by the South Entrance. The presence of this highly invasive shrub on the Snake River suggests that it could invade other habitats in the park.

**Checklist of vascular plants.** As a result of the NPS biological inventory initiative, an updated checklist of vascular plants for Yellowstone National Park was drafted that for the first time includes varieties and subspecies. Taxa on the list for which specimens have been verified have been entered into the NPS species database; this includes all catalogued herbarium specimens housed in the park, which account for 76 percent of the taxa on the list. Other flora on the checklist will be added to the database as unprocessed material at the herbarium and specimens housed at other institutions are documented.

**Alpine vegetation study.** A study to characterize alpine vegetation on volcanic substrates in the northeast corner of the park was initiated in 2000 as a Montana State University master's thesis. It is the first extensive plant ecological work to be done in the park's alpine zone.

### *Vegetation Management and Research*

**Hazard tree removal.** The management biologist assisted resource management and concessions staff in hazard tree identification and removal in the Indian Creek Campground, along the Mammoth-to-Norris and Norris-to-Canyon road corridors, and in the Lake concessions trailer court. He also

*Aerial view from the south boundary of Yellowstone looking south/southeast on the afternoon of August 16. In the central foreground is the Boundary Fire in the park; left foreground is the Glade Fire in Grand Teton National Park (GTNP) and right foreground is the Hecktman Fire in the Targhee National Forest. Smoke plumes from two other fires in southern GTNP are evident in the upper right corner, while the smoke plume from the Enos Fire in the Bridger-Teton National Forest is evident in the upper left corner.*

attended a hazard tree training course taught by the USDA Forest Pest Management Office in Missoula, Montana.

**Fire management.** The management biologist served as the contracting officer and liaison with Dr. Ron Wakimoto and graduate student Kris Sanders of the University of Montana, the Boise Interagency Fire Center, and Yellowstone's fire management program on a $22,000 grant to assess the utility of FARSITE fire behavior models in comparing model outputs with the known behavior of fires in Yellowstone.

The management biologist also served as the fire behavior analyst for fire management efforts during the active 2000 fire season. This included providing daily updates of fire spread and predicting long- and short-range fire behavior; compiling fire weather and fire behavior forecasts for daily tactical operations and shift plans; and sharing such information with public affairs and neighboring land management agencies. In all, 7,200 acres burned during the 2000 fire season.

The management biologist contributed to fuels management efforts by conducting a GIS-based analysis of fuel loadings around developed areas, and subsequently prioritizing developed areas for fuels treatments.

The management biologist also served as the staff fire ecologist, speaking to 20 different educational, professional, and international groups. As an invited speaker before the governor's Upper Yellowstone River Task Force, the management biologist spoke on fire behavior and ecology in the Yellowstone ecosystem. The management biologist regularly confers with fire management personnel regarding the collection and analysis of an array of fire-related data.

**Pest management.** Annual pesticide use proposals and pesticide use logs were compiled as part of the parkwide integrated pest management (IPM) operation. The IPM coordinator received and responded to 22 different pest complaints related to insects (15), small mammals (4), bats (2), and small birds (1), providing mitigating actions for each complaint. One such effort involved a rodent survey and exclusion efforts at a facility in the YCC camp, yielding 3,990 trap-nights.

The management biologist continued with the research and evaluation of historic forest insect outbreaks and management responses in Yellowstone National Park. This work is being done with a retired entomologist (M.M. Furniss) in conjunction with the University of Idaho, and resulted in revisiting and rephotographing a number of sites throughout Yellowstone and the surrounding area. A manuscript was compiled for submission to a major scientific journal.

**Exotic species.** Inventory and control information was compiled on exotic plant species for a presentation at the fifth biennial science conference and submitted for publication to the *Western North American Naturalist.*

The management biologist supervised two seasonal employees in the establishment and sampling of field exclosures as part of an overall site reclamation effort in the "triangle" area of the park adjacent to Gardiner, Montana. A factorial ANOVA experimental design using fencing, watering, mulching, and herbicide application was employed to assess non-native plant control and concurrent attempts to germinate and establish native plant species.

**Aspen.** The management biologist cooperated with Oregon State University researcher Dr. William Ripple to establish aspen monitoring transects inside and outside established wolf territories to quantify baseline vegetation conditions. These transects will be sampled over time to document vegetation changes, if any, that may be a result of reduced browsing pressure by elk in response to the presence

of wolves. The results of initial transect establishment were submitted and accepted for publication in *Biological Conservation.*

The management biologist also presented the results of research into postfire aspen root biomass and sucker production at a symposium on sustaining aspen in western landscapes.

## Wildlife Resources

The Wildlife Resources Team (WRT) is an assemblage of wildlife biologists, biological technicians, administrative assistants, and volunteers within the Yellowstone Center for Resources that works to achieve the mission of the National Park Service and Yellowstone National Park. During 2000, the WRT conducted a broad array of wildlife resource management, monitoring, and research activities, with principal emphasis on issues relevant to bear, bird, bison, other ungulates, and wolf conservation, as described below. Of special note:

- Staff work that led to the issuance of a federal Interagency Record of Decision for long-term bison management.
- Continued monitoring of threatened and sensitive species populations.
- Creative new fundraising and partnerships for mission-critical wildlife ecology research.
- Leadership in bear management practices that enabled YNP to continue to have the lowest rate of negative human–bear interactions in the greater Yellowstone area.
- Inventorying of herptile species richness, abundance, and distribution.
- Research on large and meso-predator life-history and predator–prey interactions; the habitat use, population demographics, and vital rates of northern range ungulates; multi-trophic level responses to restoration of the gray wolf; and epidemiology and pathogenesis of *Brucella abortus*.
- Collaboration with the park's environmental education staff to make wildlife-related presentations to park visitors.

The team worked with private sector and competitive fund sources to supplement the FY2000 park base allocation of $667,000 with funds that brought the total operational budget to $1,090,000. In December, permission was received to add two new permanent GS-11 wildlife biologist positions to the team to provide additional expertise for bison and meso-carnivore conservation management.

### *Bears*

Yellowstone National Park protects and maintains populations of grizzly bears (*Ursus arctos*) and black bears (*Ursus americanus*) as part of the park's native fauna and for providing park visitors the opportunity to safely enjoy the park's natural resources. The Interpretive, Maintenance, Resource Management Operations and Visitor Protection, and Yellowstone Center for Resources divisions each have staff who contribute to management efforts designed to reduce or prevent the chances of bear-inflicted human injuries, bear-caused property damages, and human-caused bear mortalities. To be successful, bear management must be a parkwide, multi-divisional effort.

The Bear Management Office (BMO) coordinates implementation of the park's Bear Management Plan and records data related to bear management activities in the park. Yellowstone is a member of the Interagency Grizzly Bear Study Team (IGBST), and staff assist with ecosystem-wide grizzly bear policy recommendations designed to ensure scientifically-based resource decisions. In addition, the BMO is responsible for the oversight of nuisance wildlife management and for wildlife disease, wildlife DNA, and rare mammal monitoring. In 2000, the BMO consisted of one permanent biologist, one term technician, two seasonal technicians, and one seasonal volunteer biological technician.

**Population monitoring.**

***Bear sightings.—***There were 1,166 bear sighting reports recorded in YNP in 2000. These reports included 551 observations of grizzly bears, 417 of black bears, and 42 of unidentified species of bear. In addition, there were 100 observations of grizzly bear sign, 11 observations of black bear sign, and 45 observations of sign from unidentified species of bear. The first recorded grizzly bear activity of the year was an aerial observation on March 3 in lower Cottongrass Creek. The first recorded black bear activity in 2000 was an aerial observation north of Druid Peak on March 1. The last recorded black bear activity was a visual observation on December 19 in the Biscuit Basin area. The last recorded grizzly bear activity of the year was a bear running down the road at Mud Volcano on December 6. Two grizzly bear sightings and one black bear sighting occurred in early January of 2001, which would be counted towards pre-denning activity and fall into the 2000

bear season. All three of these sightings were located in the Lamar Valley area.

***Grizzly females with cubs.—***As part of grizzly bear population monitoring in the ecosystem the IGBST counts the number of adult female grizzly bears with cubs-of-the-year (COY) each year. Adult female grizzly bears with COY are the most reliable segment of the population to count. The smaller average home range sizes of females with COY, as well as the number of cubs per litter and pelage-color combinations of different family groups, aid in identifying individual adult females.

In the GYA, 37 female grizzly bears with 74 COY were counted in 2000. Of these, 14 different female grizzly bears and 26 COY were observed in YNP by experienced bear observers. The average litter size in the park was 1.9 cubs per litter. Grizzly bear family groups observed in YNP included 3 one-cub litters, 10 two-cub litters, and 1 three-cub litter. Some of these females had home ranges entirely within the boundaries of the park. Others had home ranges that over-lapped the park boundary.

***Observation flights.—***In 2000, as part of the IGBST grizzly bear population monitoring program, the BMO conducted two series of aerial observation flights in the Lamar, Pelican/Clear Creek, Two Ocean Plateau, Washburn, and Firehole/Hayden bear management units. Due to weather related events the Two Ocean Plateau unit was unable to be flown during the first series of flights. During the first series of flights (20.3 observation hours) in the four other units, eight grizzly bears were observed in four groups. The mean group size was 2.0 bears/group. None of the observed grizzly bears were radio-marked. Three black bears were observed during the first round of observation flights. During the second series of observation flights (27.3 observation hours) that included all five units, 26 grizzly bears were observed in 14 groups. Mean group size was 1.7 bears/group. None of the observed bears was radio-collared. There were two black bears observed during the second series of flights. The lack of marked groups of bears observed in the two series of flights suggests that either collared bears avoid detection from overhead flights or that only a small proportion of the bears in the park are radio-marked. The IGBST will use this data along with observation flight data collected from outside of the park to calculate a minimum population estimate for grizzly bears in the Yellowstone ecosystem.

***Bear mortality.—***There were two known grizzly bear mortalities and two known black bear mortalities within YNP in 2000. Both of the grizzly bear mortalities were due to natural factors. One of the mortalities was from an unknown/natural cause while the other was a possible predation by wolves or an adult bear. Both bear carcasses were too old by the time they were discovered to determine the exact cause of death. Both black bear mortalities also appeared to be from natural causes.

*Grizzly bear near the top of one of the park's historic apple trees. Photo by Kerry Gunther.*

On May 30, 2000, the hide of a small grizzly bear was discovered by a Gardiner, Montana, resident photographer while hiking in the Sulphur Mountain area. He reported the hide as suspiciously missing the head and paws and was concerned that it was a possible poaching. Multiple attempts by Lake and Canyon resource management personnel to find the hide via a verbal description provided by the photographer were unsuccessful. On July 16, 2000, BMO personnel recovered the hide in the company of the photographer. The hide contained only the rump, back, hump, and portions of the hind legs. The hide

*Black bear "jam" at Rainy Lake. Photo by Darren Ireland.*

was estimated to be from a cub-of-the-year that died the previous fall or a yearling that had died that spring.

On September 20, 2000, a dead subadult grizzly bear was observed during a wolf observation flight over the upper Spruce Creek area. The bear was observed with a wolf standing over it and the rest of the wolf pack (Nez Perce pack) bedded nearby. It was unclear at the time if the wolf pack had killed the bear or just happened upon the carcass. On September 21, 2000, BMO and IGBST personnel hiked to the location but were unable to find the carcass. On October 8, 2000, IGBST personnel returned to the site and found a hair pile and possibly a baculum, suggesting the bear was a male, but no other sign of the carcass.

A note left on the Tower Ranger Station front door on August 31, 2000, reported a black bear carcass along the spur trail to backcountry campsite 1Y9. BMO personnel found the carcass of an old adult black bear on September 6, 2000. Sex and cause of death were unable to be determined from the mostly decayed carcass. Claws from both hind feet and one front foot were missing. The remaining claws and skull were collected and the carcass was moved away from the campsite so the site could be reopened.

On October 29, 2000, rangers on the South Boundary trail discovered an old bear skull under a log just off the trail. Tooth measurements of the length of maxillary molar indicated the skull was from a black bear. The molar length was 23 mm; grizzly bear second maxillary molars are usually longer than 28 mm. The condition of the skull suggests that the bear had been dead for several years.

**Availability of bear foods.** Despite the below-average abundance of many bear foods in 2000, the overall availability of foods was considered to be above average throughout most of the active bear season. The winter of 1999–2000 was mild, resulting in below average number of winter-killed elk (*Cervus elaphus*) and bison (*Bison bison*) carcasses. The summer was hot and dry causing vegetal foods to dessicate early. Although the current years production of whitebark pine (*Pinus albicaulis*) seeds in the fall was also below average, there was an abundance of over-wintered whitebark pine seeds left from the above average cone production of the previous year. Grizzly bears fed on the over-wintered whitebark pine seeds throughout the late spring, summer, and well into the fall season.

The winter of 1999–2000 was considered to be a fairly normal, mild winter in the Madison/Firehole and the upper and lower northern winter ranges.

During early to mid-spring, scavenging the relatively few ungulate carcasses available and digging earthworms were the most frequently observed grizzly bear feeding activities. During spring, grizzly bears also dug up pocket gopher (*Thomomys talpoides*) caches in localized areas where they were abundant.

Elk calves, normally an important late spring and early summer food source, did not appear to be preyed upon as extensively by bears as in past years. Instead grizzly bears dug up red squirrel (*Tamiasciurus hudsonicus*) middens and fed on the whitebark pine seeds from the previous fall. The numbers of spawning cutthroat trout (*Oncorhynchus clarki*) counted in Yellowstone Lake tributaries were similar to the long-term averages (1989–1998) on most streams except for those in the West Thumb area, which were below average. Spawning cutthroat trout are available to bears with home ranges adjacent to

Yellowstone Lake during the late spring and early summer. Trout are one of the highest sources of net digestible energy available to bears in the ecosystem.

Throughout the summer season, grizzly bears grazed clover (*Trifolium* spp.) and dug root foods where abundant. Army cutworm moths (*Euxoa auxiliaris*), were present and attracted large numbers of bears to high-elevation moth aggregation sites on the eastern side of the ecosystem.

The production of whitebark pine cones during the fall, was below average in most of the park. Deaf Jim Knob was the exception. Whitebark pine seeds are an important fall food source because of their high fat content and potential abundance as a prehibernation food source.

**Grizzly bear food sources.** Ungulates, mostly elk and bison, cutthroat trout, and whitebark pine nuts have been identified as three of the highest sources of net digestible energy available to grizzly bears in the park. The annual availability of these food sources is monitored by YNP staff.

***Winter-killed ungulate carcasses.—***The Yellowstone ecosystem is unique among areas inhabited by grizzly bears in North America because of the substantial use of ungulates as food during the spring season, as indicated by analysis of bear scats, bear feed sites, and bear hair. On average, approximately 79 percent of the energy obtained by adult male and 45 percent of the energy obtained by adult female grizzly bears in the Yellowstone ecosystem is estimated to come from meat. In contrast, in Glacier National Park, over 95 percent of the energy obtained by both adult male and female grizzly bears comes from vegetation. Ungulates rank as the second highest source of net digestible energy available to grizzly bears in the Yellowstone ecosystem. Ungulates are also important to bears because they provide a high quality food source during early spring before most vegetal foods become available. Grizzly bears feed on ungulates primarily as winter-killed carrion from March through May.

*The photo on the left shows a grizzly bear earthworm dig at Heart Lake, and on the right a grizzly bear digging in a talus rock slope for Army cutworm moths. Photos by Kerry Gunther.*

Between the beginning of April and mid-May each year, the BMO surveys 26 total routes covering 78.9 km of winter range in the Firehole River drainage, 19.8 km in the Norris Geyser Basin, 32.0 km in the Heart Lake area, and 215.5 km on the Northern Winter Range for winter-killed ungulate carcasses. Survey routes are hiked, snowshoed, or skied by teams of at least two people. All ungulate carcasses, as well as bears and bear sign (tracks, scat, feeding sign) observed from the survey routes, are recorded. Data collected include species, sex, and age class of carcasses located, evidence of scavenging or predation by grizzly bears, black bears, and other carnivores, and UTM locations of carcasses. In 2000, four bison carcasses, 43 elk carcasses, and one mule deer carcass were documented along the 270.9 km of survey routes completed.

The overall rate of one ungulate carcass observed per 8.8 km of survey route in the areas of thermally influenced ungulate winter range (Firehole thermal area, Norris Geyser Basin, and Heart Lake area) recorded in 2000, was lower than the long-term average of one large mammal carcass observed per 6.3 km of survey route recorded from 1992 to 1999. The northern winter range carcass surveys have been conducted under the current format for only three years and therefore a long-term average has not yet been established.

***Cutthroat trout spawning.—***Grizzly bears are known to prey on cutthroat trout in at least 36 different streams tributary to Yellowstone Lake. Each year, beginning May 1, eight streams within or near the Lake developed area and four streams within or near the Grant Village area are checked daily to detect the presence of adult cutthroat trout. At the onset of spawning until most adult fish return to the lake, teams of two or more persons do weekly visual

counts of adult trout to estimate peak periods and relative magnitude of spawning runs. This data is used to manage visitor use and set opening dates for recreational facilities in the Lake and Grant Village developed areas, which are adjacent to clusters of spawning streams. Management of recreational activities in these areas is necessary to reduce the potential for bear-human conflict. In past years, bear predation on spawning cutthroat trout in Yellowstone Lake tributaries within or near park developed areas has led to conflicts between humans and bears. While making fish counts, observers record bear sign (bear sightings, fish parts, hair, scats, and tracks). Tracks and track measurements are used to determine the number, species, and association of family groups of bears.

*Top photo: Staff hanging a chemical lure and setting up a grizzly hair corral. Photo on left shows a cutthroat trout partially consumed by a grizzly. Photos by Darren Ireland. The photo on the right shows evidence of grizzly bear geophagy (consumption of soil) in a geothermal basin in the Heart Lake area. Photo by Kerry Gunther.*

In 2000, a total of 904 spawning cutthroat trout were counted during the peak week in the 12 monitored frontcountry tributaries to Yellowstone Lake. Grizzly bear activity was observed on seven (58%) of these streams and black bear activity on six (50%). The number of spawners counted in each stream during the peak week in 2000 was similar to the long-term averages (1989–1999); except those streams in the West Thumb area, which were slightly below average.

***Whitebark pine seeds.—***During years with low availability of natural bear foods, especially in the fall, bears often seek alternate foods in association with human activities; both the number of bear–human conflicts and human-caused bear mortalities increase during the fall season. As part of an ecosystem-wide whitebark pine survey, cone counts are conducted at 19 whitebark pine transects located within the Yellowstone ecosystem. Park staff conduct cone counts on the 10 transects located within the park. Cone counts at these 10 transects averaged 3.2 (± 8.6 SD) cones per tree in 2000. This was lower than the long-term (1987–1999) average of 14.6 (± 33.5 SD) cones per tree, per year for all transects located within the park.

**Confrontations and conflicts with humans.**

***Confrontations.—***In 2000, there were 102 reported incidents of bear–human confrontations (incidents of actual or perceived aggression in which no one was hurt) in the park. Grizzly bears were involved in 46 of these confrontations and black bears were involved in 54. The species of bear could not be determined in two confrontations.

***Bear-inflicted human injuries.—***There were three bear-inflicted human injuries in Yellowstone in 2000. One injury was inflicted by a black bear and two were inflicted by grizzly bears. The two grizzly bear-caused human injuries recorded in 2000 were approximately equal to the 10-year average of 0.9 (± 1.3 SD) grizzly bear-inflicted human injuries re-

corded per year from 1990 to 1999. The one black bear-inflicted human injury was greater than the 10-year average of 0.1 (± 0.3 SD) per year recorded from 1990 to 1999.

On July 30, two 18 year-old males from Missouri began a day hike on the Avalanche Peak trail. When they stopped near treeline to take off their long sleeve shirts, they heard a rustling noise at the top of the hill just above them. They looked up and saw a bear standing on its hind legs while another smaller bear came up behind it. The larger bear dropped down on all fours and came toward the hikers as the smaller bear moved in the other direction. Both hikers then proceeded to drop to the ground and curl up in a defensive position (hands covering their heads and knees tucked in to their stomachs) as the bear approached. The larger bear came to the first hiker and bit his right hand and then moved away toward the other hiker. The bear sniffed the other hiker, circled both of them a couple times, and then moved away in a downhill direction. Neither hiker remembers the smaller bear coming near them during the encounter, but thought they could hear it rustling around nearby. After remaining on the ground until they no longer heard any noises they got up and began hiking back towards the trailhead.

Less than five minutes later they were walking through dense vegetation around a bend in the trail when they saw the bears again. Both hikers immediately fell to the ground again and assumed defensive positions. The larger bear, who was five to ten feet away, approached and circled them but did not make contact. This encounter lasted a shorter duration of time than the first encounter. After hearing no more noise for a couple minutes they stood up and remained at the site for about fifteen minutes while they attended to the injured hand. During this time, an off-duty park service employee arrived on the scene and radioed the communications centers to inform the local patrol rangers and BMO staff of the incident. The three then hiked back to the trailhead together. A park ranger met the two hikers when they arrived at the trailhead to treat the wounds and close the trail. One hiker sustained a puncture wound to his right wrist and abrasions to his right hand. The other was uninjured.

On August 12, after eating lunch, a couple from Sweden stopped to take a nap on the Ferris Fork Hot Spring trail approximately 0.5 miles from Three Rivers Meadows. The man was suddenly awakened by a tugging on his left hand. When he opened his eyes he saw an approximately 150 lb. reddish brown black bear biting his hand. In response he jumped to his feet causing the bear to let go and run away. The man suffered a small puncture wound to his left hand, which he treated, and he and his partner continued their backcountry trip. As the man was dressing his wound he noticed that he could still smell the "very stinky" cheese that he had eaten for lunch on his hand. He did not feel the bear acted aggressively, since it ran away as soon as he woke up. The Three Rivers Meadows region was closed due to a fire in the area by the time the hikers arrived at Old Faithful and reported the incident, so no other action was taken.

On September 1, a man on horseback that had been riding by himself on the Daly Creek trail stopped for lunch. The man stated that he was sitting under a tree trying to avoid heavy rainfall. His horse was hobbled nearby. He reported that while eating his lunch his horse snorted, he turned to his left and saw a grizzly bear "practically on top of him." The bear swatted him, knocking him face first into a tree. He tripped on his rain pants and landed face down with the bear straddling him. He got out his bear spray, rolled over, and sprayed the bear in the face and mouth. The bear rolled off of him coughing. He received minor abrasions to his cheek and forehead on the right side of his face from hitting the tree, but no injuries from the bear itself. His glasses were broken and his shirt torn. He received medical treatment and was released the same day.

***Bear-caused property damages.—***There were 13 reported incidents in which bears damaged property (but did not obtain human foods) in the park in 2000. Grizzly bears were involved in six of these incidents, black bears were involved in two, and the species of bear was unidentified in five incidents. The six grizzly bear-caused property damages reported in 2000 were significantly greater than the 10-year average of 1.8 (± 2.2 SD) grizzly bear-caused property damages per year reported from 1989 to 1999. The two black bear-caused property damages reported in 2000 were approximately equal to the 10-year average of 1.6 (± 1.1 SD) black bear-caused property damages per year reported from 1989 to 1999. The five property damages by bears of unidentified species reported in 2000 were greater than the 10-year average of 1.5 (± 1.8 SD) property damages per year by unidentified species reported from 1990 to 1999.

***Obtaining human foods.—***There were three incidents in which bears obtained human foods or garbage in the park in 2000. Two incidents involved

black bears and one involved a bear of unidentified species. The two incidents of black bears obtaining anthropogenic foods was approximately equal to the 10-year average of 2.3 (± 2.4 SD) incidents per year from 1990 to 1999. The one incident of an unidentified species of bear obtaining anthropogenic foods was approximately equal to the 10-year average of 0.5 (± 0.7 SD) incidents per year from 1990 to 1999. There were no incidents of grizzly bears obtaining anthropogenic foods, which was lower than the 10-year average of 1.9 (± 1.6 SD) incidents per year from 1990 to 1999.

**Bear management actions.** In 2000, there were 324 bear related incidents in which management action was taken, including:

- 11 postings of bear warnings at campsites, trails, or other areas;
- 14 temporary closures at campsites, trails, or other areas;
- 270 incidents where park rangers responded to roadside bear-jams to ensure the safety of park visitors;
- 28 incidents of management hazing of bears; and
- 1 incident where a black bear was trapped in a management action in a developed area in the park and translocated to a remote backcountry area.

Most (74%) bear management actions within the park occurred in the Lake (32%), Tower (26%), Mammoth (8%), and Grant (8%) subdistricts.

***Grizzly bear management captures/removals.—***There were no grizzly bears captured in management actions within YNP in 2000. This was lower than the 10-year average of 1.5 (± 1.6 SD) nuisance grizzly bears captured in management actions per year from 1990 to 1999.

No nuisance grizzly bears in YNP had to be captured and removed from the ecosystem in 2000. This was essentially equal to the 10-year average of 0.3 (± 0.5 SD) grizzly bears captured and removed per year from 1990 to 1999.

***Grizzly bears trapped outside of and relocated into YNP.—***In an effort to reduce bear–human conflicts and promote the conservation of grizzly bears in the ecosystem, YNP sometimes accepts some grizzly bears involved in bear–human conflicts in the states of Wyoming, Montana, and Idaho. In 2000 no grizzly bears from outside of the park were accepted for release into the park.

***Black bear management captures/removals.—***

*Capture, immobilization, and ear-tagging of a nuisance black bear from Canyon prior to helicopter translocation. Photo by Darren Ireland.*

There was one black bear captured in a management action within YNP in 2000. This was lower than the 10-year average of 0.6 (± 1.3 SD) nuisance black bears captured in management actions per year from 1990 to 1999.

The park did not accept any nuisance black bears from state agencies for relocation into the park in 2000. No nuisance black bears from YNP had to be captured and removed from the ecosystem in 2000. This was slightly less than the 10-year averages of 0.1 (± 0.3 SD) black bears captured and removed per year from 1990 to 1999.

***Bear-proof food storage boxes.—***Each summer visitors spend over 650,000 use nights camping in developed area campgrounds within YNP, and many campgrounds are located within or adjacent to high quality bear habitat. This can lead to bear–human conflicts. In order to reduce the chance of bear–human conflicts within campgrounds, the park installed bear-proof food storage boxes in the hiker/biker loops of park campgrounds because these visitors are generally not traveling with a vehicle in which to store their food. However, the number of bear-proof food storage boxes available in campground hiker/biker loops is not sufficient to accommodate large tour groups. In recent years, grizzly bears have obtained human foods from large bike tour groups camping in park campgrounds. Bears that obtain human foods from campgrounds are especially dangerous because they often become aggressive and may damage property and injure people, and eventually are removed from the population.

During the summer of 2000, the Bear Manage-

ment Office worked with YCC and maintenance staff to install 11 bear-proof food storage boxes. Eight of the boxes had been purchased through NRPP funds and three with park base funds. Three bear-proof food storage boxes were installed at Lewis Lake Campground, six at Pebble Creek Campground, and one each at the Mammoth and Indian Creek campgrounds.

## *Birds*

**Threatened and endangered species.**

***Bald eagle.—***In 1995, the U.S. Fish and Wildlife Service downlisted the bald eagle from endangered to threatened due to significant population gains made over the last three decades. Certain specific populations, however, are not completely recovered due to heavy metal contamination problems in the Great Lakes region, and habitat encroachment and development problems associated with riparian zones in the desert southwest. The Yellowstone bald eagle population continues to incrementally increase, with a new nest located on the northern range in 2000, and 18 eaglets fledged from 27 active nests.

Nest substrate instability as a result of the 1988 Yellowstone wildfires caused minimal problems. However, large numbers of trees are expected to fall in the coming decades, which could result in nest failure, loss of nest sites, and sudden changes in nesting territories. Occasionally bald eagles have been documented taking over previously occupied osprey nests, but the incidence appears to be gradually increasing due to competition for nest sites.

***Whooping crane.—***This endemic North American species continues to rank as the rarest and most endangered crane in the world. Current estimates place the wild population at 265 cranes and the captive population at 122 cranes (Figure 6). A 16-year-old female whooping crane that had been nesting in YNP died on March 15 after colliding with a powerline at Monte Vista National Wildlife Refuge in Colorado. Her carcass was salvaged and will be placed in a YNP museum educational exhibit. As of year-end, only two whooping cranes remained in the Rocky Mountains. One surviving crane from the original Gray's Lake experiment summered in the Centennial Valley of Montana, and the other, an "ultralight" crane, resided in eastern Idaho.

**Species of special concern.**

***Peregrine falcon.—***The peregrine falcon is managed as a species of special concern in YNP, which continues to be a stronghold for the species in the northern Rockies. Two new eyries were found in 2000, bringing the total number to 16, and the number of fledglings to 29. This is the most peregrine eyries and fledglings ever recorded in the park. The year 2000 marks the second year since the peregrine falcon was removed from the list of endangered species, and three more years of monitoring are required to fulfill federal requirements for full recovery.

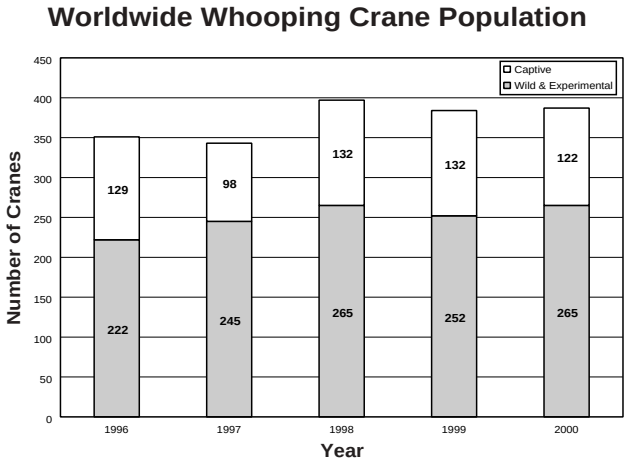



*Figure 6. Worldwide whooping crane population.*

***Trumpeter swan.—***The number of adult swans in the park has declined over the years; there were 20 in 2000, the same as in 1999. Swan recruits from Paradise Valley are the most likely reason that the Yellowstone swan population has stabilized. In recent years, nest attempts have ranged from four to 10 per year. There were seven nest attempts in 2000, compared with six in 1999 and nine in 1998. In 2000, seven cygnets fledged from two broods in the park. This was expected, since years with drought-like conditions are usually favorable for swan production. The last time this many cygnets fledged in the park was 1988, another drought year. Except for these anomalies, annual cygnet production has been scant during the last 13 years, ranging from zero to five cygnets.

***Molly Islands colonial nesting birds.—***The Molly Islands colonial nesting bird census was conducted in mid-May, early June, early August, and mid-September. The Molly Islands (two small islands named Rocky Island and Sandy Island due to the nature of the nesting substrate), are closed to all public entry because of the sensitivity of the area. The census techniques applied this year were consistent with those of the last several years; however, this year both boat and aerial surveys were employed.

*A pair of trumpeter swans on the Yellowstone River, December 2000. Photo by Terry McEneaney.*

Yellowstone Lake thawed out at the normal time in 2000, which was a banner year for colonial nesting bird production due to low water levels.

On the highest part of Rocky Island, 260 pelican nests were initiated in one aggregation. Double-crested cormorants constructed 110 nests within this pelican aggregation. As the season progressed, 230 American white pelican nests and 104 double-crested cormorant nests remained, and all were successful. Of the 140 pairs of California gulls that attempted to nest, 80 were successful in raising young. There was no Caspian tern activity on Rocky Island in 2000, probably due to the large numbers of gulls.

On Sandy Island, 98 American white pelican nests were initiated in two large aggregations, and 80 nesting pairs were successful in rearing 164 young. Neither double-crested cormorants nor Caspian terns nested on Sandy Island in 2000.

The total fledging count for the Molly Islands included 584 American white pelicans, 255 double-crested cormorants, and 152 California gulls. As the exotic lake trout management program continues on Yellowstone Lake, the status of the Molly Islands birds will play a critical role in assessing the impacts of this fish on endemic piscivorous bird species. At this time, however, lake trout do not appear to have adversely affected colonial nesting bird production. Climatic conditions continue to appear to be the most important factor influencing bird production on these islands.

***Osprey.—***The park's osprey population increased slightly in 2000, when 96 nesting pairs fledged 64 young, compared to 88 pairs fledging 62 young in 1999, and 87 pairs fledging 81 young in 1998 (Figure 7). Tree nest-site instability and weather continued to affect osprey productivity in the park. The incidence of bald eagles taking over osprey nest sites was documented at two sites.

***Harlequin duck.—***The harlequin duck population continues to vary slightly from year to year, with generally 16–20 pairs residing in the park. Monitoring annual productivity is not cost-effective, as data collection is extremely time-consuming and difficult due to the remoteness of many of the areas in which harlequins are found. Productivity is extremely variable from year to year and is highly influenced by weather and flooding.

***Common loon.—***The common loon population continues to fluctuate because of variable weather conditions, with the adult numbers ranging from 34 to 51 over the years. The low adult count in 2000 (34 loons) and moderate loon production (nine nest attempts with only eight fledglings) are a result of drought-like conditions.

**Birds added to park checklist.** Two new bird species were added to the Field Checklist of Birds of YNP in 2000. In August, several visitors reported a white-faced ibis in Hayden Valley. After careful examination of the bird, it was found to be an immature glossy ibis. This is the first record of this bird in the park. This species has been extending its range, particularly in the western United States. The staff ornithologist had observed an adult glossy ibis in Jackson, Wyoming, on May 4, 1999, which was the first record of this species in Wyoming.

On September 13, George Henley observed two dark parasitic jaegers 40 yards east of the Mt. Holmes lookout. Ravens were observed harassing the jaegers until they finally left the area.

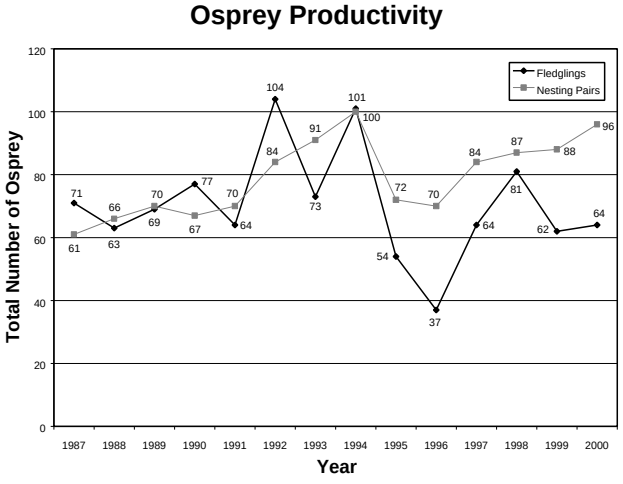



*Figure 7. Osprey productivity.*

As of 2000, 313 species of birds have been documented in the park since it was established in 1872. A revised bird checklist will be available by March 2001 and can be found on the park website.

*This immature glossy ibis is the first record of this species in YNP. Photo by Wayne Wolfersberger.*

### *Bison*

Free-ranging bison continued to thrive in the Yellowstone area, summering throughout the park and in some adjacent, high-elevation ranges, and migrating to winter range in geothermal areas and lower elevation grasslands both in and outside the park. Controversy has grown over the management of bison leaving the park in winter. Bison moving from the park onto public or private land in Montana have been shipped to slaughter or shot because some may carry brucellosis.

**Joint management plan.** On December 20, the National Park Service and the U.S. Department of Agriculture's Forest Service and Animal and Plant Health Inspection Service agreed on a joint management plan that is a slightly altered version of the plan presented in the final environmental impact statement (FEIS) that had been released in August. The State of Montana incorporated the FEIS into its own FEIS for bison management and signed their Record of Decision on December 22, which implements the same joint management plan as that agreed to by the federal agencies. It is designed to preserve the largest wild, free-ranging population of bison in the United States while managing the risk of brucellosis transmission between bison and cattle. The result of more than eight years of negotiation and seven months of mediation between the federal agencies and the State of Montana will:

- use adaptive management to provide for wild, free-ranging bison and protect cattle from the risk of brucellosis transmission, primarily through enforcement of spatial and temporal separation of bison and cattle on lands outside the park;
- maintain a spring bison population of up to 3,000 animals; and
- during winter when cattle are not present, allow very limited numbers of bison in three zones north and west of the park (Reese Creek, Eagle Creek/Bear Creek, and Horse Butte) that would be buffered with areas in which bison are not permitted.

By allowing bison the opportunity to seek winter range outside the park, the plan reflects a commitment on the part of the agencies to end the unnecessary killing of bison outside the park. The agencies also agreed to increase implementation of non-lethal management measures should severe winter conditions result in a large management removal or natural winter die-off. While the plan is not intended to be a brucellosis eradication plan, it employs many tools to manage and reduce the risk of brucellosis transmission from bison to cattle. Bison will not be allowed to intermingle with cattle and will be hazed back into the park when winter weather typically moderates in the spring (mid-April on the north side and mid-May on the west side). In an effort to further reduce the risk of transmission and protect cattle, all vaccination-eligible cattle in the north and west management zones must be vaccinated within one year, paid for by APHIS. Untested bison may be allowed outside the park in the north

*Bison calf nursing.*

and west boundary management zones after the agencies have had experience with seronegative bison in certain areas outside the park during winter and the National Park Service is able to initiate a safe and effective remote delivery system to vaccinate bison in the park.

About once a month, park staff conducted aerial surveys of the entire bison population. The high early winter count located 2,494 bison on October 24. No bison were killed or removed during the year as part of the bison management plan.

**Bison research.** Researchers continued testing vaccines for their safety in bison and in non-target wildlife including coyotes, pronghorn, mule deer, moose, bighorn sheep, birds, and rodents. In 1999 the RB51 vaccine was found to be safe in calf and yearling bison; in 2000, results showed that the vaccine does not cause mortality or morbidity in non-target species.

Funding from the U.S. Geological Survey is supporting several multi-year bison research projects including: bison ecology in Hayden Valley, reproduction and demography of brucellosis infected bison, epidemiology and pathogenesis of brucellosis in bison, genetic analyses of *Brucella* and development of a PCR-based diagnostic system, and continuation of *Brucella* vaccine safety trials in non-target species. A study is underway in cooperation with the Fish and Wildlife program at Montana State University to develop methods for conducting aerial surveys that will provide scientifically based bison population estimates, including correction factors that will account for the proportion of animals not observed during the surveys.

### *Elk and Other Ungulates*

Yellowstone National Park staff again shared costs and duties with the Northern Yellowstone Cooperative Wildlife Working Group (the National Park Service; Montana Department of Fish, Wildlife and Parks; USDA Forest Service; and USGS Biological Resources Division) to complete counts of ungulate herds on the northern range.

**Elk.** The northern range elk survey, completed on December 21, counted a total of 13,400 elk, 11,282 inside and 2,118 outside YNP. During flights conducted in and outside the park on March 4 and 5, park staff found 23 calves per 100 cows, which is within the range observed in late winter classification surveys over the last five years. The ratio of bulls to cows was also 23:100, which is the lowest ratio observed in the last five years. These results should be interpreted as an index of population structure rather than as an absolute measure of sex and age ratios.

**Mule deer.** A helicopter survey of mule deer on the northern range in and outside the park conducted by the Montana Department of Fish, Wildlife and Parks on April 26 and 27 counted 1,863 mule deer, slightly more than the 1,677 counted in 1999. Mule deer recruitment was estimated to be 54 fawns per 100 adults in 2000, compared to 46 fawns per 100 adults in 1999.

**Pronghorn.** A late winter survey of pronghorn conducted on April 3 counted 205 pronghorn antelope, nearly identical to the March 1999 count of 204 pronghorn. An attempt to evaluate aerial count accuracy by comparing the result to those of a simultaneous ground count conducted by locating radio-collared animals found that the two methods may have very similar counts. Two park volunteers conducted road surveys for the sixth consecutive year to assess pronghorn distribution and evaluate the possible effects of bison management activities on pronghorn. However, there had been no bison management activities in the Stephens Creek area by year-end for the 2000–2001 winter.

On March 16, park staff captured and radio-collared four pronghorn between Mammoth and Gardiner, Montana, for two research projects, bringing the total number of pronghorn with active collars to 22. (In February 1999, 30 female pronghorn were collared.) One project is attempting to determine the birth and survival rates of pronghorn fawns and assess the causes and timing of fawn mortality, and

*Mule deer in winter.*

*A bighorn sheep pawing through snow for vegetation.*

doe nutritional condition and stress. Another study is assessing habitat use patterns of radio-collared pronghorn.

During the late summer pronghorn composition survey on August 12, 82 pronghorn were counted (34% of the total estimated population): 56 does, 14 bucks, and 12 fawns. The fawn to doe ratio was 21:100, compared to 27:100 in 1999; and the buck to doe ratio was 25:100, compared to 22:100 in 1999.

**Bighorn sheep.** During the annual helicopter survey on April 26 and 27, the Montana Department of Fish, Wildlife and Parks located 150 bighorn sheep (75 ewes, 22 lambs, and 53 rams) in and outside the park. This count was 31 (17%) below the 1999 survey and 34 (18%) below the six-year mean of 184 bighorns. Lamb recruitment for the entire survey area in 2000 was 29 lambs/100 ewes, compared to 32 lambs/100 ewes in 1999. During the annual ground count on December 14, 40 bighorn (12 rams, 22 ewes, and 6 lambs) were observed with 27 lambs and 55 rams per 100 ewes. Although the Northern Yellowstone Cooperative Wildlife Working Group concluded that ground counts are less reliable than aerial counts for monitoring the total population, they have continued to conduct ground counts which permit closer observations of bighorns' physical condition and age.

### *Lynx*

Historically, persecution and destruction of habitat drastically reduced lynx numbers in the coterminous U.S. In 2000, the U.S. Fish and Wildlife Service listed the lynx as a threatened species. Despite evidence that lynx historically and currently have been present in YNP, little effort had been made to document their numbers and distribution, but in 1999 park staff began preparing a study plan and funding proposals. In 2000, park staff used a GIS-based analysis of Yellowstone topography to identify prime lynx habitat. In late 2000, the Yellowstone Park Foundation provided a grant to complete most of the survey project, and field work will begin in January 2001 to document lynx presence using aerial and ground-based snow-tracking surveys during winter, and to collect lynx hairs during summer using hair-snags. The hair samples will be sent to a laboratory for an analysis that will yield species and individual-specific information on lynx.

### *Wildlife Management and Monitoring*

**Rare animal records.** The most notable rare mammal observations reported in YNP in 2000 were of mountain goat, wolverine, lynx, and fisher (Table 3). All of these species are rarely observed in the park.

**Road-killed wildlife.** A total of 83 large mammals were hit and killed by vehicles on YNP roads in 2000 (Table 4). Elk (n=28, 34%) and mule deer (n=22, 27%) were the species most often killed in collisions with vehicles. Other species of large mammals hit and killed by vehicles on park roads in 1999 included 9 bison (11%), 14 coyotes (17%), and 5 moose (6%).

The average road-kill rate of all park roads combined in 2000 was 0.3 road-kills per mile of road (Table 5). The rate of road-kills on U.S. Highway #191 was approximately 1.5 road-kills per mile of road, the highest road-kill rate of any park road. U.S. Highway #191 comprises approximately 7 percent of the paved roads in YNP but accounted for 35 percent of the road-killed large mammals documented in the park. U.S. Highway #191 is the only road segment in the park with a 55-mph speed limit; all other roads are posted at 45-mph or slower. Vehicle speeds are known to be a factor contributing to the frequency of road-killed wildlife (Gunther et al. 1998). The only other road with a road-kill rate substantially higher than the park-wide average was the Madison Junction to the West Entrance road (0.8 road-kills/mile).

The 83 road-kills recorded in 2000 was the second lowest number since year-round record keeping began in 1989, and was significantly lower than the long-term average of 107 (± 27 SD) road-kills per year recorded from 1989 to 2000 (Table 6). The highest number of road-kills previously recorded in the park was 148 in 1994.

*Table 3. Most notable[a] rare animal sightings reported in Yellowstone National Park, 2000[b].*

| | Type of Report | | | | |
|---|---|---|---|---|---|
| **Species** | **Carcass or Captured Animal** | **Physical Evidence[c]** | **Observation by Experienced Observer** | **Observation by Inexperienced Observer** | **Total** |
| Amphibian[d] | 0 | 0 | 1 | 0 | 1 |
| Badger | 0 | 0 | 1 | 0 | 1 |
| Beaver | 0 | 0 | 8 | 1 | 9 |
| Bighorn Sheep | 0 | 0 | 3 | 1 | 4 |
| Bobcat | 0 | 1 | 0 | 3 | 4 |
| Fisher | 0 | 0 | 0 | 1 | 1 |
| Lynx | 3[e] | 0 | 0 | 0 | 0 |
| Mountain Goat | 0 | 0 | 9 | 4 | 13 |
| Mountain Lion | 16 | 0 | 6 | 15 | 37 |
| Muskrat | 1 | 0 | 0 | 0 | 1 |
| Pine Marten | 0 | 0 | 1 | 1 | 2 |
| Raccoon | 0 | 0 | 0 | 0 | 0 |
| Red Fox | 1 | 0 | 9 | 0 | 10 |
| Reptiles[f] | 1 | 0 | 2 | 0 | 3 |
| River Otter | 0 | 0 | 2 | 0 | 2 |
| Weasel[g] | 0 | 0 | 1 | 1 | 2 |
| White-tailed Deer | 0 | 0 | 5 | 0 | 5 |
| Wolverine | 0 | 1 | 6 | 7 | 14 |

[a] Common species in unusual locations are not included in this table.
[b] Includes sighting and sign reports from calendar year 2000 turned in to the bear management office as of January 31, 2001.
[c] Physical evidence includes photo, video, plaster cast of track, track, scat, hair, or DNA sample.
[d] Amphibian observations include 1 blotched tiger salamander.
[e] Three separate GPS locations of a radio-collared lynx from a Wyoming study.
[f] Reptile observations include 1 rubber boa, and 2 prairie rattlesnakes.
[g] Weasel observations included 2 unidentifiable weasels.

**Radionuclide concentrations study.** Atmospheric nuclear weapons testing from 1945 to 1980, and nuclear power plant accidents, such as the Chernobyl accident in Russia in 1986, have resulted in radionuclides being distributed across the northern hemisphere. Other more local sources of radionuclides in the environment come from research laboratories. Operations at the U.S. Department of Energy's Idaho National Engineering and Environmental Laboratory (INEEL) have the potential to release radioactive contaminants into the air and water. Large mammals have been sampled on and near the INEEL compound for nearly 30 years. In 2000, INEEL requested tissue samples from large mammals in YNP so that they could quantify radionuclide concentrations over a wider geographic area. The Bear Management Office was assigned to coordinate the tissue sample collection effort in YNP. One- to two-dozen tissue samples (1.5 lbs. each) are to be collected annually from large mammals that are accidentally hit and killed by vehicles on park roads or that die of natural causes.

In 2000, 12 tissue samples were collected from large mammals and sent to INEEL. Samples were collected from three elk, four mule deer, three moose, and two pronghorn antelope by Bear Management Office staff (eight samples), Grant resource management staff (three samples), and Lake resource management staff (one sample).

**Elk management.** A bull elk first came to the attention of Yellowstone managers during the peak of the elk rut, the third week of September 2000. Although not the biggest in the Mammoth Hot Springs area, that bull was the most aggressive, and he had formed and was successfully defending the largest harem of cows. On September 25, the bull behaved very aggressively, charged and gored a minimum of seven vehicles, and chased several park visitors and employees in the Mammoth developed area. Due to human safety concerns, the decision was made to capture and translocate the bull elk away from Mammoth Hot Springs to an area more remote from human activity. The elk was darted by bear and ungulate management office employees in the Mammoth employee housing area, ear-tagged with yellow tag #18, loaded into a horse trailer, and transported to the Frog Rock area, approximately eight miles (straight line distance) from Mammoth.

On September 26, the bull elk was observed back in the Mammoth Hot Springs area. As a safety precaution, park staff monitored the animal's behavior. By September 27, the elk had reformed a large harem of cow elk. On the morning of September 28, the elk had charged and gored two more vehicles and continued to pose a threat to park visitors. Late that same morning, the elk was darted near the Little People's Learning Center, radio collared, loaded into a horse trailer, transported to the Natural Bridge road south of Bridge Bay near Yellowstone Lake, and released (approximately 33 straight line miles from the capture site). The bull elk remained in the general area where it had been released from September 28 through October 5. On October 6, the bull was radio located and observed near Mud Volcano. On October 15, the radio signal of the elk was picked up near Solfatara Creek and on October 19, bull elk #18 had returned to the Mammoth Hot Springs area.

When the bull elk was first captured on September 25, due to the potential that he could leave the park and be taken during the hunting season, he was ear-tagged with a notice that the park should be contacted prior to consumption of the elk. The Food and Drug Administration specifies that there be a withholding time that must expire from the date that a drug is administered to when the animal can safely be consumed by humans. For the immobilization

*Park rangers radio collar and ear tag a tranquilized elk before loading him into a horse trailer for relocation to a remote area away from Mammoth.*

*Table 4. Number of large mammals (30 lbs. or larger) killed by vehicles on different sections of road within Yellowstone National Park, 2000.*

| | Road Code[a] | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **Total** |
| Antelope | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beaver | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bighorn Sheep | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bison | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 4 | 0 | 2 | 0 | 0 | 9 |
| Black Bear | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bobcat | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Coyote | 0 | 0 | 8 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 2 | 0 | 1 | 0 | 14 |
| Elk | 2 | 1 | 2 | 1 | 0 | 2 | 0 | 1 | 0 | 1 | 1 | 1 | 15 | 1 | 0 | 0 | 28 |
| Grizzly Bear | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lynx | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Moose | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 5 |
| Mountain Goat | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mountain Lion | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Mule Deer | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 6 | 0 | 2 | 7 | 1 | 1 | 0 | 22 |
| Raccoon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| White-tailed Deer | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wolf | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 3 |
| Wolverine | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **2** | **2** | **12** | **2** | **0** | **2** | **4** | **3** | **0** | **8** | **2** | **11** | **29** | **4** | **2** | **0** | **83** |

[a]Road Codes:
1 Gardiner to Mammoth
2 Mammoth to Tower
3 Tower to Northeast Entrance
4 Mammoth to Norris
5 Tower to Canyon
6 Norris to Canyon
7 Canyon to Fishing Bridge
8 Fishing Bridge to East Entrance
9 Fishing Bridge to West Thumb Junction
10 West Thumb to South Entrance
11 Norris to Madison
12 Madison to West Entrance
13 U.S. Highway #191
14 Madison to Old Faithful
15 Old Faithful to West Thumb Junction
16 Bechler Roads

*Table 5. Vehicle kill-rate of large mammals (30 lbs. or larger) on different sections of road within Yellowstone National Park, 2000.*

| Road Section | Road Code | Miles of Road | Percent of Park Road Total | Number of Road-Kills | Percent of Park Total Road-Kills | Kill Rate (Animals/Mile) |
|---|---|---|---|---|---|---|
| Gardiner - Mammoth | 1 | 5 | 2% | 2 | 2% | 0.4 |
| Mammoth - Tower | 2 | 18 | 7% | 2 | 2% | 0.1 |
| Tower - NE Entrance | 3 | 29 | 11% | 12 | 14% | 0.4 |
| Mammoth - Norris | 4 | 21 | 8% | 2 | 2% | 0.1 |
| Tower - Canyon | 5 | 19 | 7% | 0 | 0% | 0.0 |
| Norris - Canyon | 6 | 12 | 4% | 2 | 2% | 0.2 |
| Canyon - Fishing Bridge | 7 | 16 | 6% | 4 | 5% | 0.3 |
| Fishing Bridge - East Ent. | 8 | 27 | 10% | 3 | 4% | 0.1 |
| Fishing Bridge - West Thumb | 9 | 21 | 8% | 0 | 0% | 0.0 |
| West Thumb - South Ent. | 10 | 22 | 8% | 8 | 10% | 0.4 |
| Norris - Madison | 11 | 14 | 5% | 2 | 2% | 0.1 |
| Madison - West Ent. | 12 | 14 | 5% | 11 | 13% | 0.8 |
| U.S. Highway #191 | 13 | 20 | 7% | 29 | 35% | 1.5 |
| Madison - Old Faithful | 14 | 16 | 6% | 4 | 5% | 0.3 |
| Old Faithful - West Thumb | 15 | 17 | 6% | 2 | 2% | 0.1 |
| Bechler Road | 16 | 1 | <1% | 0 | 0% | 0.0 |
| **Total** | | **272** | **101%[a]** | **83** | **100%** | ***x* = 0.3** |

[a] Does not equal 100% due to rounding error.

*Table 6. Number of different species of large mammals[a] killed by vehicles in Yellowstone National Park, 1989–2000.*

| Species | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Antelope | 1 | 4 | 6 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 0 | 0 |
| Beaver | 1 | 1 | 1 | 3 | 1 | 0 | 2 | 2 | 0 | 2 | 0 | 0 |
| Bighorn Sheep | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 1 | 0 | 0 | 0 | 0 |
| Bison | 7 | 5 | 12 | 7 | 11 | 11 | 11 | 16 | 15 | 13 | 7 | 9 |
| Black Bear | 0 | 1 | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 3 | 1 | 0 |
| Bobcat | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Coyote | 1 | 9 | 3 | 5 | 10 | 19 | 9 | 10 | 5 | 7 | 16 | 14 |
| Elk | 50 | 35 | 54 | 34 | 37 | 49 | 52 | 64 | 24 | 32 | 37 | 28 |
| Grizzly Bear | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Lynx | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Moose | 11 | 10 | 5 | 11 | 9 | 12 | 10 | 8 | 6 | 3 | 4 | 5 |
| Mtn. Goat | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mtn. Lion | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Mule Deer | 26 | 35 | 40 | 44 | 37 | 51 | 28 | 25 | 25 | 24 | 23 | 22 |
| Raccoon | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2 | 0 | 1 |
| White-tailed Deer | 0 | 1 | 0 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| Wolf | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 2 | 1 | 0 | 3 |
| Wolverine | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **97** | **102** | **121** | **110** | **110** | **148** | **120** | **132** | **80** | **88** | **88** | **83** |

[a] Species in which adults can reach a weight of 30 pounds or more.

agents used on bull elk #18, a very conservative withholding time of at least 45 days is considered adequate. Bull elk #18 left the park and was killed by a hunter near LaDuke Hot Springs on February 9, 2001.

### *Wolves*

**Population monitoring and management.**

***Population status.—***At the end of 2000, at least 177 wolves in 18 packs were present in the greater Yellowstone area (Table 7). Thirteen of these packs had a breeding pair as defined by the U.S. Fish and Wildlife Service (a breeding male and female with two pups that survive to December 31). Eight packs (~119 wolves) resided primarily within Yellowstone National Park and 10 packs (four in Montana and six in Wyoming) including 58 to 60 wolves were outside the park (Figure 8). The three Rocky Mountain recovery areas (GYA, central Idaho, and northwest Montana) had a total of 28 breeding pairs. Removal of wolves from the endangered species list will require 30 breeding pairs distributed throughout the three recovery areas for three successive years. Acceptable wolf management plans from the states of Wyoming, Idaho, and Montana are also required.

***Reproduction.—***An estimated 71 to 77 pups survived to year-end, 55 to 60 of them born in YNP. Pup survival was higher in YNP in 2000 (55 of 68 known births in the park, 80%) than in 1999 (18 of 40, 45%). The low survival in 1999 was possibly due to parvovirus. All captured wolves in 1999 and 2000 tested positive for the disease, and mortality occurred at a time (post-weaning) when pups are most vulnerable to infection. To positively identify mortality due to parvovirus a dead pup must be collected, and no such carcass has been retrieved yet.

Sixteen litters were born to 13 packs. The Druid Peak pack had at least three litters, and the Rose Creek pack had two. Because each of these packs had one breeding male who mated with more than one female, each had only one breeding pair as defined under the recovery plan standards. Litter size ranged from 2 to 10 and averaged 5.7.

***Mortalities.—***In addition to undocumented pups that died during spring and summer, 14 wolves were known to have died in 2000 in the GYA: nine adults (6F, 3M), four yearlings (2M, 2F), and one pup (F). Eight deaths were human caused: three in control actions, two from vehicle collisions, two as a result of handling/capture (both outside YNP), and one illegal. Four deaths were due to natural causes (elk, moose, other wolves, etc.), and two could not be determined. Human-caused mortality has been responsible for at least half of wolf deaths each year since reintroduction in 1995.

***Population movements.—***Wolf population expansion was considerable outside YNP in 2000, and some established packs within YNP shifted their territorial boundaries. Six new packs formed in the GYA in 2000: one inside YNP (the Swan Lake pack), and five outside: Taylor Peaks (Madison Valley, MT),

*Table 7. Wolves in the GYA as of December 31, 2000.*

***YELLOWSTONE NATIONAL PARK***

| Pack | Adults & Yearlings | Pups Born | Pups Survived | Total |
|---|---|---|---|---|
| Chief Joseph | 7 | 8 | 6 | 13 |
| Swan Lake | 2 | 4–5 | 5 | 7 |
| Leopold | 6–8 | 10 | 5–7 | 13 |
| Rose Creek (2 grps) | 10–13 | 11 | 5–8 | 18 |
| Druid Peak | 7 | 21 | 20 | 27 |
| Mollie's | 4 | 0 | 0 | 4 |
| Yellowstone Delta | 6 | 7 | 7 | 13 |
| Nez Perce | 15 | 7 | 7 | 22 |
| Loners | 2 | 0 | 0 | 2 |
| **YNP Total** | **59–64** | **68–69** | **55–60** | **119** |

*(8 packs; 7 breeding pairs; mean pack size = 14.6)*

***OUTSIDE YELLOWSTONE NATIONAL PARK***

| Pack | Adults & Yearlings | Pups Born | Pups Survived | Total |
|---|---|---|---|---|
| Sunlight Basin | 6 | 4 | 4 | 10 |
| Absaroka | 2 | 5 | 3 | 5 |
| Beartooth | 3 | 2? | 0 | 3 |
| Teton | 4 | 0 | 0 | 4 |
| Gros Ventre | 3 | 3 | 3 | 6 |
| Washakie | 4–5 | ? | 2–3 | 6–8 |
| Taylor Peaks | 3 | 4 | 2 | 5 |
| Sheep Mountain | 7 | 0 | 0 | 7 |
| Gravelly Range | ? | ? | ? | 5? |
| Mill Creek | 3+ | ? | 2+ | 7 |
| Loners | 0 | 0 | 0 | 0 |
| **Outside YNP Total** | **35–36** | **16–18** | **16–17** | **58–60** |

*(10 packs; 6 breeding pairs; mean pack size = 5.8)*

***GREATER YELLOWSTONE ECOSYSTEM TOTAL***

| Pack | Adults & Yearlings | Pups Born | Pups Survived | Total |
|---|---|---|---|---|
| **Grand Total** | **94–100** | **84–87** | **71–77** | **177–179** |

*(18 packs; 13 breeding pairs; mean pack size = 9.3)*

Beartooth (Sunlight Basin, WY), Absaroka (Sunlight Basin, WY), Gravelly (Gravelly Range, MT), and Mill Creek (Paradise Valley, MT).

Two packs outside YNP (Sheep Mountain in Paradise Valley and Washakie in DuNoir Valley) reestablished themselves after management actions taken by the USFWS due to livestock depredations disturbed pack dynamics.

Two YNP packs were renamed because they no longer lived in the area for which they were named, and none of the original wolves were still in the pack, although their descendants were. The Crystal Creek pack, which resides in Pelican Valley, was renamed Mollie's pack after the late Director of the U.S. Fish and Wildlife Service, Mollie Beattie, to recognize her extraordinary contribution to wolf recovery in the northern Rockies. The Soda Butte pack was renamed the Yellowstone Delta pack after the Yellowstone River delta, an area of YNP where they were often located in 2000.

The Druid Peak pack swelled to 27 wolves because of high survival in three litters (20 pups total) and usurped Rose Creek pack territory west of its traditional home range. The Rose Creek pack appeared to be in decline. Down from a high of 24 wolves in 1998, by the end of 2000 they had split into two groups, referred to as the Main Rose group (seven wolves) and the Tower group (six wolves), plus five loosely associated wolves. One territorial trespass was observed in December on Slough Creek, traditional Rose Creek territory, when two wolves in the Rose Creek pack survived an attack by Druid wolves.

The large Nez Perce pack (22 wolves) was also observed making an extraterritorial move in December. For about two weeks, this pack moved onto the northern range, an area of higher elk density than their traditional territory in the Madison–Firehole area. Most of this time was spent in Leopold pack territory, but no interactions were recorded as the Leopold wolves (13 wolves) apparently avoided an encounter.

**Wolf-prey relationships.** Wolf-prey relationships were documented by observing wolf predation directly and by recording characteristics of wolf prey at kill sites. Wolf packs were monitored during two winter-study sessions, periods of time in which wolves were intensively radio-tracked each day for 30 consecutive days during March and November–December. The Leopold, Rose Creek, and Druid Peak packs were monitored by teams of two persons from the ground and from aircraft; the Chief Joseph, Crystal Creek (Mollie's), Nez Perce, Sheep Mountain, and Soda Butte (Yellowstone Delta) packs were monitored from aircraft only. Behavioral interactions between wolves and prey, predation rates, the total time wolves fed on their kills, percent consumption of kills by wolves and scavengers, characteristics of wolf prey (*e.g.*, nutritional condition), and characteristics of kill sites were recorded and entered into a database. The abundance and sex-age composition of elk within wolf pack territories were also estimated from the ground and from fixed-wing aircraft.

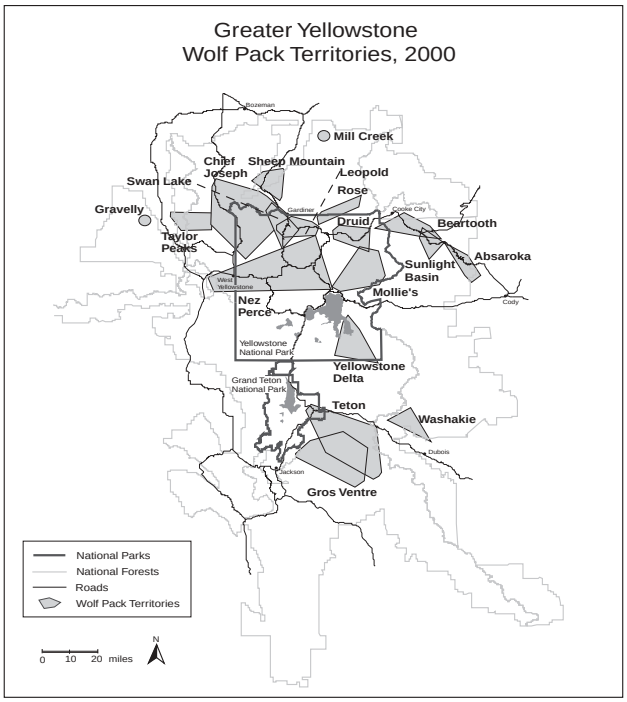



*Figure 8. Wolf pack territories. At least 177 wolves—18 packs and two wolves without established territories—occupied the GYA in 2000.*

*Kerry Murphy examines wolf #40 after she was killed by her pack mates. Photo by Douglas Smith.*

*Forty-five cow elk were captured and radio collared for research into habitat selection by elk following wolf reintroduction in the park. Photo courtesy Julie Mao.*

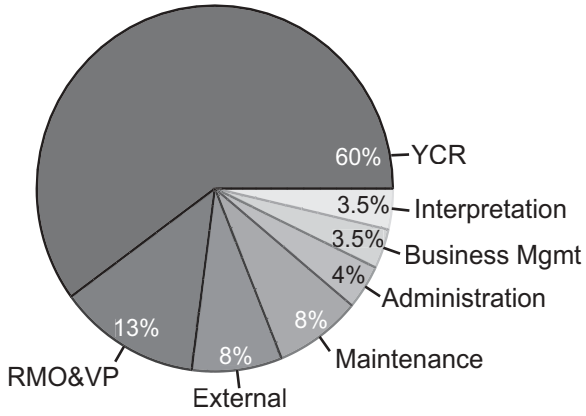
# Part IV. Yellowstone Center for Resources and Parkwide Support

This section describes the work accomplished or coordinated by the YCR staff who provide services for other YCR branches and other park divisions:

- The Spatial Analysis Center, responsible for the park's geographic information system, global positioning systems, and other resource databases;
- Resource Information, which produces publications and provides special programs on natural and cultural resource topics;
- Research Support, which oversees permitting for visiting and park researchers; and
- Funding and Personnel Support for the YCR Division.

## Spatial Analysis Center

The Spatial Analysis Center (SAC) is the home of the park's geographic information system (GIS), global positioning systems (GPS), image analysis, soil information support, and 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. SAC's goals are to maintain an up-to-date GIS lab, provide GPS equipment and expertise, increase the GIS and GPS skill level of park staff, acquire new data and make it useful, provide information and technical support to park staff, and make information available to outside agencies and the public.

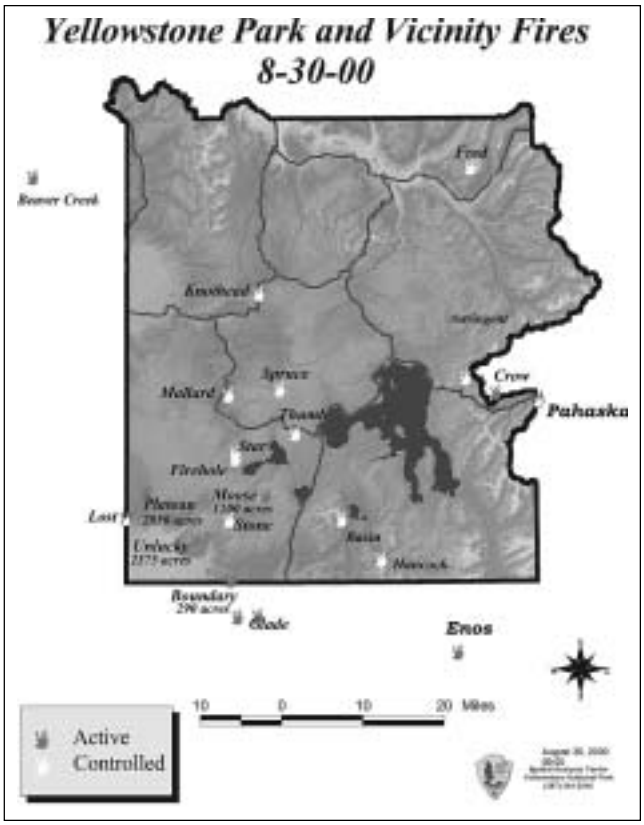



*The percentage of time in 2000 used to fulfill requests for GIS services for different divisions.*

SAC supports a wide variety of projects, including resource maps for proposed construction sites, database construction for GYA weed locations, maps of different alternatives for the bison EIS, and projects associated with the Federal Lands Highway Program, such as continuing to update databases for rare plants, archeology sites, and wetlands, along with providing GPS support for mapping the resources.

Following are some of the other projects that SAC staff supported or initiated in 2000:

- Over the last four years SAC staff have been working with the Maintenance, and Resource Management Operations and Visitor Protection divisions to create accurate spatial layers for all the backcountry trails, campsites, trail bridges, cabins, and campsite spur trails in the park. The database was built by walking every trail and visiting every campsite with a GPS unit. Almost all of the field data collection was completed in 1999. In 2000 these data layers were completed, error-checked, and made available from the GIS lab.
- This year SAC staff began working with the Maintenance and Business Management divisions to begin digitizing and georeferencing the locations of sewer lines and manholes. The goal is to create a digital, master map that contains the most accurate information available. This will be available at all locations and updated as changes happen on the ground. In the future, water lines will also be digitized.
- All power lines, substations, and transformers run by the Montana Power Company have been converted from AutoCad to georeferenced GIS layers.
- An accurate GIS layer of park buildings was completed. The database has links to building databases maintained by the Maintenance and Business Management divisions, the cultural resources branch, and the park's concessioner, AmFac Parks and Resorts.
- Several SAC staff supported the Fire Cache during the summer of 2000 by providing daily maps of fire starts and fire perimeters, accompanying Fire Cache staff on overflights to take digital photographs of fires, GPS'ing fire perimeters, and error-checking collected GIS fire data. The daily maps were utilized by the Public Affairs Office in their daily press releases during the fire season.
- SAC staff worked with subdistrict rangers to develop protocols for collecting sign information along park roads with GPS units. Rangers in each subdistrict collected GPS locations for all regulatory signs in their area, then sent the UTM coordinates to SAC staff who entered the data into a database and created a GIS layer. These data will be used to create maps of the signs in each subdistrict.
- SAC staff began working with staff from the communications center to develop maps of all roads and buildings in each developed area. All buildings will be labeled with their official and common names, then overlain with a location grid. These maps will be provided to law enforcement rangers in all areas for ease in locating specific buildings when on a call. Communications center staff will continue working on this project in 2001.




*Example of a fire map provided on a daily basis to the Public Affairs Office during summer 2000. These maps showed the currently burning and controlled fires in Yellowstone and the surrounding area.*

- A spatial inventory of thermal areas based on point locations collected with GPS units was continued for the third year. Measurements of temperature, pH, and electroconductivity were collected and attached to each point location, along with digital photographs of each feature. In 2000 SAC staff collected approximately 1,200 new points, bringing the total number of thermal features in the database to 3,923. The most recent points are from the Bear Creek area; the Norris-to-Mammoth corridor; the Gibbon, Lower, Midway, and Upper geyser basins; and the Crater Hills area.
- SAC staff began working with the inventory and monitoring program by creating several maps for use at the National Park Service's Vertebrate and Vascular Plant Inventory Workshop held in Bozeman, Montana, May 2–3, 2000. Staff will continue to support data mining and data conversion for this effort.
- In the summer of 2000, SAC staff began working with the Aquatic Resources Center to convert many years of aquatic research data from paper field notes into a digital database. The new digital information includes sampling locations (both points and stream segments), types of fish found, and whether other data (macroinvertebrates, water chemistry, genetics) exists. This project was funded by the Greater Yellowstone Coordinating Committee and specifically included mapping historic and current Yellowstone cutthroat habitat.
- As part of mapping Yellowstone cutthroat habitat, SAC staff created a spatial database of physical barriers that stop the upstream migration of fish. This includes waterfalls, cascades, and other steep gradients on watercourses. The locations of these barriers came from field notes collected by U.S. Fish and Wildlife Service personnel, verbal communications with staff from the Aquatic Resources Center, an old push-pin map of barriers, and the book *Yellowstone: The Discovery of Its Waterfalls* by Paul Rubinstein, Lee H. Whittlesey, and Mike Stevens.
- During the summer of 2000, SAC staff worked with the park's ornithologist to convert his data into GIS layers. They created a database of trumpeter swan locations around the park. SAC staff accompanied him on several bird surveys, trained him to use GPS, and used GPS to create a digital layer of the breeding bird survey transects.
- In support of the Interpretation Division, a map of the 1988 fires in the park was created for use in an interpretive display to be installed on Mount Washburn in 2001.
- SAC staff continued to share cross-boundary data of mutual interest with a variety of different agencies, including Gallatin County, Montana; U.S. Forest Service (Gallatin, Targhee, Bridger-Teton, and Shoshone national forests); Montana Fish, Wildlife and Parks; Montana State University; University of Wyoming; and many others.

### *New Hardware and Software*

SAC continues to run its GIS software on Windows NT. In 2000, two new servers were added and two computers were upgraded in the GIS lab, bringing the total number of computers with GIS capability to 14. The new servers provide enough space to house many new GIS layers and images. Three new GPS units, a Trimble GeoExplorer 3, a Garmin handheld unit, and a Trimble ProXRS unit, were added, bringing the total number of GPS units available for staff use to 13. Finally, a new printer and plotter were added to the GIS lab. Both provide high-quality color print-outs; the plotter provides large-format prints as well.

### *Resource Database Development*

SAC staff continued to work on a database designed to make relevant resource and infrastructure information more accessible to people involved with project planning, compliance, and implementation. It involved the development of detailed GIS layers tied to a database of information about each developed area and road corridor. The information includes data about historic structures and other important cultural resource information, surficial and bedrock geology, soils, wetlands, important natural resources (*e.g.*, threatened and endangered species, species of special concern, important or delicate habitats), existing infrastructure (roads, trails, and buildings), and other subjects of interest. A help document was developed that allows users of this database to click on a specific area and see all corresponding information. The help document includes text (definitions, descriptions, methods of data collection, etc.), photo-

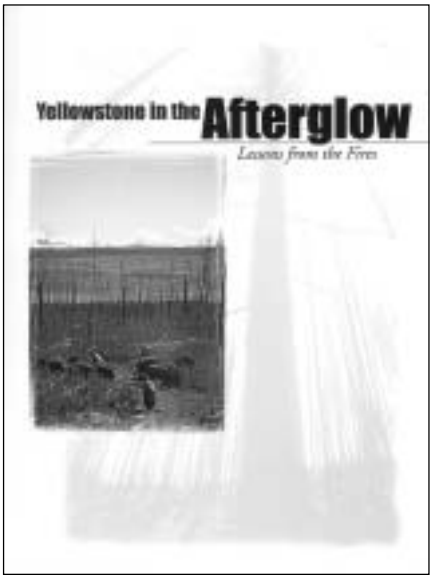
graphs, images, drawings, and any other related information that can be incorporated in digital format. A simple interface will be developed in 2001, allowing the user to see this help file and query the database and create maps, charts, and reports. It will also be possible to attach photographs, drawings, and other scanned documents that help clarify a resource situation. Finally, this database will be made accessible over the park's Intranet. This project will be completed in 2001.

### *Outreach*

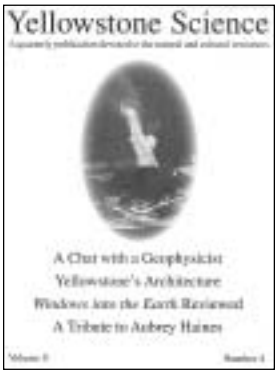
SAC staff continued to make GIS technology directly available to park employees by providing equipment, data, and training. The GIS Lab is available to all employees, and spatial data is accessible over the park network. SAC staff also continued to support GIS software on 14 computers outside of the lab and provided data on CDs to those who are not networked. Several new buttons were added to the GIS software that allow users on the network to more easily access permanent GIS data, to see metadata associated with each GIS layer, and to find UTM and lat/long coordinates. SAC staff also provided GPS training that included collecting field data with GPS units, differentially correcting the GPS data, and converting this corrected data into usable GIS layers.

## Resource Information

The new year brought several staff changes to the resource information office. Tami Blackford moved into a permanent part-time writer-editor position in January. Also in January, Kevin Schneider transferred to Yellowstone as a permanent full-time writer-editor from the National Park Service's Washington, D.C., Office of Communications. Volunteers Jim and Edna Caslick returned to Yellowstone for another winter, assisting with various special publication and resource management projects. In June, Alice Wondrak, a Ph.D. candidate and Canon National Parks Science Scholar, accepted a position as a writer-editor under the student career enhancement program. Mary Ann Franke returned to Yellowstone for the summer and fall months as a writer-editor. In October, Sue Consolo Murphy became the branch chief of cultural resources, while temporarily retaining her duties as head of the resource information group until that position could be advertised and filled. Throughout the year, the office continued to rely on the expertise of Sarah (Broadbent) Stevenson for assistance with special projects. Renée Evanoff maintained her intermittent status, providing design and artistic expertise.




### *Publications*




*Yellowstone Science*, in its eighth volume, continued to provide thought-provoking articles on Yellowstone's natural and cultural resources. Four issues were published in 2000, and they included articles on the Arctic grayling, the first tourist visit to Yellowstone, and the architecture of park buildings. The spring issue of *Yellowstone Science* represented the latter half in a two-part series on the history of ungulate management in Yellowstone. This issue included oral history interviews with the biologists and managers who oversaw the elk reductions of the 1950s and 1960s. The final edition for the year contained an interview with renowned geologist Dr. Robert Smith, and presented several of his outstanding illustrations in full color. *Yellowstone Science* is supported by generous donations from its readers, as well as a grant from the Yellowstone Association.

*Yellowstone in the Afterglow: Lessons from the Fires* was published in late 2000. Written by Mary Ann Franke, the 118-page report is a comprehensive look at the 1988 wildfires and is based on published and unpublished materials on the effects of the fires. The easy-to-read and generously illustrated book appeals both to serious academic students of Yellowstone as well as those simply seeking more information about the fires.

Tami Blackford helped edit and design a 36-page full-color report titled *Wetland Resources of Yellowstone National Park* by Chuck Elliott of the U.S. Fish and Wildlife Service and Mary Hektner of the YCR. In addition, she designed a color brochure written by Jennifer Whipple on Yellowstone sand verbena, a species endemic to Yellowstone's lakeshores. This brochure was printed through a generous grant from Canon, USA.

Other publications produced this year include the *1999 Wolf Project Annual Report*, the 1997–1998 and 1999 *Investigators' Annual Reports*, the *1999 Yellowstone Bird Report*, and the *1999 YCR Annual Report*. Resource information staff also produced five issues of the ever-popular *Buffalo Chip*, an in-house newsletter keeping park employees abreast of resource news, and provided writing, editing, and graphics assistance to other YCR staff and park researchers.

### *External Assistance*

As part of a servicewide initiative to improve the inventory and monitoring of natural resources, the Greater Yellowstone Network, consisting of Yellowstone and Grand Teton national parks and Bighorn Canyon National Recreation Area, began a comprehensive effort to inventory select vertebrates and vascular plants of the three parks. Resource information staff assisted with the organization of an "experts" workshop in Bozeman and also helped coordinate the production of a 114-page plan to conduct the inventories.

Discovery 2000, held in September, was the first nationwide NPS general conference in nearly ten years. Kevin Schneider helped coordinate media relations as a member of the conference communications team and wrote several articles promoting the conference for various internal publications.

Resource information staff also assisted with the preparation of a servicewide environmental assessment regarding the environmental impacts of using benefits-sharing agreements in national parks. Benefits-sharing agreements are collaborative agreements with researchers that allow the park to "share" in the benefits when park-based research leads to commercial success.

The National Parks Omnibus Management Act (P.L. 105–391) of 1998 states that *"The Secretary [of the Interior] may enter into negotiations with the research community and private industry for equitable, efficient benefits-sharing arrangements."*

### *Presentations, Seminars, and General Information*

The resource information group responded to hundreds of written requests, phone calls, and emails inquiring about various topics including wolves, bears, ecosystem management, human–wildlife interactions, wildland fire, threatened and endangered species, bioprospecting, elk and bison management, geology and geothermal activity, and finding employment in Yellowstone. Resource information staff presented 25 talks to visiting groups, including high school and college students, community groups, seasonal Yellowstone employees, and concession employees. In addition, staff arranged dozens of talks that were presented by other YCR employees according to their particular area of expertise. Unfortunately, staffing constraints prevented the YCR from accommodating all the requests from such visiting groups.

The resource information staff also organized seminars presented by visiting researchers, scholars, and experts for park staff. Conservation biologist Diane Debinski spoke on the use of remote sensing to monitor biodiversity, and the director of the Colorado Bird Observatory, Mike Carter, discussed bird conservation in the "Prairies to Peaks." Anthropologist Dr. Henry Lewis presented two talks concerning his research on how aboriginal peoples used fire in Australia, Canada, and the United States.

Finally, the resource information office maintains a master bibliography of publications germane to Yellowstone National Park. This list is updated periodically, and selected publications are available on racks in the YCR lobby.

## Research Support

During 2000, 238 research collecting permits were approved; 56 were new, and 182 were renewed. In addition, 100 investigators were assisted as they explored the possibility of performing research in Yellowstone, but 50 did not submit a research proposal in 2000. Of all the research in the park in 2000, 18 percent was related to animal populations including birds, fish, insects, and mammals (mam-

malogy made up 64% of the animal studies). Ecology, including fire and forestry studies, made up 15 percent of the research. Seventeen percent was dedicated to some form of geology, and the study of microorganisms totaled 19 percent. Thirteen percent were educational permits granted to allow students and their teachers to conduct simple studies in the park. Vegetation and exotic species studies made up 5 percent. Another 5 percent of the research in the park included social sciences, archeology, and interpretation projects. The remaining 8 percent included management studies, air and water quality studies, and miscellaneous subjects.

A Research Review Committee composed of representatives from the Office of Planning and Compliance, and the Yellowstone Center for Resources, Resource Management Operations and Visitor Protection, Maintenance, and Interpretation divisions are responsible for insuring that all research activities are in keeping with the park mission. The Research Review Committee evaluates impacts to public health and safety, environmental and scenic values, natural and cultural resources, and scientific research. They also evaluate the impacts of the implementation of management responsibilities, proper allocation and use of facilities, and avoidance of conflict among visitor use activities. Modifications are made to the projects if they significantly impact one of the above areas. Researchers are required to submit a summary of their work, which is published in the park's *Investigators' Annual Reports* along with reprints of any publications in connection with their Yellowstone research. Recent reports are available on the park web site at *www.nps.gov/yell*.

*Octopus Spring may be the most studied and well-known geothermal spring in the world. This has raised questions about the purported conflict between preservation values and the need to produce new knowledge.*

## Funding and Personnel

### *Base Operating Budget*

Superintendent Finley approved a base operating budget of $2,568,600 for the YCR in March 2000. This represented an increase of $36,700 over FY99 funding levels. The additional funds were used to help defray the cost of employees' benefits increases.

### *Additional Funding*

**Recreation Fee Demonstration funds.** Funding was granted to complete or continue eight of the ten resource management projects approved in FY99. Six new projects were also authorized, bringing the allocation of Recreation Fee Demonstration funds for the YCR to a total of $631,000 in FY00 and the overall amount allocated to the YCR since the inception of the program to $1,300,000.

**Fishing fee program.** The YCR received authorization to use $280,000 from fishing permit fee revenue to partially cover the estimated $671,000 total cost of the aquatic resources program in FY00.

**Federal Lands Highway Program.** Federal Highways funded $214,900 for natural resource inventories, archeological surveys, and resource compliance along the road corridors in the park scheduled for major repair or reconstruction in the near future.

**Special Emphasis Program Allocation System.** The Branch of Natural Resources received $237,500 to implement the lake trout control program on Yellowstone Lake and to increase access to park natural resource information through GIS and data management improvements from this funding source in FY00.

The Branch of Cultural Resources successfully competed for a total of $101,000 in special emphasis program funding. These funds were used for ethnographic resource inventories, NAGPRA consultations, two cataloging projects, and to preserve and increase the accessibility of the museum collections housed in the Albright Visitor Center.

**Other NPS and federal funds.** The YCR administered funds and provided support for a number of other federally-sponsored projects in FY00, most significantly the bison management plan and court-ordered environmental impact statement ($679,000), the Benefits-Sharing Environmental Assessment ($739,000), and USGS grizzly bear studies and bison-related research ($41,300).

**Private funds.** A total of $52,700 was donated to the park by private organizations or individuals for support of wolf recovery program operations, whirling disease surveys, archival projects, and the biennial science conference.

### *Personnel*

There were 228 personnel actions processed in FY00. Of special note were the following:

- Laura Joss, branch chief of cultural resources, was selected as the superintendent of Fort McHenry National Monument in Baltimore, Maryland, and left Yellowstone in March 2000.

*Laura Joss.*

- Sue Consolo Murphy, resource management specialist, was selected to replace Laura Joss as the branch chief of cultural resources in FY00. Her new appointment became effective FY2001 (October 1, 2000).
- Geologists Dr. Paul K. Doss and Dr. Nancy Hinman joined the Yellowstone staff in June 2000 to lay the foundation for a physical resources and geothermal monitoring program.
- A second recruiting effort for an aquatic resources team leader proved unsuccessful, so the process was initiated for a third time.
- The servicewide Natural and Cultural Resources Professional Development Program was signed by Director Stanton on December 17, 1999, and was implemented by the parks as of May 15, 2000. In accordance with the new career development guidelines, the GIS program manager position was upgraded and two cultural resources positions were converted to professional series with potential for noncompetitive promotion.
- S. Thomas Olliff, formerly the resource management coordinator for the Resource Management Operations and Visitor Protection Division, was selected as the branch chief of natural resources in August 2000. Tom replaced Stu Coleman, who retired in January 1999.

### *Contracting*

Twenty-four contracting actions were processed in FY00, totaling obligations of $758,400 in contracts or task agreements. More than a third of this total ($294,400) was dedicated to aquatic resources program projects, including building a new boat for the lake trout control program, a fisheries operation review and analysis, baseline sediment studies on the Gibbon River, a New Zealand mudsnail distribution survey, a whirling disease distribution survey, and lake trout DNA analysis. Other significant contracting actions involved the Montana Water Compact, archeological surveys and evaluations, bison/brucellosis research, a pronghorn antelope study, the biodiversity EIS, and a study of willow persistence on Yellowstone's northern range in cooperation with the USGS-Biological Resources Division.

### *Procurement Actions*

There were 770 procurement actions processed in FY00, totaling approximately $953,800.

### *Clerical Support*

There were 1,679 pieces of correspondence and 288 travel authorizations processed in FY00.

## Table 1. Yellowstone Center for Resources distribution of FY00 funds.

| Program | Park Base | Nat Res Project Funds | Cult Res Project Funds | Fish Fee | FLHP | Fee Demo | Other NPS | Other Federal | Private | Total | % of Total Funding |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Support: Mgt, Admin, Sci, Pubs, GIS | 930,900 | - | - | - | - | 30,000 | - | - | 3,000 | 963,900 | 17.4% |
| Natural Resources | 1,178,200 | 237,500 | - | 280,000 | 99,300 | 396,000 | - | 41,300 | 39,300 | 2,271,600 | 41.0% |
| Cultural Resources | 402,000 | - | 101,000 | - | 115,600 | 205,000 | - | - | 10,400 | 834,000 | 15.0% |
| Bison Management EIS | 57,500 | - | - | - | - | - | 679,000 | - | - | 736,500 | 13.3% |
| Biodiversity EIS | - | - | - | - | - | - | 739,000 | - | - | 739,000 | 13.3% |
| **Total:** | **2,568,600** | **237,500** | **101,000** | **280,000** | **214,900** | **631,000** | **1,418,000** | **41,300** | **52,700** | **5,545,000** | **100%** |

## Table 2. Funding history of the Yellowstone Center for Resources. (Records prior to 1993 reflect funding only for the former Research Division.)

| | National Park Service Funds | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FY | ONPS | Fee | PFRP | Nat Res Project Funds | Cult Res Project Funds | WRD | FLHP | Fee Demo | Other | USFWS | Other Federal | Donations to NPS Accounts | Total |
| 83 | 165,500 | - | - | - | - | - | - | - | - | 104,000 | - | - | 269,500 |
| 84 | 501,300 | - | - | - | - | 161,400 | - | - | - | 104,000 | - | - | 766,700 |
| 85 | 588,400 | - | - | - | - | 133,000 | - | - | - | 104,000 | - | 3,512 | 828,912 |
| 86 | 607,400 | - | - | 150,000 | - | 112,000 | - | - | - | 136,550 | - | 9,310 | 1,015,260 |
| 87 | 719,300 | - | - | 200,000 | - | 108,000 | - | - | - | 115,000 | - | 6,758 | 1,149,058 |
| 88 | 767,000 | 170,000 | - | 250,000 | - | 172,000 | - | - | - | 104,000 | 5,400 | 2,824 | 1,471,224 |
| 89 | 793,400 | 406,000 | 1,863,000 | 56,000 | - | 108,000 | - | - | - | 133,000 | 4,000 | 3,017 | 3,366,417 |
| 90 | 847,400 | - | 755,000 | 56,000 | - | 75,000 | - | - | - | 111,650 | 12,000 | 2,157 | 1,859,207 |
| 91 | 916,300 | - | 785,200 | 56,000 | - | - | - | - | - | 148,123 | 15,000 | 55,101 | 1,975,724 |
| 92 | 1,025,660 | - | 685,000 | 25,000 | - | - | - | - | - | 182,050 | 10,000 | 10,100 | 1,937,810 |
| 93 | 1,004,600 | - | 785,000 | 16,000 | - | - | - | - | - | 188,000 | - | 20,000 | 2,013,600 |
| 94 | 1,250,000 | 65,000 | - | 260,000 | 33,200 | 156,000 | 43,300 | - | 164,600 | 55,000 | 24,600 | 10,000 | 2,061,700 |
| 95 | 1,500,000 | 65,000 | - | 420,000 | 45,000 | 6,800 | 303,600 | - | 53,000 | 20,000 | - | 5,300 | 2,418,700 |
| 96 | 1,544,100 | 274,500 | - | 404,000 | 201,100 | 119,800 | 626,700 | - | 38,000 | - | 64,958 | 31,504 | 3,304,662 |
| 97 | 1,674,100 | 213,400 | - | 204,000 | 228,400 | - | 433,700 | 340,000 | 42,700 | - | 398,300 | 48,000 | 3,582,600 |
| 98 | 2,245,600 | 284,800 | - | 130,500 | 242,100 | 24,000 | 330,800 | 31,000 | - | - | 65,300 | 37,700 | 3,391,800 |
| 99 | 2,531,900 | 285,000 | - | - | 221,900 | - | 396,500 | 298,000 | 152,888 | - | 105,200 | 56,700 | 4,048,088 |
| 00 | 2,568,600 | 280,000 | - | 237,500 | 101,000 | - | 214,900 | 631,000 | 1,418,000 | - | 41,300 | 52,700 | 5,545,000 |

# Appendix I. Personnel Roster for Fiscal Year 2000

| | | FTE | Borrowed FTE |
|---|---|---|---|
| **Headquarters/Professional Support** | | | |
| Tami Blackford | Technical Writer-Editor | 0.40 | |
| Wayne Brewster | Deputy Director | 1.00 | |
| Ann Deutch | Administrative Assistant | 1.00 | |
| Renée Evanoff | Visual Information Specialist | 0.44 | |
| Mary Ann Franke | Technical Writer-Editor | 0.32 | |
| Christie Hendrix | Secretary | 0.57 | |
| Sara Housley | Clerk Typist | 0.31 | |
| Michelle LeBeau | Administrative Assistant | 0.36 | |
| Kendra Maas | Office Assistant | 0.20 | |
| Melissa McAdam | Supervisory Budget Analyst | 1.00 | |
| Sue Consolo Murphy | Resource Management Specialist | 1.00 | |
| Joy Perius | Administrative Assistant | 1.00 | |
| Lori Roberts | Visitor Use Assistant | | 0.25 |
| Kevin Schneider | Technical Writer-Editor | 0.69 | |
| Paul Schullery | Resource Naturalist | 0.40 | |
| Lessie Sites | Center Clerk | 0.18 | |
| Stacy Stermitz | Administrative Assistant | 0.44 | |
| Sarah Stevenson | Technical Writer-Editor | 0.25 | |
| John Varley | Director | 1.00 | |
| Alice Wondrak | Technical Writer-Editor | 0.09 | |
| **Advanced Resources Technology/Spatial Analysis Center** | | | |
| Viktoria Magnis | Cartographic Technician | 0.80 | |
| Steve Miller | Cartographic Technician | 0.61 | |
| Joel Nelson | Computer Operator | 0.23 | |
| Ann Rodman | Supervisory GIS Specialist | 1.00 | |
| Shannon Savage | Cartographic Technician | 0.98 | |
| Andrew Smith | Computer Operator | 0.23 | |
| Ian Varley | Computer Operator | | 0.19 |
| Andrew Welch | Cartographic Technician | 0.29 | |
| **Natural Resources** | | | |
| Rebecca Anthony | Biological Science Technician/Clerk | 0.72 | |
| Robert Auger | Biological Science Technician | 0.38 | |
| Mark Biel | Biological Science Technician | 0.96 | |
| Ben Bohmfalk | Clerk Typist | 0.11 | |
| Sarah Bransom | Senior Environmental Planner | | 0.01 |
| Wendy Clark | Wildlife Biologist | 0.56 | |
| McCrea Cobb | Biological Science Technician | 0.27 | |
| Heath Corrigan | Biological Science Technician | 0.25 | |
| Paul Doss | Geologist | 0.28 | |
| Shana Driscoll | Biological Science Technician | 0.07 | |
| Brian Ertel | Biological Science Technician | 0.96 | |
| Steve Gale | Biological Science Technician | 0.36 | |
| Trisha Giambra | Biological Science Technician | 0.46 | |
| Rachael Gray | Biological Science Technician | 0.30 | |
| Deb Guernsey | Program Assistant | 0.96 | |

| | | FTE | Borrowed FTE |
|---|---|---|---|
| Kerry Gunther | Wildlife Biologist | 1.00 | |
| Mary Hektner | Resource Management Specialist | 1.00 | |
| Christie Hendrix | Biological Science Technician/Secretary | 0.33 | |
| Nancy Hinman | Geologist | 0.29 | |
| Sara Housley | Clerk Typist | 0.16 | |
| Michael Humling | Biological Science Technician | 0.31 | |
| Darren Ireland | Biological Science Technician | 0.35 | |
| Bryan Irvin | Biological Science Technician | 0.53 | |
| Sharit Koser | Park Ranger | | 0.05 |
| Gregg Kurz | Biological Science Technician | 0.90 | |
| Kristin Legg | Resource Management Specialist | | 0.04 |
| Meredee Lloyd | Biological Science Technician | 0.06 | |
| Jeff Lutch | Biological Science Technician | 0.96 | |
| John Mack | Wildlife Biologist | 1.00 | |
| Dan Mahony | Fishery Biologist | 1.00 | |
| Mimi Matsuda | Biological Science Technician | | 0.11 |
| Kerrie McCartney | Administrative Support Assistant | 0.11 | |
| Terry McEneaney | Wildlife Biologist | 1.00 | |
| Richard McIntyre | Biological Science Technician | 0.42 | |
| Kerry Murphy | Wildlife Biologist | 0.96 | |
| Tom Olliff | Natural Resource Program Manager | 0.10 | |
| Glenn Plumb | Supervisory Wildlife Biologist | 1.00 | |
| Sally Plumb | Cultural Resources Assistant | 0.03 | |
| Tiffany Potter | Biological Science Technician | 0.06 | |
| Roy Renkin | Vegetation Management Specialist | 0.84 | |
| Freya Ross | Biologial Science Technician | | 0.15 |
| Jim Ruzycki | Fishery Biologist | 0.33 | |
| William Saueressig | Clerk Typist | 0.11 | |
| Gretchen Schenk | Biological Science Technician | 0.36 | |
| Amy Schmoller | Biological Science Technician | 0.16 | |
| David Schmoller | Biological Science Technician | 0.30 | |
| Thomas Seals | Biological Science Technician | 0.06 | |
| Jim Sinclair | Biological Science Technician | 0.08 | |
| Doug Smith | Wildlife Biologist | 1.00 | |
| Sarah Stevenson | Technical Writer-Editor | 0.01 | |
| Beth Taylor | Administrative Support Assistant | 0.21 | |
| Eric Tomasik | Biological Science Technician | 0.31 | |
| Tim Thompson | Physical Science Technician | 0.12 | |
| Jennifer Whipple | Botanist | 0.89 | |
| **Cultural Resources** | | | |
| Sean Cahill | Museum Technician | 0.98 | |
| Vanessa Christopher | Museum Technician | 0.68 | |
| Jon Dahlheim | Museum Technician | 0.94 | |
| Kamiah Dumontier | Cultural Resources Clerk | 0.19 | |
| Elaine Hale | Cultural Resources Technician | 1.00 | |
| Holly Hampton | Archeological Technician | | 0.06 |
| Harold Housley | Archives Specialist | 1.00 | |
| Sara Housley | Clerk Typist | 0.04 | |
| Ann Johnson | Archeologist | 1.00 | |

| | | FTE | Borrowed FTE |
|---|---|---|---|
| Lon Johnson | Cultural Resources Program Manager | 1.00 | |
| Laura Joss | Chief, Branch of Cultural Resources | 0.48 | |
| Anne Kern | Archeological Technician | | 0.02 |
| Susan Kraft | Supervisory Museum Curator | 1.00 | |
| Kathryn Lancaster | Library Technician | 0.91 | |
| Kerrie McCartney | Administrative Support Assistant | 0.37 | |
| Sally Plumb | Cultural Resources Technician | 0.05 | |
| Beth Raz | Museum Aide | 0.46 | |
| Charissa Reid | Cultural Resources Assistant | 0.21 | |
| Lisa Stanley | Archeological Technician | | 0.04 |
| Stacy Stermitz | Administrative Support | 0.01 | |
| Rosemary Sucec | Cultural Anthropologist | 0.44 | |
| Lee Whittlesey | Archivist | 1.00 | |
| **IGBST & BRD** | | | |
| Maureen Hartmann | Biological Science Technician | 0.14 | |
| Jason Hicks | Biological Science Technician | 0.50 | |
| Craig Jamison | Biological Science Technician | 0.08 | |
| Christopher McQuery | Biological Science Technician | 0.36 | |
| **TOTAL FTE** | | **50.62** | **0.92** |

# APPENDIX II. PUBLICATIONS, REPORTS, AND PAPERS

The following publications and reports published in 2000 were authored or co-authored by Yellowstone Center for Resources staff.

### *Professional Publications*


Biel, M.J., K.A. Gunther, and H.E. Hoekstra. 2000. Bear attractant of biodiesel fuel. Pages 43–52 *in* Curlee, A.P., A. Gillesberg, and D. Casey, eds. Greater Yellowstone predators: Ecology and conservation in a changing landscape. Proceedings of third biennial conference on the greater Yellowstone ecosystem. Northern Rockies Conservation Cooperative, Jackson, Wyo. 212 pp.

Consolo Murphy, S., and M.M. Meagher. 2000. The status of wolverines, lynx, and fishers in Yellowstone National Park. Pages 57–62 *in* Curlee, A.P., A. Gillesberg, and D. Casey, eds. Greater Yellowstone predators: Ecology and conservation in a changing landscape. Proceedings of third biennial conference on the greater Yellowstone ecosystem. Northern Rockies Conservation Cooperative, Jackson, Wyo. 212 pp.

Crabtree, R.L., and J.D. Varley. 2000. The ecological and sociodemographic role of the coyote on Yellowstone's northern range. Pages 63–84 *in* Curlee, A.P., A. Gillesberg, and D. Casey, eds. Greater Yellowstone predators: Ecology and conservation in a changing landscape. Proceedings of third biennial conference on the greater Yellowstone ecosystem. Northern Rockies Conservation Cooperative, Jackson, Wyo. 212 pp.

Elliott, C.R., and M.M. Hektner. 2000. Wetland resources of Yellowstone National Park. National Park Service, Mammoth Hot Springs, Wyo. 32 pp.

Franke, M.A. 2000. Yellowstone in the afterglow: Lessons from the fires. National Park Service, Mammoth Hot Springs, Wyo. YCR-NR-2000-03. 118 pp.

Gunther, K.A., M.J. Biel, and H.R. Robison. 2000. Influence of vehicle speed and vegetation covertype on road-killed wildlife in Yellowstone National Park. Pages 42–47 *in* Proceedings of wildlife and highways; seeking solutions to an ecological and socio-economic dilemma. Seventh annual meeting of the Wildlife Society, September 12–16, Nashville, TN. 169 pp.

Gunther, K.A., M.J. Biel, K.A. Churchill, and R.L. Danforth. 2000. Changing problems in Yellowstone bear management, 23 years after the dumps. Pages 85–110 *in* Curlee, A.P., A. Gillesberg, and D. Casey, eds. Greater Yellowstone predators: Ecology and conservation in a changing landscape. Proceedings of third biennial conference on the greater Yellowstone ecosystem. Northern Rockies Conservation Cooperative, Jackson, Wyo. 212 pp.

McEneaney, T. 2000. The common raven: Field notes on an important Yellowstone predator. Pages 151–156 *in* Curlee, A.P., A. Gillesberg, and D. Casey, eds. Greater Yellowstone predators: Ecology and conservation in a changing landscape. Proceedings of third biennial conference on the greater Yellowstone ecosystem. Northern Rockies Conservation Cooperative, Jackson, Wyo. 212 pp.

———. 2000. The Yellowstone bird report, 1999. National Park Service, Mammoth Hot Springs, Wyo. YCR-NR-2000-02. 26 pp.

McIntyre, R., and D.W. Smith. 2000. The death of a queen: Yellowstone mutiny ends tyrannical rule over Druid pack. *International Wolf* 10: (4)8–11.

Olliff, T., and S. Consolo Murphy. 2000. Seeking a scientific approach to backcountry management in Yellowstone National Park. USDA Forest Service Proceedings RMRS-P-15 vol 5.

Reinhart, D.P., S.T. Olliff, and K.A. Gunther. 2000. Managing bears and developments on cutthroat spawning streams in Yellowstone National Park. Pages 161–170 *in* Curlee, A.P., A. Gillesberg, and D. Casey, eds. Greater Yellowstone predators: Ecology and conservation in a changing landscape. Proceedings of third biennial conference on the greater Yellowstone ecosystem. Northern Rockies Conservation Cooperative, Jackson, Wyo. 212 pp.

Renkin, R.A., and K.A. Gunther. 2000. Predicting grizzly bear mortality in developed areas of Yellowstone National Park. Pages 171–176 *in* Curlee, A.P., A. Gillesberg, and D. Casey, eds. Greater Yellowstone predators: Ecology and conservation in a changing landscape. Proceedings of third biennial conference on the greater

Yellowstone ecosystem. Northern Rockies Conservation Cooperative, Jackson, Wyo. 212 pp.

Rubinstein, P., L.H. Whittlesey, and M. Stevens. 2000. The guide to Yellowstone waterfalls and their discovery. Westcliffe Publishing Company, Englewood, Colo. 296 pp.

Schullery, P. 2000. Yogi lives: The evolving image of the bears of Yellowstone. Pages 3–16 *in* Curlee, A.P., A. Gillesberg, and D. Casey, eds. Greater Yellowstone predators: Ecology and conservation in a changing landscape. Proceedings of third biennial conference on the greater Yellowstone ecosystem. Northern Rockies Conservation Cooperative, Jackson, Wyo. 212 pp.

Schullery, P., and L. Whittlesey. 2000. Yellowstone Nature Notes: A neglected documentary resource. *Yellowstone Science* 8(1): 2–5.

Smith, D.W., L.D. Mech, M. Meagher, W.E. Clark, R. Jaffe, M.K. Phillips, and J.A. Mack. 2000. Wolf-bison interactions in Yellowstone National Park. *Journal of Mammalogy* 81(4): 1128–1135.

Smith, D.W., K.M. Murphy, and D. Guernsey. 2000. Yellowstone wolf project, annual report 1999. National Park Service, Mammoth Hot Springs, Wyo. YCR-NR-2000-01. 20 pp.

Smith, D.W., and M.K. Phillips. 2000. Northern Rocky Mountain wolf. Pages 219–223 *in* Reading, R.P., and B. Miller, eds. Endangered animals: A reference guide to conflicting issues. Greenwood Press, Westport, Conn.

Whittlesey, L. 2000. Two gifted historians: Aubrey L. Haines and Don G. Rickey, Jr. Pages 69–70 *in* Rankin, C.E., ed. *Montana The Magazine of Western History* 50.

Wilson, C.L., N.W. Hinman, and R.P. Sheridan. 2000. Hydrogen peroxide formation and decay in iron-rich geothermal waters: The relative roles of abiotic and biotic mechanisms. *Photochemistry and Photobiology* 71(6): 691–699.

Yellowstone National Park. 2000. Yellowstone Center for Resources, annual report, 1999. National Park Service, Mammoth Hot Springs, Wyo. YCR-AR-1999. 86 pp.

### *Administrative Reports*

Evans, S., D.W. Smith, and K. Murphy. 2000. Evaluation of wolf activity along the Tower to Canyon road in Yellowstone National Park, 1995–1999. YNP report. 17 pp.

Gunther, K.A., and M.J. Biel. 2000. Yellowstone National Park 1999 annual report of bear management activities conducted under endangered species sub-permit #87-1. National Park Service, Yellowstone Bear Management Office, Mammoth Hot Springs, Wyo. 11 pp.

———. 2000. Evaluation of road-killed wildlife on the Dunraven Road, Yellowstone National Park, 1989–1998. National Park Service, Yellowstone Bear Management Office, Mammoth Hot Springs, Wyo. 18 pp.

———. 2000. Evaluation of road-killed wildlife on the Canyon Junction to Fishing Bridge road of Yellowstone National Park, 1989–1998. National Park Service, Yellowstone Bear Management Office, Mammoth Hot Springs, Wyo. 16 pp.

———. 2000. Bear management office administrative annual report for calendar year 1999. National Park Service, Yellowstone Bear Management Office, Mammoth Hot Springs, Wyo.

Gunther, K.A., M.T. Bruscino, S. Cain, K. Frey, M.A. Haroldson, and C.C. Schwartz. 2000. Grizzly bear–human conflicts, confrontations, and management actions in the Yellowstone ecosystem, 1999. Pages 55–108 *in* Schwartz, C.C., and M.A. Haroldson, eds. Yellowstone grizzly bear investigations: Annual report of the Interagency Grizzly Bear Study Team, 1999. U.S. Geological Survey, Bozeman, Mont. 128 pp.

Ireland, D., K.A. Gunther, M.J. Biel, H. Corrigan, and E. Kiberd. 2000. Biological assessment of Canada lynx activity and habitat along four road sections and the proposed Canyon Contractor Camp, Yellowstone National Park. National Park Service, Yellowstone Bear Management Office, Mammoth Hot Springs, Wyo. 16 pp.

Kurz, G., Reinertson, E., and D. Reinhart. 2000. Winter bison monitoring. National Park Service, Mammoth Hot Springs, Wyo. 40 pp.

McEneaney, T. 2000. An ornithological and herpetological assessment of federal highway projects. YNP report.

Yellowstone National Park. 2000. Investigators' annual reports, 1997–98. National Park Service, Mammoth Hot Springs, Wyo. YCR-IAR-1997–98. 158 pp.

———. 2000. Investigators' annual reports, 1999. National Park Service, Mammoth Hot Springs, Wyo. YCR-IAR-1999. 152 pp.

# YELLOWSTONE CENTER FOR RESOURCES

## ANNUAL REPORT 2000