

YELLOWSTONE CENTER FOR RESOURCES



ANNUAL REPORT
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FISCAL YEAR (OCTOBER 1, 2003, TO SEPTEMBER 30, 2004)



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

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Front cover: From top left, Wolf Project Lead Doug Smith and Yellowstone Center for Resources Director John Varley at the Seventh Biennial Scientific Conference on the Greater Yellowstone Ecosystem; elk calf; Levi Holt, Nez Perce Tribe, plays the flute at the Nez Perce Memorial Ceremony; thermal microbial mats; a rare chestnut-sided warbler.

Title page: Yellowstone cutthroat trout. Photo by Charles Walton.

Above: Xanterra employee Kelly McAdams operates a forklift loading a Shaw & Powell Camping Company safe into a truck during the move of the archives, library, and museum collections.

Back cover: Grizzly tracks in sand.

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Introduction

Fiscal Year 2004 saw the rewarding culmination of several multi-year efforts on the part of Yellowstone Center for Resources (YCR) staff. Highlights of this year's annual report, for instance, include a detailed summary of the archives, library, and museum collections' move to the park's new Heritage and Research Center. The relocation, which required not only years of planning and construction of a new building, but also the inventory, preparation, packing, unpacking, and shelving of each of Yellowstone's 5.3 million objects, could not have been accomplished without the assistance of the 40 volunteers who came from parks and museums across the nation to lend their time and energy to this monumental undertaking.

The Seventh Biennial Scientific Conference on the Greater Yellowstone Ecosystem brought together academics, resource professionals, and the interested public not only from across the nation, but also from around the world. *Beyond the Arch: Community and Conservation in Greater Yellowstone and East Africa* broke all previous conference attendance records, fostered relationships and information-sharing on an international scale, and featured a world-class slate of keynote speakers, including Dr. Richard Leakey.

The park's Lynx Project concluded after four years of intensive surveys and data collection, and the results are in—lynx were detected in the park 10 times, including three times using DNA-based methods. These detections likely represented at least four individuals, including two kittens born in two different years—an important finding, because as with most carnivores, reproducing Canada lynx females are typically resident, as opposed to nomadic or transient. The project's findings provide inventory data necessary to avoid adverse effects from park management activities on this federally-listed threatened species; no such information previously existed.

YCR's partnerships and agreements with other federal and state agencies, academia, and public organizations continued to be critical to our continued successes in stewardship. Overall, YCR staff participated in 29 standing partnerships and 99 project-based partnerships in FY04. Research Permit Office (RPO) staff authorized 208 research permits to investigators from across the U.S. and 6 foreign countries, again showing the park's value as a scientific laboratory as well as a pleasuring ground. The RPO also collaborated with Montana State University's Thermal Biology Institute to initiate a researcher check-in pilot project aimed at improving researcher-ranger communications through a web-based communication system, and to create a set of educational brochures and videos on Leave No Trace ethics specific to ways researchers can conduct fieldwork without leaving lasting evidence of their presence at field locations.

We hope this report continues to assist us in attaining the goals of the YCR, which are to provide outreach, contribute to literature, promote interpretation, and most of all, strive to learn more about the resources we are mandated to manage and protect. For more information about specific topics of interest, readers may contact us at (307) 344-2203, or visit the park's web site at <www.nps.gov/yell>.



John D. Varley
Director, Yellowstone Center for Resources



Horace Axtell and Wilfred Scott, Nez Perce Tribe (seated, center), co-leaders of the commemoration of the 1877 Nez Perce War in Yellowstone National Park, August 2004.

Part I: Resource Highlights

Nez Perce Tribe Holds Pipe Ceremony

The park's Ethnography Program coordinated a request from two members of the Nez Perce Tribe (Wilfred Scott, of the Nez Perce Executive Council, and Horace Axtell, elder and historian) to hold a memorial and pipe ceremony at the park. The ceremony was conducted to commemorate those Nez Perce people who trekked through the park in the summer of 1877. Held August 21, 2004, along Fountain Flat Drive near Nez Perce Creek, the event was attended by several hundred visitors and park staff, including Superintendent Suzanne Lewis and Deputy Superintendent Frank Walker. On the following day, Resource Management and Visitor Protection Division staff, the deputy superintendent, and retired rangers Jerry Mernin and John Lounsbury joined several Nez Perce on horseback for a trek into Hayden Valley, where they experienced the terrain their ancestors once traveled. This event was one of the first of its kind for Yellowstone, and enabled the park to fulfill the recommendation of the National Park System Advisory Board in helping to conserve the irreplaceable connections that ancestral and indigenous people have with the parks, and to nurture those connections for future generations.

Archives, Library, and Museum Collections Move Safely Completed

In FY04, the park's Archives, Library, and Museum Collections staff conducted a 100% inventory of the more than 5.3 million-item collections in preparation for the move to the new Yellowstone Heritage and Research Center (HRC) in Gardiner, Montana, accomplished during the summer. Move participants were recruited from other parks, private museums, and graduate programs; a total of 40 people from across the country were chosen from almost 80 applicants, and were divided into five teams that spent two weeks each at Yellowstone. Each team, once it arrived in the park, was divided into four groups and put under a team leader from the park's curatorial staff. These four groups included archives and library collections packing; museum collections packing; preparation and packing of objects and furniture in historic vehicle storage; and receiving and unpacking at the HRC. The physical move of the library collections (2,250 linear feet of books and 130 linear feet of vertical files) was completed in early July, and the archives (over 2,500 linear feet) were moved by August. The archives and library team then was reassigned to assist with all aspects of moving the museum collections. These collections (over 300,000 items) were completely moved by August 16, 2004. This collections move, the largest in NPS history, was completed on time, and with no object loss or participant injury.

Seventh Biennial Scientific Conference a Success

The Seventh Biennial Scientific Conference on the Greater Yellowstone Ecosystem (GYE), *Beyond the Arch: Community and Conservation in Greater Yellowstone and East Africa*, took place on October 6–8, 2003. Through a publicly-oriented discussion of issues that drew together national parks in the Greater Yellowstone and East Africa, managers, sci-

entists, policymakers, and the public came together to discuss and consider the interdependence of both nature–society relations and natural and cultural history in local and global contexts. Conference attendance broke all previous records, with 188 pre-registered participants and attendees, and several walk-up registrants. Paper and panel presentations included discussions of local ranchland dynamics; national policy and the rights of local peoples; conservation trends in both East Africa and the GYE; environmental perception and imagery; comparative ecosystem analyses; and the sometime collision of conservation efforts and cultural agendas. The conference attracted speakers and attendees from across North America and from Africa. Keynote speakers included Drs. Richard Leakey, Dan Flores, A.R.E. Sinclair, Steven Sanderson, Charles Preston, Lee Talbot, and Robin Reid. Editing and layout of the conference proceedings was completed; they will be published in FY05. The conference was planned and organized by the Support Branch's Resource Information Team.



Samson Lenjirr of Kenya's Narok Council addresses an audience at the Seventh Biennial Scientific Conference.

Another Record Year for Lake Trout Removal

The 2004 field season represented another record year for lake trout suppression efforts on Yellowstone Lake. A total of 27,770 of these non-native predators, illegally introduced to the lake at least 20 years ago, were killed through gillnetting and angling to preserve the remaining native Yellowstone cutthroat trout (YCT). More than 100,000 lake trout have been killed by gillnetting since they were first discovered in 1994. Because each lake trout could consume 41 YCT each year, the gillnetting effort has saved a tremendous number of YCT.

In an effort to capitalize on the lake trout's spawning behavior, an additional capture method was used in 2004. Electrofishing (introducing a pulsed direct current, supplied by a portable generator, into the water to administer an electric shock) is a widely used technique for capturing fish. The electric shock temporarily stuns the fish, allowing easy capture with a dip net. On the nights of September 21 and 22, 975 additional mature lake trout were removed



In 2004, the Aquatics Section's lake trout suppression crew removed 26,707 lake trout from Yellowstone Lake (including this one) by gillnetting.

from Yellowstone Lake by electrofishing. During the following week, only 88 were captured, indicating the spawn was likely over.

Despite the recent increase in numbers of spawn-

ing lake trout, results of the lake trout suppression program are encouraging. Overall catch per unit of effort (CPUE) remains low, and continued decline in mean total length of lake trout caught near spawning areas indicates continued removal of the older, larger, and therefore most detrimental lake trout. Low CPUE, continued decrease in spawner size, and the large number of lake trout removed from the system, are positive indications that gillnetting operations are exerting measurable lake trout mortality in this system. However, the increase in numbers of spawning fish underscores the importance of maintaining the effort to keep this non-native predatory population in check. Lake trout densities in the West Thumb area remain high and a serious threat to YCT.

New Researcher Information Programs Initiated

The Research Permit Office worked jointly on two projects with Montana State University's Thermal Biology Institute (TBI). The researcher check-in pilot project aimed to improve researcher-ranger communications through a web-based communication system. While in the park, researchers were able to report their whereabouts and contact information on a website. Rangers were able to query and access researcher entries specific to their management areas.

The second Yellowstone-TBI project involved the creation of an educational brochure and video for researchers. The brochure and video conveyed to researchers a field ethic comparable to the Leave No Trace ethic promoted to hikers nationwide by the National Outdoor Leadership School. These educational materials provided examples of ways researchers can conduct fieldwork without leaving lasting evidence of their presence at field locations. The brochure and video also promote safe work habits while researchers conduct field studies in Yellowstone.

Staff also worked closely with YCR's Spatial

Analysis Center staff on a mapping project of locations where research is conducted throughout the park, and of locations where researchers collect specimens and install equipment in the field.

Lynx Survey Project Completed

In 2000, the Canada lynx (*Lynx canadensis*) was federally listed as a threatened species in the conterminous United States. Information about the distribution and ecological requirements of Canada lynx is necessary to ensure that management actions do not adversely affect the species. In Yellowstone, a dearth of this information spurred the initiation of a multi-year, parkwide survey project with the objective of documenting Canada lynx presence and distribution in the park from 2001 to 2004. A final project report summarizing methods, results, and conclusions was completed in June 2004.

Lynx were detected in the park 10 times, including three times using DNA-based methods. Their



A member of the lynx crew collects hairs for DNA analysis.

distribution was largely restricted to the east and possibly the Central Plateau sectors. The cumulative detections likely represented at least four individuals, including two kittens born in two different years. The presence of offspring was an important finding, because as with most carnivores, reproducing Canada lynx females are typically resident, as opposed to nomadic or transient.

The weak signal of Canada lynx presence, and their restricted distribution, point to reduced population viability of this species in the ecosystem. This condition is not surprising for a species living at the periphery of its continental range. It is recommended that this survey be repeated at 10-year intervals with the same search intensity and spatial extent as during 2000–2004.

Osprey Beach Archeological Report Published

Publication of the technical report, *Osprey Beach: A Cody Complex Camp on Yellowstone Lake* (Ann Johnson, Brian O.K. Reeves, and Mack W. Shortt, 2004), detailing the salvage excavations for the Osprey Beach site on Yellowstone Lake, marked the completion of a project grant from the Yellowstone Park Foundation. This remarkable site is going to change how archeologists think about Paleoindian people and their use of high intermountain areas and obsidian. For instance, the Cody Complex, of which the Osprey Beach site is an example, is traditionally viewed as representing “classic” early Native American Plains bison hunters, different from contemporaneous peoples who inhabited foothills and mountain regions. That impression was founded upon the excavation of Cody Complex bison kills and their associated processing and campsite areas in the northwestern plains, foothills, and intermountain basins. As these large bison kill sites appear to be absent from the mountains, it was hypothesized that different people lived in the mountains. Mountain people were thought to utilize more diverse animal and plant communities.

In light of the findings at Osprey Beach and elsewhere in the Greater Yellowstone Area, that hypothesis appears to have been based upon incomplete



Museum of the Rockies archeologist Mack Shortt talks to a Yellowstone Park Foundation group visiting the Osprey Beach site.

information. The broad distribution of the lithic materials in many Cody Complex sites in Greater Yellowstone and beyond shows that some of the summer resident Cody Complex bands probably wintered in the foothills, where they hunted bison. As such, the apparent plains peoples vs. mountain peoples subsistence dichotomy (i.e., bison hunting vs. broad-based subsistence) can now be seen as seasonal subsistence variation, rather than an actual dichotomy.

In 2004, a revisit to the shoreline around the Osprey Beach site recovered a high number of tools, including several Cody knives. Further excavations at this site would be worthwhile.

Bear Management Staff Improve Backcountry Safety

Proper food storage at remote backcountry wildland fire camps has been a challenge due to the large number of firefighters who often need to be flown in to temporary camps on short notice. In the past, the park's aluminum bear traps have been used for this purpose. However, there have been safety concerns with fire crews' entering and exiting the traps through the guillotine-style doors to retrieve their food.

In addition, the traps are sometimes unavailable for use on fires as food storage devices because they are needed for trapping bears. To address this concern, Bear Management Office staff designed and had built two helicopter-transportable, lightweight aluminum, bear-proof food storage boxes for use in backcountry fire camps. Although these fire camp boxes worked well on the ground, they tended to spin in the air when being long-lined by helicopter to the fire camps, raising safety concerns by the helicopter pilots. In response, the Bear Management Office worked with helicopter pilots to design tail fins that could be attached to the boxes to stabilize

them in flight, making them safer for the pilots and ground crews. Two of the Bear Management Office's portable aluminum bear traps were also modified and updated for bear and human safety purposes.

Tauck Volunteer Program

The second year of the Tauck Volunteer Program began in mid-May 2004, with the project expanding into the West Thumb and Grant Village areas. The average number of volunteers per group grew by approximately 10–15 people from 2003, to an average group size of 25–35 people, making it necessary to use tour buses to transport volunteers daily. Volunteers came from the Middle East, Australia, England, Germany, and Asia, as well as from all over the U.S. Many expressed appreciation at being given the opportunity to give back to the national parks.

Overall, treatment was completed on numerous historic structures, six historic districts, two ranger stations, employee housing, support buildings, landscaping and erosion control projects, fire hydrants, protective railings, and other projects at Lake, Bridge Bay, Fishing Bridge, West Thumb, Grant Village, Old Faithful, and other smaller areas. Volunteers contributed 3,360 hours of effort.

Fen Study

Summer 2004 was the first field season of a study funded by the Yellowstone Park Foundation and Canon U.S.A., Inc., to inventory and classify vegetation communities occurring in Yellowstone's fens. Fens, unusual types of wetlands, can occur in a variety of different settings, but all sites are permanently saturated to such an extent that they build up thick layers of organic soil. They are relatively rare in the central Rocky Mountains, and little was previously known about their nature and extent in Yellowstone. By the end of the summer, 65 individual fen sites were surveyed throughout the park, and species information, as well as water and soil chemistry data, were collected on 242 stands of vegetation within those sites.

Based on the initial data, Yellowstone contains a wide variety of fen types. Some sites are very nutrient-rich, and often contain high plant species diversity. These sites generally occur where groundwater moves constantly through the site, flushing minerals out of surrounding rock. Other sites have very low ion concentration, and can be dominated by a carpet of *Sphagnum* moss species. Some of the most interesting sites include a suite located near known geothermal areas. Though they are not fed directly by hot geothermal waters, these sites are very acidic, likely influenced by the geothermal heating. These sites contain vascular plant species such as *Pinus contorta*, *Carex aquatilis*, *Deschampsia cespitosa*, and pillows of mosses in the genera *Polytrichum* and *Sphagnum*.



NIPSOULG SMITH

A collaborative analysis of the initial consequences of wolf recovery on the migratory population of northern Yellowstone elk was published in FY04.

Elk–Wolf Study Results Published

In October 2003, the Yellowstone Center for Resources and Montana State University published a collaborative analysis of the initial consequences of wolf recovery on the migratory population of northern Yellowstone elk. Vital rates for northern Yellowstone elk after wolf restoration (1996–2004) were estimated to assess the population trajectory and relative influence of harvests and wolf predation on elk demographics.

Findings included the following: Elk counts decreased from 19,045 to 8,335 during 1994–2004. Pregnancy rates for prime-age females (3–15 years) were high (0.90), and similar to those prior to wolf restoration. The survival rate for prime-aged females was 0.85, compared to 0.99 when harvests were low and wolves absent (1969–1975). Moderate-to-liberal human harvests (hunting) and wolf predation were the primary factors limiting adult female survival. Harvests during 1989–2003 removed a relatively constant proportion (27%) of migratory animals each year (mean = 1,302), primarily prime-aged females. By 2003, 85 wolves had killed an estimated 538–1,076 adult female elk per year, primarily older animals. Wolves maintained high kill rates and rapid population growth despite a 50% decrease in elk counts. Elk numbers will likely continue to decrease until levels of harvest and/or predation decrease sufficiently to allow an increase in recruitment and adult survival.



Before and after: *Left*, former archives storage in the basement of the Albright Visitor Center. *Right*, archivist Harold Housley demonstrates the new, mobile storage units in the Yellowstone Heritage and Research Center.

Part II: Cultural Resource Programs

This section describes the work accomplished or coordinated by YCR staff who comprise the following units of the Branch of Cultural Resources:

- *Archeology*
- *Ethnography*
- *Historic Research*
- *Historic Structures*
- *Archives, Library, and Museum Collections*

Archeology

These staff are responsible for archeological inventories and data recovery, environmental compliance associated with the Federal Lands Highway Program, trails rehabilitation, wildland–urban interface issues, site testing, obsidian studies, and multiple property documentation. The Archeology Program had a busy, successful year, with thanks to the Fire Cache, as well as to Resource Management and Visitor Protection rangers for their assistance with access, information, and logistics (supplies, boats, and backcountry cabins), and to Corral & Stock Operations for their cooperation and professionalism in providing horses and packing and transporting equipment, artifacts, and soil samples in and out of seven sites in the Black Canyon of the Yellowstone. The trail was difficult, and each trip was a challenge that was accomplished safely. Volunteers John Reynolds, Mary Meagher, and Diane Hargreaves were again integral to the program, assisting with the move to the new Heritage and Research Center, making progress on archeological cataloging, and conducting fieldwork.

In March 2004, Elaine Hale was accredited as a Registered Professional Archaeologist by the Registry of Professional Archaeologists (RPA), affiliated with the Society of American Archaeologists and the National Park Service. The registry confirms professional competence, requires adherence to a professional code of conduct, and provides standards for archeological research performance.

The park's archeological database (ASMIS) contains 1,126 sites—likely a small fraction of the total number of sites in the park. Thirty-four sites in seven projects were documented in Fiscal Year 2004 (FY04), with 59 acres intensively inventoried.

Wildland–Urban Interface (WUI) Projects

Archeology staff worked closely with the Fire Cache to complete archeological inventories and, occasionally, archeological site documentation for hazard fuel reduction projects around front- and backcountry developed areas. Five archeological resources were identified; four were historic dumps.

Although few important archeological sites were identified, the WUI projects have several benefits for the Archeology Program. First, they ensure that archeological resources will not be impacted by fuel reduction projects. Second, by traveling to new parts of the park, the archeologist gains insights into the topography, vegetation, and water that contribute to a better understanding of how early people may have used these areas.

While following up on the 2003 Frank Island fire, a fire effects crew identified a precontact site during a visit to the island in 2004. This resource, not visible prior to the fire, was documented.

Archeological Inventories

Quadrant Mountain/Fawn Pass/Swan Lake Flat. In 2003, Archeologist Ann Johnson and Mary Meagher identified hunting pits and drive lines on a ridge west of Swan Lake Flat. These sites were documented in 2004. Unfortunately, because no culturally diagnostic tools were found, it is not known who used these features. A large tipi ring site on Glen Creek also was documented.

The Lifeways of Canada archeological crew carried out a sample inventory of the Quadrant Mountain and Fawn Pass area, and recorded 25 precontact sites. Sites along Fawn Pass contained tools of obsidian and various cherts. Based upon the likely sources of these stones, the sites may be related to people traveling between the Gallatin area and the interior of the park. The cherts are typical of the tool-quality stones commonly found in the gravels of the Gallatin River. The obsidian may relate to the same or different people moving back to the west. A sample of the obsidian tools will be fingerprinted to determine the source(s) of the obsidian.

Sites on ridges away from the trail appeared to be related to hunting activity. None of the pits and rock lines found on the west side of Swan Lake Flat were observed in the Quadrant area. Over half of the diagnostic tools (projectile points) were of the Pelican Lake type, dating from 1000 B.C. to A.D. 200. This

is the most common prehistoric culture in the park, and it would be worthwhile to try to determine what the environmental conditions were at that time.

Several other points belonged to the McKean Complex, dating to about 3500 B.C.; these are also relatively common in the park. Consistent with other findings, the crew found only one point that might date from the past 800 years, possibly because the Little Ice Age made weather conditions in the park less desirable, especially compared to the Pelican Lake period of park use. The absence of diagnostics for the most recent period (A.D. 1150–1800) calls into question whether the park had local inhabitants in any numbers during those years. One implication is that there may have been little human hunting pressure on ungulates in the park in the near-historic centuries.

Archeological Data Recovery

The purpose of archeological data recovery is to salvage through excavation important information that is being or will be lost from a site.

Osprey Beach site. Publication of the technical report, *Osprey Beach: A Cody Complex Camp on Yellowstone Lake* (Ann Johnson, Brian O.K. Reeves, and Mack W. Shortt, 2004), detailing the salvage excavations for the Osprey Beach site on Yellowstone Lake, marked the completion of a project grant from the Yellowstone Park Foundation. This remarkable site is going to change what archeologists think about Paleoindian people and their use of high intermountain areas and obsidian.

For instance, the Cody Complex, of which the Osprey Beach site is an example, is traditionally viewed as representing “classic” early Native American Plains bison hunters, different from contemporaneous peoples who inhabited foothills and mountain regions. That impression was founded upon the excavation of Cody Complex bison kills and their associated processing and campsite areas in the northwestern plains, foothills, and intermountain basins. As these large bison kill sites appear to be absent from the mountains, it was hypothesized that different people lived in the mountains. Mountain people were thought to utilize more diverse animal and plant communities.

In light of the findings at Osprey Beach and elsewhere in the Greater Yellowstone Area, that hypothesis appears to have been based upon incomplete

information. The broad distribution of the lithic materials in many Cody Complex sites in Greater Yellowstone and beyond shows that some of the summer resident Cody Complex bands probably wintered in the foothills, where they hunted bison. As such, the apparent plains peoples vs. mountain peoples subsistence dichotomy (i.e., bison hunting vs. broad-based subsistence) can now be seen as seasonal subsistence variation, rather than an actual dichotomy.

Also, through contributions by geologists John Albanese and Ken Pierce, more information became available about the ages and development of terraces on Yellowstone Lake. In the vicinity of the Osprey Beach site, there are six distinct shorelines above the current waterline, and two underwater. The boundary of the Osprey Beach site was expanded to the south, away from the eroding terrace edge. Further excavations at this site would be worthwhile.

The Archeology Program received a new grant through the Yellowstone Park Foundation to inventory a portion of the Yellowstone Lake shoreline for archeological sites. In 2004, a revisit to the shoreline around the Osprey Beach site recovered a high number of tools, including several Cody knives. Ann Johnson and four volunteers also returned to the south shore of Yellowstone Lake. Sites identified in FY03 were revisited, with additional documentation performed.

Site 24YE353. Salvage excavations were carried out at site 24YE353 for the second and final year to mitigate erosion caused by spring runoff of the Yellowstone River. From the first year's work, it was

known that there were seven prehistoric campsites stacked upon one another at this location. The 2004 work determined that the deepest camp (more than five feet below the current surface) was made by Cody Complex people—the same cultural group

as those who camped at Osprey Beach. This culture dated to between 9000 and 7000 B.C. Three radiocarbon dates ranging from 7570 and 7510 B.C. on the lowest campsite showed that this is the oldest site excavated in the park to date.

A soil column was collected to share with park geologists. The results from its analysis are expected to provide information about terrace formation along this section of the Yellowstone River.

Site 48YE114. A crew from the Office of the Wyoming State Archaeologist began investigations at a National Register-eligible precontact campsite south of Obsidian Cliff, which is truncated by the current road alignment

and adjacent to an extensive thermal area. Work at this site supports environmental compliance for highway reconstruction between Norris Junction and Mammoth Hot Springs. Elaine Hale worked with the crew conducting magnetometry and systematic shovel testing of the site. Test units were excavated in several areas where buried cultural material was encountered or indicated by the magnetic readings. Approximately one third of the archeological investigations specified by the data recovery plan were accomplished in 2004.

Shovel tests revealed a buried hearth with datable carbon and diagnostic projectile points, chipping stations with concentrations of flake stone debris,



Archeologist Visti Kjar holds Flatbed (mule), while packers Tim McGrady (left) and Monty Simenson load archeological samples from site 24YE353.

and work areas with large scrapers, hammer-stones, and other domestic tools. A radiocarbon date of 310 B.C. from the buried hearth is compatible with the Pelican Lake projectile points, indicating that one of the components of this multi-use site was a campsite. Many site areas are yet to be investigated.

Data recovery is scheduled to continue in 2005, and will continue to reveal precontact peoples' use of both Obsidian Cliff obsidian and the park's thermal areas. Park staff participated in three field trips to the site for discussions about the park's prehistory.

Site Testing

Yellowstone River. Elaine Hale joined the archeological crew from the Office of the Wyoming State Archaeologist for three 10-day backcountry sessions conducting National Register testing of sites along the banks of the Yellowstone River. The investigations were part of a multiple-year Yellowstone River inventory project to record sites and salvage archeological remains eroding into the river and being lost to unauthorized collecting.

Six sites were investigated for National Register eligibility. Distinct intact, buried precontact cultural levels were encountered at five of the sites. Buried cultural materials included diagnostic projectile points, scrapers and other tools, flaked stone debris, and concentrations of burned and butchered bone. Diagnostic projectile points from approximately 5000 B.C. through 1,000-year-old cultural complexes were recovered from subsurface cultural deposits; radiocarbon dating supported these estimates. The diagnostic projectile points and radiocarbon dates indicated continued use of the Yellowstone River sites; analysis of the bone may indicate winter use of the area. The historic components found at two sites may provide important information on a variety of topics ranging from turn-of-the-century poaching of game animals to possible Civilian Conservation Corps (CCC) trail maintenance activities. Five of the sites were recommended eligible for the National Register of Historic Places.

In the Black Canyon of the Yellowstone, fetal bones (probably bighorn sheep) were identified at two sites. These materials represent camps during the spring (between March and May) of the year, and support similar results at other Black Canyon sites. The campsites are immediately adjacent to bighorn sheep winter range, have water, winter sun,



Archeologists Kevin Thorsen and Doug Mitchell (foreground) carry out excavations at site 24YE353. The dark zones represent prehistoric campsite debris.

and shelter from the wind, and are at some of the lowest elevations in the park, where there should be less snow and milder temperatures. If precontact people were in the park during the winter, these areas are likely sites for those camps. However, as winter campsites have not been found in the most likely locations, winter use of the park by precontact people appears to have been unlikely or at least infrequent.

Possible burial site. In 2002, Jim Hepburn, the aging grandson of a pioneer family, identified a rock-lined area near the new Heritage and Research Center where his grandfather, 70 years previously, told him that early pioneers were buried. The site is just outside the construction limits and appears to be undisturbed. It was fenced for protection, and limited testing of the subsurface density was conducted in 2003. This indicated that sediments inside the rock alignment were less densely packed compared to the surrounding area. Dr. Danny Walker, Office of the Wyoming State Archaeologist, and Elaine

Hale conducted a minimal number of auger tests around the edges of the probable burial site in May 2004. No cultural materials were observed, but the tests revealed disturbed sediments compared to the undisturbed sediments just outside the rock-lined area. The limited tests indicate a probable burial site, but the extent to which any cultural remains are preserved is unknown. It is recommended that additional non-invasive testing (ground penetrating radar, conductivity, resistivity, and gradiometric tests) be conducted to provide information about the nature and extent of the subsurface disturbance. Photographs and information concerning the site were presented for tribal review, but to date, no information or concerns about the site have been forthcoming.

Five-Year Plan

In 1999, a five-year plan was developed to address deficiencies in the Archeology Program. Significant work has been accomplished. While few of the proposed projects were completed, progress was made in inventory, site testing, data recovery, cataloging, data management, and National Register nominations. The Archeology Program is seriously deficient in monitoring sites and, despite the successful data recovery projects identified above, significant precontact sites continue to be lost to erosion and unauthorized collection.

Multiple Property Documentation

Final reviews were completed for Elaine Hale's National Register Multiple Property Document (MPD) that provides a cultural history of the park's precontact human use and information on common and shared properties of early archeological remains along the Yellowstone River and Yellowstone Lake. All reviewing groups responded positively to the document, and encouraged all agencies to prepare more NR nominations for archeological sites. After final revision, the MPD and the National Register nomination for site 24YE14 will be transmitted to the National Register of Historic Places for listing consideration early in 2005.

Paleoindian Projectile Points Sourced to Obsidian Cliff

Diagnostic portions of obsidian projectile points from two private sources were temporarily loaned

to the park for analysis. X-ray fluorescence analysis of the specimens identified the origin of their lithic material as the Obsidian Cliff Plateau. These results suggest an early Paleoindian presence at Obsidian Cliff, again strengthening the case for the antiquity of human use of Yellowstone's resources. The broken Clovis projectile point and the Folsom point base were returned to their owners after professional photographs were taken, technical line drawings completed, and resin casts made of each of the artifacts. Elaine Hale presented these findings at the 2004 Plains Anthropological Conference and drafted an article for publication in scientific journals. A museum display of the two Paleoindian points will be developed.

Ethnography

These staff are responsible for intergovernmental meetings, ethnographic resources, assistance to park-associated tribes, and education opportunities for tribes, park staff, and the public.

Intergovernmental Meetings

Spring consultation meeting at Yellowstone. More than 30 individuals representing 12 tribal nations attended the government-to-government consultation meeting on June 3. Representatives from the following associated tribal governments were present: Cheyenne River Sioux Tribe, Confederated Salish & Kootenai Tribes, Crow Creek Sioux Tribe, Eastern Shoshone Tribe, Nez Perce Tribe, Northern Arapaho Tribe, Northern Cheyenne Tribe, Oglala Sioux Tribe, Shoshone-Bannock Tribes, and Sisseton-Wahpeton Sioux Tribe. Delegates from the Ute Tribe (in Utah) and the Saginaw Chippewa Tribe (in Michigan) also attended, as well as two representatives from the Inter-Tribal Bison Cooperative (ITBC). Yellowstone staff who participated in the meeting included Deputy Superintendent Frank Walker, Yellowstone Center for Resources Director John Varley, Cultural Resources Branch Chief Roger Anderson, Wildlife Biologist Rick Wallen, Cultural Anthropologist Rosemary Sucec, and Cultural Resources Technician Tasha Felton. Grand Teton National Park (GRTE) staff included Deputy Superintendent Jim Bellamy, Chief of Science and Resource Management Sue Consolo Murphy, and Archeologist Jaqueline St. Clair. Issues discussed at

the meeting included an update on the winter's bison activities and on vaccination and quarantine efforts; bison and elk management at GRTE and the National Elk Refuge; the effect of wolves and other factors on the northern range elk herd; and seismic activity in Yellowstone.

Tribal representatives voiced their concerns on a number of issues, including interagency bison management efforts. Tribes are still dissatisfied with the current actions of capture and lethal removal of bison. However, many representatives commented that positive changes have resulted from suggestions made by tribes, including the movement toward creating a bison quarantine facility. The ITBC and other tribal representatives again expressed frustration that they do not have voting rights in the Greater Yellowstone Interagency Brucellosis Committee, though they do have representation there.

On the evening of June 5, the park and the Bear Creek Council co-sponsored a community potluck to welcome tribal members to Yellowstone. More than 110 people attended. In addition to the now-annual activities of storytelling and sharing a meal of buffalo stew, the park sponsored the Montana State University Bobcat Singers, an intertribal drumming group, who shared songs and fielded questions about Native American drumming. On June 6, tribal members participated in three field trips. These included visiting sites of recent seismic activity with park geologist Hank Heasler; visiting the Stephens Creek bison capture facility with Rick Wallen; and taking a driving tour of one segment of the Bannock Trail sites with Rosemary Sucec.

Numerous phone calls and other communications are required for a successful annual tribal consultation. This year, ethnography staff made over 26 calls to schedule the meeting time, participated in over 140 phone conversations concerning logistics and meeting agenda, and made more than 26 follow-up calls to survey representatives' reactions to and concerns about the meeting.

Meeting with Shoshone-Bannock Business Council. In November, Frank Walker, Rick Wallen, and Rosemary Sucec met with the full governing council for the Shoshone-Bannock Tribes at Fort Hall, Idaho. Representatives from GRTE and from the National Elk Refuge (NER) were also present. Topics discussed included the bison and elk management planning process underway in GRTE and

NER; the proposed contract with the Shoshone-Bannock Tribes regarding their traditional, historic uses of natural resources in those jurisdictions, Yellowstone National Park (YELL)'s fee exemption policy, winter use, the park's efforts at incorporating American Indian and Shoshone-Bannock knowledge into visitor center exhibits, bison management, and employment/internship possibilities for members of the Tribes, and the park's work on the Bannock Trail. The council requested that YELL nominate the trail both as a National Register property and as a nationally significant historic trail; Yvette Tuell, of the Tribes, and Rosemary Sucec, are working on this idea with Jere Krakow, National Park Service superintendent of Long Distance Trails. The Council also apprised the park of their perceived treaty rights in both YELL and GRTE, and requested that tribal members be allowed to sell their arts and crafts in park concession stores. Ethnography staff contacted business management and cultural resource staff in several parks and reported their findings on this issue to park management.

After the council meeting, Rosemary Sucec met with members of the Tribes' cultural staff. They discussed the report authored by the Tribes on the results of the ethnographic inventory of the Mammoth-to-Norris road segment, the nomination of Obsidian Cliff as a traditional cultural property (TCP), and the proposed sole source contract with the Tribes to conduct a traditional use study. YELL staff agreed to consider the TCP nomination and inform park management of the Tribes' wishes.

Ethnographic Research and Management

Interpretive Media for the Nez Perce (Nee-Mee-Poo) National Historic Trail (NPNHT). Efforts continued in 2004 to develop visitor education media (wayside signs, a visitor brochure, and a CD) for the NPNHT where it transects Yellowstone National Park. The Ethnography Program works on this project in partnership with the Division of Interpretation and three tribes (the Joseph Band of the Confederated Tribes of the Colville Indian Reservation, the Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce Tribe). These efforts will produce a more inclusive historical context for the 1877 trek throughout the park that will reflect not only scholarly understandings, but also the perspectives of Nez Perce descendants.



YCR and Interpretive Division staff hosted a retreat for the three Nez Perce writers designated to produce interpretive media for the Yellowstone segment of the Nez Perce National Historic Trail. From left, exhibit technician Jo Suderman (Interpretation), Albert Andrews Redstar (Joseph Band of the Confederated Tribes of the Colville Indian Reservation), park historian Lee Whittlesey (YCR), Roberta Conner (Confederated Tribes of the Umatilla Indian Reservation), park ranger John Lounsbury (now retired), and Allen Pinkham (Nez Perce tribe).

In FY03, the Ethnography Program and Division of Interpretation received a grant from the Intermountain Regional Office's *Partnership and Volunteer Strategic Funds* to host a retreat for the three Nez Perce writers (Albert Andrews Redstar of the Joseph Band of the Confederated Tribes of the Colville Indian Reservation, Allen Pinkham of the Nez Perce Tribe, and Roberta Conner of the Confederated Tribes of the Umatilla Indian Reservation) designated to produce a visitor education brochure for the Yellowstone segment of the NPNHT. From October 11 to 15, the writers received an orientation, visited accessible 1877 war sites, researched reference materials, and drafted an outline for the brochure. Their work will continue into 2005. Additional funding is being pursued for completion of the CD and wayside exhibits. If secured, all of the media will be premiered in summer 2006.

In preparation for the writers' retreat and in support of all planned NPNHT interpretive media, the Ethnography Program produced *The Nez Perce in Yellowstone: a Compendium of Materials Located in*

the Yellowstone Heritage & Research Center Library. This compendium includes all documents in the park archives related to the 1877 war: 54 primary and secondary sources; 6 maps; 15 audio, video, and digital recordings; and 27 photographic images. Annotated citations were made for each of these categories and compiled as appendices to the document. The compendium will assist with the development of the park interpretive media for the NPNHT and serve as a resource for interpreters and researchers.

Staff and volunteers also finalized eight interviews and public presentations conducted in the park by representatives of the three tribes referenced above and descendants of those who trekked through the park in 1877. This effort required transcription, editing, formatting, preparation of a final draft for review by the interviewee/presenter, and creation of

a final copy for inclusion in the park's oral history collection.

Nez Perce (Nee-Mee-Poo) National Historic Trail GIS maps. Spatial Analysis Center and ethnography staff collaborated to create digitized maps depicting the 1877 route of the Nez Perce as they traveled from Pelican Valley to the Wyoming Basin. Copies of the maps will be given to the Nez Perce Tribe, the Joseph Band of the Confederated Tribes of the Colville Indian Reservation, and the Confederated Tribes of the Umatilla Reservation for their review and comment. They have also been distributed to backcountry rangers, the park historian, and the park archeologist. The maps will be used to apply for grant money to conduct an archeological/ethnographic survey of the NPNHT.

Yellowstone Association Institute class on the Crow Tribe and Yellowstone National Park. The Yellowstone Association Institute offered a class, "We are Not Fools Yet: Crow Culture and Yellowstone National Park," from July 27 to 29. Instructors from the Crow Tribe included Marvin Dawes, Sr., and Timothy McCleary. Through classroom lectures and

field trips, they provided an overview of Crow history and discussed medicinal uses of Yellowstone flora by the Crow people; legendary events from mythic times that occurred at hydrothermal areas in Yellowstone; use of hydrothermal clays; and ceremonial uses of sites in Yellowstone. Sessions from this class were recorded and are being transcribed. Information from the transcripts will be entered into the Ethnographic Resources Inventory (ERI) and deposited at the Heritage and Research Center.

Ethnographic overview and assessment for Grand Teton National Park and the National Elk Refuge. Dr. Deward Walker of the University of Colorado at Boulder was contracted to conduct a baseline study documenting American Indian tribes associated with GRTE and the NER. This is one of three parts of a study that looks at the traditional and historic uses of natural resources by American Indians in Greater Yellowstone; Yellowstone's baseline study, *American Indians and Yellowstone National Park* (L. Loendorf and P. Nabakov), is complete. Rosemary Sucec is the contracting officer's representative for the project. The research has focused upon an extensive review of literature, including ethnographies, archeological reports, historical documents, and records from the Indian Claims Commission, and has been augmented by selected interviews with relevant tribal elders. The contractor found that those tribes with a history of federal recognition in the GRTE and NER area include the Cheyenne, Crow, Shoshone-Bannock-Paiute, Lemhi Shoshone, Arapaho, Nez Perce, Umatilla, Yakama, Kootenai, Flathead, Blackfeet, Gros Ventre, Bitterroot Salish, and Upper Pend d'Oreille. Dr. Walker also classified park and refuge ecological zones according to their uses. Use areas tended to overlap; for example, during a fish run, a tribe's women would also go out to dig roots in nearby meadows while some men journeyed to hunting grounds for bison, deer, elk, and sheep.

Wickiup study. David White, of Applied Cultural Dynamics in Santa Fe, New Mexico, was contracted to conduct a literature review on wickiups in the Bridger-Teton National Forest, Grand Teton National Park, and Yellowstone National Park. The review will focus on the dual ethnographic and archeological nature of wickiup sites, including the opportunity that wickiups provide for bridging objective and subjective study methods. The contractor has



Rosemary Sucec stands inside a wickiup in the Bridger-Teton National Forest. Bridger-Teton is one of three jurisdictions that were recently funded to examine the significance of wickiups to the 26 affiliated tribes of the Greater Yellowstone Ecosystem.

completed, to date, a working bibliography of nearly 400 references. It is clear already that the term "wickiup" is used in a broad manner by historians, ethnographers, and archeologists in reference to many architecturally- and culturally-distinct types of log and brush shelters used by Native American people. It will be necessary to secure tribally-specific typologies of shelters for application to the remains being investigated by this project.

Bannock Trail research. The Ethnography Program produced a digitized map illustrating the path of the Bannock Trail across the park. This map represents the cumulative efforts of a number of researchers including Wayne Repogle, Aubrey Haines, and Joseph Weixelman. Alternative and theorized routes are depicted through color coding. This map will serve as a resource to researchers and

for future work on the Bannock Trail.

Ethnographic Resources Inventory (ERI) database. ERI is the National Park Service database that stores information about ethnographic resources for parks. Ethnographic resources are park resources that associated tribes have identified as having contemporary or historical significance to their people. They include wildlife such as wolves, land features such as mountain peaks, hydrothermal features such as Dragons Mouth Spring at Mud Volcano, and plants such as lichen. Information must be entered into 50 fields, including resource description, resource location, explanation of cultural significance, and the source of the information. The ERI database is used for planning, management, and visitor education.

Forty-six new ethnographic resources were added to the park's ERI this year, as well as 48 new uses of resources that were already entered. The current total number of ethnographic resources in the database is 232. Nine entries are for landscapes, 35 for animals, 33 for park places, 70 for non-faunal natural resources, and 85 for objects. The Blackfeet, Colville, Crow, Kiowa, Nez Perce, Shoshone-Bannock, and Umatilla are the ethnographic groups with the greatest number of ethnographic resources associated with them.

Yellowstone National Park is one of the pilot program sites for the ERI. With the assistance of a full-time intern, Katie White, the park's ERI received approximately 180 hours of attention. Problems were identified in the software and operation, and great strides were made in expanding the entry of ethnographic resources into the database and making it more user-friendly. The Ethnography Program thanks not only Katie White, but also the WASO office coordinator, Mark Schoepfle, for his able assistance in taking care of operating problems. Thanks also go to Roger Whiteside of the park's Computer Support Services.

Assistance to Other Park Divisions

Division of Planning, Compliance, and Landscape Architecture. The anthropologist reviewed and contributed text to several environmental planning documents, including the Fire Management Plan and the Justice Center Environmental Assessment. Staff also consulted with this division about their mailings to park-associated tribes.

Division of Interpretation. The *Management Policies 2001* (7.5.5) for the National Park Service require the Division of Interpretation to consult with American Indian tribes to present factual, balanced, and sensitive presentations of their cultures. The Division of Interpretation is also mandated to use ethnographic data and concepts. Ethnography staff invested almost 400 hours in assisting the Division of Interpretation with this work.

Numerous questions were fielded from 12 interpreters about specific park resources (e.g., bison, wolves, and thermal features) important to associated tribes, and the significance of those resources. In many cases, materials were provided and time set aside to discuss these and other issues. The work conducted by the Ethnography Program represents the first opportunity for many interpreters to obtain this kind of information, which they may now provide to more than 3.2 million visitors each year.

Ethnography staff provided feedback and reviewed sections of three draft documents that incorporated information about Native Americans' associations with the park. These included the curriculum for *Expedition Yellowstone!*; the electronic field trip narrative, "The Wolves of Yellowstone: Legacy, Legend, and Recovery;" and park trail guides for Mud Volcano, Mammoth Hot Springs, West Thumb, and Norris Geyser Basin. These are the first trail guides to include information about Native Americans associated with the park.

At the request of the *Expedition Yellowstone!* staff, ethnography staff spoke to two park-associated tribal school groups (Lame Deer School on the reservation of the Northern Cheyenne Tribe, and the St. Labre School located on the Crow reservation) that participated in *Expedition Yellowstone!*. The continuity of tribal association with the park, the number of tribes with historical and traditional connections to it, and the role of the Ethnography Program as a liaison with associated tribal governments were discussed.

Ethnography staff also provided the Division of Interpretation with information about American Indians and hydrothermals for an exhibit planned for the new Old Faithful Visitor Education Center, "Yellowstone National Park Protects the Rarest Collection of Geysers and Hot Springs on Earth." For this effort, ethnography staff initiated formal consultation through a letter with 26 associated

tribes, which was mailed to 80 tribal chairs and their representatives. Approximately 35 follow-up calls were made. From the phone consultation, oral history transcripts, and information contained in the ERI, a table was developed summarizing Native American uses of and perspectives on hydrothermals. This information was distributed to the exhibit planners and tribal representatives for feedback. Approximately 60 exchanges occurred with tribes about information in the table. Oral history recordings, transcripts, and photos were gathered for exhibit planners. More than 230 hours of staff time were devoted to this project in 2004, and it will continue into next year.

Assistance to Tribes and Other Partners

Services offered by the Ethnography Program. Throughout the year, ethnography staff were in phone contact with more than 70 members of the park-associated and bison-interested tribes on a broad range of issues including bison management, the park's collection policy, requests to conduct ceremonies and other traditional activities, and coordination with the park on visitor education. For instance, ethnography staff assisted Grand Teton National Park staff with a request to conduct a ceremony within Grand Teton's jurisdiction, but related to increased hydrothermal activity in Yellowstone over the past year. More than 100 requests via e-mail and telephone were fielded from those who had been notified of the ceremony via the Internet and were concerned about whether a volcanic eruption would occur in the park. The park geologist, Hank Heasler, was involved in helping to address these concerns. The park also received a request from the Crow Tribe to facilitate a property transfer of a surplus four-wheel-drive vehicle from the park to assist the Tribe's cultural program. With the assistance of the Property and Procurement Office and the Division of Maintenance, the park was able to accommodate their need. These types of requests generally involve a good deal of research, as many are first-time endeavors for the park.

As an added service to tribes, the Ethnography

Program maintains a listserv for members of park-associated and bison-interested tribes. These individuals regularly receive job vacancy announcements, press releases, and planning documents from Administrative Services, Public Affairs, and the Division of Planning, Compliance, and Landscape Architecture.

Nez Perce Tribe holds pipe ceremony at the park. The Ethnography Program coordinated a request from two members of the Nez Perce Tribe (Wilfred Scott, of the Nez Perce Executive Council, and Horace Axtell, elder and historian) to hold a



Members of the Nez Perce Tribe in full regalia and on horses during the commemoration ceremony, August 2004.

memorial and pipe ceremony at the park. More than 160 hours were invested in ensuring that a successful memorial and pipe ceremony took place. Thanks go to staff in other divisions for their hard work and cooperation. The ceremony was conducted to commemorate those Nez Perce people who trekked through the park in the summer of 1877. Held August 21, 2004, along Fountain Flat Drive near Nez Perce Creek, the event was attended by several hundred visitors and park staff, including Superintendent Suzanne Lewis and Deputy Superintendent Frank Walker. On the following day, Resource Management and Visitor Protection Division staff, the deputy superintendent, and retired rangers Jerry Mernin and John Lounsbury joined several Nez Perce on horseback for a trek into Hayden Valley, where they experienced the terrain their ancestors once traveled. This event was one of the first of its kind for

Yellowstone, and enabled the park to fulfill the recommendation of the National Park System Advisory Board in helping to conserve the irreplaceable connections that ancestral and indigenous people have with the parks, and to nurture those connections for future generations.

Assistance to other parks and partners. Almost 100 hours were spent filling requests for materials and fielding questions about the park's consultation program, the ERI database, and contract management issues from other parks and partners such as Xanterra Parks and Resorts, the Big Sky Institute, and other federal and state agencies.

Educational Opportunities

Opportunity for the youth of the Crow Tribe. In FY04, the Ethnography Program submitted and was awarded a Yellowstone Park Foundation grant that will fund a group of students from the Crow Tribe to travel to the park for three days. While in the park, they will participate in a specially designed educational program aimed at connecting the students to their ancestral home and heritage. The youths will meet and interact with park staff, including project leaders and the management team. Implementation of the project is scheduled for fall 2005.

Educational opportunities for park staff and the visiting public. This year, Rosemary Sucec team-taught a Yellowstone Association Institute backpacking course on the Bannock Trail and Nez Perce trails in the park. She also assisted with the course about the Crow Tribe's connection to Yellowstone National Park.

Volunteers

The Ethnography Program received a generous donation of 163 hours of volunteer time in 2004. Heartfelt thanks go to Jamie Cox, Carolyn Duckworth, Mary Ann Franke, Sabrina Hanan, Susan Kraft, Paul Miller, Sue Mills, Dan McNulty, George Nell, Beth Taylor, Celine Wendt, and Dagan Klein. The program couldn't have provided the services identified in this section without their strong commitment and interest. Their help with transcribing and editing oral history interviews, conducting research, filing and organizing, entering ERI data, and especially, assisting with events in which tribal representatives were present, was invaluable.

Historic Research

The park historian is primarily responsible for researching and writing a variety of documents ranging from scholarly articles to support materials for law enforcement investigations and planning documents; reviewing outside manuscripts; and providing outreach in the form of speeches and informal talks on park history. In FY04, on his own time, Historian Lee Whittlesey completed a Master's degree in History at Montana State University. His thesis will be published by the University of Oklahoma Press as *Storytelling in Yellowstone: Horse-and-Buggy Tour Guides in the Grand Old Park, 1872-1930*.

Books and Articles Prepared

The park historian published or submitted several articles for publication, including "Music, Song, and Laughter: Yellowstone's Fountain Hotel, 1891-1916" (*Montana the Magazine of Western History* 53, Winter 2003:22-35). He completed researching and writing "A Brief History of the Canyon Area Buildings Associated with the Blister Rust Control Operations of 1944-1974" as part of a resource assessment for wildland-urban interface fuels reductions in the Canyon developed area. He was also in demand as the author of the forewords to several books: Ruth Quinn's *Dream Weaver: The Life of Robert Chambers Reamer* (published in fall 2004), Bob Blair's new edition of William Henry Jackson's *The Pioneer Photographer* (to be published in 2005), and Karen Reinhart's and Jeff Henry's *Old Faithful Inn: Crown Jewel of National Park Lodges* (published in early summer 2004).

Manuscript Reviews

The park historian read and reviewed numerous manuscripts by other writers and researchers, including the following: Kiki Rydell's and Mary Shivers Culpin's 10-chapter administrative history of the park; Stephen Biddulph's 500-page *Five Old Men of Yellowstone*; Peter Martin's "The Nineteenth Century Postal History of Yellowstone National Park," published in *The Congress Book 2004*; articles published in *Yellowstone Science* by Alice Wondrak Biel, Brad Coon, Tamsen Hert, Ruth Quinn, and Karen Reinhart; portions of the draft of Mary Ann Franke's book, *To Save the Wild Bison*; Jane Demaray's manuscript, "The Wylie Way;" Paul Schullery's

article, “Their Numbers Are Perfectly Fabulous: Sport, Science, and Subsistence in Yellowstone, 1870;” Ruth Quinn’s manuscript for *Dream Weaver: The Life of Robert Chambers Reamer*; chapters of Hal Rothman’s draft manuscript, *National Park Service Fire History*; the draft history portions of the Interpretive Division’s *Yellowstone Resources and Issues, 2004*; and Bob Goss’s article, “Yellowstone’s First General Store: The Legacy of Jennie Henderson and Her Family,” being readied for publication in *Yellowstone Science*. He also met with author Janet Chapple concerning revisions to her book, *Yellowstone Treasures*, and her upcoming book about stagecoach travelers to Yellowstone, completed reading and taking notes on Fort Yellowstone records (1886–1902) microfilmed from the National Archives, and added them to the park library.

Assistance to Other Park Divisions and Partners

The historian provided advice and historical assistance to the following Yellowstone National Park divisions and NPS partners:

- Yellowstone Institute: was guest speaker for Leslie Stoltz’s class about Yellowstone Lake. Taught the three-day class, “Yellowstone’s Southern Roadside History.” Co-taught a four-day backpacking class on the Nez Perce.
- Visiting museum staff assisting with the move to the new Heritage and Research Center: presented numerous hour-long “brown bag” talks on park history and led an evening walking tour of the Gardiner cemetery.
- Parkwide interdivisional: beginning in 2003, was involved in the months of planning for Old Faithful Inn’s hundredth anniversary activities in May and summer 2004. Presented a program for the official opening of the anniversary ceremonies and two programs for subsequent Old Faithful Inn Heritage Days celebrations.
- Division of Resource Management and Visitor Protection: met with attorneys involved with the Lance Bucci thermal burn case, and compiled and provided copies of park archival materials to them as requested. Gave an all-day bus tour to 40 new NPS employees for the Visitor Services Office.
- Division of Interpretation: consulted on several occasions regarding exhibit planning for the

new Old Faithful Visitor Center and reviewed the Old Faithful Visitor Education Center Project Environmental Assessment.

- Division of Maintenance: gave all-day bus tours to 35 members of Jim Evanoff’s commerce group from 12 western states.
- Xanterra Parks and Resorts: taught a one-day Yellowstone history class to Xanterra’s incoming tour guides and bus drivers.
- YCR: on several occasions, assisted Spatial Analysis Center staff with their project to make a detailed map of all Yellowstone cultural sites. Met with Mimi Mather of Shapins & Associates, contractors for the Cultural Landscapes Inventory of Old Faithful, and reviewed both their draft and their 95% manuscripts.

Outreach and Assistance

The historian provided numerous speeches, informal talks, and assistance in FY04. He created a PowerPoint presentation based upon a chapter in his new *Storytelling* book, and presented it at least a dozen different times in summer and fall. He gave all-day walking tours of Mammoth Hot Springs and the old ghost towns of Cinnabar and Electric for members of the Montana Genealogical Association, and gave a morning-long personal tour of the Mammoth area to Mel and Tina Henderson, descendants of G.L. Henderson (early hotel owner at Mammoth and the park’s first interpreter, who gave many place names to Yellowstone). He met with city planners Patricia Grabow and three others from Livingston, Montana, with regard to their planned summer programs on the history of Calamity Jane (Martha Jane Canary) and her time in the Yellowstone country, and hosted the screening of David Scheerer’s film, *Yellowstone: America’s Eden* for the annual meeting of the Greater Yellowstone Coalition. He met and exchanged information with Steve Mishkin, a Seattle attorney who is working on a legal history of Yellowstone, and with George Perkins, whose transcripts of the OTO Ranch reminiscences of Dick Randall were added to the park library. He conferred with Roger Payne of the U.S. Board on Geographic Names about current procedures for submitting park place names to the Board, accompanied Randy Ingersoll to the site of Randy’s discovery of dinosaur bones, and wrote a brief report on the site for park archeologists.

Other History-related Activities

Beginning in May, the historian moved his office to the park's new Heritage and Research Center in Gardiner, Montana. He completed preliminary investigations and paperwork to place Jones Pass on the National Register of Historic Places, and purchased LeRoy Hafen's 10-volume set, *The Mountain Men and the Fur Trade of the Far West* for the park library. He received, read, and added to the library numerous newly donated unpublished diaries and manuscripts, including accounts by Mrs. Joseph Lawrence Townsend, Florence Michaels Wallace, Ella Shaw Wallace, and at least five other such accounts, as well as Bob Goss's self-published pamphlet, "Coating Curiosities in Yellowstone: Ole Anderson and the Specimen House." He obtained a large number of historic Yellowstone Park School photographs and records from Principal David Stringfield for addition to the park archives and historic photo collection, and obtained from Diane Papineau a collection of Mammoth Hot Springs Hotel china for the park museum collection.

Historic Structures

The park historic architect is responsible for historic structures conservation and related compliance issues.



Tauk World Discovery volunteers donated 3,360 hours to park projects in FY04.

Tauk Volunteer Program

The second year of the Tauk Volunteer Program began in mid-May 2004, with the arrival of Tauk Volunteer Coordinator Bruce Fladmark, a retired National Park Service (NPS) ranger and former cultural resource manager at Glacier National Park. The program was primarily funded with a \$20,000 grant from Tauk World Discovery to the Yellowstone Park Foundation, to which the Tauk Foundation added another \$5,000. In March, the historic architect was awarded \$7,000 from the Intermountain Regional Partnership and Volunteer Strategic Fund for purchase of equipment and materials including lightweight scaffolding, ladders, portable power equipment, a pressure washer, wheelbarrows, and weed eaters for use by the volunteers. This year, with Tauk's assistance, the Historic Structures Program was able to vastly improve project communications, organization, and information exchange by purchasing a fax/copier/scanner, a telephone landline, and internet service for the office trailer at the Lake subdistrict.

Though efforts were occasionally complicated by uncontrollable events such as the massive Sylvan Pass mudslide and ensuing road construction, the Tauk volunteers completed an enormous amount of work, with the project expanding into the West Thumb and Grant Village areas. In 2003, the program operated in 5-10-mile radii around the Old Faithful and Lake areas; in FY04, this was extended to 20-mile radii, allowing the volunteer work to range south and west to the Grant Village subdistrict and West Thumb Geyser Basin, to as far north as the Nez Perce Patrol Cabin. This allowed for more diverse experience and a wider range of work. For instance, with the assistance of Old Faithful backcountry office staff, a group of 42 volunteers—everyone from great-grandparents to five-year-old children—traveled out to the patrol cabin, where they cleaned and log-oiled the entire structure in one hour under the supervision of the park historic architect and the Tauk volunteer coordinator.

As a result of promotion by Tauck, the average number of volunteers per group grew by approximately 10–15 people from 2003, to an average group size of 25–35 people, making it necessary to use tour buses to transport volunteers daily. Volunteers came from the Middle East, Australia, England, Germany, and Asia, as well as from all over the U.S. Many expressed appreciation at being given the opportunity to give back to the national parks.

In the Lake subdistrict, volunteers performed general winter cleanup around the Bridge Bay marina as well as the Lake Hotel and Lake Lodge parking lots. At the Bridge Bay Campground, campsites were cleaned, and an estimated 750 bumper logs were scraped, broomed off, and stained, with weeds around them pulled and cut. Volunteers also assisted the structural fire crew by painting fire hydrants throughout the Grant Village complex and Old Faithful subdistrict. When supplies of the special metallic red paint ran short, the Tauck Volunteer Program account bought several more cases for use.

At Old Faithful, the volunteer groups, in conjunction with Yellowstone National Park maintenance and Xanterra personnel, helped with structural preservation and stabilization, landscape reclamation, and general clean-up, as well as staining and painting a wide variety of structures and picnic area features. Overall, the grounds around the Fishing Bridge Museum and Amphitheater, Lake Lodge, Lake Hotel, Old Faithful Lodge, and Old Faithful Inn did not require the extensive work that the groups performed there the first year.

Overall, treatment was completed on numerous historic structures, six historic districts, two ranger stations, employee housing, support buildings, landscaping and erosion control projects, fire hydrants, protective railings, and other projects at Lake, Bridge Bay, Fishing Bridge, West Thumb, Grant Village, Old Faithful, and other areas. Volunteers contributed 3,360 hours of effort. It is planned to continue the program next year. The success of this program has led the Tauck Foundation to sponsor a new program, through a grant to the National Park Foundation, to provide money for volunteer programs in five other parks.

Virginia City Grant Administration

In FY03, the historic architect was appointed as the on-site grant coordinator for the \$1.8 million

National Park Service grant to the Montana Heritage Commission. Consequently, his duties expanded to include consultation with the Montana State Historic Preservation Office (SHPO), Montana Heritage Commission, and the Commission's architectural and engineering consultants. In FY04, the historic architect traveled to Virginia City to monitor work there, attended meetings of the Preservation and Interpretation Committee of the Montana Heritage Commission, shared technical expertise, and met with a number of people interested in or working on the site. He also helped interview a potential donor for the Stonewall Hall, which is still owned by the heirs of the Charles and Sue Bovey Estate.

New projects this year included an Historic Structures Report on Content's Corner and the Gilbert Brewery, both of which date from the mid-1860s Montana gold rush period. Significant work on seismically stabilizing these structures and the Kiskadden Barn continues. Other work included briefing the new Historic Preservation Team leader, Jeff MacDonald, on work done since the State of Montana acquired the Bovey properties in Virginia City and Nevada City in 1997. The historic architect also helped prioritize work, brief the regional staff, and ensure that the grant was used in an efficient manner. The project involves stabilization of more than 250 structures, and includes restoration and rehabilitation of nationally significant historic properties that are one of the most intact groups of mid-nineteenth-century mining town structures extant in the U.S.

List of Classified Structures

Work continued on inventorying properties identified for inclusion on the List of Classified Structures (LCS), a servicewide computer database that itemizes known historic structures in every park in the National Park System. The historic architect worked closely with the LCS team from the Intermountain Support Office in Denver in FY04, and conducted LCS inspections on the buildings at Fort Yellowstone National Historic Landmark District and other contributing properties within the Mammoth Hot Springs Historic District.

Monitoring of Historic Properties and Solicitation of Funding Requests

Funding requests through the Servicewide

Consolidated Call. The historic architect drafted and revised a large number of Special Emphasis Program Allocation System (SEPAS) funding requests for a variety of properties throughout the park. Four proposals were successful, with a total of almost \$350,000 in regional dollars tentatively awarded for FY05.

The successful projects included:

1. Stabilization of the Mail Carrier's House. This building, located in the Mammoth Hot Springs Historic District, housed seasonal employees until structural problems malformed the ground floor to the point where it could not be used. It is the last log structure at Mammoth Hot Springs that was part of the original Fort Yellowstone development. The stabilization project ranked #1 in the regional review of 39 projects submitted throughout the region, and the reviewing panel believed that the building's National Register significance should be revised to a national level of historic significance. In preparation for the work scheduled to begin in 2005, the historic architect and volunteer Frank Massaro, a registered architect from the Seattle area, measured the building for construction documents. Massaro then prepared preliminary drawings for the building.
2. Cultural cyclic maintenance of the Lake Lodge Guest Cabins. This \$49,000, three-phase roofing and repair project will bring the original 1930s guest cabins back into good condition.
3. Cultural cyclic maintenance of the Buffalo Keeper's House. The Buffalo Keeper's House, located at the Lamar Buffalo Ranch, serves as the office and residence of the Northeast Entrance/Lamar Valley subdistrict ranger. It is the next-to-last original Buffalo Ranch building that needs serious maintenance work; the Assistant Buffalo Keeper's House and the ranch barn were restored in summer 2002, under a previous funding request.
4. Stabilization of the Mammoth Carpenter Shop. This building was one of the park's original cavalry stables and workshops. It recently received a new, pressed metal shingle roof, but is leaning downhill. To pull the building back into vertical alignment, the historic architect proposed utilizing an independent

steel framework that would support this long structure—an engineering solution developed for the Kiskadden Barn, the 1863–64 livery stable in Virginia City, Montana. The Montana Heritage Commission will loan Yellowstone National Park the independent steel framework, which will be brought from Virginia City to stabilize this National Historic Landmark structure.

Work planned but not funded included repair of the Northeast Entrance Station's deteriorated log structural elements, and of the flagstone around the building's perimeter. In FY04, a semi-truck side-swiped this National Historic Landmark, one of the last examples of the 1930s "parkitecture" entrance stations remaining in the National Park System. The historic architect worked with park law enforcement rangers and maintenance staff to assess the damage and assemble cost estimates for repairs. Based on the new damage and continuing degradation of the building, the historic architect will submit the project for FY06 funding.



The historic mail carrier's house will receive much-needed stabilization.

Work was also proposed for the Norris Museum, to correct problems with stonework on the chimney and retaining walls of the building's surrounding patios, and stabilize the log structural components of the historic comfort station, now the Yellowstone Association bookstore. The historic architect interviewed the bookstore employee, measured and inventoried the existing damage on the bookstore, and thoroughly inspected the museum. Work originally done by Harrison Goodall of Conservation

Services, Inc., in 1981–1982 is in need of new specialized epoxy repairs to replace the epoxy-cast endcaps, which prevent moisture conditions inside the large scale log beams supporting the roof structure.

National Register of Historic Places

The historic architect continued to inventory properties in the Old Faithful area, where the existing Old Faithful Visitor Center, scheduled for demolition, was determined to be eligible for listing on the National Register. In age, this Modern-style visitor center, built in 1972, is the newest NPS visitor center determined to be eligible for such listing. In cooperation with the LCS team, the historic architect prepared Consensus Determinations of Eligibility for 30 cabins in the Roosevelt Lodge Historic District, and six buildings in the Fishing Bridge Historic District that were not recorded as part of the original survey of structures, but were found during the LCS survey. This work was done in consultation with the Wyoming SHPO. The historic architect also continued to verify the location of both known and missing buildings; inventory survey results, building numbers, and small structures that had been overlooked; and prepare new LCS surveys for submittal to the various divisions and the superintendent.

NHPA Compliance

State of Montana. In February 2004, the Montana SHPO's architectural preservation specialist and National Register historian visited the park and met with representatives from the Branch of Cultural Resources, the Maintenance Division, and the Division of Planning, Compliance, and Landscape Architecture to discuss the rehabilitation of the interior of the Stephens Creek residence. In the end, the residence retained its historic interior woodwork, but historic wall fabric was lost because of the type of material that had been used as a wall surface in 1934. Beneath the surface, maintenance



The Northeast Entrance Station suffered significant damage when it was sideswiped by a semi. Shown here, the original log ridge beam was shorn in half from the force of the collision, revealing the iron connecting spike.

FY06 SEPAS funds will be requested to stabilize this National Historic Landmark.

employees found graffiti and dates from the National Park Service employees who moved the house from its original site north of Stephens Creek in the fall of 1933. The house was then remodeled, and a bedroom and upstairs bathroom added. The historic architect selected new bathroom fixtures and lighting to match the late Craftsman/Art Deco features of the house. Samples of the wall coverings in the house were kept intact by the crew and turned over to the new Heritage and Research Center. The house was nearing completion at the end of the year.

State of Wyoming. In mid-September, the Wyoming SHPO's new historian visited the park and met with representatives from the Branch of Cultural Resources and Division of Planning, Compliance, and Landscape Architecture. She toured the Lake Hotel area; inspected ongoing work at the superintendent's residence, Lake Fish Hatchery, and Lake Lodge cabins; and visited the sites of the Tower general store and Tower Junction gas station (both proposed for demolition), the proposed sites for the Mammoth Justice Center/courthouse, and the Mail Carrier's House. A Safety Office and Maintenance Division project to protect pedestrians in front of Building 38 was also discussed.

Assistance to Other Divisions

Tower Subdistrict ambulance addition. The historic architect worked with north district maintenance foreman Ray Lawless to develop a plan for adding a new ambulance bay to an existing non-historic garage in the Tower Junction Historic District. The garage, moved from the Old Faithful Administrative Area in 1999, is used to store a snowplow in the winter. The ambulance addition would allow Tower EMS personnel to store medical supplies in the ambulance without fear of freezing plasma and other temperature-sensitive supplies. The historic architect helped present the project to the park's Resource Council, and corresponded and consulted with the Wyoming SHPO, which concurred with a determination of no adverse effect.

Historic lighting fixtures. The historic architect continued working with landscape architect Lynn Chan on the development of historic replica lighting fixtures to replace non-historic fixtures, and to retro-fit existing fixtures at the Lake Hotel, Old Faithful Historic District, and Fort Yellowstone National Historic Landmark District. The new lighting will provide low-level, non-glare illumination for these areas, in compliance with the park's Dark Skies Initiative.

Section 106 and NEPA compliance. The historic architect provided professional experience and technical assistance to the Division of Planning, Compliance, and Landscape Architecture, Division of Maintenance, and Division of Interpretation on several projects. These included the writing and public review of environmental assessments for the new West Entrance Station, Old Faithful Visitor Education Center, and Yellowstone Justice Center.

Other assistance. The historic architect served on the Value Analysis Team for the White Grass Ranch Historic Preservation Training Center in Grand Teton National Park (GRTE) in February. The team included the NPS's leading historic preservation experts, GRTE representatives, and Barbara Pahl from the National Trust for Historic Preservation. Team members skied to the White Grass Ranch to photograph and inspect it. The ranch has not been maintained since it ceased dude ranch operations in the mid-1980s.

The historic architect consulted with the Maintenance Division's Madison subdistrict staff prior to demolition of five cabins, some of which

were believed to have come from the old Fishing Bridge Cabin Camp. The historic architect photo-documented the buildings and forwarded a written report to the NPS's List of Classified Structures team in Denver, but the team was not able to accurately identify any of the buildings.

Archives, Library, and Museum Collections

These staff are responsible for collections preservation, conservation, and access; acquisitions; research; and technical assistance.

Staffing

Fiscal Year 2004 saw many changes in the museum and library staff. Jackie Jerla was hired as a part-time librarian in December 2003. Jackie previously worked for Xanterra Parks and Resorts for 20 years and the Yellowstone Association for 12 years. Term museum technician Sean Cahill resigned in November 2003, and Maria Capozzi was hired to fill this position. Maria has previously worked at several National Park Service sites, including Cape Cod National Seashore and the Northeast Museum Services Center. Museum Technician Steve Tustanowski-Marsh resigned in September 2004 after his wife accepted a position at Harpers Ferry Center in West Virginia; the park hopes to fill this position soon. Librarian Tara Cross, who had worked in the Yellowstone Research Library for more than three years, resigned at the end of September 2004 to attend graduate school at the University of Washington. A full-time librarian, Heather Thams, was hired, and will begin work in October 2004, when Librarian Jackie Jerla will also move to full-time. Special project monies continued to support the two term museum technician positions, and Yellowstone Association funds supported the two librarian positions. Two seasonal museum technicians (Bridgette Case and David Amott) and one librarian technician (Jessica Gerdes) returned this past summer to assist staff with the large collections move to the HRC.

Yellowstone Heritage and Research Center

Most staff time this year was dedicated to preparing all aspects of the operation for the move to

the new Heritage and Research Center (HRC) in Gardiner, Montana, and for organization of storage areas and office space thereafter. This was, by far, the largest project undertaken by Archives, Library, and Museum Collections (ALMC) staff this year. Access to the museum collections and photograph archives was suspended in October 2003, as staff began to conduct a 100% inventory of the park's collections (more than 5.3 million objects). Access to the archives and library was slowly phased out in fall 2003, as hours were reduced and finally curtailed in December. Archivist Harold Housley, with the assistance of several volunteers, began inventorying the park's archival holdings in February 2004, completing the project in mid-May. Cultural Resources Technician Tasha Felton spearheaded the inventory of the museum collections, completed in May 2004 with the assistance of the park's curatorial staff and volunteers from other divisions. Librarian Tara Cross completely inventoried the rare book collection, and she and Librarian Jackie Jerla partially completed an inventory of the library books. Museum Technician Bridgette Case oversaw the fabrication of almost 80 metal shelving units (most were 112" high). Museum Technicians Maria Capozzi and Steve Tustanowski-Marsh inventoried, arranged, and prepared all packing and re-housing materials.

Curator Colleen Curry worked with Alice Newton, NPS registrar at the Harpers Ferry Center, to recruit helpers from other parks, private museums, and graduate programs. They decided to treat the move as a training experience, and gave recruitment preference to people who will be performing collections moves at their parks or museums in the near future. A total of 40 people from parks and museums across the country were chosen from almost 80 applicants, and were divided into five teams that spent two weeks each at Yellowstone assisting with the collections move. Each team, once

it arrived in the park, was divided into four groups and assigned a team leader from the park's curatorial staff. These four groups included archives and library collections packing (under Archivist Harold Housley and Librarians Tara Cross and Jackie Jerla); museum collections packing (under graduate intern Kelly Rushing and Registrar Alice Newton); preparation and packing of objects and furniture in historic vehicle storage (under Museum Technician Maria Capozzi); and receiving and unpacking at the HRC (under Cultural Resources Technician Tasha Felton and Museum Technician Bridgette Case). The first team arrived at the beginning of June and immediately began cleaning and packing collections and cleaning fixtures and cabinets in the HRC. Staff also anchored and secured shelving units in the new museum and archive storage areas to make them seismically stable. The park hired Mergenthaler Transfer from Bozeman, Montana, to assist with moving all office furniture, cabinets, and large collection items. Small or fragile objects were hand-carried to the HRC by staff. The first objects, rare books, were moved into the HRC on June 21, 2004.

The rest of the teams and staff continued to work through the summer. In all areas, objects were cleaned and re-housed with acid-free materials where necessary. Re-housing meant that most had custom boxes made for them with special cushioning. The vehicle storage facility was one of the most challenging areas, not only because of the size and quantity of objects there (most of the park's furniture collection was stored there and had to be moved to the HRC), but also because of the large amount of dirt and dust with which the team leader and participants had to contend. Objects moved from vehicle storage were cleaned *in situ* and then moved to the HRC foyer, where they were cleaned again and checked for mold and insects before being placed into museum storage. Throughout the summer, the



The Yellowstone Heritage and Research Center—from architect's renderings to physical reality!

team at the HRC received and unpacked objects, cleaned storage cabinets as they were moved there, and placed objects back in cabinets. All teams filled out inventory sheets for every object and box packed; these sheets recorded the object, its catalog number, and the location from which it was being moved. At the HRC, the team used these inventory sheets to fill out ANCS+ Location Modification sheets that included the object, catalog number, old location, and new location. These sheets were then used to make the location changes in the ANCS+ collections management database. Once all of these changes are complete, staff will once again conduct a 100% inventory of the collection to ensure that everything is correctly accounted for in the database.

The physical move of the library collections (2,250 linear feet of books and 130 linear feet of vertical files) was completed in early July, and the archives (over 2,500 linear feet) were moved by August. The archives and library team then was reassigned to assist with all aspects of moving the museum collections. These collections (over 300,000 items) were completely moved by August 16, 2004. This collections move, the largest in NPS history, was completed on time and with no object loss or participant injury!

After the completion of the move, ALMC staff began working on preparing the HRC for its general opening on August 25, 2005. Much time was spent meeting with contractors and park staff to discuss

and rectify security, maintenance, and mechanical issues in the HRC, on updating locations for all objects moved, organizing storage and research areas, and furnishing the building. Through the generosity of the Yellowstone Park Foundation, the



Above, suited up in Tyvek and respirators for working near arsenic-laden natural history specimens. Below, Jason Wolvington of the University of Kansas wraps a bear trap.



park was able to order furniture (reading tables, chairs, study carrels, computer stations, and benches) for the library reading room. Furniture for all offices and research and conference rooms also has been ordered, through funds generously provided by the Yellowstone Association. Staff also began writing various plans and policies for the new building, and conducting environmental and Integrated Pest Management monitoring. Library staff moved the vertical files into new Fire King filing cabinets; the files were also reorganized to accommodate future expansion.

Park staff and contractors were given access to the HRC in October 2004 on an appointment-only basis. Staff hope to provide

HRC access to other researchers by May 2005. Offices located in the HRC include the archives, library, and curatorial offices, and those of Ann Johnson (archeologist), Paul Schullery (writer-editor), Jennifer Whipple (botanist), and Lee Whittlesey (historian). The HRC is also providing temporary office space for NPS employees displaced by the ongoing rehabilitation of the park's Administrative Headquarters building.

Preservation, Conservation, and Access

Staff worked on a variety of projects to improve collections preservation and accessibility. The Yellowstone Association, Yellowstone Park Foundation, and NPS Special Emphasis Program Allocation System (SEPAS) funded these projects and the staff needed to accomplish them.

Access. In preparation for the move to the HRC, staff scanned several thousand images and made them available on the park's internal drives. Librarian Tara Cross finished cataloging the library's manuscript files, and these records were added to the park's online catalog (<http://wyld.state.wy.us/yrl/>) that is administered by the Wyoming Libraries Database (WYLD), making this collection more accessible to researchers.

Grants. Through a Save America's Treasures grant awarded at the end of 2003, a team of students from the University of Colorado, through the Cooperative Ecosystem Studies Unit (CESU) program, began identifying, re-housing, and cataloging architectural drawings and blueprints from Xanterra Parks and Resorts. At the end of their work, the students transferred a large group of drawings to the archives. Matching funds for this grant were provided by the Yellowstone Park Foundation, Canon U.S.A., Inc., and Yellowstone National Park. This project will continue during summer 2005, with an additional team of students digitizing drawings with the assistance of the NPS Denver Service Center's Technical Information Center.

The Yellowstone Association and Yellowstone Park Foundation funded several projects to assist with the large-scale collections move. The Yellowstone Association provided funding for the creation of a move plan, assistance with the 100% inventory of the library holdings, and staffing and furniture for HRC offices and conference rooms. The Yellowstone Park Foundation granted funds for the "Wonderland on Exhibit" project to purchase exhibit cases and install the first temporary exhibit in the HRC upon its opening in summer 2005. It also funded the "Furnishing Our Heritage" project to allow staff to purchase furniture for the HRC library. Canon U.S.A., Inc., funded the "Moving the Memories" project, allowing staff to purchase much-needed storage equipment and furniture for the new building.

Loans. Museum staff arranged for the loan of nine pieces of artwork from May 2004 through

2006 for the exhibit, "Drawn to Yellowstone: Artists in America's First National Park," based on Peter Hassrick's book of the same name. The Autry Museum of Western Heritage in Los Angeles, California, created the exhibit that will be on view there until January 23, 2005; it will then travel to the Buffalo Bill Historical Center in Cody, Wyoming (April 16–October 2, 2005), and the Northwest Museum of Arts and Crafts in Spokane, Washington (November 10, 2005–February 1, 2006). The Museum of the Rockies is being considered as an additional venue in 2006. The pieces loaned include two paintings by Thomas Moran (*Great Springs of the Firehole River*, *East Wall of Canyon from Inspiration Point*); two by John Henry Renshaw; one each by Charles Moore, Walter Trumbull, and James Everett Stuart; and two drawings by Henry Wood Elliott.

Staff were also approached by the Joslyn Art Museum in Omaha, Nebraska, for the loan of five pieces of artwork for an exhibit, "Wonderlands on Stone: Thomas Moran's Western Chromolithography," that was to run from October 1, 2005 to January 31, 2006, but was canceled due to lack of funding. The pieces included four works by Thomas Moran and one by Walter Trumbull. The Joslyn Art Museum did borrow transparencies of the pieces, and will publish a book on this topic.

Harry Child loaned the only known existing ball finial to one of the original flagpoles that was atop the Old Faithful Inn when it opened in 1904. Staff plan to exhibit it in the new HRC.

Notable Acquisitions

The park's curatorial staff did not actively seek additions to the collections this year because of the move to the HRC. Still, many items were added through the generosity of numerous donors. The list that follows highlights a few of the more notable acquisitions in FY04, but is not meant in any way to diminish the importance of those objects not included.

Archives. The archives received many interesting items this year, including 13 oral history interviews. Some of these were transcriptions of interviews with individuals who served in Civilian Conservation Corps (CCC) camps in Yellowstone. These oral histories resulted from a project undertaken by Mary Swier-Bolhuis (a high school teacher in the Bozeman, Montana, area) and coordinated by oral

historian Charissa Reid, to document the CCC in Yellowstone.

Records from the park's Research Permit Office were also transferred to the archives. These records included permits, correspondence, reports, and proposals, and provide key information on research conducted in the park from the 1980s through 1997.

Another important collection included over 120 documents relating to the purchase, maintenance, and disposal of nearly 100 Yellowstone Park Company fleet vehicles—primarily manufactured by the White Motor Company, but also including some Ford, Lincoln, Mercury, Dodge, Chrysler, Willys, and Buick models. Bob Goss of Xanterra



The Yellowstone Archives received 13 oral history interviews with former CCC workers in FY04. This photo shows a CCC camp in Yellowstone, circa 1933.

donated this collection that includes titles, bills of sale, and correspondence from 1926 to 1959. There is information on models dating as far back as 1917, as well as an inventory, prepared by Yellowstone vehicle enthusiast Bruce Austin, that describes the documents and categorizes them according to fleet number, manufacturer, engine number, and serial number.

The archives also received records from the Yellowstone Park School, including general correspondence, teacher contracts, and fiscal records. These records provide important information on the history of the school from 1931 to 1981. Also received were readings from the infrared chart drive rolls that record eruptions of Old Faithful Geyser (1975–1997), and footage from the Busch Foundation documenting the reintroduction of wolves into the park. The park is still awaiting master copies of this footage, which was used to produce a documentary by the Turner Broadcasting System.

Library. Through the generosity of donors, and with funds from the Yellowstone Association, several new books, rare books, maps, and bound periodicals were added to the Yellowstone Research Library's holdings during FY04. Notable acquisitions included:

- *The Mountain Men and the Fur Trade of the Far West* (10-volume set), edited by LeRoy Hafen;
- *Where Gush the Geysers: Oregon Short Line All Rail Route to Yellowstone* (1910);
- *American Indians in U.S. History*, by Roger L. Nichols (2003);
- *Dress Clothing of the Plains Indians*, by Ronald P. Koch;
- *Gold Camp Desperadoes*, by R.E. Mather and F.E. Boswell (1993);
- *Lakota and Cheyenne: Indian Views of the Great Sioux War, 1876–1877*, edited by Jerome A. Greene (1994);
- *Morning Star Down: The Powder River Expedition and the Northern Cheyennes, 1876*, by Jerome A. Greene (2003);
- *The Buffalo Soldiers: A Narrative of the Black Cavalry in the West*, by William H. and Shirley A. Leckie (2003);
- *Elizabeth Bacon Custer and the Making of a Myth*, by Shirley A. Leckie (1993);
- *The Western Range Revisited*, by Debra L. Donahue (1999);
- *Common and Contested Ground: A Human and Environmental History of the Northwestern Plains*, by Theodore Binnema (2001);
- *Forgotten Fires: Native Americans and the Transient Wilderness*, by Omar C. Stewart (2002);
- *After the Fires: The Ecology of Change in Yellowstone National Park*, by Linda L. Wallace (2004);
- *The Anatomy of Nature: Geology and American Landscape Painting 1825–1875*, by Rebecca Bedell (2001);
- *Lives of Grizzlies: Montana and Wyoming*, by Jim Cole (2004);
- *A Yellowstone Savage from Fishing Bridge*, by James O. Wolfe (2003); and
- Collection of fiction, dated between 1885 and 1999, set in Yellowstone National Park.

Museum. Museum staff curtailed its collecting this year in preparation for the move to the HRC.

However, the following were some of the more noteworthy items collected:

- Drum and pipe, donated by John Potter and Scott Frazier, used to bless the reintroduction of the wolves into Yellowstone National Park from 1995 to 1996.
- Complete set of retired china from the Old Faithful Inn, as well as commemorative wine glasses and champagne glasses, menus, and the guest book from the Inn's centennial event in May 2004, donated by Xanterra Parks and Resorts.
- Three souvenir Yellowstone National Park pins.
- White Motor Company ad (ca. 1940s) featuring the Grand Canyon of the Yellowstone;
- Ad for Greyhound from 1952 *National Geographic* issue, containing depiction of Yellowstone National Park.
- Scrapbook of visits to park from 1936 to 1938.
- Framed color photograph of the Roosevelt Arch, by Tom Murphy.
- "Yellowstone Park Camps" brochure (1924).

Research, Technical Assistance, and Outreach

Before shutting down operations in the fall, ALMC staff assisted many park staff and independent researchers with a variety of research topics, publications, and projects. Archivist Harold Housley assisted park staff and other researchers in finding archival documents for projects on fire history, bison management, Yellowstone ranger Wayne Replogle, research permitting, and the centennial of the Old Faithful Inn.

Museum Technicians Maria Capozzi and Bridgette Case assisted several researchers with requests for copies of historic photographs. Keith Samuels of the U.S. Army's Environmental Policy Institute (Arlington, Virginia) requested images of soldiers and the environment in Yellowstone for an Army Environmental History Project. This project is researching problem-solving by the U.S. Army in environmental and natural resource arenas. Rich Young of the Fort Casper Museum (Casper, Wyoming) needed "bird's eye view" images of Fort Yellowstone for the museum's exhibitions on forts in Wyoming. Rick Hoenninghausen of Xanterra Parks and Resorts requested historic images of

park concessions and the park itself for an internal report, while Joe Flanagan of the NPS Washington (D.C.) Office asked for photographs of museum objects for an article in *Common Ground* about the HRC. Finally, Tom Gibney of Shapins & Associates (Boulder, Colorado) requested images of the Yancey, Roosevelt, and Tower areas of the park for a cultural landscape inventory of these areas.

Curatorial staff also worked with park staff, contractors, and architects involved with Phase I of the Old Faithful Inn renovations to determine which items of historic significance may be disturbed by the work, and what objects can and/or should be added to the park's collections.

Exhibits. Cultural Resources Technician Tasha Felton and Museum Technician Steve Tustanowski-Marsh researched and fabricated two exhibit panels for the centennial event at the Old Faithful Inn. These were mounted in the windows of the Inn's dining room. At the request of Xanterra and the park's Business Management Office, curatorial staff dismantled the Shaw & Powell mountain spring wagon that had been on display in the lobby of the Old Faithful Lodge. The wagon, built by Studebaker Brothers of South Bend, Indiana, circa 1898, was used to transport visitors staying in Shaw & Powell tent camps within the park. The Shaw & Powell Company of Livingston, Montana, was one of only two official tent companies in the park, and operated from 1898 to 1916. With the help of Mergenthaler Transfer, curatorial staff dismantled the wagon and transported it to Gardiner, Montana, where it was reassembled in the lobby of the HRC. The wagon is the only Shaw & Powell vehicle known to exist in good condition.

Staff also conducted opening and closing activities in the Museum of the National Park Ranger and the Fishing Bridge Museum. This entailed cleaning all areas and replacing objects on exhibition for the season opening in spring, and stored and covered objects in preparation for closing in fall.

Assistance and outreach. Library staff continued to be active with the Wyoming Libraries Database network (WYLD), of which the park library is a member. Librarian Tara Cross attended the WYLD regional meeting at the Buffalo Bill Historical Center in January, toured the library and archives facilities there, and discussed pertinent issues with the librarians. She also visited the main

WYLD office in Cheyenne, Wyoming, where she received training from support staff and discussed library issues. Librarian Jackie Jerla attended the Region 2 WYLD meeting in Powell, Wyoming, in August. Tara and Jackie also attended the Wyoming Libraries Network's annual meeting in Riverton, Wyoming, in May; both attended training sessions on using WYLD's resources, and Tara attended the annual business meeting.

The park renewed its general agreement with the McCracken Research Library at the Buffalo Bill Historical Center in Cody, Wyoming. This agreement gives each institution preferred Inter-Library Loan and photocopying privileges in order to enhance their cooperative work.

Archivist Harold Housley and Curator Colleen Curry met with staff from the National Archives and Records Administration (NARA) from September 21 to 23, 2004, for NARA's annual inspection of the park's archives. Yellowstone National Park is the only National Park Service site to be an affiliate of NARA and, as such, is able to keep all of its management and planning records in the park instead of sending

them to a Federal Records Center for processing and storage. As an affiliate, the park's archives are subject to an annual inspection by NARA personnel. NARA staff participating in this year's inspection included Diane Vogt-O'Connor (senior archivist for affiliated and regional archives), Joel Barker (assistant regional administrator, NARA Rocky Mountain Region), and Linda Blaser (national preservation officer, NARA). The group toured the HRC, gathered statistics on the use of the park's archives, provided advice on preservation and storage issues, and met with Deputy Superintendent Frank Walker, YCR Director John Varley, and Acting Branch Chief of Cultural Resources Roger Anderson. NARA staff also provided park staff with new guidelines from the Office of Homeland Security and the Department of Justice on access to NARA records.

Tours. Staff gave numerous tours of the HRC to interested groups, including the Yellowstone Park Foundation (YPF) Board, YPF staff, and park staff. All five of the move teams were given orientation talks and tours of the collection facilities and areas.



The HRC lobby provides much-needed space for exhibits to be displayed on a rotating basis. This wagon is the only Shaw & Powell vehicle known to exist in good condition.

Notes



Fisheries Technician Shane Keep checks a whirling disease sentinel cage in the upper Pelican Creek watershed during 2004.

Part III: Natural Resource Programs

This section describes the work accomplished or coordinated by YCR staff who comprise the following units of the Branch of Natural Resources:

- *Air, Land, and Water*
- *Aquatic Resources and Fisheries*
- *Geology and Geothermal Resources*
- *Vegetation*
- *Wildlife*

Air, Land, and Water

These staff are responsible for management, research, and monitoring of air quality, disturbed lands, and wetlands.

Air Quality

Ambient air quality monitoring. Yellowstone continued to participate in a nationwide, interagency air quality monitoring network designed to determine levels of air pollutants, identify and assess trends in air quality, and determine compliance with National Ambient Air Quality Standards. Atmospheric deposition, wet (acid rain), and dry atmospheric deposition were monitored at the Tower Ranger Station. Visibility (fine

particulates, $PM_{2.5}$) and gaseous pollutants (ozone and sulfur dioxides) were monitored at the Lake water tank site. Carbon monoxide and fine particulates were monitored at Old Faithful and the West Entrance. Ranger staff operated the stations; the samples and raw data were sent to and analyzed by various national programs. Air quality, including visibility, was generally considered to be excellent, and there were no measured excesses of Clean Air standards. Occasional periods of degradation occurred due to regional haze or forest fire smoke. Localized emissions from campfires and wood burning stoves were occasionally visible. Emissions from oversnow vehicles have also been an issue.

Winter air quality monitoring. Ongoing questions about oversnow vehicle emissions led to continued year-round monitoring of carbon monoxide (CO) and particulate matter ($PM_{2.5}$) at the West Entrance, and the addition of a winter-season monitoring station at Old Faithful. A significant decrease in snowmobile traffic during the 2003–2004 winter season was mirrored by decreases in the concentrations of particle matter and carbon monoxide. All observed concentrations of $PM_{2.5}$ and CO were below the National Ambient Air Quality standards set by the EPA. The maximum rolling 24-hour average concentration for $PM_{2.5}$ decreased by about 60%, and the maximum 1-hour and 8-hour CO concentrations decreased by about 24% at Old Faithful. Peak values, as indicated by maximum 1-hour or by the 90th percentile, also decreased. The combination of less traffic, cleaner engine exhaust, ethanol-enhanced fuels, and less idling time appears to have successfully improved air quality at the two monitoring locations.

Disturbed Lands and Mining Impacts

Turbid Lake Road. Restoration of the remaining 3.5 miles of the abandoned Turbid Lake Road between Turbid Lake and the East Entrance road began in 2002, using NPS Natural Resource Preservation Program Disturbed Lands Reclamation funding. Approximately 1.3 miles (6.0 acres) of the abandoned Turbid Lake Road were restored in 2004, the third year of the project. Original contours were re-established using an excavator and a bulldozer. The excavator also salvaged and placed topsoil and plant material to speed revegetation. Park crews spread locally collected native seed and raked it into

the soil on the steeper, most potentially erodible re-contoured slopes. Funds donated by Canon U.S.A., Inc., paid for Montana Conservation Corps hand-crews to assist the park trail crew in re-constructing the Turbid Lake Trail to park standards. Early snow in mid-October stopped the project. Approximately 0.4 miles of the road remain to be restored in summer 2005. To date, 3.1 miles (14.0 acres) have been restored, including the restoration of 20 separate wetlands.

Heritage Center site restoration. Funds generated from the sale of coins commemorating Yellowstone's 125th anniversary were successfully used to obtain a non-government 1:1 match from the Secretary of Interior's Cooperative Conservation Initiative. Funds from the Initiative and the matching "coin money" were used to restore native vegetation on five acres of the former Gardiner Gravel pit/new Heritage and Research Center site. In FY04, park staff used heavy equipment to re-establish natural contours. Park and Montana Conservation Corps crews fenced the site, installed a temporary irrigation system, seeded and planted native species, weeded, and mulched. Revegetation with nursery-grown native plants will continue for over the next two years as additional nursery-grown plants become available.

Historic mining impacts. Park staff continued to participate in planning and technical meetings, and to monitor proposed and ongoing reclamation projects associated with three mining areas located outside the park: the New World Mining District Response and Restoration Project, the McLaren Mill mine tailings, and the Great Republic Smelter.

Environmental cleanup of historic mining impacts in the New World Mining District adjacent to the park's Northeast Entrance proceeded smoothly. The U.S. Forest Service continued to identify sources of pollution and conduct site investigations to refine cleanup activities. Resource management specialist Mary Hektner continued to serve as the Department of Interior's Project Coordinator for the New World project.

Park and NPS Water Resources and Geologic Resources staff continued to work with the Montana Department of Environmental Quality to explore options for treatment and removal of the McLaren Mill mine tailings and the Great Republic Smelter site, which are both located upstream and just

outside the park's northeast boundary near Cooke City, Montana.

Gardiner Basin Restoration

In 1926, Congress added several thousand acres to the northern part of the park to "provide the winter range and winter feed facilities indispensable for the adequate and proper protection, preservation, and propagation of the elk, antelope, and other game animals of Yellowstone National Park." Though this area, variously known as the Boundary Line or Gardiner Basin Area, is now dominated by exotic vegetation introduced through homesteading, railroading, and gravel mining activities, it is still a crucial feeding ground, especially for Yellowstone's dwindling pronghorn population. The park has tried various experiments to re-establish native vegetation to improve winter forage. Unfortunately, these efforts have had little success, in part due to the staff's limited experience with the semi-desert environment found in the rain shadow of the Gardiner Basin.

For that reason, funding was sought and secured from the Yellowstone Park Foundation, Greater Yellowstone Coordinating Committee, and the Rocky Mountains Cooperative Ecosystem Studies Unit to convene a workshop of 10–12 specialists in arid lands reclamation. The workshop will be held in Gardiner, Montana, on April 19–21, 2005. It will focus on collaborative strategies for restoring semi-arid regions and develop an action plan for reclamation and long-term management of park and Gallatin National Forest lands within the Gardiner Basin. Resource Management Specialist Mary Hektner is leading a steering committee made up of staff from Yellowstone National Park, Gallatin National Forest, and Montana State University's Center for Invasive Plant Management to organize the workshop.

Snow Survey

Over 75% of the surface water supply in the western United States is derived from snowmelt in the higher, mountainous areas of the West. Changing conditions from year to year and region to region can range from extreme drought to severe flooding. To monitor and help manage this important resource for public safety, health, and economic viability, the Natural Resource Conservation Service (NRCS), under the federally mandated Snow Survey and Water Supply Forecasting Program, operates and

maintains an extensive monitoring system designed to collect snowpack and related climate information.

Yellowstone National Park is an important partner to the NRCS Snow Survey and Water Supply Forecasting Program, as it serves as the headwaters area for two major national river systems: the Yellowstone River on the east side of the Continental Divide, and the Snake River on the west side. Yellowstone is home to 10 NRCS automated snow depth (SNOTEL) stations and five manual snow course sites.

Over the past two years, NRCS has been adding snow depth sensors at the SNOTEL stations to collect snow depth measurements in addition to the snow water equivalent, precipitation, and temperature data historically collected at the sites. This information will help NRCS hydrologists to assess hydrologic and climate conditions relating to water supply more accurately, and provide for better management decisions. Avalanche forecasters use these data to assess avalanche potential; wildlife managers use it to assess winter severity and its effects on wildlife and winter range. Winter visitors such as skiers and snowmobilers also use this information for planning trips and other activities.

Plans call for adding soil moisture and soil temperature sensors to the SNOTEL network over the next few years. These data will provide important information needed for hydrologic models to better forecast both the quantity and timing of spring and summer stream flows.

Wetlands

Wetland mapping and delineation was completed along the 2.8-mile-long Fishing Bridge-to-Indian Pond road segment as part of the parkwide road reconstruction program. Surveys for wetlands were also conducted for one backcountry trail, two SNOTEL monitoring sites, two park construction project areas, and two frontcountry and four backcountry areas slated for wildland–urban interface hazardous fuels/forest-thinning treatments. The surveys were conducted to ensure that impacts to wetland resources would be avoided or minimized.

Revegetation and groundwater monitoring of ongoing work to restore the abandoned Turbid Lake Road to natural conditions continued in 2004. The Phase I restoration work, begun in 1995, was

highly successful, as upland and wetland areas were beginning to revegetate with native plant species. Additional vegetation monitoring plots and groundwater wells to document wetland restoration success were installed on the 1.3-mile portion of the Phase 2 road restoration completed this year.

Aquatic Resources

These staff are responsible for management, research, and monitoring the park's aquatic ecosystems. The program's two main goals are preservation of Yellowstone Lake cutthroat trout (the largest remaining concentration of genetically pure inland cutthroat trout in the world), and restoration of fluvial populations of native trout, largely lost due to introduced species.

The Aquatics Section would like to extend special thanks to the Yellowstone Park Foundation and the many private individuals that have graciously provided support for critical fisheries projects in the park. Thanks also go to the many volunteers who have dedicated their time and also a great deal of other expense to our Aquatics Section. Without them, much of what we do in our programs would not be possible.

Yellowstone Cutthroat Trout Preservation

Lake trout removal. The 2004 field season represented another record year for lake trout (*Salvelinus namaycush*) suppression efforts on Yellowstone Lake. A total of 27,770 of these non-native predators, illegally introduced to the lake at least 20 years ago, were killed through gillnetting and angling to preserve the remaining native Yellowstone cutthroat trout (YCT, *Oncorhynchus clarki bouvieri*). More than 100,000 lake trout have been killed by gillnetting since they were first discovered in the lake in 1994. Because each lake trout could consume 41 YCT each year, the gillnetting effort has saved a tremendous number of YCT.

In 2004, 26,707 lake trout were removed from Yellowstone Lake by gillnetting. The concurrent ratio of lake trout killed to YCT sacrificed remained low (0.07 YCT lost for every lake trout killed). Catch per unit of effort (CPUE) rose slightly in 2004 (1.69), but was still dramatically below the 1998 level, when an average of 5.51 lake trout were caught with each unit of effort.

The majority of the removal effort was targeted at young lake trout residing in depths greater than those occupied by YCT. Small-mesh gillnets were placed on the lake bottom, usually in water 40–65 m deep. On a typical day, over 10 miles of gillnet were in place fishing for lake trout.

In an effort to capitalize on the lake trout's spawning behavior, an additional capture method was used in 2004. Electrofishing (introducing a pulsed direct current, supplied by a portable generator, into the water to administer an electric shock) is a widely used technique for capturing fish. The electric shock temporarily stuns the fish, allowing easy capture with a dip net. On the nights of September 21 and 22, 975 additional mature lake trout were removed from Yellowstone Lake by electrofishing. During the following week, only 88 were captured, indicating the spawn was likely over.

Approximate locations of three lake trout spawning areas are known in Yellowstone Lake: near Carrington Island, west of the mouth of Solution Creek, and northeast of West Thumb Geyser Basin. Given the importance of spawning areas, a research project was initiated to identify additional potential spawning areas throughout Yellowstone Lake. Using geomorphologic data, known lake trout spawning habitat preferences from other areas, and habitat preferences observed in Yellowstone Lake, staff will predict areas with the highest potential for spawning habitat that could be pioneered and used by lake trout in the future. Gillnetting staff can then monitor these areas and kill lake trout if they occur there during the fall spawning period.

The size of lake trout caught in gillnets near spawning areas continued to decrease in 2004. Mean total length (528.4 mm) decreased over 12 mm from 2003. Females were larger than males, and the male-to-female ratio was 1:0.77. Despite the decrease in average size, a large increase in the numbers of spawning lake trout in Yellowstone Lake is being observed. For the first time since the program began, gillnets were found to have filled so full of fish that they collapsed to the lake bottom and were no longer fishing after being set just one night. Combined with electrofishing, 8,346 lake trout were removed from spawning areas in 2004—a new record. The current increase in lake trout spawners is not unexpected. Lake trout typically mature at age 6–7, and offspring from 1998 would have been age six during the past



PHIL DOEPKE

Fisheries Technicians Krisi Anderson (left) and Stacey Sigler (right) with SCA volunteer Anna Varian process gillnets on board the *Hammerhead*.

season. If this is the case, due to the large numbers of lake trout noted that year, continued high numbers of spawning fish should be expected over the next 3–5 years.

Despite the recent increase in spawning fish, results of the lake trout suppression program are encouraging. Overall CPUE remains low, and continued decline in mean total length of lake trout caught near spawning areas indicates continued removal of the older, larger, and therefore most detrimental lake trout. Low CPUE, continued decrease in spawner size, and the large number of lake trout removed from the system, are positive indications that gillnetting operations are exerting measurable lake trout mortality in this system. However, the increase in numbers of spawning fish underscores the importance of maintaining the effort to keep this non-native predatory population in check. Lake trout densities in the West Thumb remain high and a serious threat to YCT.

Whirling disease and its effects on cutthroat trout. Research on the native Yellowstone cutthroat trout of the Yellowstone Lake basin has provided strong evidence that this subspecies and strain is extremely susceptible to *Myxobolus cerebralis*, the parasite that causes whirling disease. Up to 20% of all juvenile and adult YCT within the lake are infected. Although the widespread presence of this harmful parasite in the lake is disturbing, the dis-

covery of *M. cerebralis* spores in adult fish each year suggests that at least some YCT are surviving initial *M. cerebralis* infection. Sentinel exposure studies suggest that risk of infection is highest in the Yellowstone River and Pelican Creek (the second-largest tributary to Yellowstone Lake), where the impacts of *M. cerebralis* have been found to be most severe. Few wild-reared fry have been observed in Pelican Creek in recent years (2001–2004), and netting near a historical weir for upstream-migrating adults in 2002–2004 indicated that the spawning YCT population of Pelican Creek, which in 1981 was nearly 30,000 fish, has been essentially lost. Establishment of *M. cerebralis* has likely contributed to the severe decline of YCT within Pelican Creek, and the overall population decline within the Yellowstone Lake ecosystem.

A better understanding of how *M. cerebralis* is dispersed may help us to prevent introductions to additional Yellowstone waters in the future. Movement of infected hatchery fish has been blamed for the spread of *M. cerebralis* in Colorado and Wyoming, but fish have not been stocked (legally) in the Yellowstone River drainage within Yellowstone National Park since 1955, which was prior to the first discovery of whirling disease in the U.S. The risk of *M. cerebralis* spread to additional waters within the Greater Yellowstone Ecosystem is unclear. Obvious vectors include the movement of myxospores by humans (anglers and their gear) or by fish-eating wildlife, especially those capable of traveling long distances in a short period of time such as avian piscivores. Research is ongoing.

Long-term population monitoring. Contemporary data suggest that a significant decline has recently occurred in the Yellowstone Lake YCT population. The number of upstream-migrating YCT counted at Clear Creek was 1,438 during 2004. This count was down from 3,432 in 2003, and 6,613 in 2002, and was the lowest count since 1954. The fish-counting station operated on Bridge Creek, a small northwestern tributary, indicated that only a single fish migrated upstream during 2004. The number of spawning YCT in recent years has declined by more than 50% annually in Bridge Creek, and has decreased by more than 99% since counts began

in 1999, when 2,363 YCT ascended the stream to spawn. During 2003–2004, however, the fall netting assessment provided some of the first indications that the YCT population may be responding positively to efforts to remove non-native lake trout. An average of 7.4 fish were caught per net in 2003, and 7.9 fish were caught per net in 2004. Prior to 2003, the reduction in catch by the fall netting program had been 0–21% each year (averaging 11% per year) since 1994, the year lake trout were first discovered in Yellowstone Lake.

Native Fish Restoration

Arctic grayling. The fluvial arctic grayling (*Thymallus arcticus*) is a candidate species for listing under the Endangered Species Act in the upper Missouri River drainage, where its only known remnant population is restricted to the upper Big Hole River in Montana. In Yellowstone National Park, fluvial arctic grayling originally existed in the Madison, Gibbon, and Firehole rivers. Non-native brown trout introductions and the creation of Hebgen Reservoir quickly led to what appeared to be the complete loss of fluvial arctic grayling within the park by the mid-1900s.

In recent years, both anglers and electrofishing surveys have consistently found arctic grayling throughout the Gibbon River. However, it is not known if these fish are truly fluvial, or if they are merely strays moving downstream from headwater lake populations. Because of this, the Aquatics Section has initiated collaborative research with the specific goal of determining if there is a viable population of fluvial arctic grayling within the Gibbon River system. Results will have immediate relevance for the park's management and conservation of fluvial arctic grayling, if indeed they are found to exist here.

Westslope cutthroat trout. Like other salmonids in the western U.S., many populations of westslope cutthroat trout (*Onchorhynchus clarki lewisi*) have been substantially reduced as a result of interbreeding with other non-native trout, particularly YCT and rainbow trout (*Onchorhynchus mykiss*). The park's only pure population of westslope cutthroat trout likely resided in North Fork Fan Creek, a tributary of the Gallatin River. However, recent genetic samples taken from this population have suggested that this suspected pure population has become hybridized with rainbow trout in the past five years.

The overall goal for westslope cutthroat trout restoration within Yellowstone National Park is to reverse the further loss of genetic integrity and establish new, genetically pure populations. In 2004, the Aquatics Section began surveying other streams in the historical westslope cutthroat trout range within the park, and concentrated on Specimen Creek as a possible restoration site. Because of its

close proximity to North Fork Fan Creek and the fact that its trout population is highly hybridized, Specimen Creek, especially the East Fork, will be the focus for westslope cutthroat trout restoration in the short term.

Yellowstone cutthroat trout. Stream surveys have revealed that genetically pure YCT exist only in a fraction of their historical range in rivers and streams outside the Yellowstone Lake basin. Invasion of stream systems by non-native species is continuing in the park, and remaining genetically pure YCT populations are being lost. The YCT of Yellowstone Lake and its associated drainage have remained



Hybridization with nonnative rainbow trout is a significant threat to the persistence of cutthroat trout within Yellowstone National Park. These cutthroat/rainbow hybrids were caught in Specimen Creek in 2004.



genetically pure due to isolation provided by the Lower and Upper Falls of the Yellowstone River located 25 km downstream from the lake outlet near Canyon. The genetic purity of these fish makes them extremely valuable.

The Aquatics Section continues to take steps to ensure the long-term persistence of genetically pure wild YCT populations. Reversing the loss of these populations within Yellowstone National Park streams must occur now, while genetically pure fish still exist for reintroduction efforts. Given the declining probabilities for persistence of existing populations, the overall goal for fluvial YCT restoration within Yellowstone National Park is to focus on watersheds within the park's northern range, and identify those that have the highest probability of success for stream restoration. Streams of the northern range have been chosen for initial focus because of their accessibility; the logistics for completing stream restorations in this region are very good.

Fishery Inventories

Road reconstruction monitoring. In 2004, surveys of fish populations conducted by Aquatic Section personnel included ongoing monitoring of road-impacted streams in many locations of the park, as well as monitoring associated with road reconstruction projects. Road projects can potentially impact fish populations if excessive sediment is generated during construction or improperly designed or placed road culverts impede fish passage after completion of the project. Road-related fish surveys were conducted at several sites in the Hayden Valley portion of the road-resurfacing project between Fishing Bridge and Canyon Junction (begun in 2003); at a small tributary of Cascade Creek that flows under the Dunraven Pass road; and at four locations in the Gibbon River between Gibbon Meadows and Madison Junction. For the fourth consecutive year, fish populations were monitored by three-pass electrofishing removal estimates at two 100-m sample sites along the Avalanche Peak-to-East Entrance road.

Snake River surveys. In August 2004, in a cooperative effort with fishery biologists from the Bridger-Teton National Forest, the main stem of the Snake River and several tributaries were surveyed for native fish species. The survey downstream from the confluence with the Heart River (approximately 30

km of river) was sampled for historical comparison with a survey in 1983. An additional 20 km upstream from the Heart River–Snake River confluence was surveyed for the first time ever. Preliminary results included:

- Several waterfalls about halfway between the headwaters and the Heart River presumably function as barriers to upstream fish migration, and separate the main stem Snake River fish into two populations.
- Mountain whitefish (*Prosopium williamsoni*) were the most abundant salmonid downstream from the Heart River.
- Young cutthroat trout were found at almost all sites.
- Adult YCT (large-spotted) were found infrequently, and rarely exceeded 250 mm in length.
- The rare, fine-spotted form (Snake River fine-spotted cutthroat trout) was only collected downstream from the Heart River confluence.
- Other native species collected included long-nose dace (*Rhinichthys cataractae*), speckled dace (*Rhinichthys osculus*), and mottled sculpin.
- In at least two headwater tributaries, waterfalls delimited areas of historically fishless portions of streams.

The Snake River survey will be completed in 2005, with a focus on the stream's many remote, headwater tributaries.

Status of cutthroat trout in the upper Yellowstone River. Because there has never been a comprehensive fishery survey of the Yellowstone River upstream of Yellowstone Lake, the National Park Service, in cooperation with the Wyoming Game and Fish Department, initiated a fisheries assessment of this remote river section in 2003. The study will help determine movements of adult Yellowstone cutthroat trout during their spawning migration in the Yellowstone River and several of its tributaries, and attempt to determine if any resident populations exist in the drainage.

In 2003, 65 adult YCT were surgically implanted with radio transmitters in the Yellowstone River and several of its tributaries (Thorofare Creek, Mountain Creek, and Atlantic Creek), with an additional 67 fish implanted with transmitters in 2004. All fish

collected were measured, weighed, sexed, had scale samples taken, and were fin-clipped for genetic testing.

Fish outfitted with radio transmitters were monitored with weekly tracking flights by fixed wing aircraft and several ground-truthing trips from June to November 2004, and monthly from December through mid-April 2005. Surveys to locate fish that moved into Yellowstone Lake were conducted via aircraft and boat.

Initial analysis indicated that the majority of adult YCT tagged in the upper Yellowstone River and its tributaries migrated back to Yellowstone Lake following the spawning period. Some YCT traveled great distances to spawn; several migrated from Yellowstone Lake upstream over 30 miles to the upper reaches of Thorofare Creek. Several male YCT tagged during 2003 returned to spawn in 2004, indicating that males may spawn in successive seasons. No female fish tagged during 2003 returned during 2004, indicating that females in this system may not spawn in successive seasons.

Monitoring of fish movement patterns is planned for at least two more field seasons, as this information is some of the first ever obtained for these remote waters of the park.

Aquatic Ecosystem Health

Aquatic invasive species program. Yellowstone's world-class fisheries are threatened by introductions of aquatic invasive species (AIS). These harmful, non-native (from elsewhere in North America) and exotic (from another continent) invading species displace precious native species, such as YCT and many native macroinvertebrates upon which native fish depend. Aquatic invasive species have the potential to impact important trout consumers such as eagles, ospreys, and grizzly bears, causing a disruption of the Greater Yellowstone Ecosystem.

The New Zealand mud snail and the parasite that causes whirling disease in trout are examples of exotic AIS that are already present in park waters. The zebra mussel and Eurasian water-milfoil are examples of AIS that are quickly approaching the park, and there are more than 300 others now in North America. Aquatic invasive species are often difficult to see, and as a result are often transported from one lake or stream to another within the water of a boat bilge or livewell, or in mud, dirt, sand, or

plant fragments attached to boats, fishing equipment, or clothing.

During 2004, a resource team was established to develop both short- and long-term goals for the prevention of additional AIS invasions of Yellowstone National Park waters. Prevention is key, because once introduced and established in park waters, harmful aquatic invasive species are virtually impossible to eradicate.

The team identified several "critical control points" that could be used for the prevention of AIS introductions to park waters. These control methods will require funding, both for establishment and for long-term maintenance. They include enhancing public awareness of AIS issues; conducting mandatory boat inspections by trained personnel; establishing boat washing stations; and providing facilities for cleaning waders and other angler gear. Yellowstone National Park is a partner in the "Stop Aquatic Hitchhikers" campaign, led by the U.S. Fish and Wildlife Service. Whenever possible, images and other educational materials common to the campaign are used for purposes of AIS prevention within the park.

Water quality monitoring. During 2004, the Aquatics Section continued to conduct water quality monitoring at 12 established sites on major river basins throughout Yellowstone National Park. A multiparameter probe was used to collect water temperature, dissolved oxygen (DO), pH, specific conductance, and turbidity. Water samples were collected at each location for total suspended solids (TSS) and volatile suspended solids analysis. The primary purpose of the water quality monitoring program is to obtain baseline information regarding the health of major streams and rivers within Yellowstone National Park.

During 2004, most parameters varied considerably within and between sites, primarily due to diurnal cycles, higher flows during spring snowmelt, rain events, seasonal temperature changes, altitude differences, and thermal influences. Highest mean water temperature of 15.5 degrees Celsius (°C) occurred on the Firehole River (range 7.8–24.0°C), a thermally influenced stream. Lowest mean water temperature of 4.6°C occurred on upper Soda Butte Creek (range 0.1–13.7°C).

Highest mean DO concentration of 10.7 milligrams/Liter (mg/L⁻¹) was recorded for Lamar River

(range 8.7–13.4 mg/L⁻¹); lowest mean DO concentration of 8.1 mg/L⁻¹ was recorded for Pelican Creek (range 2.4–11.0 mg/L⁻¹). Typically, DO concentrations of less than 5 mg/L⁻¹ are considered stressful to most aquatic organisms.

The highest mean pH value for all sites sampled was 8.4 standard units on the Firehole (range 7.7–8.8) and Gardner (range 7.9–8.7) rivers. Conversely, the Gibbon River had a mean pH value of 7.0 (range 6.4–7.3). This river drainage receives considerable runoff from the Norris Geyser Basin, which is typically more acidic than other geyser basins within the park. The Yellowstone River at Artist Point had the lowest mean pH of all water quality sites, with a value of 6.9 (range 5.9–8.0).

Higher specific conductivity values were generally found at sample sites with thermal contributions. The highest mean specific conductivity for all sites sampled was recorded for the Gardner River, with 582.1 microseimens per centimeter (μS/cm⁻¹). The lowest specific conductivity value was recorded on the Lamar River, with 69 μS/cm⁻¹.

Increases in turbidity, caused by suspended particles present in the water column, can affect aquatic plants (reduce photosynthesis) and animals (influence feeding behavior of visual predators). Higher turbidity values usually corresponded to spring runoff or localized precipitation events during summer months. Most sites had mean turbidity measurements below 10 nephelometric turbidity units (NTU).

TSS is a quantitative measure of the total fraction of inorganic and organic material suspended in the water column. Increases in TSS can lead to increased deposition of sediments in the streambed, eventually decreasing benthic productivity and causing loss of fish habitat. Concentrations of TSS at stream sites mirrored turbidity readings. The highest mean TSS was recorded for Pelican Creek, with a mean of 27.2 mg/L⁻¹ (range 0.9–168.6 mg/L⁻¹). The lowest mean TSS was recorded for Fishing Bridge with a mean concentration of 2.3 mg/L⁻¹ (range 0.4–15.5 mg/L⁻¹). Values for specific conductance, turbidity, and TSS were highly seasonal, and seemed to be correlated to river discharge.

Water quality associated with winter road use. From March 20 to April 3, 2004, snowmelt runoff was collected from four sample locations in the road

corridor between the West Entrance and Old Faithful, and sampled for concentrations of volatile organic compounds (VOC). Sample analysis was conducted by the U.S. Geological Survey's laboratory in Denver, Colorado. Nine compounds within the VOC category were analyzed: benzene, ethylbenzene, ethyl tert-butyl ether, isopropyl ether, m-xylene/p-xylene, methyl tert-butyl ether, o-xylene, tert-pentyl methyl ether, and toluene. Samples of snowmelt runoff near Old Faithful contained a high of five compounds during at least one sample event. Their maximum concentration was (units are in μg/L⁻¹): benzene, 0.026 (estimated); ethylbenzene, 0.720; m-xylene/p-xylene, 3.365; o-xylene, 2.183; and toluene, 1.008.



PHIL DOBNIK

Collection and analysis of data on Yellowstone Lake's limnology will provide park fisheries biologists with important information regarding movement patterns of lake trout.

Only two VOC compounds (m-xylene/p-xylene, and toluene) were detected from snowmelt runoff near the West Entrance site, in contrast to 2003, when all five compounds were identified. Both m-xylene/p-xylene and toluene were found in very low concentrations, with maximum estimated values of 0.008 and 0.037 μg/L⁻¹ respectively. VOCs were not detected in any test sample from the Madison Junction site. The concentrations of these compounds were well below the Environmental Protection Agency's level of toxicity to aquatic organisms.

Yellowstone Lake limnology. Collection and analysis of physical and chemical parameters of Yellowstone Lake's limnology will provide park fisheries biologists with important information regarding movement patterns of lake trout while

lake trout gillnetting operations are underway. For example, during summer months, when the thermocline (area in water column of greatest temperature change) becomes established, lake trout generally move into deeper, cooler waters, avoiding the warmer water near the lake surface.

The seven long-term water quality monitoring sites on Yellowstone Lake were sampled from May 21 through October 20, 2004, with data collected every two weeks. Mean surface water temperature, DO, pH, and specific conductance values were fairly consistent among all seven sample locations. Surface water temperatures reflected seasonal changes. The highest mean surface water temperature of 11.2°C (range 4.5–17.5°C) was recorded at the Mary Bay site; the lowest mean surface water temperature of 9.7°C (range 4.5–15.2°C) was recorded at the West Thumb site. Data from water temperature depth profiles indicated that water temperature remained fairly constant throughout the water column, about 4°C, until mid-June, when surface water temperatures began to rise. By early July, the lake began to stratify with the development of the thermocline, which was established at approximately 20 meters by mid-September.

Trends in DO concentrations were similar among all sites, with lower values recorded during July and August, when surface water temperatures were warmest, and higher values recorded during May and June, when surface water temperatures were coolest. Mean DO concentrations were similar among all sites, with values ranging between 8.6 and 8.8 mg/L⁻¹. Examination of the depth profile data indicated that DO concentrations remain comparatively consistent

throughout the water column for any given sample day. The highest mean pH value of 8.0 (range 7.5–8.3) was recorded for the South Arm site; the lowest mean pH value of 7.6 (range 7.3–7.9) was recorded for the Mary Bay site.

Overall, mean specific conductivity values for all sites ranged from 84–94.4 µS/cm⁻¹. The highest mean specific conductivity value of 94.4 (range 92–96 µS/cm⁻¹) was recorded for the West Thumb site; the lowest mean specific conductivity value of 84 µS/cm⁻¹ (range 69–91 µS/cm⁻¹) was recorded for the Southeast Arm site.

Mean turbidity measurements were quite low for all sites. The highest mean turbidity of 1.6 NTU (range 0.4–6.0 NTU) was recorded for the Southeast Arm site; the lowest mean turbidity measurement of 0.5 NTU (range 0.3–1.0 NTU) was recorded at the Stevenson Island site. TSS measurements for all sites were quite low throughout the season. The highest mean TSS measurement of 0.097 mg/L⁻¹ (range 0–0.212 mg/L⁻¹) was recorded for the Mary Bay site; the lowest mean TSS measurement of 0.039 mg/L⁻¹ (range 0–0.091 mg/L⁻¹) was recorded for the West Thumb site.

Macroinvertebrates as health indicators.

During 2004, aquatic macroinvertebrate samples were again collected as part of the Aquatic Section's aquatic ecosystem health program. Macroinvertebrate monitoring was conducted in response to a variety of factors that currently threaten the health of aquatic resources within the park. In 2004, 17 sites on 10 stream segments were sampled relative to road construction, and a site on upper Soda Butte Creek near the park's northeast boundary was sampled to monitor possible effects of the McLaren Mine tailings, located



During 2004, 68 anglers participated in the Volunteer Fly-Fishing Program and information was obtained from many locations throughout the park.

upstream of the park boundary near Cooke City, Montana.

Invertebrate samples were also collected as part of the westslope cutthroat trout restoration project currently underway in the Specimen and Fan creek drainages. During August 2004, six invertebrate locations were sampled throughout the Specimen Creek drainage to evaluate current water quality conditions. This data will also provide necessary background information regarding inventory and distribution patterns of aquatic invertebrate assemblages needed prior to any fish restoration attempt there.

In response to a fire retardant drop that occurred in the Bacon Rind Creek drainage during September 2003, staff conducted invertebrate sampling to examine potential impacts the spill might have had on stream water quality. Most fire retardants, as was the case with the Bacon Rind spill, contain high concentrations of ammonia, which is toxic to most plants and animals. The initial site inspection, which occurred during October 2003, concluded that the main volume of fire retardant was dropped approximately 90 meters from Bacon Rind Creek. By examining the spray pattern on materials near the stream channel, it was also determined that approximately 33% of the stream surface area within a 20-meter reach was affected by the fire retardant. To evaluate the effects of fire retardant on stream water quality and aquatic biota, staff collected invertebrates from two stream segments—one downstream, and one upstream of the impacted area. Eight surber net samples (0.09m², 500- μ m mesh) were collected from each stream segment. Preliminary results indicated that the area immediately downstream of the fire retardant drop may have been mildly impacted by the fire retardant. Additionally, the number of intolerant taxa (groups of organisms that are not tolerant of environmental pollutants) was slightly lower at the downstream location (10 taxa) than the upstream location (12 taxa). However, the Hilsenhoff Biotic Index, which evaluates tolerance levels of benthic macroinvertebrates to pollutants, scored both of these stream segments as being in excellent condition. Impacts, if any, the fire retardant had on the water quality of Bacon Rind Creek appeared to be short lived, with no evident adverse effects on aquatic biota.

Public Involvement

Volunteer Flyfishing Program. In this program, flyfishing volunteers use catch-and-release angling to gather biological information on fish populations throughout the park. In 2004, 68 volunteer anglers from across the U.S. participated. Projects addressed included a determination of the range of hybridized YCT in the Lamar River, its major tributaries, and several other park waters, and documentation of the status and movement patterns of grayling originating in Grebe and Wolf lakes of the Gibbon River system. More than 300 grayling are now tagged in the Gibbon River, and much of the current understanding of grayling distribution within the Gibbon River is the result of efforts by the flyfishing volunteers.

Another highlight of the 2004 field season was the initiation of a hook-type study, where half of the volunteer anglers fished with barbed hooks, and the others with barbless hooks. The study will be continued in 2005, but preliminary results indicated no difference among hook types for injuring fish or causing mortality.

In addition, East Fork Specimen Creek was fished on numerous occasions in 2004 in conjunction with the Volunteer Flyfishing Program. This group of directed anglers fished for a total of about 850 hours and caught 28 cutthroat trout and 12 rainbow trout. Lengths of the angler-caught trout in the main stem section were similar to those from electrofishing surveys.

Trends from the Volunteer Angler Report cards. An estimated 51,542 people fished in park waters during 2004, with more than 3,000 angler outings documented through the VAR program. Data from 2004 indicated that anglers fished for an average of 2.87 hours a day during a typical outing, and fished 1.69 days during the season. Sixty-two percent of anglers fished only one day, and accounted for 82% of fish caught. Only 5.1% of these anglers kept fish. Anglers reported being satisfied with the overall fishing experience (76%), with the number of fish caught (62%) and with the size of fish (68%).

Anglers caught an estimated 606,521 fish in the park. Native cutthroat trout remained the most sought-after and caught fish species, comprising 52% of the total catch, followed distantly by rainbow trout (16%), brown trout (12%), brook trout (9%), lake trout (5%), mountain whitefish (3%), and grayling (3%).

One quarter of all fishing effort in the park occurred on Yellowstone Lake. These anglers reported catching 0.83 cutthroat trout per hour of fishing. This catch rate is less than in recent years, and follows a five-year downward trend since a record high in 1998. The average length of cutthroat trout caught by anglers increased again in 2004, to 448 mm (17.7 inches), and is at an all-time high. The angler-reported catch rate for lake trout in Yellowstone Lake decreased in 2004, to 0.13 fish per hour. This is the first year since 1998, and the second since their discovery in Yellowstone Lake, that the angler catch per effort has decreased, and is a positive sign that the effort to reduce lake trout is achieving some success. Anglers caught an estimated 8,465 lake trout in Yellowstone Lake during the 2004 angling season.

Long-term volunteer assistance. The Aquatics Section recruits long-term (more than 12-week) volunteers from the Student Conservation Association and other sources. All aspects of the Aquatics Section greatly benefit from both long- and short-term volunteer support. In 2004, a total of 103 volunteers dedicated 4,441 hours to Aquatics Section activities.

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

Geology

These staff protect Yellowstone's unique geologic resources, which include the park's landscape, rocks, minerals, fossils, and thermal features, and the geologic processes that form them.

The program's part-time staff, partnerships, students, and dedicated volunteers are responsible for its growth and success. In FY04, new geologic staff augmented efforts to protect geologic resources and aided cooperation with other programs and park divisions.

Notable geologic events during the year consisted of an earthquake swarm in April, numerous precipitation-triggered landslides throughout the park, and two thermal disturbances (in February and September) at Norris Geyser Basin. There were

no major eruptions of Steamboat Geyser this year. Thermal and geologic activity is reported by calendar year rather than federal fiscal year.

Hot Topics in Yellowstone Geology

Thermal disturbances at Norris Geyser Basin. A seasonal interpretive ranger at Norris Geyser Basin noted that Pearl Geyser changed from a blue pool to a steam vent on February 25, 2004. On March 16, Geology Program personnel observed Pearl Geyser, Yellow Funnel, and Son of Green Dragon all in steam phase; eruptions of Vixen Geyser; and the mudpot near Son of Green Dragon spurting steam and mud onto the closed portion of the Back Basin Trail. Data from thermal loggers confirmed that a thermal disturbance occurred between February 22 and 23, 2004. The changes in thermal features during this disturbance were similar to the changes noted during the July 2003 thermal disturbance at Norris.

Thermal loggers on Echinus Geyser and near Vixen Geyser quantified the thermal disturbances at Norris Geyser Basin and complemented human observations. During the February disturbance, Echinus Geyser changed from an irregular eruptive interval to a regular eruptive interval on February 23. The thermal logger on the trail near Vixen Geyser showed a spike in ground temperatures between February 23 and February 25. Scientists and other observers have noticed similar thermal disturbances at Norris Geyser Basin for decades.

Another thermal disturbance, also documented and monitored using temperature loggers, began on September 18, 2004. Norris Geyser Basin interpretive staff, geology staff, and volunteers all noted changes in the thermal activity of Echinus, Pearl, and Vixen geysers, as well as other thermal features. The thermal feature near Son of Green Dragon erupted hot, acidic mud onto a portion of the former trail and obscured the restored Back Basin Trail. Because of the Back Basin Trail re-route and new boardwalk constructed during summer 2004, visitors and park staff could easily view the changing thermal features during September. New eruptive activity at a pre-existing thermal feature was a highlight of this thermal disturbance. In contrast to the July 2003 thermal disturbance, no trails were closed as a result of the September 2004 thermal disturbance. The ending date of the September thermal disturbance was less clear than its initiation. Ongoing scientific

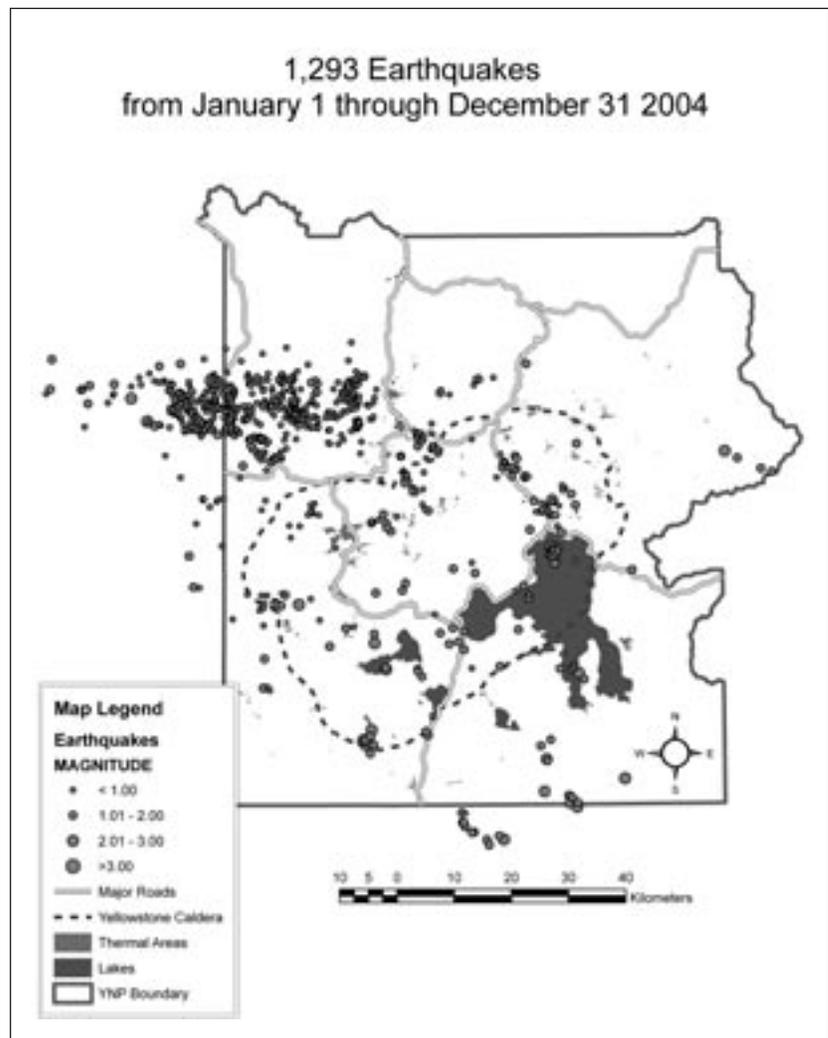
studies by Yellowstone Volcano Observatory scientists and others will increase understanding of the changes in heat and hydrology that occur during thermal disturbances. Data from these two thermal disturbances clearly show why the term “annual” disturbance is errant.

Bison deaths near Norris Geyser Basin. On March 11, 2004, geology staff joined bear management biologists to investigate the deaths of five bison found along the Gibbon River. The two adults, two calves, and one yearling were lying on their sides, with their feet perpendicular to their bodies. The unusual position of the carcasses led biologists to suspect that the bison had died very rapidly, as a group; they established that the bison had been dead for approximately one week. Multiple gas vents occur uphill from the site of the bison carcasses, on both sides of the Gibbon River. Park personnel and Yellowstone Volcano Observatory (YVO) scientists used gas detectors to measure concentrations of hydrogen sulfide (H_2S) and carbon dioxide (CO_2). Park personnel measured high concentrations of H_2S (>200 ppm) at gas vents, and YVO scientists measured CO_2 from a pool near the Gibbon River. In an active volcanic area such as Yellowstone, CO_2 is more abundant than H_2S . An electronic temperature logger at the nearby Norris Museum showed unusually cold temperatures on the evening of March 1, and the early morning of March 2, 2004. It is possible that the bison were asphyxiated by CO_2 and/or H_2S gases on a cold March night with still air.

April earthquake swarm. During January–December 2004, the Yellowstone area experienced 1,293 earthquakes. This was similar to the number of earthquakes recorded during 2003 (1,002), but about half the number recorded during 2002 (2,375). During April 2004, almost 400 small-magnitude earthquakes (0–2.7) occurred over a three-day period near the Lake area. Sediments underlying the Lake area caused residents and park visitors to feel the

earthquakes more strongly than people in other areas of Yellowstone. Numerous small earthquakes that occur over a limited area and time (such as in this case) are known as a swarm. Past earthquake swarms have been recorded during 1977, November 1985, July 1995, and 1999. The April 2004 swarm was less intense than the 1985 and 1995 earthquake swarms. More information about earthquake swarms is available at <<http://volcanoes.usgs.gov/yvo/2004/Apr04Swarm.html>>.

July 18 landslides. On the evening of July 18, 2004, intense precipitation triggered numerous landslides and generated rills (small brooks) throughout Yellowstone National Park. According to the National Weather Service at Riverton, Wyoming, several rounds of storms with locally heavy rainfall moved through eastern portions of the park between 3:00 PM and 10:00 PM. Local rain gauges



Locations of Yellowstone-area earthquakes in 2004.

reported rainfall rates from one-half inch to almost two inches per hour between 5:00 PM and 7:00 PM. The precipitation triggered significant landslides in the Mammoth area, Lamar Valley, Thorofare, and along the East Entrance Road. The media and press focused attention on the dramatic landslides that stranded visitors along the East Entrance Road, where 16 people were rescued from one of the massive debris flows. Fortunately, no one was injured by these powerful geologic events.

While conducting a survey in the park's Trident region, Yellowstone National Park's ornithologist noticed the toe of a major debris flow on July 27, and reported it to the park's geologists. The ornithologist estimated that the debris flow had moved at least one-half mile down an unnamed creek. The photograph and UTM coordinates were taken at the intersection of the creek and the Thorofare Trail. Other unmapped landslides resulting from the precipitation of July 18 probably occurred within Yellowstone.

U.S. Geological Survey gauging stations on the Gardner and Lamar rivers clearly showed a rise in discharge from the locally intense precipitation, and provided valuable hydrologic information for this event to the Geology Program, Yellowstone's geothermal monitoring efforts, and other Yellowstone programs.

Potential eruption of the Yellowstone caldera. During 2004, the media and general public were still concerned about the possibility of a catastrophic eruption of the Yellowstone caldera. Geologic mapping of Yellowstone Lake, the ever-changing thermal activity at Norris Geyser Basin, and the April 2004 earthquake swarm spurred speculation about a cataclysmic eruption. However, monitoring data do not support the hypothesis that a large volcanic eruption is imminent. Yellowstone National Park geologists, U.S. Geological Survey personnel, and University of Utah scientists continue to monitor Yellowstone's volcanic hazards and share their information with the media, general public, resource managers, and other researchers.



On July 18, intense precipitation triggered numerous landslides, such as this one found in the park's Trident region.

Turbidity in Middle Creek. Yellowstone National Park geologists, U.S. Geological Survey geologists, and East Entrance rangers sampled and monitored waters in Middle Creek during August and September, in response to reports that the creek was running milky white, rather than clear or chocolate brown. The flow of turbid, milky-white water decreased during the month of September. The source of the white sediments is being investigated.

Yellowstone's Geothermal Monitoring Program

Chloride flux. With more than 30 years of data, the chloride flux portion of the geothermal monitoring program provides continuous as well as baseline data for protecting Yellowstone's hydrothermal features during 2004. Chloride flux and real-time streamflow data are available online at the Yellowstone Volcano Observatory's website, <<http://volcanoes.usgs.gov/yvo/>>, and the U.S. Geological Survey, Water Resources Discipline, Montana District's website, <<http://mt.water.usgs.gov/index.html>>.

New Tantalus Creek gauging station. Discharge information is essential for estimating the chloride flux of a single geyser basin such as Norris Geyser Basin, as well as the chloride flux of the entire park. A newly installed U.S. Geological Survey gauging station on Tantalus Creek provided more accurate

estimates of discharges for Norris Geyser Basin and documented geyser eruptions. After its installation in May 2004, the Tantalus Creek gauge captured the pulsing temperature and discharge associated with eruptions of Echinus Geyser. Before the September 2004 thermal disturbance, Echinus's pulse as recorded on the Tantalus Creek gauge was irregular. After the September disturbance, Echinus's pulse was shown as a regular, three-hour, 30-minute spike in temperature and discharge on the gauge station's graph. This increased precision in estimating discharge of thermal waters for Norris Geyser Basin improved the park's ability to protect thermal features from anthropogenic changes and to monitor changes in geologic processes.

Electronic temperature loggers. Electronic tem-

perature loggers continued to record temperature data for selected features within Norris Geyser Basin and at the Beryl Spring bridge. The temperature loggers recorded two thermal disturbances within Norris Geyser Basin during 2004.

Electronic database and catalog of geyser eruptions. During 2004, Ralph Taylor, President of the Geyser Observation and Study Association (GOSA) and Yellowstone Center for Resources volunteer extraordinaire, deployed, maintained, and analyzed thermal loggers until late September. The thermal loggers allowed Ralph to predict eruptions of selected geysers for park interpreters and visitors. After September, park geologists took over Ralph's data-downloading tasks, and will continue this work until Ralph Taylor returns in summer 2005. This

Excerpts from Ralph Taylor's 2004 Report

At various times in 2004, recorders monitored 42 different features. As of September 30, there were 10 loggers on Geyser Hill, 13 in the rest of the Upper Geyser Basin, two at Black Sand Basin, one at Midway Geyser Basin, five in the Lower Geyser Basin, one at Norris Geyser Basin, two at West Thumb Geyser Basin, and two at Potts Hot Spring Basin. Summary statistics for most of the geyser data have been posted on the GOSA website, <www.geyserstudy.org>.

We have recorded a large amount of data over the past few years, and are getting a much better record of geyser activity year-round. Although loggers are lost to animal activity and to damage from the elements each year, the total number of loggers is increasing, and with the combined efforts of myself in the summer months and park geologist Henry Heasler and his staff in the winter, we are widening our coverage.

Echinus Geyser. Due to technical and other difficulties, the 2004 data record on Echinus exists only from January 1–February 10, and from April 17–September 30. From January 1–February 10, there were

34 eruption intervals, ranging from 7 hours, 12 minutes to 86 hours, 6 minutes, with a median of 13 hours, 46 minutes, and a mean of 29 hours. Between eruptions, the temperature record showed steady overflow. The eruptions during this period were not uniformly distributed. Eruptions were relatively frequent (8–12-hour intervals) at the beginning and end of January and into early February, and less frequent throughout mid-January (January 4–29).

When logging resumed in April, Echinus was settling into a pattern of very long intervals, often two days or so, with periods of more frequent eruptions in between the long intervals. The shorter intervals during the active interludes were typically in the 4–5 hour range. This pattern continued until a disturbance on September 16. At that time, and until the end of the data on September 30, eruptions occurred quite regularly, about every 3 hours, 30 minutes. Unfortunately, we have no further data, and the logger is currently missing.

Old Faithful Geyser. Old Faithful was, well, faithful in 2004. The trend line for intervals was nearly

flat; the mean intervals increased by well under a minute over the year. The peak of the interval distribution occurred between 92 and 93 minutes, accounting for 6.5% of all intervals.

For the year, there were 5,737 intervals, ranging from 47 minutes to 2 hours, 5 minutes, with a mean of 1 hour, 31 minutes, 40 seconds, and a median of 1 hour, 32 minutes. There were just 118 "short" intervals (less than 1 hour, 15 minutes), or 2.06% of all intervals. Just seven intervals were under one hour, and two were over two hours. 95.8% of all intervals were between 1 hour, 20 minutes and 1 hour, 49 minutes.

The intervals have remained essentially constant since January 2003. For the past two years, short intervals have tended to occur in groups, with multiple-day stretches with no short intervals at all. At the end of 2004, starting around December 27, Old Faithful's daily median intervals began a slight increase, amounting to about four minutes. This trend persisted until about January 20, when the daily median intervals dropped back to the 92-minute range.

data collection effort is important because it shows how selected geysers vary with seasonal changes. In addition to his work with thermal loggers, Ralph and fellow volunteer Dick Powell (research affiliate with the Indiana Geological Survey) cleaned thermal features, interacted with visitors, maintained a catalog of thermal data, escorted researchers, monitored Potts Hot Spring Basin, consulted on geyser activity, and maintained an impressive log of yearly activities.

Remote sensing. The primary goal of the remote sensing component of Yellowstone's geothermal monitoring program is to provide resource managers and park staff with timely, parkwide maps of annual changes in thermal features or thermal energy. Ongoing partnerships and collaboration with academic institutions and government agencies improve the ability of park staff to monitor and protect geothermal resources, and to recognize changes in thermal features or energy. For example, Colin Hardy (University of Montana and U.S. Forest Service Fire Lab) generated a 3–5-micron thermal, nighttime, infrared mosaic of Norris Geyser Basin showing the influence of major north, northeast, and northwest-trending fractures on the flow of thermal water. This thermal imagery was one criterion used for re-routing the Back Basin Trail. Similar thermal mapping efforts will assist geology staff in other areas as well.

Hydrology. Groundwater in Yellowstone National Park is found in a diverse variety of aquifers: shallow alluvial, glacial, and shallow volcanic. These aquifers are loosely grouped and referred to as "cold water" aquifers. High-temperature geothermal fluids associated with magma bodies beneath and near the Yellowstone caldera are the other major component of the park's groundwater system. Waters from the "cold" aquifers are part of the hydrothermal flow system which is heated and discharged in geothermal features throughout Yellowstone Park; the heated water may also mix with cold water locally. In order to understand short-term cyclical, catastrophic changes as well as long-term natural or anthropogenic changes to the Yellowstone geothermal system, both cold groundwater and geothermal systems must be monitored and assessed. During 2004, geology personnel deployed and analyzed data from electronic temperature loggers and began to monitor "cold" shallow aquifers at selected locations.

Paleontology

With the support of YCR's branches of natural and cultural resources, Yellowstone's paleontology program continued to develop information on the park's fossil resources throughout 2004. Although staffing and funds were not available to conduct inventory and documentation of new fossil localities, efforts were extended to complete reports for previously conducted field inventories. Elaine Hale successfully packed and moved the paleontology files, as well as fossil specimens under analysis for identification prior to museum accessioning, to the new Heritage and Research Center.

Move to the Heritage and Research Center. Due to the need to house administrative support operations during the repair and stabilization of the Mammoth administrative building, the combined geology and paleontology laboratory in the basement of the Heritage and Research Center (HRC) is temporarily being occupied by winter use staff. In the meantime, the paleontological resource library, site files, administrative files, and microscope station are being stored in an alternative HRC location. The collected fossil specimens awaiting analysis and identification are stored in the artifact room of the archeology laboratory.

Information on more than 30 previously undocumented fossil sites is now on file, with 20 of the sites documented to National Park Service (NPS) standards. For these sites, Paleontology Locality Forms have been completed, and photographs, maps, and a small, representative sample of the fossils have been assembled. There is sufficient information for Fossil Locality Forms to be completed for an additional 5–10 sites without further field investigations. Although these efforts have documented less than 1% of the fossil sites known to exist in Yellowstone's extensive fossil forests and Paleozoic, Mesozoic, and Cenozoic fossiliferous exposures, they do represent a measurable start from which future strategic planning goals can be developed.

In 2004, the paleontological research library acquired 27 volumes of the *Treatise on Invertebrate Paleontology*, of which 31 volumes are currently in print. The library also acquired the 1,400-page, two-volume *Encyclopedia of Paleontology, Vertebrate Paleontology and Evolution, Paleobotany and the Evolution of Plants*, and *Palaeobiology II*. These acquisitions will enable YCR and other park staff,

researchers, museum staff, visiting experts, and others working with Yellowstone's fossil collections to accurately identify collected fossils in-house, at the HRC.

Trilobite Point paleontological resource survey. Dr. Ellis L. Yochelson, Research Associate with the Department of Paleobiology, National Museum of Natural History (NMNH) in Washington, D.C., completed laboratory analysis of fossil-bearing slabs of rock collected from the Pilgrim Limestone outcrops on Trilobite Point. The matrix stone was dissolved in a solution of acetic acid, resulting in the recovery of silicified brachiopods identified by Dr. J. Thomas Dutro, Jr., Research Associate with the NMNH, as *Billingsella perfecta*, a species first described in 1936 at Teton Pass, Wyoming. With incorporation of this information, the survey report was completed.

The Trilobite Point project, funded by the Jane Smith Turner Foundation, through the Yellowstone Park Foundation, successfully located and documented nine previously unidentified fossil-bearing sites on Trilobite Point of Mount Holmes. Numerous species of invertebrate fossils were collected, identified, and accessioned into the park's museum collection, including Agnostid, Ptycoferia, and Crepicephalus trilobites, numerous brachiopods of various sizes, Crinoids (a fern-like plant), Hyoliths (a cone-like shell possessing one of the earliest evolved mechanisms, called an operculum, used for closing off the interior of the shell), fossil hash (concentrations of skeletal parts of organisms), and various trace fossils of worm and feeding burrows. The report documents the survey process, provides specific fossil site information, and discusses the Middle Cambrian exposures (540–520 million years ago) on Mount Holmes. The report, *Trilobite Point Paleontological Resource Survey Report*, by Elaine Skinner Hale and Julia Fitzke, contains protected information and therefore is not available to the public, but copies have been placed in the park archives and the NPS Technical Information Center for future

management needs and paleontological research.

Mount Everts stratigraphy study. The purpose of this study was to acquire a better understanding of the stratigraphy, paleontology, and depositional environments of the Mount Everts area during the Cretaceous Period (140–70 million years before present.) Highlights of the collaborative research conducted by paleontologists and geologists with the U.S. Geological Survey, Montana Bureau of Mines and Geology, and Yellowstone National Park included: 1) the occurrence of Bear River fauna in rocks identified as Muddy Sandstone at Mount Everts, indicating that the Muddy Sandstone of Mount Everts is chronostratigraphically equivalent



The Mount Everts stratigraphy study revealed this fossilized fish scale from the Mowry Shale. Fish scales like these are fairly common, but are informative as to environment (marine) and sometimes even species.

(occurs at the same geologic time, in the same stratigraphic layers) to the Bear River Formation of southwestern Montana; 2) the lower part of the Mowry Shale on Mount Everts consists of pastel-colored bentonitic mudstone that is lithostratigraphically equivalent to the lower Mowry beds in south-central Montana and the Vaughn Member of the Blackleaf Formation in southwestern Montana; 3) the lower

sandstone–shale unit of the Frontier Formation on Mount Everts yielded middle Cenomanian (94–97 million years ago) palynomorphs (pollens), whereas the upper glauconitic unit is dated by megafossils as Turonian (91–88 million years ago); 4) several samples of the Everts Formation collected on Mount Everts yielded fossil pollen and spores indicative of a non-marine depositional environment. Based on the pollen species present, the age of the formation can be no other than Coniacian (88.5–87.5 million years ago); and 5) fossil pollen and spores were also found in the Landslide Creek Formation, indicating a Campanian (84–74 million years ago) date, or younger.

The preliminary results of field investigations were presented in poster format, titled *Multidisciplinary Assessment of Cretaceous Rocks at Mount Everts, Yellowstone National Park and Surrounding Area, Wyoming and Montana*, by E.S. Hale, W.A. Cobban, T.S. Dyman, J.L. Fitzke, D.J. Nichols, K.W. Porter, and K.I. Takahashi, at the Denver 2004 Geologic Society of America conference.

The final results of the Mount Everts multidisciplinary stratigraphic study, when published, will provide an updated interpretation of the region's geologic history, as well as specimens for museum and roadside interpretive sites, and will help guide park management decisions, especially during reconstruction of the roadway through the area. The study also identifies areas of continuing interest to geologists and paleontologists focused on the Cretaceous Western Interior Seaway, on the edge of which Mount Evert rose.

East Entrance Road paleontological survey. *Park Paleontology* 8(2), published in fall 2004, featured an article discussing the results of the 2002 survey to locate fossil sites within the area of impact of the Sylvan Pass-to-East Entrance road reconstruction. "Planned Widening of East Entrance Road Reveals Important Geological Resources," by Marc S. Hendrix, Professor of Geology at the University of Montana, identified an area where the current road alignment cut a cross-section through an ancient, now-extinct volcano. The volcano, centered near Hoyt Peak about one mile north of Sylvan Pass, was active about 45 million years ago, during the Eocene Epoch. It is possible that the road reconstruction will better expose the volcanic flow, providing an

opportunity to develop interpretation. The debris flow extends outside the park in the impressive cliffs, canyons, and mountainsides seen on the road to Cody, Wyoming. Careful study of the flow revealed casts of fossil wood from forests that colonized the sides of the volcano before it erupted. The inventory report also provided protocols for recovery and identification of any fossils impacted by the current road reconstruction activities.

Collaboration. Yellowstone's paleontological program continued to benefit from its relationships with the U.S. Geological Survey in Denver, Colorado, the Smithsonian Institution and its National Museum of Natural History, the Montana Bureau of Mines and Geology, the University of Montana Department of Geology (through the Cooperative Ecosystem Studies Unit), the Yellowstone Gateway Museum of Park County, Montana, the Yellowstone Park Foundation, and the Paleontology Program of the NPS Geologic Resources Division.

Partnerships

Montana Compact and Technical Oversight Committee. The cooperative agreement with the State of Montana for the administration of the water rights in the controlled groundwater area continued in 2004. Yellowstone National Park geologist Hank Heasler and members of the National Park Service's Water Resources Division reviewed groundwater use applications for the controlled groundwater area north of Yellowstone. Members of the Technical Oversight Committee provided comments about Yellowstone's geothermal monitoring plan. Remote sensing is an important component of efficient monitoring of all Yellowstone's geothermal features; to this end, funding is being pursued to implement a comprehensive geothermal monitoring plan for Yellowstone.

University of Montana and U.S. Department of Agriculture Fire Sciences Laboratory. During 2004, Colin Hardy completed a georectified, calibrated thermal mosaic of the Norris-to-Mammoth corridor from Norris Geyser Basin to Roaring Mountain. Park geologists and resource managers used the airborne, 3–5-micron, nighttime mosaic for placing a new boardwalk within the Back Basin of Norris and planning for the Norris-to-Mammoth road segment. Colin Hardy continues to work on a

thermal inertia map for the same area. Thermal inertia maps, constructed from daytime and nighttime thermal images of the same area, will provide useful information on sediments and rocks.

Yellowstone Volcano Observatory. The Yellowstone Volcano Observatory website, <<http://volcanoes.usgs.gov/yvo/>>, provided real-time and non-real-time data to scientists, interested Yellowstone visitors, and the general public. The Yellowstone Volcano Observatory is a partnership of three entities: Yellowstone National Park, the U.S. Geological Survey, and the University of Utah. Real-time data included the following: live seismograms, an earthquake catalog of the Yellowstone area, GPS station velocities, stream discharge and temperature at Tantalus Creek, streamflow for several major rivers in Yellowstone, and temperature logs for Steamboat Geyser. Non-real-time data included leveling surveys.

Dr. Jake Lowenstern, Scientist-in-Charge of the Yellowstone Volcano Observatory, assisted park operations by lecturing at the parkwide interpreter training session held in May, by answering many inquiries concerning geologic activity in Yellowstone, and by conducting a reconnaissance of gases emanating from the Yellowstone volcano. Gases were measured at Mammoth, Tower, and Norris.

Support of Park Operations

Geology personnel assisted with ongoing projects, provided training, and responded to requests from all park divisions.

Artist Point erosion. Yellowstone National Park landscape architects and geologists discussed the potential causes of and possible solutions to erosion near Artist Point. Currently, water drains along the road from the Uncle Tom's Trail to Artist Point. At Artist Point, the water is channeled to a single drain; this encourages erosion along the edges of the asphalt walkway. Restoration of wetlands to catch water rather than channel it could enhance visitor experience and decrease erosion at Artist Point.

Canyon Visitor Center. Geology staff continued discussions with Interpretation staff about exhibits for the new Canyon Visitor Center.

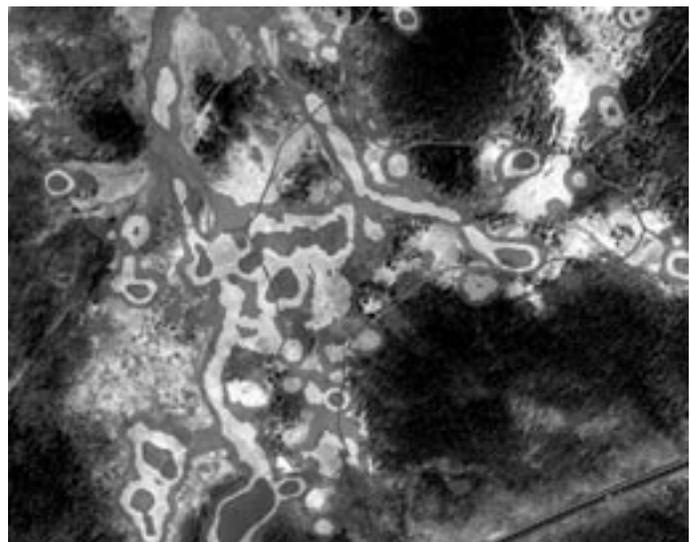
East Entrance Road construction. Geology personnel discussed the geology and geologic hazards of the East Entrance Road with land-

scape architects and Federal Highway Administration engineers. Oversteepening slopes and culvert size were major areas of concern.

Hydrothermal resource damage at Orange Spring Mound and Artesia Geyser. Geology staff documented resource damage to Orange Spring Mound in the Mammoth area, and at Artesia Geyser on the Firehole Lake Drive. At Orange Spring Mound, visitors chipped and removed travertine. Outraged witnesses contacted law enforcement rangers. At Artesia, a visitor who decided to walk off the boardwalk broke through the thin sinter. The visitor received thermal burns to both legs and was cited by law enforcement rangers.

Thermal activity affecting boardwalks and trails. At Norris Geyser Basin, ground temperatures, hollow ground, and hot, acidic mud continued to affect a segment of the Back Basin Trail near the Son of Green Dragon thermal feature. During spring 2004, a resource team met to discuss the re-route of the portion of the Back Basin Trail. Colin Hardy's nighttime, thermal, infrared image was one criterion used to re-route the Back Basin Trail around Porkchop Geyser. The newly constructed Back Basin boardwalk protects the thermal features and provides new, safe views of Porkchop Geyser for all park visitors.

At Mammoth, Canary Springs continued to grow new terraces, now unhindered by boardwalks. The removal of boardwalks restricting the flow of thermal water, and construction of new boardwalks,



Nighttime, thermal, infrared image was one criterion used to re-route the Back Basin Trail at Norris Geyser Basin.

allowed natural processes to deposit calcium carbonate and provide new thermal habitat. In contrast, natural processes continued to be impeded at Palette Spring. Palette Spring also continued to threaten asphalt and impact visitor safety by spreading thermal waters and depositing minerals over the Lower Terraces Trail.

Norris wastewater treatment plant. Geology personnel measured natural fractures exposed in excavations, and monitored blasting for the Norris water and wastewater treatment plants. At both sites, fractures showed similar north, northeast, and northwest trends. In the Norris parking lot, blasts were diffused through time to lessen any acoustic shock. A nearby seismic station recorded the blasts. Data from temperature loggers showed no adverse effects to the Norris thermal system.

Northeast Entrance Road. Geology staff examined the erosion occurring along the Northeast Entrance Road near Soda Butte and at the junction of the Lamar River and Soda Butte Creek. Rip-rap, a temporary solution, continued to be placed at these locations to protect the Northeast Entrance Road from river erosion.

Old Faithful Visitor Education Center. Geology personnel continued monitoring shallow groundwater flow in the area of the proposed Old Faithful Visitor Education Center. Twenty-two temperature sensors are currently deployed and gathering data. These data are being analyzed to determine the presence of shallow subsurface groundwater flow.

Vegetation

These staff are responsible for management, research, and monitoring of rare plants, plant inventories and monitoring, vegetation studies, and integrated pest management.

Herbarium

Park personnel and outside researchers continued to use the herbarium extensively, especially during the summer months, until its move to the new Yellowstone Heritage and Research Center (HRC) in August. Lichen and bryophyte specimens collected during vegetation mapping in the 1970s were finally sorted; multiple species found in single collecting bags were separated into appropriate specimens. Labels were produced, and some of the specimens

were identified. During the 2004 field season, 175 vascular plant specimens were collected for mounting and cataloging into the herbarium, and added to the approximately 8,000 specimens of vascular and non-vascular plants that are currently identified, mounted, and cataloged into ANCS+. These new specimens, which document both native flora in under-collected portions of Yellowstone and the arrival and spread of exotic species, were needed to strengthen the collection.

The move to the HRC was accomplished in a whirlwind of three days in August. The move was efficient, and no significant damage occurred to the herbarium collection. Prior to the move, it was extremely difficult to process and prepare additional specimens for the vascular plant collection. Now, with increased space and the addition of herbarium cabinets that have long been in storage, the herbarium will be efficient. Specimens will be properly stored at various stages of the lengthy process between initial pressing and completed mounting with entry into ANCS+, making it possible to start reducing the backlog of unprocessed vascular plant specimens that now numbers over 3,000.

Rare Plants

Yellowstone sand verbena. Yellowstone sand verbena, [*Abronia ammophila* Greene], is an endemic species of Yellowstone National Park that occurs only at four sites along the shoreline of Yellowstone Lake. One of these sites harbors 96% of the plants, which puts the entire species at risk from a single random event. The need to gather information about the basic biology of this species is paramount to ensuring its continued survival. Because the total number of individuals is very low, one of the concerns associated with managing this unique plant is whether sand verbena is dependent on or limited by the presence (or absence) of pollinators. A research project funded by Canon U.S.A., Inc.'s *Eyes on Yellowstone*, with a matching grant from the National Fish and Wildlife Foundation Native Plant Conservation Initiative, enabled the park to contract with Dr. Sedonia Sipes, Assistant Professor, Department of Plant Biology, Southern Illinois University at Carbondale, to research the breeding system of Yellowstone sand verbena. During the summers of 2003 and 2004, a combination of observational data and hand-pollination

experiments were performed to determine if *A. ammophila* has an autogamous, outcrossing, or mixed breeding system. These investigations were also designed to identify the pollinators and their relative importance in regard to reproduction, and to provide information about seed production.

Data collected during the study revealed that while the stigmas are receptive for the three average days of anthesis, the pollen is viable nearly exclusively on the first day. Fortuitously, and in contrast to other members of the genus that appear to need cross-pollination for successful reproduction, Yellowstone sand verbena was found to exhibit a mixed-mating system, characterized by the ability to both cross-pollinate and self-pollinate. Seed set was extremely high per inflorescence, and coupled with the unusually long blooming season (mid-June to early September), suggested that seed production is not currently a limiting factor for the species. There was variation in the reproductive output of different plants due to microsite differences between individuals. The number of pollinators was low, but apparently adequate. Pollinators were comprised primarily of noctuid and sphingid moths, but butterflies and bumblebees may also be important contributors. Even though these plants can self-pollinate, pollinators are still important; their absence could lead to inbreeding, or depression in other life stages, such as depressed germination, growth, survival, or future reproduction.

Ross' bentgrass. Ross' bentgrass [*Agrostis rossiae* Vasey] is a Yellowstone National Park endemic only known to occur in some of the park's geyser basins. This summer, a trip to Shoshone Geyser Basin included an investigation of the status of Ross' bentgrass at this location. Previously, there was a social trail from Bubbling Beach through the main part of the population in the geyser basin. This trail was re-routed five years ago, both for safety reasons and to lessen the impacts on this rare grass. The re-route is working well, and Ross' bentgrass has recolonized one area of the old social trail.

Northern adder's-tongue. Another goal of the trip to Shoshone Geyser Basin was to re-locate

northern adder's-tongue [*Ophioglossum pusillum* Raf.]. In 1985, a group of botanists located northern adder's-tongue somewhere near the Shoshone Geyser Basin.

In subsequent years, various botanists failed to relocate the population. The labels on the specimens from 1985 were very general, so it was possible that they could have been anywhere along Shoshone Creek near the geyser basin. Two of the three botanists who were on the 1985 trip were questioned about exactly where they had seen this rare fern, but neither could remember any specifics or whether the species was within the area of the Shoshone Geyser Basin proper. The plants are easily



Northern adder's-tongue, a rare, diminutive fern found in one of Yellowstone's thermally-influenced wetlands.

overlooked, because the entire above-ground portion can be only one or two inches high, with one simple, inconspicuous frond. Over the course of two days, the original collection site was rediscovered. This population was in a small, thermally influenced wetland site within the geyser basin. The ferns were present in a small area of about 10 feet by 20 feet. Because there can be more than one frond from the roots, estimating the size of the population is difficult. However, there were approximately 100–200 separate fronds.

This site is the only known location where this diminutive fern occurs in the state of Wyoming. Northern adder's-tongue is found in the northeastern U.S. and adjacent Canada, and then is disjunct to

the Pacific Northwest and adjacent British Columbia. The distribution of this particular species is primarily north of the southern boundary of the Wisconsin glaciation. Adder's-tongues are noteworthy for having the highest known chromosome numbers of any vascular plants. Numbers as high as $2n = 1,200$ have been reported in the genus, with the chromosome number for *Ophioglossum pusillum* being $2n = 960$. The site is in an area unlikely to be disturbed by either trail construction or maintenance, or inadvertently by visitors.

Rare plant surveys.

Summer fieldwork concentrated on work associated with Federal Highway Administration projects. The final portions of the rare plant survey for the Norris-to-Golden Gate road reconstruction were completed. Rare plant sites that were potentially vulnerable during various stages of road construction were visited when advantageous or necessary. Park landscape architects continued to develop a revegetation plan for the section of Gibbon Canyon where the Grand Loop Road will be removed from the river corridor, necessitating numerous meetings with appropriate staff. Because there are several rare plants in the vicinity, the plans will include specific recommendations in regard to species of special concern such as warm springs spikerush [*Eleocharis flavescens* (Poiret) Urban var. *thermalis* (Rydb.) Cronq.].

Additional fieldwork involved rare plant surveys associated with various construction projects throughout the park. Frontcountry construction sites investigated for rare plants included the expansion/upgrade of the Madison Wastewater Treatment Plant; minor reconstruction at the Mammoth, Slough Creek, Pebble Creek, and Indian Creek campgrounds; vista clearing at Grant Village; possible trail routes to create a connection from the road to the railroad grade west of Gardiner, Montana; and various re-routes of the boardwalks in the Back Basin at Norris and around the Mammoth Terraces. Other surveys

initiated for ground-disturbing activities included major backcountry bridge reconstruction on the trail immediately south of Shoshone Geyser Basin. Staff investigated the current social trail to Pocket Lake, and a possible re-directed route; surveyed the backcountry trail south of Lone Star Geyser; granted clearance for areas of road erosion near Pumice Point necessitating rip-rap; checked various areas where outside researchers' studies were likely to result in ground disturbance; surveyed for the



This site within Shoshone Geyser Basin is the only known location where northern adder's tongue occurs in the state of Wyoming.

expansion of the Tantalus Creek weir site at Norris Geyser Basin; cleared the route for buried cable and the location of additional equipment at the Parker Peak SNOTEL site; surveyed Lewis Lake Divide and Thumb Divide SNOTEL sites; surveyed the location for the new vault toilet near Pumice Point; and surveyed the immediate areas around South Riverside backcountry cabin, the Bechler Ranger Station, and the Canyon, South Entrance, and West Entrance developments for the wildland-urban interface fuel reduction program. The Heart Lake and Thorofare cabins had already been cleared for rare plants.

The summer field season resulted in documentation of 84 additional sites into the rare plant GIS layer of "species of special concern," or rare plants in Yellowstone National Park.

Plant Inventories

The servicewide Inventory and Monitoring (I&M) initiative calls for documenting at least 90% of the vascular plant species in each park involved in the program. The current knowledge of Yellowstone's flora is within that goal; the region in the park most likely to harbor species previously unknown in the park is the alpine zone, especially in the Gallatin Mountains. The Gallatin Mountains Alpine Plant Survey was initiated in summer 2003, and continued during the 2004 field season. The target area this summer was the southern portion of the range, in the vicinity of Trilobite Point. With the help of backcountry ranger Brian Helms and Corrals Operations staff, the field crew camped near Trilobite Lake for five days, carrying out investigations in several different directions, including to the summit of Trilobite Point. The field crew included members of the Vegetation Unit, Geologist Cheryl Jaworowski, and Elizabeth Crowe from the Greater Yellowstone Network I&M staff in Bozeman, Montana. No previously unreported species were located, but this summer's fieldwork did confirm the presence of two taxa that had been previously reported to occur in the park. Pendant-pod crazyweed [*Oxytropis deflexa* (Pallas) DC. var. *sericea* T. & G.] is often encountered at lower elevations in the park, but the higher elevation variety [*Oxytropis deflexa* (Pallas) DC. var. *foliolosa* (Hook.) Barneby] had been collected in 2001, in fruit, without any flowers. The possibility of a correct identification without the distinctive colored flower had been questioned by a reputable botanist. This collection summer confirmed that the 2001 identification was correct; two different populations of the variety of pendant-pod crazyweed [*Oxytropis deflexa* var. *foliolosa*] in flower were located in the southern Gallatin Mountains. Pine needlegrass [*Achnatherum pinetorum* (Jones) Barkw.] or [*Stipa pinetorum* Jones] had been reported to occur in the Gallatin Mountains by a field researcher in the 1980s, but there apparently was not a specimen to confirm this identification. Dry, rocky slopes in the vicinity of Trilobite Lake harbored pine needlegrass.

Only one unreported native species was located within the park this year. Vasey's rush [*Juncus vaseyi* Engelm.] was encountered during rare plant surveys in the vicinity of the Bechler Ranger Station. There were no new exotic species located within the park this year, which was extremely gratifying.

Alpine Vegetation Study

A study to characterize alpine vegetation on volcanic substrates in the northeast corner of the park continued in 2004. The work is being done by Dr. Tad Weaver of Montana State University, with graduate student Ken Aho. This is the first extensive plant ecological work to be done in the park's alpine zone of the Absaroka Mountains, and the first alpine vegetation study of any volcanic mountains in the central or northern Rockies. Weaver and Aho have quantitatively described 12 distinct alpine vegetation community types, and are studying the relation of these types to environmental qualities that influence them (e.g., water, conductivity, pH, and phosphorus) and/or are influenced by them (e.g., fine soils, organic matter, and soil nitrogen). They are also examining the importance of the volcanic substrate as a determinant of vegetation quality, by comparing alpine vegetation of the park with vegetation on nearby limestone and granite sites (i.e., sites with a similar climate on the Beartooth Plateau). In addition, they are describing the vegetation of cliffs by sampling moist, mesic, and dry sites on both limestone and volcanic substrates in the Barronette/Thunderer area. Permanent vegetation monitoring transects have been installed on nine mountains to establish a baseline from which the park can monitor potential impacts from exotic mountain goats, which are increasingly moving into and utilizing the area.

Fen Study

Summer 2004 was the first field season of a study funded by the Yellowstone Park Foundation and Canon U.S.A., Inc., to inventory and classify vegetation communities occurring in Yellowstone's fens. Fens, unusual types of wetlands, can occur in a variety of different settings, but all sites are permanently saturated to such an extent that they build up thick layers of organic soil. They are relatively rare in the central Rocky Mountains, and little was previously known about their nature and extent in Yellowstone. The study is being done by Dr. David Cooper of Colorado State University, with graduate student Joanna Lemly. By the end of the summer, 65 individual fen sites were surveyed throughout the park, and species information was collected on 242 stands of vegetation within those sites.

In addition to species data, Cooper and Lemly collected water and soil chemistry data. From each

of the surveyed sites, they recorded in-site water chemistry parameters such as pH, temperature, and electroconductivity (a measure of ion concentration in the water), and collected water samples for further lab analysis. Both the total concentration of ions and the specific ion ratios can affect which plant communities occur within a given site. Along with water samples, one or more samples of peat soil were collected from each site to measure organic content. This winter's classification analysis will focus on relating environmental variables—such as the water and soil chemistry data, climatic data, bedrock type, and proximity to geothermal features—with the vegetation community data to identify patterns relating to where certain communities occur.

Based on the initial data, Yellowstone contains a wide variety of fen types. Some sites are very nutrient-rich, with electroconductivity readings of more than 1,300 micro-Siemens (μS), and often contain high plant species diversity. These sites generally occur where groundwater moves constantly through the site, flushing minerals out of surrounding rock. Other sites have very low ion concentration ($<20 \mu\text{S}$), and can be dominated by a carpet of *Sphagnum* moss species. Some of the most interesting sites include a suite located near known geothermal areas. Though they are not fed directly by hot geothermal waters, these sites are very acidic; the lowest pH recorded was 2.73. The acidity is very likely influenced by the geothermal heating. These sites contain vascular plant species such as *Pinus contorta*, *Carex aquatilis*, *Deschampsia cespitosa*, and pillows of mosses in the genera *Polytrichum* and *Sphagnum*.

Vegetation Management and Research

Hazard tree removal. Vegetation Management Specialist Roy Renkin co-authored the draft Hazard Tree Management Plan currently under review, and performed a hazard tree evaluation in the Norris Campground, where 15 trees were uprooted and an additional 19 were broken off above ground level as a result of wind events. The evaluation revealed an additional 55 trees with significant wind-related damage or other tree defects necessitating removal. Removal was coordinated among Fire Cache, Resource Management and Visitor Protection, and Maintenance personnel. Additionally, the management specialist conducted isolated hazard tree ratings on a cottonwood tree in the Mammoth Historic

District and an eagle-roost tree along the Canyon-to-Lake road corridor, and investigated the conditions promoting a tree failure in the Canyon area that resulted in property damage. He also provided hazard tree management and removal documentation in relation to a lawsuit brought against the park for personal and property damage resulting from tree failure in August 2000. The lawsuit was settled out-of-court just prior to trial.

Inventory and monitoring. The management biologist participated in the inventory of bats in the park being conducted by personnel from The Nature Conservancy's Wyoming Natural Heritage Program. He assisted with overnight mist netting operations at the Crevice Mine and Hoodoo field sampling sites. He also served on a team of interagency personnel to develop an inventory and monitoring program to address the health of whitebark pine in the Greater Yellowstone Area (GYA). The effort required the development of a landscape-level sampling scheme and site sampling protocols to detect long-term changes in the presence and intensity of exotic white pine blister rust infection and native mountain pine beetle infestations in whitebark pine stands. During this first year of fieldwork, 45 permanent plots were established.

Fire management. The management specialist participated in the management of fires during the 2004 season, during which 26 different ignitions resulted in 194 acres burned. He provided short- and long-term fire behavior analyses for inclusion in daily shift plans, and flew daily aerial reconnaissance flights to map fire growth in support of fire behavior predictions for the Broken Ankle (25 acres) and Promontory (169 acres) fires.

He participated as a member of an interagency GYA fire management working group to develop a consistent fire/fuels mapping database for fire behavior modeling application across all units, and attended a two-day meeting to discuss and distribute the dataset to interagency fire management staff. He similarly participated as a member of the park's Fire Strategy Team to update Yellowstone's fire management plan and compile implementation plans and an environmental assessment for fuels treatments in the wildland-urban interface.

The management biologist served as an instructor for the courses S130-190 (Introduction to Fire Behavior) and S290 (Intermediate Fire Behavior)

held in the park, and successfully completed the one-week training course, S493 FARSITE fire area simulation, in Albuquerque, New Mexico. He also traveled to Glacier National Park as an invited guest to speak on the “Lessons Learned” in Yellowstone following the 1988 fire season.

Northern range issues. The management biologist completed the field sampling of 112 permanent aspen transects for analysis of tree (pith) architecture as part of a study to assess historic browse frequency and intensity in aspen. One hundred thirty-three paired core samples were collected from subject trees for determination of growth rate in relation to browse frequency/intensity while the trees were in the seedling/sapling stage. In conjunction with cooperating researchers from Oregon State University and the University of Wisconsin at Stevens Point, transects were further re-sampled to describe aspen vegetation condition in relation to wolf-elk dynamics. He attended the conference, “Managing Aspen in Western Landscapes,” held in Cedar City, Utah.

The management biologist further served as the park liaison and contracting specialist for interdisciplinary research into riparian communities on Yellowstone’s northern range. Financial and logistical support was provided for ongoing studies of willow community performance following wolf restoration (USGS Intermountain Science Support Center), development and utility of remotely-sensed imagery to map willow communities (Yellowstone Ecological Research Center), influence of hydrology and herbivory on willow community dynamics (Colorado State University), stratigraphic radiocarbon analysis of pond sediments in relation to beavers and climate change (University of New Mexico), and

secondary metabolite analysis of woody aspen tissue (Brigham Young University). Planning and logistical support were also provided for a study initiated by the University of Montana to assess potential trophic cascade interactions involving wolves, elk, and aspen.

Integrated Pest Management

As the park’s Integrated Pest Management Coordinator, the management specialist responded to 24 different pest complaints involving 10 different taxa, and provided information and/or actions to mitigate or eliminate the problem. Pest complaints were associated with small mammals (11), insects (9), and spiders (4). He compiled Pesticide Use Logs for FY03 and Pesticide Use Requests for FY04, and submitted such documentation to the Washington Office. He met with new employees from park concessioners Xanterra and Delaware North, and reviewed programmatic Integrated Pest Management Plans for concessions facilities.

Although the scheduled aerial detection survey for forest insect activity was cancelled because of inclement weather, the management biologist continued to monitor current levels of forest insect activity throughout



Spruce budworm pupa case on Douglas-fir.

the park. All of the forest insects of economic and ecologic importance have been active and increasing for at least the past five years. Spruce budworm activity in Douglas-fir, affecting about 14,000 acres in the park, was not as locally intense as in 2003, but lighter levels of activity were observed across the broad geographic area of the northern range than in 2003. Mountain pine beetle activity continued to increase dramatically in 2004, affecting approximately 18,000 acres of whitebark pine, but only

about 700 acres of lodgepole pine. Western balsam bark beetle activity also continued to increase, now affecting about 14,000 acres of high-elevation sub-alpine fir. Both the Douglas-fir beetle in Douglas-fir, affecting some 2,300 acres, and the Engelmann spruce beetle in Engelmann spruce, occupying about 8,700 acres, remained relatively stable compared to activity recorded during 2003. The management biologist cooperated with researchers from Harvard University studying the interaction between forest insect activity and fire occurrence/behavior in the park. Historic maps of forest insect activity from 1974 through 1985 were sent to Harvard for digitization and, along with fire history data, will form the basis of such analysis.

Wildlife

The Wildlife Resources Team (WRT) is an assemblage of wildlife biologists, biological technicians, administrative assistants, students, and volunteers within the Yellowstone Center for Resources. The team works to achieve the missions of the National Park Service, Yellowstone National Park, and the Yellowstone Center for Resources. These staff are responsible for management, research, and monitoring of wildlife, specifically bears, birds, bison, lynx, ungulates, and wolves.

Collaboration, Assistance, and Research

During 2004, the WRT conducted an array of wildlife monitoring, management, research, assistance, and planning activities through extensive and diverse collaboration with professionals and members of the public associated with other park divisions, federal and state agencies, tribes, and universities. The WRT engaged in interagency cooperation regarding wildlife whose life histories are trans-jurisdictional, supporting park planning efforts through successful Section 7 consultation on threatened and endangered species, bison ecology and brucellosis management, wolf recovery, sensitive bird species monitoring, grizzly bear conservation, and improving knowledge of mid-sized carnivores and sensitive and declining ungulate populations. The park's

supervisory wildlife biologist was closely involved with the following projects, among others:

- Initiated planning for a four-year ecology and management field study of wolverines. Project cooperators will include the U.S. Forest Service Rocky Mountain Research Laboratory; NPS Rocky Mountains Cooperative Ecosystem Studies Unit; the Shoshone, Bridger-Teton, and Gallatin National Forests; the Wyoming Game and Fish Department; and the Montana Department of Fish, Wildlife and Parks.
- Initiated a new collaboration between multiple stakeholders of Greater Yellowstone and Greater Serengeti, East Africa, through funding by the Department of State (USAID) to



Planning for a four-year ecology and management study of wolverines was initiated in 2004.

- one of Yellowstone's close partners: Big Sky Institute at Montana State University.
- Initiated a collaborative analysis of a 62-year park trumpeter swan population dataset with the USGS Northern Prairie Wildlife Research Center.
- Initiated brucellosis vaccination of calf and yearling bison captured at Stephens Creek as part of the Interagency Bison Management Plan. An environmental impact statement for remote vaccination of free-ranging bison inside the park was also initiated.
- Participated in the development of a Memorandum of Understanding for wolf data sharing between the NPS and the Wyoming Game and Fish Department.

- Provided service to the Division of Planning, Compliance, and Landscape Architecture to assess effects of park management activities on threatened and endangered species and other species of management concern.
- Provided service to the Interpretive Division's Formal Education Office to provide numerous wildlife-related conservation education presentations to audiences inside and outside the park.
- Continued development and implementation of the *Eyes on Yellowstone* program, an educational and research program made possible through generous funding by Canon U.S.A., Inc. The program is helping to pay for important scientific research and breaks new ground in conservation, endangered species protection, and the application of cutting-edge technology to managing park wildlife and ecosystems.
- Continued collaborative monitoring and studies of bison ecology to identify anthropogenic effects of winter use and identify bison travel corridors, effects of bison management removals on population ecology and demography, and effects of winter severity on bison movements between seasonal transboundary habitats.
- Continued collaboration with multiple federal, state, and private sector scientists to evaluate the bio-safety of the RB51 brucellosis vaccine for bison and other non-target wildlife, and to evaluate the safety, efficacy, and feasibility of remote ballistic vaccination of free-ranging bison.
- Continued collaboration with Colorado State University to improve delivery effectiveness of *Brucella* vaccine deployed in bio-bullets used for vaccinating bison. This project is studying creative ways to package live vaccine through a photopolymerization process.

Bears

Population Monitoring

Grizzly bear recovery status. Human-caused grizzly bear mortality was low inside Yellowstone

National Park in 2004. However, there was a high number of human-caused mortalities outside the park, which caused the allowable human-caused female grizzly bear mortality threshold for the Greater Yellowstone Ecosystem (GYE) to be exceeded for the first time since 1997. The grizzly bear has been listed as a threatened species under the Endangered Species Act (ESA) since 1975. The Grizzly Bear Recovery Plan sets forth three population goals that must be achieved before the grizzly bear will be considered for a status change within the Yellowstone ecosystem: 1) to have a six-year average of 15 adult females with cubs-of-the-year per year both inside the recovery zone and within a 10-mile area immediately surrounding the recovery zone; 2) to have 16 of the 18 BMUs in the recovery zone occupied by females with young from a running six-year sum of observations, with no two adjacent BMUs unoccupied; and 3) to have known human-caused mortality not exceed 4% of the minimum population estimate based on the most recent three-year sum of females with cubs minus known adult female deaths. In addition, no more than 30% of the known human-caused mortality can be females. To meet the recovery requirements, these mortality limits cannot be exceeded during any two consecutive years.

The three population goals outlined in the Grizzly Bear Recovery Plan were met in the Yellowstone ecosystem for the first time in 1994, but the mortality limits were exceeded in each of the next three years. The population goals were achieved again in 1998, and were achieved each year from 1998 through 2003. The allowable female grizzly bear mortality goal was exceeded in 2004. A Grizzly Bear Conservation Strategy that outlines how grizzly bears will be managed if and when they are de-listed has been completed and approved by all land and wildlife management agencies with jurisdiction over grizzly bear management in the GYE.

Bear sightings. There were 2,609 bear sighting reports recorded in Yellowstone National Park in 2004. These reports included 1,445 observations of grizzly bears, 981 of black bears, and 41 of unidentified species of bear. In addition, there were 101 observations of grizzly bear sign, 12 observations of black bear sign, and 30 observations of bear sign where the species could not be determined. The first observation of spring grizzly bear activity after

den emergence was recorded on March 12, west of Norris Geyser Basin. The first black bear activity of the year was observed on March 28, near Turkey Pen Peak. The last grizzly bear activity observed prior to den entrance was a grizzly scavenging a wolf-killed ungulate carcass west of Hellroaring Creek on December 12, 2004. The last black bear activity was an orphaned cub-of-the-year observed on December 22, 2004, near the lower Gardiner River Bridge between Mammoth and the town of Gardiner, Montana.

Observation flights. In 2004, as part of the Interagency Grizzly Bear Study Team grizzly bear population monitoring program, Yellowstone's Bear Management Office conducted two series of aerial observation flights over the park. During the first series of flights (17.13 observation hours) in June, 40 grizzly bears were observed in 26 groups. The mean group size was 1.5 grizzly bears per group. None of the observed grizzly bears was radio-marked. In addition, seven black bears were observed; mean group size was one black bear per group. None of the observed black bears was radio-marked. Observation rates were 2.3 grizzly bears and 0.4 black bears per flight hour. During the second series of observation flights (14.29 observation hours) in July, 56 grizzly bears were observed in 30 groups. Mean grizzly bear group size was 1.9 bears per group. Two observed grizzly bears were radio-marked. There were eight black bears observed in five groups during the second series of flights. Mean group size was 1.6 black bears per group. Observation rates were 3.9 grizzly bears and 0.6 black bears per flight hour.

Reproduction. The number of individual female grizzly bears that produce cubs are counted each year using both ground and aerial observations from qualified observers. At least 22 different individual female grizzly bears with home ranges either wholly or partially within Yellowstone National Park produced cubs in 2004. Forty-five cubs were counted with these 22 adult females. Average grizzly bear litter size in the park was 2.1 cubs per litter. There were 6 three-cub litters, 11 two-cub litters, and 5 one-cub litters. Some of these females had home ranges entirely within Yellowstone's boundaries,

while others had home ranges that overlapped the park boundary.

Bear mortalities. At least four grizzly bears and seven black bears were known to have died in Yellowstone National Park in 2004 (Table 1). On May 23, the carcass of a 15-lb. male cub-of-the-year was found on the southwest slope of Druid Peak. Canine puncture wounds indicated that the cub was killed by another predator. Canine width measurements of the puncture wounds were within the ranges that could have been inflicted by wolves, mountain lions, and small black bears. Behavioral characteristics showed that predation by wolves was the most likely cause of death, but could not be confirmed or refuted by available physical evidence. On June 7, the carcass of a female grizzly bear cub-of-the-year was found on the south ridge of Druid Peak. The carcass was very dehydrated and decomposed, indicating that the cub had been dead for several weeks. Cause of death could not be determined. On September 7, a 473-lb. adult male grizzly bear (#G80) was hit and killed by an SUV in the Fountain Flat area of the Grand Loop Road. Also on September 7, a 170-lb. subadult female grizzly (#G96) was captured in the Pebble Creek Campground and euthanized. This female had damaged property at the campground and obtained anthropogenic foods at a backcountry campsite in Lamar Valley. There may have been one additional grizzly bear mortality. On May 18, park



Researchers weigh a black bear cub at a den site on the northern range as part of a collaborative multi-carnivore habitat use study, including black bear demographics (see Appendix III).

Table 1. Known grizzly bear and black bear mortalities in Yellowstone National Park, 2004.

Type of mortality	Grizzly bear	Black bear
Known natural death	2 ^{ab}	1
Vehicle kill	1	5
Management removal (euthanized)	1	0
Accidental management death	0	1 ^c
Total	4	7

^aDoes not include the skull of a grizzly bear found near Sedge Bay on April 30, because the condition of the skull indicated that it did not die in 2004 but had probably died 10–25 years ago.

^bDoes not include possible death of grizzly bear cub by wolves on May 18, because carcass could not be found to confirm mortality and species of bear.

^cBlack bear killed during hazing operation at Slough Creek Campground. The bear was accidentally killed when a cracker shell inadvertently hit the bear and penetrated the abdomen, killing the bear.

visitors reported seeing a pack of wolves chasing a female grizzly bear with three cubs on the ridge west of Bison Peak. The visitors saw one wolf run off carrying a cub in its mouth. Bear Management Office staff investigated the area but could not find the cub carcass to confirm the mortality or species of bear involved. On April 30, the skull of a grizzly bear was found near Sedge Bay. However, the condition of the skull indicated that the bear had not died in 2004, but rather more than 10 years ago.

Five of the seven black bear mortalities were due to collisions with vehicles. On June 15, two 20-lb. black bear cubs from the same litter were struck and killed by a vehicle just north of the Sheepeater Cliffs Picnic Area. On July 1, a 111-lb. adult female black bear was hit and killed by a vehicle near Seven Mile Bridge on the Madison-to-West Entrance road. On August 16, a black bear cub-of-the-year was hit and killed by a vehicle at milepost 11 on U.S. Highway 191 in the park. On August 19, a 132-lb. adult female black bear was struck and killed by a vehicle one-half mile east of the Grebe Lake Trailhead. One black bear died in a management hazing accident. On July 18, a park ranger was attempting to haze a 183-lb. adult male black bear out of the Slough Creek Campground with cracker shells. One cracker shell inadvertently hit the bear and penetrated the abdomen, killing the bear. On December 28, the radio collar of black bear #22506 was found along the bank of Slough Creek. A large mat of bear hair was also found at the site, indicating that the bear was dead. Due to snow cover, no bones could be found (Table 1).

Bear Foods Monitoring

In 2004, the availability of high quality, con-

centrated bear foods was average during spring (den emergence through mid-May), above average during estrous (mid-May through mid-July) and early hyperphagia (mid-July through end of August), and average during late hyperphagia (September 1 through den entrance). The availability of winter-killed ungulate carcasses was average in low elevation and thermally influenced ungulate winter ranges during spring. Spring and summer 2004 were wet and rainy, which resulted in abundant vegetal foods that stayed succulent late into the summer. During estrous, the numbers of spawning cutthroat trout counted in tributary streams around Yellowstone Lake were below average. However, during this period and early hyperphagia, there was an abundance of over-wintered whitebark pine seeds available from the high whitebark pine seed production from the fall of 2003. This abundance kept bears at high elevations and away from human activities during the estrous and early hyperphagia seasons, and likely contributed to the low numbers of bear-human conflicts that occurred in the park. Biscuitroot was also abundant during the estrous and early hyperphagia seasons, and sign observed in the field indicated that bears were making extensive use of it. Yampa was abundant, and bears used its roots extensively during early and late hyperphagia. In 2004, whitebark pine seed production was significantly below average, causing bears to frequent lower elevations to dig roots during late hyperphagia.

Winter-killed ungulate carcasses. Twenty-five routes in ungulate winter range (12 low elevation, 13 thermally influenced) were surveyed to monitor the relative abundance of winter-killed ungulate carcasses available for bears to scavenge after

den emergence in spring. A total of 16 bison and 12 elk carcasses were documented along the 265.4 km of survey routes completed—an average of 0.1 carcasses/km surveyed.

Twelve routes totaling 161 km were surveyed in low elevation northern winter range. Northern range carcass transect “L” was not completed due to a closure in effect to protect wolf den sites. Two bison and three elk carcasses were observed for an average of 0.03 ungulate carcasses per km of survey route. Grizzly bear sign was observed on two of the 12 surveyed routes. Black bear sign was also observed on two of the 12 routes. Bear sign that could not be identified to species was observed on five of the 12 surveyed routes.

Eight routes totaling 72.9 km were surveyed in the thermally influenced ungulate winter range in the Firehole River area. Seven bison and eight elk carcasses were observed, for an average of 0.2 ungulate carcasses per km. Grizzly bear sign was observed along five of the eight routes. No black bear sign was observed on the Firehole River area transects. Sign of one bear that could not be identified to species was observed on one of the eight routes surveyed. Four routes totaling 24.1 km were surveyed in the thermally influenced ungulate winter range in the Norris Geyser Basin. Seven bison carcasses and one elk carcass were observed, for an average of 0.3 carcass/km of transects surveyed. Grizzly bear sign was observed along all four of the routes. No black bear sign was observed along the four routes. One route (A) totaling 7.4 km was surveyed in the thermally influenced winter range in the Heart Lake area. Two of the routes were not completed due to eight inches of fresh snow, which would have covered any carcasses along transects B and C. No carcasses were observed on Transect A (0.0 carcass/kilometer). Grizzly bear sign was observed on Transect A. No black bear sign was observed.

Overall, the numbers of ungulate carcasses recorded in 2004 were not significantly different than long-term averages on either the low elevation northern winter range or the thermally influenced winter ranges (Firehole River Area, Norris Geyser Basin,



Biological Science Technician Travis Wyman measures a grizzly bear track found during a spring survey for winter-killed ungulate carcasses.

and Heart Lake Area). The overall rate of 0.1 ungulate carcasses per km on the low-elevation northern range in 2004 was approximately equal to the long-term average of 0.2 carcasses per km recorded from 1997 to 2003. In areas of thermally influenced winter range, the overall rate of 0.21 ungulate carcasses per km recorded in 2004 did not differ significantly from the long-term average of 0.25 ungulate carcasses per km recorded from 1992 to 2003.

Spawning cutthroat trout. To monitor the availability of spawning cutthroat trout to grizzly bears, park staff conduct surveys along eight streams within or near the Lake developed area, and four streams within or near the Grant Village developed area. In addition, spawning surveys are conducted on the Trout Lake inlet to determine the potential of this stream for fishing activity by bears.

In 2004, a total of only 28 spawning cutthroat trout were counted during the peak week of the spawn on each of the 12 monitored tributaries to Yellowstone Lake. Grizzly bear activity was observed on three (25%) of these streams. No black bear activity was observed. The number of spawning cutthroat counted in each stream during the peak week in 2004 was lower than the long-term average of 59.7 (SD = 103.6) spawners counted during the peak week of the spawn from 1995 to 2003.

Cutthroat trout spawning activity began in the

Table 2. Bear-human confrontations reported in Yellowstone National Park, 2004.

Species	Bluff charge, aggressive encounter	Bear approached/followed people	Bear in backcountry campsite	Bear in developed area	Total
Grizzly	14	14	7	51	86
Black	4	1	5	77	87
Unidentified	0	0	2	5	7
Total	18	15	14	133	180

Trout Lake Inlet during the week of June 15. The last spawning cutthroat trout in the inlet were observed the last week of June. During the peak week of the spawn, 94 cutthroat trout were counted—significantly lower than the long-term average of 261.8 (SD = 149.8) spawning cutthroat trout per year recorded from 1999 to 2003. Grizzly bear sign was observed along the stream corridor the first week of June, before spawning activity began. No evidence of black bear activity was observed in the area during the surveys.

Whitebark pine cone counts. Whitebark pine seeds are an important fall food for bears due to their high fat content and potential abundance as a pre-hibernation food source. During years with low availability of natural bear foods, especially fall foods, bears often seek alternate foods in association with human activities. 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 Greater Yellowstone Ecosystem. Park staff conduct cone counts on the 10 transects located within the park. Cone counts at these 10 transects averaged 2.8 (\pm 8.3 SD) cones per tree in 2004. This was considerably less than the long-term (1987–2003) average of 14.8 (\pm 32.6 SD) cones per tree, per year for all transects located within the park.

A high level of mountain pine beetle-caused tree mortality has been observed in the whitebark pine transects in Yellowstone National Park in recent years. All 100 transect trees were alive in 2002. There was a 12% mortality (12 of 100) of transect trees between 2002 and 2003, and a 28% mortality (25 of the remaining 88) of transect trees between 2003 and 2004. Thirty-seven percent (37 of 100) of transect trees have died over the last two years

(2003–2004).

Confrontations and Conflicts with Humans

Bear-human confrontations. Confrontations are defined as incidents in which bears approach, follow, charge at, or otherwise act aggressively toward people; enter occupied backcountry campsites; or enter developments without inflicting human injury. These incidents are listed as confrontations because of the potential threat posed to human safety, even if the bears involved did not behave aggressively. Incidents of bear-inflicted human injury are listed in the bear-human conflicts section.

In 2004, there were 180 bear-human confrontations reported (Table 2). These included 18 incidents in which bears charged or acted aggressively, 14 incidents in which bears entered occupied backcountry campsites, 15 incidents in which bears approached or followed people, and 133 incidents in which bears entered developed areas (Table 2).

Bear-human conflicts. Bear-human conflicts are defined as incidents in which bears damage property, obtain anthropogenic foods, or injure people. In 2004, there were 12 bear-human conflicts reported (Table 3). These included six incidents in which bears damaged property but did not receive a food reward, four incidents in which bears obtained anthropogenic foods, and two bear-inflicted human injuries (Table 3).

Bear Management Actions

In 2004, there were 1,061 bear-related incidents in which management action was taken (Table 4), including:

- 919 incidents in which park personnel responded to roadside bear jams to provide traffic control, answer visitors' questions, and ensure that visitors did not approach or throw

Table 3. Bear-human conflicts reported in Yellowstone National Park, 2004.

Species	Property damage	Anthropogenic foods	Human injury	Total
Grizzly	1	1	2	4
Black	2	3	0	5
Unidentified	3	0	0	3
Total	6	4	2	12

food to bears;

- 99 incidents in which bears were hazed out of developed areas or away from roadsides due to concern for human safety;
- 19 incidents in which “Bear Frequenting Area” signs were posted at trailheads, campsites, or other public use areas to warn visitors of concentrated bear activity;
- 22 incidents in which trails, campsites, or other public use areas were temporarily closed to recreational activity due to safety concerns related to bear activity;
- 1 incident in which a grizzly bear that was suspected of being involved in conflicts with people was trapped and radio-marked so its behavior could be monitored; and
- 1 incident in which a grizzly bear that had damaged property and obtained anthropogenic foods was trapped and euthanized.

Grizzly bear captures/relocations/removals.

Two grizzly bears were captured in management actions in 2004. A young adult male (became bear #453) that weighed 332 lbs. was captured at the Pebble Creek Campground on May 24. Bear #453 was suspected of being involved in incidents in which tents were crushed at the Pebble Creek and Slough Creek campgrounds in 2003. Bear #453 was ear-tagged and radio-collared so its behavior could be closely monitored, then released at the capture site. Bear #453 was not known to be involved in any bear-human conflicts in Yellowstone National Park

for the rest of the summer of 2004.

On September 7, a 170-lb. subadult female grizzly bear (#G96) was captured at the Pebble Creek Campground. Bear #G96 had damaged property in the campground and obtained anthropogenic foods at a backcountry campsite in Lamar Valley. Because bear #G96 was conditioned to human foods and had aggressively entered occupied campsites, she was considered a serious threat to human safety and was chemically euthanized.

Black bear captures/relocations/removals. No black bears were captured, relocated, or removed from the park in management actions in 2004 (Table 4).

Outreach

Visitor education is a key component of the park’s bear management program. The long-term survival of bears in the Greater Yellowstone Ecosystem depends on park visitors and surrounding communities having an understanding of bears and bear management practices. As part of this goal, the Bear Management Office presented 20 bear-related educational talks, field trips, and slide shows to various groups in 2004.

To reduce the chances of bear-caused property damages and bear-inflicted human injuries, preventing bears from obtaining human foods is another important component of the park’s bear management program. As part of this program, the Bear Management Office purchased and installed

Table 4. Bear management actions in Yellowstone National Park, 2004.

Species	Bear warnings	Area closure	Bear jam management	Hazing	Management captures	Total
Grizzly	14	20	306	25	2	367
Black	2	2	611	74	0	689
Unidentified	3	0	2	0	0	5
Total	19	22	919	99	2	1,061



Park staff managed 919 bear jams in 2004.

twelve 30-cubic-foot, bear-proof food storage boxes at several backcountry locations throughout the park. Due to the large volume of food brought to the six backcountry campsites on Yellowstone Lake equipped with boat docks, the existing food storage poles were inadequate. Six food storage boxes were installed at these sites to address this need (two at Plover Point, two at Wolf Bay, and two at Eagle Bay). In addition, three food storage boxes were installed at the group sites in the Lewis Lake Campground, and one was installed at the Youth Conservation Corps group site in the South Entrance housing area. Two additional boxes were flown via helicopter to the location where Heart Lake stock site 8J2 is to be relocated. They will be installed in the new stock site next summer.

Proper food storage at remote backcountry wildland fire camps has been a challenge due to the large number of firefighters who often need to be flown in to temporary camps on short notice. In the past, the park's aluminum bear traps have been used for this purpose. However, there have been safety concerns with fire crews' entering and exiting the traps through the guillotine-style doors to retrieve their food. In addition, the traps are sometimes unavailable for use on fires as food storage devices because they are needed for trapping bears. To address this concern, Bear Management Office staff designed and had built two helicopter-transportable, lightweight aluminum, bear-proof food storage boxes for use in backcountry fire camps. Although the fire camp boxes worked

well on the ground, they tended to spin in the air when being long-lined by helicopter to the fire camps, raising safety concerns by the helicopter pilots. To address this concern, the Bear Management Office worked with helicopter pilots to design tail fins that could be attached to the boxes to stabilize them in flight, making them safer for the pilots and ground crews. Two of the Bear Management Office's portable aluminum bear traps were also modified and updated for bear and human safety purposes.

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.

In Yellowstone, a total of 18 eaglets fledged from 32 active nests during 2004. This year's low fledgling rate was primarily due to the weather, namely in the form of wet snows and strong winds that caused nest destruction or failure. While the Yellowstone bald eagle subpopulation continues to incrementally increase, territorial shifts and new nests are appearing in unexpected places. For the third year in a row, a pair of bald eagles took up residence in a tree nest 55 meters off the Madison-to-West Yellowstone road. This created quite an attraction for visitors, and kept wildlife managers and rangers busy with crowd control throughout the spring and summer. On May 14, 2004, a severe windstorm with soaking rain dislodged the top-heavy nest, causing it to fall down and forward several feet, finally landing on its side on a tree branch, dumping its contents. The two eaglets in the nest died on impact. Interestingly, the paired adults did not abandon the site, and continued to place sticks on the fallen nest throughout the remainder of the year. Nest substrate instability, as a result of the 1988 Yellowstone wildfires, coupled with

wind, continue to raise havoc with nesting pairs; over the next couple of decades, additional nest trees are expected to topple, which will undoubtedly result in further nest failure, loss of nest sites, or sudden changes in location of a nesting territory. Bald eagles have occasionally been documented taking over previously occupied osprey nests, and the incidence of takeover appears to be gradually increasing due to competition for nest sites.

Whooping crane. The whooping crane is currently classified as an endangered species. The worldwide population consists of both wild and captive populations. This endemic North American species continues to rank as the rarest and most endangered crane in the world. As of summer 2004, the wild population was 339 cranes, and the captive population was 133 cranes, for a total world population numbering 472 whooping cranes. In 2004, the U.S. Fish and Wildlife Service removed the whooping crane from the list of endangered species known or suspected to occur at Yellowstone National Park.

Species of Special Concern

Peregrine falcon. On August 26, 1999, the peregrine falcon was removed from the list of threatened and endangered species. Under provisions afforded by the Endangered Species Act, this species still needs to be monitored closely to ensure its recovery. The park continues to be a stronghold for peregrines in the northern Rockies. Three new eyries were found in 2004, bringing the total number of active peregrine eyries to 26. A total of 48 young fledged in 2004, making this the second highest number of fledged peregrine ever recorded in Yellowstone National Park. This marked the fifth year since delisting, and Yellowstone data support the contention that peregrines are on the road to recovery.

Trumpeter swan. The Yellowstone National Park resident trumpeter swan subpopulation continues to show signs of a species at risk of local imperilment. Traditionally, Montana's Centennial Valley has been a hotspot for cygnet production in the Greater

Yellowstone Area. Swan recruitment from outside Yellowstone National Park is believed to be a critical factor in maintaining the resident swan population. Historically, swans from outside the park (namely the Centennial Valley) eventually replaced swans that died in the park. However, events over the last decade have led to a reduction in breeding swan numbers, particularly outside the park. Coupled with low numbers of fledged cygnets throughout the Greater Yellowstone, this poses a serious concern.

The number of subadult/adult swans in Yellowstone National Park has declined steadily since 1961, and currently stands at only 16 individuals. This is the fourth-lowest number of adults ever recorded in the park, and represents numbers reminiscent of the early 1930s. Adult swan recruits from Montana's Paradise Valley have helped in maintain-

ing the Yellowstone swan population for the time being. Adult swan recruitment was observed for the first time in more than three years. The single adult swan at Seven Mile Bridge on the Madison River finally picked up a mate after 40 months of being alone on the territory.

There were only four swan nesting pairs in 2004, with nest attempts recently ranging from 2 to 10 per

year. In 2004, two cygnets fledged from one brood in Yellowstone National Park. This was somewhat expected, because years with drought-like conditions are usually favorable for swan production. Cygnet production has been dismal over the last 14 years, ranging from zero to five cygnets per year.

Molly Islands colonial nesting birds. The Molly Islands Colonial Nesting Bird Census was conducted in mid-May, early June, early August, and mid-September 2004. The Molly Islands consist of two small islands appropriately named Rocky Island and Sandy Island. On Rocky Island, a total of 43 American white pelicans initiated nests. Double-crested cormorants constructed 53 nests in the same area. The islands were free of flooding this year, and snow meltwater runoff was gradual, which is usually a promising sign for colonial nesting birds. California



Adult trumpeter swan recruitment was seen for the first time in more than three years in 2004.

gulls attempted 180 nests, of which 154 were successful in hatching young. Four nest attempts by Caspian terns were successful in hatching and rearing young.

On Sandy Island, a total of 210 American white pelican nests were initiated, but only 164 nests were successful in rearing 192 young. Double-crested cormorants attempted 81 nests, of which 69 nests were successful in fledging 138 young. Pelicans nested again in four distinct aggregations: two large, and two small. No Caspian terns or California gulls nested on this island this year.

In summary, 2004 was a year of surprisingly good colonial nesting bird production. Lake flooding did not occur due to the drought, which presented favorable conditions for nesting. Total production on the Molly Islands resulted in fledging 237 American white pelicans, 254 double-crested cormorants, 207 California gulls, and 3 Caspian terns.

Osprey. The Yellowstone National Park osprey population continues to show signs of natural annual variation. In 2004, only 19 young fledged from 54 nests, compared to 17 young fledging from 58 nests in 2003, and 24 young fledging from 83 nests in 2002. This represents the second-worst production ever experienced in the last 17 years of collecting detailed osprey population data. A series of strong winds throughout the summer caused many of the nests and/or nest trees to fall to the ground, resulting in high failure rates again this year. This pattern has been occurring more frequently in the last five years. Tree nest site instability and weather continue to play a major role in influencing osprey productivity in the park. Most of Frank Island, a major osprey production area on Yellowstone Lake, burned in 2003, and only one pair nested on Frank Island in 2004. The incidence of bald eagles taking over osprey nest sites was noted again this year. Monitoring the population dynamics of ospreys and other piscivorous bird species will remain important as lake trout numbers are charted over time.

Harlequin duck. The harlequin duck population in Yellowstone continues to maintain itself, and is only mildly variable from year to year, with generally 16–24 pairs residing in the park. Monitoring adults is the most effective method of keeping track of population vigor and trends.

Common loon. Yellowstone's common loon population continues to fluctuate from year to year.

There were nine nest attempts in 2004, with only three loonlets managing to reach fledgling age. Retreating water levels resulting from the continuing drought were the principal reason for the poor loon production in 2004. A total of 44 adults were found in the park in 2004. These adult numbers have reliably ranged between 34 and 51 individuals over the last 16 years.

Population Monitoring

North American Bird Migration Count. Yellowstone National Park participated in the North American Bird Migration Count for the twelfth consecutive year in 2004. This survey is designed to collect quantitative and qualitative spring bird migration information on a continental scale, and was conducted on May 8. Four observers recorded a total of 1,420 individual birds. A total of 90 species of birds were recorded during the count, including 66 species within the confines of Yellowstone National Park.

Mid-winter eagle survey. The annual mid-winter bald eagle/golden eagle survey was conducted for the eighteenth consecutive year in Yellowstone National Park and on portions of the northern range outside the park. A total of 65 eagles were counted on January 9, 2004. Of the total, 58 were identified as bald eagles, and seven were identified as golden eagles. Fifty-two of the 65 total wintering eagles were found in the Jardine/Gardiner/Mammoth area. Although eagles take advantage of carcasses exposed by wolf packs, the northern range outside Yellowstone National Park continued to be the hot-spot for wintering eagles due to carrion availability from the regular- and late-season elk hunts. Weather continues to play a major role in eagle distribution, as does prey and carrion availability.

Breeding Bird Surveys. Three Breeding Bird Surveys were conducted in 2004. These songbird data were sent to the continental database clearinghouse located at the Patuxent Wildlife Research Center in Laurel, Maryland, and is included in the information available online at <www.mp2-pwrc.usgs.gov/bbs>. Data from these surveys are used to develop population trends for North American songbirds. Yellowstone National Park Breeding Bird Surveys date back to 1982.

Glacier Boulder Route songbird survey. The Glacier Boulder songbird survey documents

birdlife found exclusively in lodgepole pine habitats in Yellowstone, and is conducted because of the importance of establishing additional baseline data for neotropical migrant landbird monitoring. The survey was conducted in 2004. The transect begins at the Glacier Boulder Trailhead near Inspiration Point. The point count census consists of 30 stations. Census protocol for this survey is similar to that of a Breeding Bird Survey. This survey first began in 1986, and only one year (2002) has been missed to date. Because traffic noise during the summer is beginning to affect Breeding Bird Survey routes, census routes are being developed away from established roads.

Christmas Bird Count.

On December 19, 2004, the Yellowstone Christmas Bird Count (YCBC) was conducted in the Gardiner, Montana, and Mammoth, Wyoming areas, marking the thirty-second year for this traditional winter bird survey. The 2004 Yellowstone Christmas Bird Count tallied a total of 35 bird species and 1,004 individual birds—the thirteenth-highest number of species (slightly above average) and twenty-fifth-highest number of individuals (slightly below average) ever recorded on count day. This year's YCBC also tied for the third-highest number of observers in the count's history. Temperatures ranged from 20–40°F, with 0–3" of snow, depending on the elevation. River edges were not frozen. No new species of wintering birds were detected. Several bird records were tied or broken during the 2004 YCBC. Tied records included: 1 prairie falcon (previous record set in 1988, 1997, 2000, and 2002); and 1 northern pygmy owl (previous records set in eight individual years). Four records were broken. New abundance records included: 5 marsh wrens (previous record was 4 in 2003); 6 gadwalls (previous record was 3 in 2003); 13 golden eagles (previous record was 12 in 1992 and 1999); and 2 white-crowned sparrows (previous record was 1 in 1991, 1992, 1994, 1998, and 2003). A grand total of 97 spe-



A record 13 golden eagles were recorded during the 2004 Yellowstone Christmas Bird Count.

cies have been recorded on the YCBC (102 species with count day and count week combined) during the 32 years the count has taken place. Experience shows that colder temperatures and above average snow depths are the optimum conditions for finding the greatest bird richness and abundance during the YCBC. Details on past Yellowstone Christmas Bird Count methods, results, and summaries can be found in the Winter 2001 and Winter 2002 issues of *Yellowstone Science*.

Birds added to the park

checklist. Two new bird species were added to the Field Checklist of Birds of Yellowstone National Park in 2004. The American Ornithologists' Union split the Canada goose into two species (Canada goose *Branta canadensis* and cackling goose *Branta hutchinsii*) as of August 2004, meaning that the cackling goose found in April 2003 by the staff ornithologist can now be included as a new species for Yellowstone National Park. On June 19, 2004, a prairie warbler (*Dendroica discolor*) was found at Stephens Creek (Montana)

by Erik Hendrickson, making this the first known record for the species in the park.

Bison

In FY04, the Bison Ecology and Management Office (BEMO) continued collaboration with partner agencies to implement the Interagency Bison Management Plan (IBMP). A field program continued to gather information for management-related decision-making and monitoring long-term ecological parameters. Progress was made in developing a remote delivery vaccination program by investigating the capabilities of currently available remote delivery equipment and developing new methods to encapsulate vaccine. A study of bison movement patterns, initiated this year, should provide information to assess the feasibility of remote vaccination and the extent to which bison use road corridors during

winter. BEMO staff conducted field studies to monitor demographic parameters such as birth rate, age-specific mortality rates, and disease prevalence.

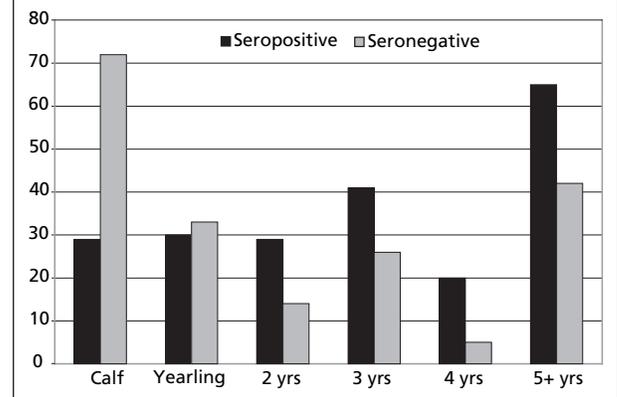
Implementation of the Interagency Bison Management Plan

Managing the risk of disease transmission. Implementation of the IBMP continued to focus on spatial and temporal separation of bison and cattle outside Yellowstone's boundaries. BEMO staff kept a record of interagency activities, and disseminated a compilation of actions accomplished in a bi-weekly report to interested park staff and partner agencies. Twenty-four bi-weekly reports were completed and distributed. Reports documented hazing activities, mortalities, and distribution and abundance of bison near boundary areas.

One hundred twenty-one hazing operations were conducted during this year: 36 at the north boundary, and 85 at the west boundary. Sixty-four percent of hazing operations along the north boundary involved the movement of groups of mixed age and gender. At the west boundary, mixed-group hazing operations accounted for 30% of all those conducted. Average size of mixed-age/gender groups was 60 (north boundary) and 46 (west boundary).

Capture operations were initiated on February 23, 2004, at the Stephens Creek capture facility. Eight capture operations resulted in 464 bison captured over four weeks. Two hundred sixty-four bison were consigned to the Montana Department of Livestock for transport to slaughterhouses in Montana. One additional bison that tested positive for brucellosis exposure died while confined in the holding facility. At the capture pen, 407 bison were tested for brucellosis. One hundred ninety-nine animals tested negative, with the younger age classes exhibiting a higher proportion of negative test results (Figure 1). All calves and yearlings (113) that were held in the Stephens Creek facility after testing negative for brucellosis were vaccinated prior to release. One adult bull (older than 4½ years) was released after testing negative; the remainder of the test-negative bison were held in a paddock at the Stephens Creek administrative area and released on April 6. The holding paddock was designed to hold approximately 200 bison. Consequently, the last group of 50 bison processed went directly to slaughter because there was no room in the holding paddock for more

Figure 1. Brucellosis serology results of all bison tested at the Stephens Creek facility, by age class.



test-negative bison.

Monitoring abundance and distribution during winter. Bison abundance and distribution in the special management zones were monitored through aerial surveys conducted approximately monthly from November through April, depending on suitable weather conditions. The area of coverage was based on the monitoring needs as described in the interagency field operating procedures (December 2002). Bison abundance peaked in the northern boundary areas in February, and in the west boundary area in April (Table 1).

Population estimates. Population surveys were conducted in February and August to monitor changes in abundance between seasons and years. Population estimates were obtained by conducting aerial counts in the areas with the highest probability of having bison found in them during the season of the year when each estimate was completed. The data were analyzed using correction models that accounted for seasonal detection rates of bison. As expected, it was more difficult to observe bison during winter, because some animals congregated in thermal areas where layers of steam and fog hide them, and where detection of dark-colored animals on a dark background can be difficult. The between-flight variation in total animals counted from the air is much greater during winter than summer (Table 2). The midsummer population estimate was 4,240 bison (Table 3). A mean count of 605 calves was observed during summer surveys.

Remote vaccination. The IBMP Record of Decision (2000) directed Yellowstone National Park to develop a safe and effective delivery system for

Table 1. Yellowstone National Park Bison Management Zone summary.

	Nov. 2003	Dec. 2003	Jan. 2004	Feb. 20, 2004	Feb. 21, 2004	April 2004
Northern Management Zone						
Outside park (Zone 2)	0	0	0	0	0	0
IBMP Zone 1	0	2	61	316	320	0
Eagle Creek/Bear Creek Area	1	7	5	130	115	33
Tower/Hellroaring/ Mammoth	448	480	659	344	374	386
Swan Lake Flat/Roaring Mountain	23	99	71	65	47	0
Total for Northern Zone	472	588	796	855	856	419
Western Management Zone						
Outside Park (Zone 2)	0	0	0	0	3	6
IBMP Zone 1	10	37	57	54	73	184
North/West of Seven Mile Bridge	122	89	4	44	19	201
Seven Mile Bridge/Madison Junction	44	55	43	66	95	232
Total for Western Zone	176	181	104	164	190	623

Table 2. Number of bison observed per flight in 2004.

Date	Adults	Calves	Total Bison
February 20	3,090	N/A*	3,090
February 21	3,569	N/A*	3,569
July 21	3,503	637	4,140
July 28	3,421	573	3,994
August 4	4,215	N/A*	4,215

* = calves not counted separately (only total bison counted)

Table 3. Population estimates based on parkwide aerial counts.

	Late winter	Summer
Population estimate	3,624	4,240
Upper 95% confidence limit	4,654	4,447
Lower 95% confidence limit	2,593	4,032

vaccinating wild, free-ranging bison throughout the park's interior. An environmental planning process for this activity was initiated this year; the appropriate vehicle for effects disclosure was determined to be an environmental impact statement (EIS). Briefings were conducted for each governor of the three surrounding states, for each congressional delegation, and for the Washington offices of the National Park Service and Department of the Interior. A Notice of Intent to prepare an EIS was published in the Federal Register on August 3, 2004. The public scoping process was conducted between August 3 and October 2, 2004.

Mary Mountain study. The seasonal migration of bison from high-elevation plateaus inside the

park to lower-elevation winter range along defined, relatively narrow corridors may facilitate remote vaccination. A trail across Mary Mountain has been identified as a significant migratory path utilized by bison traveling between winter range in the Firehole River basin and summer range in Hayden Valley. Approximately 54% of the bison population travels this route between May and July each year. As a follow-up to previous work, bison migration was observed, and mock vaccination trials were conducted on target animals defined as yearling bison to observe animal behavior in response to the noise of simulated remote delivery equipment.

BEMO staff observed migratory movements in the Mary Lake vicinity from May 11 to June 8, with

a hiatus from May 29–June 1. The first observed movement of mixed groups across Mary Mountain occurred on May 13, with 46 bison moving east. Over the course of the survey period, field staff observed a total of 334 bison comprised of 42.5% adult bulls, 39.2% adult cows, 9.6% calves, and 8.7% yearlings. Of these bison, 305 (91%) traveled east into Hayden Valley, and 29 (9%) traveled west toward Nez Perce Creek. All of the bison observed traveling west were adult bulls.



Of marked female bison, 72% were observed to be pregnant in late spring 2004. By midsummer, 54% were tending calves.

Five mixed groups of 221 bison migrated across Mary Mountain during the observation period. These groups consisted of 43 adult bulls (19% of total), 117 adult cows (53%), 32 calves (15%), and 29 yearlings (13%), with an average group size of 44.2 bison per group and a range of 7–74. When mixed groups containing yearlings moved through the pass on Mary Mountain, staff attempted to perform mock vaccinations. Twenty-nine yearlings traveled past the field staff, providing opportunities to make 26 mock vaccination attempts on 24 of these individuals. Some of the animals in this group were running either as they entered the target zone or as they left the target zone. Four (17%) target animals were not within 30 meters, and did not provide unobstructed views when entering the target zone. Two of these animals, however, were available as they exited the target zone. Sixty percent of available animals entering the target zone were walking, 20% were trotting, and 20% were running. Forty-five percent of available animals entering the target zone exhibited

an increase in gait as they moved through the target zone. In summary, 71% of all yearlings were available and walking or trotting at some point in the target zone, making vaccination attempts feasible.

Bison Demographics

Summer classification of the population. During July, two surveys each of both the central and northern subpopulations classified 5,065 total individual animals (central herd) and 1,870 individual animals (northern range).

More than 95% of all bison observed were classified (Table 4). Age structure did not differ significantly between the central (Hayden Valley) and northern range subpopulations. Calf-to-cow ratios were 44 calves per 100 cows in Hayden Valley, and 39 calves per 100 cows on the northern range. Based on aerial population counts, approximately 85% of central herd and nearly 100% of northern range bison were classified.

Pregnancy rates. Pregnancy rates are a critical population statistic that provide managers with information about the status of the population. The growth rate of the bison population has remained relatively high for many years. Seventy-four percent of known marked adult females were determined to be pregnant; one aborted pregnancy was documented, and 72% of the marked sample of females were observed with calves in late spring. However, by midsummer, only 54% of these same individuals were observed tending calves. These observations calibrate well with the data gathered through

Table 4. Summer parkwide classification results.

	Bulls			Cows			Calves	Unclassified
	3+ yrs	2 yrs	1 yr	3+ yrs	2 yrs	1 yr		
Central Herd	23.04%	6.06%	6.00%	34.51%	5.33%	5.07%	17.67%	2.31%
Northern Range	23.05%	6.69%	3.69%	37.49%	5.03%	4.39%	16.52%	3.53%

classification of the central subpopulation of bison.

Mortalities. An understanding of mortality patterns and causes provides an index for explaining ecological processes. Ninety-seven mortalities were documented (aside from those caused by management actions in Special Management Areas near the north and west boundaries) (Figure 2).

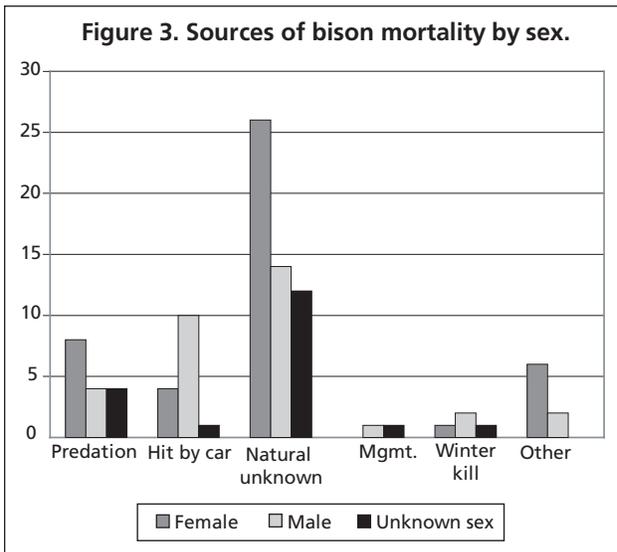
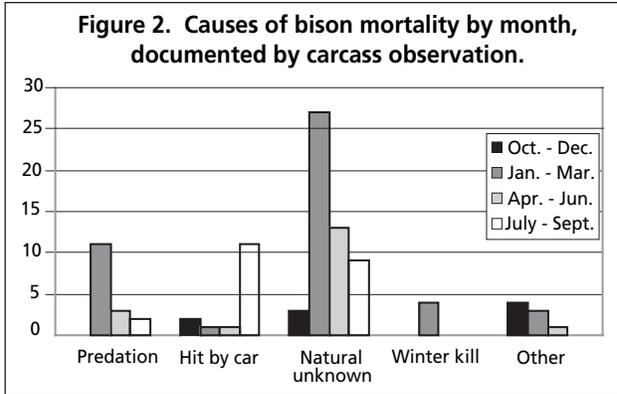
Predation and motor vehicle accidents each caused about 15% of these known bison deaths. Fifty-two carcasses were located in which evidence of cause was inconclusive. Circumstantial evidence pointed to greater numbers of mortalities resulting from predation than can be currently validated in the field. Twice as many adult females as compared to adult males die as a result of both predation and natural unknown causes (Figure 3).

Monitoring Bison Movement Patterns

During this year, 23 bison wore functioning VHF radio collars. Fifteen of those were placed on bison randomly distributed throughout the central subpopulation. Animals wearing these devices also had a Global Positioning System data recording device attached to the collar for monitoring their activities on a more frequent basis. Thirty-three percent of the bison with randomly placed transmitting units left Hayden Valley and eventually ended up on winter range near the park’s north boundary. Three of those five bison were captured and removed from the population during winter management operations. One animal died during early winter in Hayden Valley. After mid-January, all 14 remaining animals had moved out of Hayden Valley to winter ranges west of Mary Mountain. Each of the bison that survived until spring returned to Hayden Valley by mid-June. Telemetered bison also provided an opportunity to evaluate the efficacy of hazing operations at the north boundary. One animal moved far away from the Reese Creek boundary as a result of hazing operations on February 19. She moved south, was observed near Norris Geyser Basin on February 21, then returned to the Mammoth area by February 29. She was observed back at Reese Creek on March 1, and subsequently captured.

Lynx

In 2000, the Canada lynx (*Lynx canadensis*) was federally listed as a threatened species in the con-



tinuous United States. In Yellowstone, very little has been known about the distribution and ecological requirements of Canada lynx. The species historically occupied this area, but appears to have been uncommon relative to similarly sized forest carnivores such as the red fox.

Recent listing as a threatened species and lack of comprehensive survey data in the park underscored the need for basic information on Canada lynx. Inventory data are essential to avoid adverse effects from park management activities, such as road reconstruction, and to support joint conservation planning efforts among federal and state agencies. In response to the dearth of information, a parkwide survey was initiated with the objective of documenting Canada lynx presence and distribution in the park from 2001 to 2004. A final project report summarizing project methods, results, and conclusions was completed in June 2004.

The survey included three summer field

seasons, during which lynx project staff used the U.S. Forest Service (USFS) lynx detection protocol (hair snares and laboratory-based DNA extractions). Work was focused primarily on the park's east side, but occurred opportunistically in other parts of Yellowstone as well. In total, 510 samples of animal hair and other material were obtained for DNA analysis. The survey also included four winters of ski-, snowmobile-, and aircraft-based snow tracking efforts in habitats dominated by mid-aged (>50 years), mature, and old-aged stands of lodgepole pine, spruce, and subalpine fir. Over 3,000 km of widely distributed transects were searched for rare carnivore sign.

Lynx were detected in the park 10 times, including three times using DNA-based methods. Although Canada lynx persisted in the park at low density, their distribution was largely restricted to the east and possibly the Central Plateau sectors. Canada lynx were not detected in other portions of the park, but they may have occurred there as well, as the detection techniques used did not detect lynx with certainty. The distribution of detections was consistent with snow tracking data that suggested that the highest densities of snowshoe hares occurred in the east sector. This portion of the park is dominated by andesitic soils that exceed other park soils in moisture-holding capacity and nutrients. Andesitic soils better support the subalpine and Engelmann spruce forests and dense understory vegetation that provide sufficient horizontal and vertical cover for snowshoe hares.

The cumulative detections likely represented at least four individuals, including two kittens born in two different years. The presence of offspring indicated that resident, breeding individuals were present—an important finding, because Canada lynx reproduction has not been previously documented

in the park, and rarely in the Greater Yellowstone Ecosystem (GYE). As with most carnivores, reproducing Canada lynx females are typically resident, as opposed to nomadic or transient. Although detections of offspring do not confirm the presence of a viable, reproductively stable population in the park or ecosystem, they do suggest that reproduction of resident females may have contributed to population persistence.



Sarah Cobler baits a scent lure in hopes of attracting lynx to a hair snare site.

Nearly all other small, medium, and large carnivores known to occur in Yellowstone National Park were detected using a variety of methods, including wolverines in three park sectors on five total occasions. Gray wolves, grizzly bears, and black bears were routinely detected. Fishers were not detected.

The conclusion that Canada lynx persisted in the park was consistent with recent DNA-based detections by USFS personnel using hair snares, snow tracking, and animal captures—the species persists at low densities in the GYE, but appears to be limited in distribution. Of approximately 15 hair snare grids deployed by USFS and NPS units in the ecosystem from 1998 to present, Canada lynx were detected in only six grids, distributed across three portions of the ecosystem. In addition, snowtracking was completed in most USFS and NPS units, but DNA-based detections were made in only three.

The weak signal of Canada lynx presence, and its restricted distribution, point to reduced population viability of this species in the GYE. This condition is not surprising for a species living at the periphery of its continental range. Wet, boreal forests that characterize snowshoe hare and Canada lynx habitat in the U.S. Rocky Mountains, including the GYE, are highly fragmented, and support Canada lynx in lower densities than suitable habitats in Canada and Alaska.

It is recommended that this survey be repeated at 10-year intervals with the same search intensity and spatial extent as during 2000–2004. Because the numbers and distribution of Canada lynx may improve due to increases in snowshoe hare abundance that are expected from post-fire (1988) lodgepole pine regeneration, future surveys must be geographically broad. It is also recommended that snowshoe hare studies be continued to document trends in this prey's abundance, distribution, underlying demographic characteristics, and functional relationships with the Canada lynx.

Ungulates

Elk

Population trends. The estimated minimum number of elk wintering on the northern range was 11,000, based on an aerial count of 8,335 animals during December 2003, with a sightability correction factor of 1.32 to approximate the number of elk not observed during the survey. The long-term trend in counts of northern Yellowstone elk suggests that their abundance has decreased at a rate of approximately 6% per year since 1994. Moderate-to-liberal harvests of prime-aged females during the Gardiner Late Hunt and predation by wolves and other large carnivores have been the primary factors contributing to this decreasing trend. Other contributing factors include a substantial winter-kill owing to severe snow pack during 1997 and, possibly, drought-related effects on pregnancy and survival. It is expected that this decreasing trend in abundance will continue in the near future until: 1) levels of harvest by humans and/or predators decrease sufficiently; 2) there is sufficient time for recruitment of calves to prime breeding age; and 3) there is a numerical response of predators to decreased elk abundance.

A late winter elk classification flight was flown via helicopter on the northern range on March 4, 2004. A total of 3,167 elk were classified, and 12 calves and 24 bulls per 100 cows were observed. The estimated ratio of 12 calves per 100 cows is similar to the late winter ratios during 2002 and 2003 (i.e., 12–14 calves per 100 cows), but less than the range of 22–34 calves per 100 cows observed during the previous six years. Low calf-to-cow ratios in recent years suggest that recruitment into the northern range elk population

was relatively low for these cohorts. Thus, few immature female elk entered the population each year, and the population likely has less resiliency to respond with high recruitment rates during good conditions and increase at relatively high growth rates following weather- or human-induced decreases in abundance. Low recruitment in recent years was most likely due to predation and drought-related effects on maternal condition and calf survival. Sustained low recruitment in subsequent years will likely contribute to a sustained decrease in elk abundance, because estimates of off-take by predators and humans currently exceed recruitment of animals into the population.

The estimated number of non-migratory elk residing in the west-central portion of the park during spring 2004 was 261, ± 29 elk. This estimate was derived from a series of 10 daily mark/recapture experiments conducted in collaboration with biologists from Montana State University along the road system during April. This estimate is lower than the average count of 524 elk (range 440–651 elk, $n = 13$) for this population during 1965 to 1997. A ratio of approximately 2 calves per 100 cows was observed during the April surveys. Wide annual variability in recruitment (<1 –38 calves per 100 cows) has been observed in this population since 1992, owing to variations in snowpack and predation pressure.

Research and monitoring. In 1999, Yellowstone National Park initiated a broad monitoring and collaborative research program to evaluate the consequences of wolf restoration on the park ecosystem. There are four integrated components to the project: 1) wolf functional and numerical responses; 2) elk habitat selection and population demographics; 3) elk and wolf behavioral adjustments; and 4) vegetation responses to changes in elk densities. Radio telemetry is used to monitor the survival, reproduction, movements, and resource selection of elk during these studies. Since 1999, biologists have obtained more than 4,700 aerial locations and 14,000 Global Positioning System (GPS) locations from 113 adult female elk fit with radio collars that wintered on the northern range. There have been 47 deaths of radio-collared elk, including 12 elk legally harvested by hunters outside the park, 23 elk killed by predators (i.e., 17 wolves, 3 mountain lions, 2 unknown predators, 1 bear), 3 winter-killed elk, 1 calving-related death, and 8 elk that died due to unknown causes. Currently, 31 adult female elk on the northern range



The estimated minimum number of elk wintering on the northern range was 11,000 in 2004.

are equipped with functional radio collars.

Since 1991, Yellowstone National Park has partnered with Montana State University to investigate the demographics of elk in the west-central portion of the park. This investigation was expanded in scope to include predator-prey interactions when wolves established a territory in this area of the park during 1998. Ungulate demographic data collected during this effort included multiple annual population estimates, indices of annual pregnancy rates and recruitment, and estimates of survival and cause-specific mortality. To date, population distribution and individual movement databases include approximately 12,500 locations from adult female elk with radio collars, 850 wolf pack locations, 2,000 kilometers of travel vectors for wolves obtained from snow tracking, and the identification of 490 wolf kills. In conjunction with this effort, researchers from California State University-Monterey Bay initiated an ambitious study of snowpack characteristics, distribution, and dynamics two years ago. This effort has produced databases including 2,000 snow cores; 40 snowpack, temperature, and hardness profiles; and one season of continuous snowpack thermal gradient measurements from nine sites in varying terrain with co-located measurements of forest leaf area index and stem diameter. This team also completed an unprecedented inventory of geothermal features in Yellowstone using advanced remote sensing technology and classification techniques.

During May 2003, the Yellowstone Center for

Resources, U.S. Geological Survey, and University of Minnesota initiated a three-year study (FY2003–2005) of mortality in northern Yellowstone elk calves. The primary objectives of the study were to: 1) estimate the relative causes and timing of calf deaths; 2) estimate calf survival rates; and 3) evaluate factors that may predispose calves to death. During May–June 2003, a total of 51 calves ≤ 6 days old were captured and fit with ear tag transmitters. These calves were subsequently monitored on approximately a daily basis. During May 2003 through April 2004, 36 instrumented calves died (32 predation, 4 other causes), and one transmitter ceased functioning. Preliminary determinations of causes of death for instrumented calves were 19 killed by bears, 5 killed by wolves, 4 killed by coyotes, 2 killed by either wolves or bears, 1 killed by a mountain lion, 1 killed by a wolverine, 1 shot by a hunter, and 3 non-predation deaths due to unknown causes. In addition, one yearling likely succumbed to disease on July 14, 2004, near the West Thumb of Yellowstone Lake. During May–June 2004, a total of 44 calves ≤ 6 days old were captured and fit with ear tag transmitters. To date, 31 of these calves have died (29 predation, 2 other causes). Preliminary determinations of causes of death for instrumented calves were 18 killed by bears, 3 by wolves, 4 by coyotes, 1 by a golden eagle, 1 by either wolves or bears, 2 by unknown predators, and 2 non-predation deaths due to unknown causes. Blood samples collected from captured calves have been sent to various laboratories for assays of disease and nutritional condition. Monitoring of instrumented calves will continue through winter 2005, and the next capture is scheduled for May–June 2005.

Chronic Wasting Disease (CWD) was detected during winter 2004, approximately 130 miles from the southeastern boundary of Yellowstone National Park, near an area where elk that summer in the park could commingle with mule deer during winter. This disease can contribute to substantial decreases in abundance of infected deer or elk populations if left unmanaged. Thus, this disease poses an imminent, fundamental threat to elk and deer in the Greater Yellowstone Area. Ungulate staff collaborated with Montana Fish, Wildlife and Parks to test 400 northern Yellowstone elk harvested during the 2004 Gardiner Late Hunt for CWD. Lymph node samples were analyzed at the Veterinary Diagnostic

Lab at Colorado State University in Fort Collins. All tested samples were negative for CWD.

During October 2003, the Yellowstone Center for Resources and Montana State University published a collaborative analysis of the initial consequences of wolf recovery on the world-renowned migratory population of northern Yellowstone elk. Vital rates for northern Yellowstone elk after wolf restoration (1996–2004) were estimated to assess the population trajectory and relative influence of harvests and wolf predation on elk demographics. Elk counts decreased from 19,045 to 8,335 during 1994–2004. Pregnancy rates for prime-age females (3–15 years) were high (0.90), and similar to those spanning a range of densities (i.e., 1.5–9 elk/km²) prior to wolf restoration. Thus, a biologically significant increase is unlikely if elk numbers continue to decrease. The survival rate for prime-aged females was 0.85 (CI = 0.81–0.87), compared to 0.99 when harvests were low and wolves absent (1969–1975). Moderate-to-liberal harvests and wolf predation were the primary factors limiting adult female survival. Harvests during 1989–2003 removed a relatively constant proportion (27%) of migratory animals each year (mean = 1,302), primarily prime-aged females. By 2003, 85 wolves had killed an estimated 538–1,076 adult female elk per year, primarily older animals. Recruitment decreased as the ratio of wolves to elk increased, but there is substantial potential for predation on calves to be compensatory (i.e., a calf killed by wolves would have died anyway, or one calf death promoted the survival of another).

Wolves maintained high kill rates and rapid population growth despite a 50% decrease in elk counts. Thus, elk numbers will likely continue to decrease until levels of harvest and/or predation decrease sufficiently to allow an increase in recruitment and adult survival.

In addition, the park solicited and funded an update of a predator–prey model, built by Mark Boyce (University of Alberta) prior to wolf reintroduction, with new data accumulated since wolves were released in 1995. Structural assumptions of the model included a dynamic carrying capacity for northern Yellowstone elk varying as a function of winter severity and summer forage production. During severe winters, the aerial extent of the northern winter range gets smaller, resulting in density-dependent migration of elk outside the park, where

they are subject to hunter harvest. The deterministic model without wolves or hunter harvest reached equilibrium at 16,243 elk. Introducing the additional variables (random variations) of winter severity and forage production reduced the average elk population to 14,728, with wide variation in year-to-year numbers. The addition of hunter harvest of elk governed by density-dependent rules established by the Montana Department of Fish, Wildlife and Parks caused further decline to a mean herd size of 12,254. Finally, adding wolf predation to the model resulted in a further, 21% reduction to 9,713 elk, with wolf populations fluctuating around a mean of 109 wolves that consume a mean of 1,035 elk each year. Modeled elk harvest was reduced by wolf recovery, but with moderate and conservative seasons, simulated hunter kill could be sustained at an average 1,074 elk per year. Alternate prey species were little affected by wolf recovery.

Mule Deer and Bighorn Sheep

Early migration of mule deer and bighorn sheep prevented the completion of annual spring counts of these ungulates this year.

Pronghorn

The annual spring count of Yellowstone pronghorn was conducted on April 6, 2004, using a fixed-wing airplane and a single observer. Traditionally, this survey has encompassed the relatively small winter range that extends from Mammoth to Mol Heron Creek on the west side of the Gardiner and Yellowstone rivers. However, during spring 2004, pronghorn began migrating approximately 2–4 weeks ahead of “normal” (i.e., early March), owing to mild late winter conditions and early vegetation green-up. Thus, both the winter and summer ranges of Yellowstone pronghorn between Mol Heron Creek in the Gardiner basin and Cache/Calfee ridges near the Lamar Valley were surveyed. After each portion of the range was surveyed, telemetry was used to locate radio-collared (i.e., marked) pronghorn known to be in the vicinity and to determine if each group containing at least one radio-collared pronghorn was located during the original survey. One hundred sixty-nine pronghorn were observed during the survey, 46% of which were in the migratory portion of the summer range (i.e., Mount Everts to Lamar Valley). This minimum count was certainly

an underestimate of total abundance, given that only 10 of 14 marked animals, and 8 of 12 groups with marked animals, were detected during the survey. All of the groups with marked animals that were not observed during the original survey were in the portion of the summer range used by migratory animals. The observations of marked individuals and marked groups were used to derive Petersen population estimates of 210 and 228 pronghorn, respectively, with 95% confidence intervals ranging between 150 and 290 animals. The Petersen estimates are not directly comparable to minimum counts obtained during previous years, but the similarity of the 2004 estimates and counts obtained during 1995–2003 (range = 204–235 pronghorn) suggest that the abundance of Yellowstone pronghorn has remained relatively constant during this time period.

The annual summer classification of Yellowstone pronghorn was conducted on August 19, 2004, using a fixed-wing airplane and a single observer. One hundred sixty-eight pronghorn (120 adult females, 23 adult males, and 25 fawns) in 26 groups were classified. Observed sex and age ratios for these pronghorn were 21 fawns per 100 adult females, and 19 adult males per 100 adult females. These results suggest that fawn survival and recruitment was similar to that observed from 1998 to 2002. Thirty-four percent ($n = 57$) of the observed adult pronghorn were non-migratory residents of the Gardiner basin, whereas 66% ($n = 111$) of the adults were migratory and summered in areas east of Mammoth. More fawns were observed in migratory groups ($n = 16$ fawns) than non-migratory groups ($n = 9$). However, the ratio of fawns per 100 adult females was similar between non-migratory (26 fawns per 100 females) and migratory (19 fawns per 100 females) groups.

During 1999–2002, biologists from Montana State University, the University of Idaho, and the Yellowstone Center for Resources conducted a cooperative study of Yellowstone pronghorn fecundity,

fawn mortality, and resource selection. Radio telemetry data were collected from 34 adult does during this period. During 2003 and 2004, the Yellowstone Center for Resources continued to monitor the remaining radio-collared pronghorn ($n \approx 11$ –14) on a weekly basis to build upon baseline information regarding vital rates, distribution, and movements of Yellowstone pronghorn collected during 1999–2002. Preliminary results of these studies suggest that annual adult female survival was relatively low (mean = 0.84; range = 0.74–0.92), and recruitment of pronghorn fawns was poor (0.04–0.61 fawn per female) during 1999–2002.

Delineation of pronghorn migratory movements also continued, owing to a proposal by the Federal Highway Administration to re-align the North Entrance road between the Gardner River and base of Mount Everts. Proposed alternative alignments pass through or near areas in the vicinity of Mount Everts that may be important for Yellowstone pronghorn prior to or during migratory movements. Data collected to date indicate that migratory pronghorn “stage” on the flats and lower elevation slopes at the northwest end of Mount Everts for approximately 1–2 weeks prior to their migratory movements. Spring migra-

tory movements occur primarily during April and early May, while autumn movements occur during August through early November. Pronghorn appear to use at least three migratory routes over Mount Everts to travel to and from their summer range. Migratory pronghorn summer in widely dispersed areas, including the Blacktail Deer Plateau, Oxbow Creek slopes, Hellroaring slopes, Specimen Ridge, and Lamar Valley.

Mountain Goats

During September 9–27, 2004, staff conducted aerial surveys for mountain goats in and adjacent to Yellowstone National Park. One hundred sixty-one mountain goats (131 adults, 30 kids) were observed



Pronghorn appear to use at least three migratory routes over Mount Everts to travel to and from their summer range.

during the surveys. Goats were widely distributed, with observations on Meldrum Mountain, Bighorn Peak, Ramshorn Peak, Quadrant Mountain, Dome Mountain, Mount Hornaday, Barronette Peak, Cutoff Mountain, Sunset Peak, Meridian Peak, Mineral Peak, Abiathar Peak, Little Saddle Mountain, in the Horse Creek drainage, and near Shooting Star Lake. No goats were observed in the Washburn Range, and only one group of goats was observed south of Abiathar Peak on the eastern boundary.

The composition (i.e., 23 kids per 100 adults) of observed mountain goats during 2004 was within the range (13–48 kids per 100 adults) observed during 1997–2003. Mountain goats have clearly established a breeding population in the park, and their relative abundance appears to be increasing. Sustained colonization of suitable habitats south of The Thunderer and along the eastern park boundary has not yet occurred, but the observation of females with young of the year on Little Saddle Mountain during 2004 suggests that mountain goats may now be successfully reproducing in this area. Based on surveys during 1997–2004, there are probably 125–200 goats in Yellowstone National Park.

The recent colonization and relatively rapid increase in abundance and distribution of descendants of introduced mountain goats in Yellowstone National Park raises important policy and management questions. Thus, habitat and population monitoring of mountain goats to evaluate their potential ecological effects will continue, as will collaboration and consultation with other federal and state agencies to begin developing a management plan for mountain goats.

Responses of Ungulates to Motorized Winter Use

The behavioral responses of wildlife to motorized winter recreation were monitored from December through March for comparison to data from previous and future winters. Snowmobiles and wheeled vehicles were used to conduct repeated surveys of wildlife responses to motorized winter use vehicles and human activities along nine groomed or plowed road segments. The sampling unit was the interaction between motorized winter use and an observed group of wildlife within 500 meters of the road. Monitoring was focused on the responses of bison, elk, and trumpeter swans to motorized winter use

vehicles relative to the proximity and/or perceived sensitivity of these species to motorized vehicles during winter.

Snowpack during early winter (i.e., October and November 2003) was less than the historic average since 1981. Snowpack was approximately average by late winter, with the exception of the northern range area, where it remained below average throughout the winter. There was relatively low motorized use by visitors during winter 2004, compared to previous winters. Approximately 16,000 oversnow vehicles (i.e., snowmobiles and snowcoaches; OSVs) entered the park's west entrance during winter 2004, compared to >22,000 OSVs during winter 2003 (which was also a relatively low visitation winter owing to poor snowpack). This lower visitation resulted, in part, from court orders in December and February and the accompanying uncertainty imposed on motorized recreation in the park.

Similar to other winters since 1999, the responses of most wildlife species to OSVs and associated humans during winter 2004 were typically minor, with 58% ($n = 1,296$) of the 2,239 total observed wildlife responses categorized as no apparent response, 18% ($n = 410$) look/resume, 11% ($n = 252$) attention/ alarm, 9% ($n = 196$) travel, 4% ($n = 82$) flight, and <1% ($n = 3$) defense. Wildlife responses to motorized winter use were consistent across species (bison, elk, and swans), but the magnitude of the responses varied considerably among species. The likelihood of observing an active response to snowcoaches or increasing numbers of snowmobiles in a group was similar for bison and swans, but significantly higher for elk. The likelihood of a response by each species decreased as distance from the road increased. The estimated odds of observing an active response compared to no response by bison or elk were significantly higher for administrative traffic than for guided OSVs. Also, wheeled vehicles elicited substantially fewer active responses by bison or elk than either administrative or guided groups of OSVs.

Independent studies of the responses of wildlife to OSVs and associated humans in Yellowstone National Park during 1999–2004 have consistently reported that behavioral responses were relatively infrequent, short in duration, and of low intensity. Also, bison and elk were less likely to respond on days with higher traffic, likely due to a level of habituation to relatively continuous traffic. Gross estimates of the



Research and monitoring of wildlife response to motorized recreation continued in 2004.

additional energy costs of travel or flight responses provoked by OSVs were relatively moderate for elk. Thus, animals exposed to OSVs likely do not incur a substantial energetic cost from such interactions, and these costs are likely easily compensated for without any significant demographic consequences. These findings are supported by trends in the abundance of bison and elk populations since the onset of motorized winter use in Yellowstone National Park, which provide no evidence of adverse population-level effects to ungulates from motorized winter use, because their abundance either increased or remained relatively stable prior to wolf restoration. Thus, any adverse effects of motorized winter use on ungulates have apparently been compensated for at the population level.

Bison were observed on groomed roads during 311 of 2,597 observations of bison groups from December 12, 2003, through April 1, 2004. Thus, the vast majority of observed bison groups were using areas off the groomed roads, as has also been noted in previous winters. Staff are currently collaborating with researchers from Montana State University and California State University–Monterey Bay to analyze bison distribution and use of groomed roads during 1997–2004. Conceptual models of bison movement through the park have been developed based on remotely sensed landscape features (e.g., vegetation, terrain, and geothermal maps), snowpack measurements and modeling, and bison distribution data.

These models have been used to predict bison trail systems and movements based on environmental constraints. Staff intend to compare these with the existing groomed road system to evaluate how grooming has affected bison movements.

Wildlife Management and Monitoring

Road-killed Wildlife

Bear Management staff maintain a database of wildlife killed on the park's roads each year. A total of 95 large mammals (those that can attain weights of >30 pounds) were hit and killed by vehicles on park roads in 2004. Elk (37%, $n = 35$), mule deer (24%, $n = 23$), and bison (16%, $n = 15$) were the species most often killed in collisions with vehicles. Other species of large mammals hit and killed by vehicles on park roads included coyotes (10%, $n = 9$), black bears (5%, $n = 5$), wolves (3%, $n = 3$), moose (2%, $n = 2$), bighorn sheep (1%, $n = 1$), grizzly bear (1%, $n = 1$), and white-tail deer (1%, $n = 1$). The average rate of vehicle strike mortality for all park roads combined was 0.4 large mammal road-kills per mile of park road. The highest vehicle strike kill rate occurred on the section of U.S. Highway 191 in the park (1.7 road-killed large mammals per mile of road). U.S. Highway 191 is the only park road with a 55-mph posted speed limit. All other park roads are posted at 45 mph or lower. U.S. Highway 191 comprises only 8% of the paved roads in Yellowstone, but accounted for 37% of the total vehicle-strike wildlife mortality in the park in 2004.

Wolves

Population Monitoring and Management

Population status. At the end of September 2004, at least 170 wolves in 15 packs occupied Yellowstone National Park (Figure 1, Table 1). This represented no gain of wolves from 2003, marking only the second year since reintroduction that the wolf population did not increase (1999 was the other year). Three new packs formed, one of which was disbanded

by the end of the year (Specimen Ridge pack). Two packs that historically used the park moved north onto the Gallatin National Forest (Rose Creek and Buffalo Fork packs). In the Madison–Firehole area, a dispersing wolf from the Nez Perce pack had pups and created the Biscuit Basin pack that ranges in the Old Faithful area. Another dispersing wolf from the Cougar Creek pack helped form the Gibbon Meadows pack, which ranges in the Gibbon Meadows/Gibbon River area. The Rose Creek and Buffalo Fork packs no longer reside or use Yellowstone National Park during any time of the year, so were not counted as part of the park’s population total.

In FY04, six packs (87 wolves) used the northern range, and nine packs (87 wolves) used the rest of the park. Pack size ranged from four (Bechler) to 24 (Leopold), and averaged 12.4, the largest average pack size in any year so far. Pack size was slightly larger on the northern range (mean = 14.5) than elsewhere in the park (mean = 10.8). Interestingly, the largest pack on the northern range is now the Leopold pack, a pack that was of moderate size (10–15 wolves) for most of its prior existence.

The pack of wolves on the northern range with the largest size has shifted between three packs since reintroduction: Rose Creek, Druid Peak, and Leopold, respectively. The Rose Creek pack reached 24 wolves early on (in 1998), occupied a large territory, and dominated territorial encounters. In 2001, the Druid Peak pack increased to 37 wolves, perhaps the largest of any pack ever recorded. This shift heralded the beginning of a long decline for the Rose Creek wolves that persists to this day; the Rose Creek pack no longer uses Yellowstone National Park. The Druid Peak pack pushed west, usurping territory from Rose Creek, but eventually lost control of this new area and returned to their traditional area of use, primarily Lamar Valley. This old Rose/Druid territory came to be used by four packs that were spawned from the Druids: Agate Creek, Slough Creek, Geode Creek, and Buffalo Fork (no longer inside Yellowstone National Park). Now, both of these old, big packs are small (<10 wolves), and the historically homebody Leopold pack is expanding its territory, or at least behaving as such. The Leopolds, which have used a very consistent, stable territory in the past, have been making first-time, extra-territorial forays—suggesting that larger pack

size confers territorial advantages for wolves on the northern range.

Competitive relationships between packs are usually not as intense in the park’s interior, because these packs typically do not have close neighbors. Therefore, interpack skirmishes are fewer, and no territorial advantage is evident for large packs. This dynamic may be changing, as there is some evidence of increased interpack conflict occurring in the Madison–Firehole region, where the body condition of two of the four resident packs is fair-to-poor.

Packs in the interior are also different from northern range packs for other reasons. Most importantly, northern range wolves live in a prey-rich elk environment in the winter, whereas winter prey for interior wolves is limited to few elk (most elk

Table 1. Preliminary wolf population count, October–November 2004.

Pack	Total
Northern range	
Agate Creek	11
Druid Peak	11
Geode Creek	14
Leopold	23
Slough Creek	16
Specimen Ridge	5
Swan Lake	9
Northern range total	89
Non-northern range	
Biscuit Basin	10
Bechler	4
Chief Joseph	6
Cougar Creek	12
Gibbon Meadows	6
Mollie’s	10
Nez Perce	14
Yellowstone Delta	19
Non-northern range total	81
Yellowstone National Park total	170
Pack count estimates north of Yellowstone National Park	
Rose Creek II	2
Mill Creek	4
Lone Bear	4
Mission Creek	6
Moccasin Lake	6
Casey Lake	3
Sheep Mountain	6
Total	31

migrate) and many bison, which are difficult to kill. Snow is also deeper in the interior, and thermal areas are common; both of these factors affect ungulate vulnerability. More prey, yet more wolves competing for it, has led to greater population instability on the northern range. Pack sizes decline more during winter on the northern range than in the interior, and wolves (especially pups) are beginning to show body condition declines and increased mortality on the northern range. These are early indicators, but clearly life for a wolf is different in the north. A complete picture of the differences is yet to form.

Wolf distribution was largely unchanged from 2003. Wolf range continued to be the northern range, Pelican Valley, the Madison–Firehole, north of the Madison River, Thorofare, and Bechler. One of the new packs that formed (Biscuit Basin) sandwiched itself into occupied territory in the Madison–Firehole, but it appears that this pack also leaves the park for significant periods of time. The other new pack (Gibbon Meadows) established itself in a little-used section of the Gibbon Meadows–Norris area. An uncollared group of four wolves was consistently reported in Hayden Valley, also an area without a previously resident pack. Reports included pups, indicating reproduction. Without radio collars, further information is lacking, and future tracking will be difficult.

Of these 15 packs, 12 counted toward the breeding pair objective for the Yellowstone Recovery Area. No pups survived in the Bechler pack, and only one pup survived in the Gibbon Meadows pack, so these did not count as breeding pairs under the definition. To count toward the breeding pair objective, a pack must consist of an adult male, an adult female, and two pups-of-the-year that survive to December 31. Because they could not be reliably tracked, the pack in Hayden Valley also did not count toward this total.

Reproduction. At least 86 pups were born and 64 survived in 15 packs to the end of September 2004. One pack dissolved after the death of its alpha male (Specimen Ridge pack), and the status of the pups is unknown. The Druid Peak, Leopold, and Geode Creek packs each had two litters of pups.

The number of pups per litter ranged from one to nine, with an average of 5.1 pups counted at den sites in May and June. Despite two litters for the Druid Peak pack, only two pups survived. It is unknown if any of the Bechler pack pups survived. All of the Leopold, Biscuit Basin, and Cougar Creek pups survived. Overall, pup survival was 74%. Den sites were re-visited, and scats picked up to track summer food habits. Seven (58%) of 12 den sites were re-used by packs that had denned before.

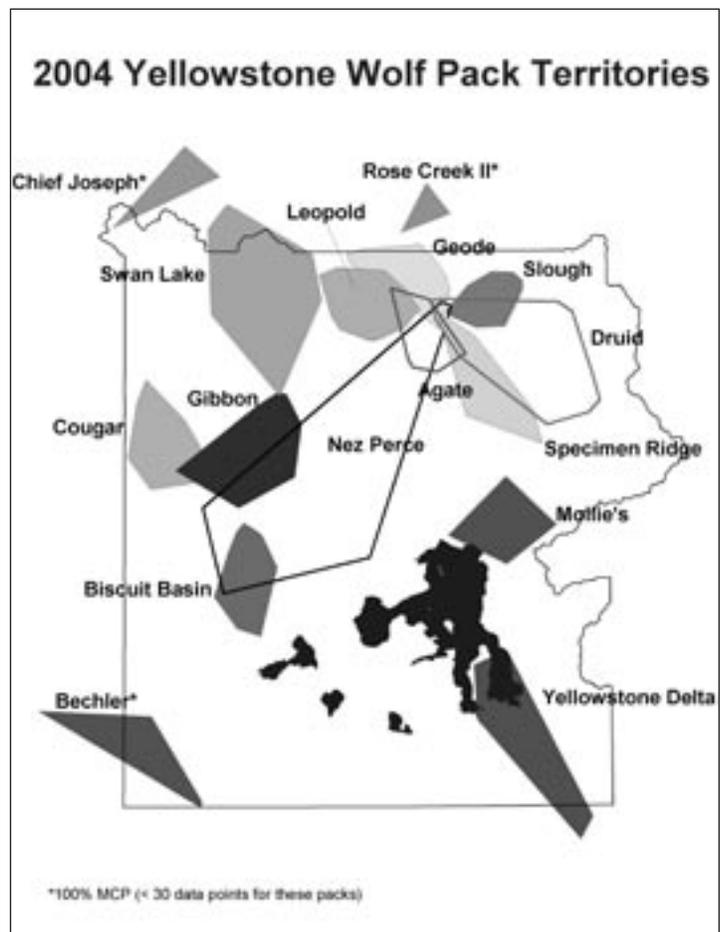


Figure 1. Yellowstone wolf pack territories, 2004.

Mortalities. Twenty wolves were known to have died in Yellowstone National Park during FY04: 3 old adults (>6 years old), 10 adults (2–5 years), 2 yearlings, and 5 pups. They included nine males, nine females, and two of unknown sex. All of the wolves that died within the park died of natural causes. Six wolves (30%) died in intra-specific conflicts, 4 (20%) from vehicle strikes, 3 (15%) in control actions (these began the year inside Yellowstone National Park and traveled outside and were shot

due to livestock depredations), 6 (30%) from natural unknown causes, and 1 (5%) from unknown causes. The mortality rate for collared wolves from 2004 to 2005 was 20%, which is the 10-year average. Mortality has ranged from a low of 9% in 1998, to a high of 43% in 1997. Mange was reported for the first time inside Yellowstone National Park. A Chief Joseph pack wolf was sighted in Daly Creek with hair loss. This is the only location in the park where mange has been observed, and so far, no mortalities are known to have resulted from mange.

Status of original reintroduced wolves. None of the 31 originally reintroduced wolves remains alive. The last Yellowstone National Park wolf to die was #42F, who was with the Druid Peak pack when she was killed by wolves from Mollie's pack in late January 2004. The last of all to die was her sister, wolf #41F, originally of the Druid Peak pack, who was shot in a control action east of the park. She had a severe case of mange at the time of death. All wolves currently alive in the population are descendants of reintroduced wolves.

Wolf–Prey Relationships

Wolf–prey relationships were documented by observing wolf predation directly and by recording the characteristics of wolf prey at kill sites. Wolf packs were monitored during two winter-study sessions, 30-day periods in March and November–December during which wolves were intensively radio-tracked. The Leopold, Geode Creek, and Druid Peak packs were monitored by two-person teams from the ground and from aircraft; the Swan Lake, Agate Creek, Slough Creek, Mollie's, Gibbon Meadows, Biscuit Basin, Nez Perce, Cougar Creek, Bechler, and Yellowstone Delta were monitored from aircraft only. Yellowstone National Park staff recorded and entered into a database 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. In addition, similar data were collected opportunistically throughout the year during weekly monitoring flights and ground observations. The abundance and sex/age composition of elk within wolf pack territories were also estimated from the ground and from fixed-wing aircraft.

Composition of wolf kills. Project staff detected

294 definite and probable kills made by wolves during FY04, including 244 elk (83% of total), 15 bison (5%), 5 deer (<2%), 3 pronghorn (1%), 2 moose (<1%), 1 cougar (<1%), 5 coyotes (<2%), 5 wolves (<2%), 2 grizzly bears (<1%), 1 golden eagle (<1%), and 11 unknown prey (4%) (Table 2, Figure 2). The composition of elk kills was 22% calves (0–12 months), 11% cows (1–9 years old), 18% old cows (≥10 years old), 32% bulls, and 17% elk of unknown sex and/or age. Bison kills included four calves, seven cows, two bulls, and two of unknown sex and age. During winter, wolves residing on the northern range killed an average of 1.8 elk per wolf per 30-day study period.

Winter studies. During the 2004 March winter study (30 days), wolves were observed for 379 hours from the ground. The number of days that individual wolf packs were located from the air ranged from one (Yellowstone Delta and Bechler) to 21 (Leopold, Geode, Druid Peak, and Slough Creek). Sixty-six definite or probable wolf kills were detected, including 56 elk, 6 bison, 2 mule deer, and 2 of unknown species. Among elk, 16% ($n = 9$) were calves, 25% ($n = 14$) were cows, 45% ($n = 25$) were bulls, 9% ($n = 5$) were adults of unknown sex, and 4% ($n = 2$) were of



Wolves killed 15 bison in 2004—primarily in the park's interior, where elk are absent in winter.

unknown sex and age. During the 2003 November–December winter study (30 days), wolves were observed for 317 hours from the ground. The number of days that individual wolf packs were located from the air ranged from 0 (Yellowstone Delta and Rose Creek) to 10 (Leopold, Druid Peak, Geode

Creek, Slough Creek, Agate Creek, and #302M's group). Fifty-seven definite, probable, or possible wolf kills were detected, including 50 elk, 1 coyote, 1 moose, 1 mule deer, 2 wolves, and 2 unknown prey. Among elk, 44% ($n = 22$) of the kills were calves, 12% ($n = 6$) were cows, 8% ($n = 4$) were old cows (10+ years), 24% ($n = 12$) were bulls, 2% ($n = 1$) were adult elk of unknown sex, and 10% ($n = 5$) were of unknown sex or age.

Summer predation. In the summer of 2004, Wolf Project staff continued efforts to document summer predation patterns by wolves. Documenting the predatory habits of wolves in summer is problematic due to the lack of snow for tracking, increased nighttime activity of wolves, lack of pack cohesiveness, and smaller prey packages, leading to quick consumption and loss of evidence. Traditionally, the best data concerning wolf summer food habits have come from analysis of scat contents collected at den and rendezvous sites. Although scat collection efforts continued in 2004, downloadable GPS (Global Positioning System) collars have opened a new door to studying summer wolf predation.

The Wolf Project deployed five GPS collars in the 2004 capture season to enhance understanding of 1) seasonal predation patterns; 2) spatial and temporal interactions with other wolf packs and other carnivores; 3) movements with respect to dens during pup-rearing season; and 4) territory size, use, and overlap. Because GPS collars provide more accurate and numerous data compared to traditional radio telemetry collars, and reduce reliance on aerial monitoring, the program has expanded the GPS collar program. Using these collars, with downloadable data acquisition technology, weekly data gathering this summer has yielded unprecedented information on wolf summer predation patterns. Collars programmed to collect location data every 30 minutes during the summer season have provided researchers with a fairly comprehensive picture of wolf movements, and allowed wolf kills to be found—even newborn elk calves. The data have allowed researchers to find recent kill sites to collect scavenger data, and in one case, showed where a wolf pack had displaced a cougar from a cow elk kill and scavenged the remainder of the carcass. Data collection methods from summer 2004 will be replicated in summer 2005, if funding is available.

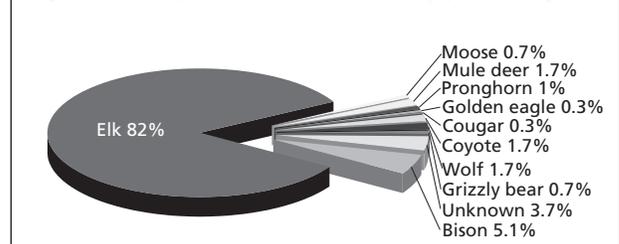
A GPS collar on Geode wolf #392M performed

extremely well, and allowed staff to document 14 kills made by members of the Geode pack from May 3 until June 21. Of these kills, five were neonate elk calves, three were adult bull elk, three were adult cow

Table 2. Wolf kills, 2004.

Prey	Number	Percent
Bison	15	5.1%
Elk	244	83.0%
Moose	2	0.7%
Mule deer	5	1.7%
Pronghorn	3	1.0%
Golden eagle	1	0.3%
Cougar	1	0.3%
Coyote	5	1.7%
Wolf	5	1.7%
Grizzly bear	2	0.7%
Unknown	11	3.7%
Total	294	

Figure 2. Composition of wolf kills by percentage.



elk, and three were approximately one year of age. In addition, GPS points allowed Wolf Project staff to document five carcasses scavenged, one belonging to a GPS collared cougar in the Hellroaring study area. Similar studies are planned for 2005.

Summer scavenging. The effects of wolf restoration on scavenger guilds in the Greater Yellowstone Ecosystem is an important aspect of trophic cascade research. Research on wolf and scavenger interactions has been conducted since 1998, through support from Canon U.S.A., Inc., and the Yellowstone Center for Resources. This research, largely conducted in winter, has monitored how wolves influence the abundance and distribution of carrion, both spatially and temporally, as well as how they facilitate food acquisition by other carnivores. Although a great deal has been learned about the magnitude and relative importance of wolf-killed carcasses to winter scavenger communities, little is known about impacts to summer scavengers, both vertebrate and

invertebrate. Focusing on summer scavenging will likely lead to a more complete understanding of the ecological relationship between wolves and scavengers as it relates to seasonal variation, abundance, and diversity.

In summer 2004, Wolf Project staff increased monitoring efforts on summer carcasses to document scavenger utilization and behavioral interactions between wolves and scavengers. At the end of the summer study period, scavenging data were collected on three bison and four elk carcasses, for a total of seven carcasses. Most carcasses were



The Leopold pack traveling on Blacktail Plateau, summer 2004.

observed from early stages of consumption until they were reduced to bone and hide. Every carcass was visited by wolves, grizzly bears, coyotes, bald eagles, golden eagles, ravens, and magpies. A black bear fed on one. Overall, vertebrate scavenger numbers were lower at summer carcasses than in winter. The high count for ravens at a summer carcass in the study area was 47, compared to raven counts exceeding 100 individuals observed at winter carcasses in the same study area. Preliminary data suggest that

in contrast to winter, bears (both grizzly and black) benefit more from wolf kills in summer, and in general, vertebrate scavenger densities are lower at each carcass in summer.

Feeding patterns of wolves in summer are different from that of winter, largely due to the necessity of bringing food from a carcass back to a den site to feed growing pups; this sometimes requires adult wolves to travel miles with food in their mouths and stomachs. This, in turn, allows other vertebrate scavengers to feed on carcasses in the wolves' absence. In winter, wolves would more aggressively defend their food source from scavengers, and an entire pack is typically assembled together. Summer offers another difference in foraging strategies for wolves, in that newborn ungulates are on the landscape. This food source is small and easy to consume in a shorter period, almost exclusively allowing wolves to benefit from their hunting success, leaving little for scavengers.

Druid Road Management Project

This was the fifth year that private funds were used to manage wolf viewing in Lamar Valley. The Druid Peak pack has denned close to the road since 1997, and growing visitor interest has warranted increased park management. Two paid personnel were hired through the Yellowstone Park Foundation, and one volunteer assisted. The project began on May 16 and ended on September 18, 2004. There were no accidents involving visitors, vehicles, or wolves during the 126 days of the Druid Road Management Project's season, and wolves successfully crossed the road on 81% of their first attempts. Because the wolves spent less time at the rendezvous site in July and August, fewer visitors saw wolves this season (8,721) than last year (9,827); it is estimated that wolves were in sight for 395 hours. Visitors contacted this summer numbered 11,710—about the same as in 2003. In addition, there was one case of wolf habituation during this field season.



The Seventh Biennial Scientific Conference, *Beyond the Arch: Community and Conservation in Greater Yellowstone and East Africa*, featured a contingent of world-class speakers. Shown here with YCR director John Varley (third from right), are (left to right) Drs. Lee Talbot, Robin Reid, Steven Sanderson, Dan Flores, Charles Preston, A.R.E. Sinclair, and Richard Leakey.

Part IV: Professional Support Programs

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

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

Spatial Analysis Center

The Spatial Analysis Center (SAC) is home to the park's geographic information systems (GIS), global positioning systems (GPS), image analysis systems, soil information support, and a park resource database system. Its main business is the acquisition, analysis, organization, storage, and maintenance of data and the presentation of information, especially concerning the cultural and natural resources of Yellowstone National Park. The 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 them useful, provide information and technical support to park staff, and make information available to outside agencies and the public.

In FY04, approximately 70% of SAC staff time was spent supporting Yellowstone projects, 16% was used for SAC administration (administering, improving, and maintaining the program), and 14% supported external (non-Yellowstone) users (Figure 1).

Support

Interdivisional. SAC staff spent approximately 38 pay periods working with other park divisions in support of their high priority projects. Time spent supporting parkwide projects (6,300 hours) was divided between the divisions of YCR (51%), Maintenance (29%), Resource Management and Visitor Protection (10%), Administration (8%), and Interpretation (2%) (Figure 2). Some of the major efforts in FY04 included:

Facility maps. SAC staff worked closely with the Division of Maintenance to map the distribution (drinking water) and collection (wastewater and sewer) facilities. Using available drawings and local knowledge, staff located each component in the field and used GPS equipment to record digital locations. SAC staff also recorded relevant attributes such as depth, pipe size, and valve type. These new data were used to create information layers in a GIS database. The new layers include manholes, sewer mains, cleanouts, lift stations, valves, water mains, and hydrants. SAC staff have created up-to-date, accurate maps that the Division of Maintenance is using to locate assets, inventory features, assess conditions, and plan future projects. SAC staff is linking this data to the new Facilities Management Software System (FMSS), currently used service-wide by NPS Maintenance. Areas completed include: Old Faithful, Canyon, Grant Village, West Thumb, Lewis Lake, South Entrance, Madison, West Entrance, Bechler, Mammoth, Lake, Bridge Bay, and Fishing Bridge. Approximately 961 manholes, 25.5 miles of sewer mains, 43 lagoons, 414 hydrants, 1,181 valves, and 28.3 miles of water mains were mapped as of September 2004.

Wildland-urban interface (WUI) support. Since 2001, the Spatial Analysis Center has provided data and maps for various WUI projects throughout the park. During FY04, SAC staff undertook the process of first finding, then organizing all data that have been created/collected for WUI projects in previous years. With this organization complete, staff were much more efficient in supporting the more than 20 requests to digitize focus areas and print new maps.

Fire Management Plan. SAC staff created new Fire Management Unit (FMU) maps based on the locations of park roads, the Yellowstone Lake boundary, the park boundary, and the Yellowstone River. Staff also calculated various statistics for each

FMU, including the total number of frontcountry and backcountry structures, miles of trails, number of campsites, area of land and major lakes, number of historic fire starts, area burned, and post-1988 land cover.

Other fire-related projects. Several SAC staff supported the park's Fire Cache during the summer of 2004 by providing daily maps of fire starts and fire perimeters, error-checking collected GIS fire data, and updating the Fire Cache's public internet site. SAC staff worked with the Fire Cache to create accurate fire perimeters and burn severity maps of all fires using imagery from LANDSAT satellites. In addition, SAC staff are assisting in documenting the park's fire history and creating a GIS layer of Yellowstone fire locations that goes back into the 1800s.

Foundation planning efforts. In FY04, a strategy called "foundation planning" was developed and implemented on projects at Old Faithful and Tower. The overall purpose of this type of planning is to generate a collaborative vision for each developed area that identifies the unique resources and range of experience desired for the area while supporting the mission of the park. The SAC provided support for these planning efforts by supplying many different maps for each area and suggesting other data and analysis techniques that might be useful to the planning effort.

Recreation Opportunity Spectrum (ROS) mapping project. SAC staff assisted with the Greater Yellowstone Area (GYA)-wide planning effort to divide the park into different recreational opportunity areas. SAC staff created the boundaries of the new areas based on buffered distances from roads, trails, and developed areas. Staff worked with the park's Office of Planning, Compliance, and Landscape Architecture through multiple iterations of the concept to produce a final Yellowstone product for the Greater Yellowstone Coordinating Committee.

Interpretive program assistance. SAC staff worked with the Division of Interpretation to provide information for their electronic field trips, and showed *Expedition Yellowstone!* student participants how to inventory thermal areas and use GPS equipment. SAC staff also introduced the students to GIS and let them experiment with data in the GIS lab.

Other projects. SAC staff also responded to many smaller requests involving computer support,

map making, data analysis, and questions about data. Some examples included:

- maps used by horse packers to find and retrieve smoke jumpers;
- the location of the hottest thermal features;
- maps for a court case in Cooke City, Montana;
- a map used to locate a valve under 40 inches of snow at Grant Village;
- maps of weed locations in the North District;
- the percentage of roads between Norris and Golden Gate that are adjacent to wetlands;
- map of Heart Lake bathymetry;
- map used for accident investigation at Old Faithful;
- the location of the 15 highest peaks in the park;
- maps of Mammoth-area trails to post at trail-heads; and
- a map of Lake-area housing, to be used in a court case.

YCR. SAC staff divided YCR support between Natural Resources (41%), Cultural Resources (37%), general computer/software support (20%), and the Research Permit Office (2%) (Figure 3). Some examples include:

Human Impacts database. SAC staff created a database of recent human history as documented in numerous abandoned buildings, roads, trails, dumps, and fences scattered throughout the park, and continue to modify the database structure as the project evolves. First, individuals with local knowledge were interviewed. Then, the features were located in the field using high-accuracy GPS equipment and digital photography. Finally, the locations and pertinent information were entered into the Human Impacts database. In 2004, data collection efforts were concentrated within the Gardiner-to-Norris corridor and throughout the Old Faithful area. SAC staff documented 67 new features, bringing the total number of sites described in the database to 534.

Thermal Inventory database. A digital inventory of Yellowstone's thermal features has been in progress since 1996. In 2004, staff added 1,083 new features to the Thermal Inventory database. As of fall 2004, the database contained locations, photographs, and basic chemistry for 8,899 geothermal features in Yellowstone. In 2004, efforts were concentrated in Solfatara Plateau, Pelican Valley, Mirror

Figure 1.
SAC total project hours, FY04.

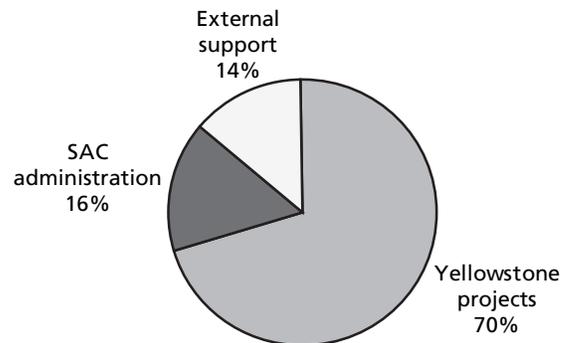


Figure 2.
SAC work by divisions, FY04.

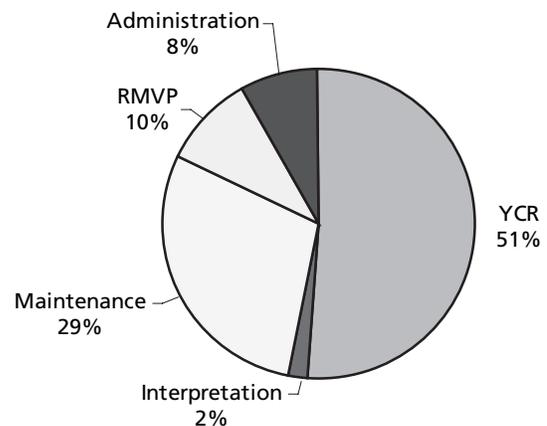
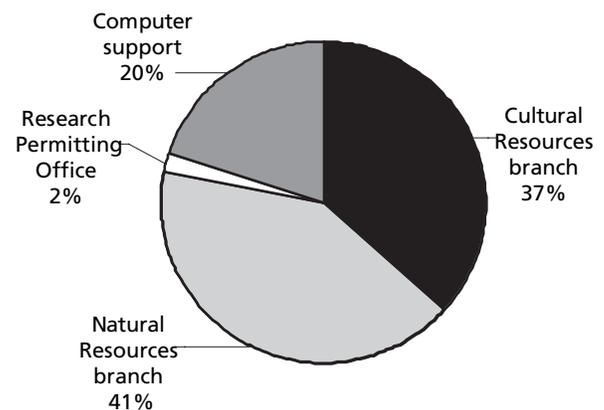


Figure 3.
SAC work in YCR.



Plateau, Bechler, and the South Entrance area.

Thermophile Inventory. SAC staff have been working with the University of New Mexico and Portland State University for three years to inventory the phylogenetic and physiological diversity of Yellowstone's thermal springs. The project involves two types of data collection: detailed data from 100 representative springs, and less-detailed data from a larger number of satellite springs in the vicinity of the detailed sites. At the detailed sites, samples were collected to identify the full 16S rRNA gene sequences (~1,500 bases per organism), analyze water chemistry (pH, temperature, anions, cations, nutrients, sulfur species, stable isotopes, dissolved oxygen, and dissolved organic carbon), and identify the geologic setting (rock type, alteration, and soil development). At the satellite sites, SAC staff recorded pH, temperature, and location, and collected samples to identify the partial 16S rRNA gene sequences (~200 bases per organism).

Nez Perce trail. SAC staff worked with the park's ethnographer to map the 1877 Nez Perce route through Yellowstone, and met with Stan Hoggatt of Billings, Montana, to digitize his interpretation of the route. Stan has spent the last 15 years researching the Nez Perce trail, both on the ground and through extensive literature reviews. He recently produced two small-scale maps and a digital book, "Nez Perce Triumph at Clarks Fork Canyon," that are now available to the public. SAC staff focused upon Stan's route this year because park staff are anxious to inventory any physical evidence that might still exist along the route. The Spatial Analysis Center plans to investigate and map other interpretations of the corridor in FY05.

Northern range vegetation mapping. Shannon Savage continued work on her Master's thesis, "Non-forest vegetation mapping and change detection using Landsat TM and ETM+ imagery in the northern range of Yellowstone National Park," in which she is comparing maps created from older and more recent imagery to detect changes in the non-forested vegetation on Yellowstone's northern range. She is classifying vegetation in the field and using aerial

photos to collect training and accuracy assessment data for her satellite image classification. Shannon intends to have a final classification completed and a change detection method developed in early FY05.

Archeology site maps. The Wyoming State Historic Preservation Office (WYSHPO) recently shared their master geodatabase of archeology sur-



In 2004, staff added 1,083 new features to the Thermal Inventory database, concentrating efforts in Solfatara Plateau, Pelican Valley, Mirror Plateau, Bechler, and the South Entrance area.

veys and sites for Wyoming with the SAC. After comparing this to other data sources, SAC staff discovered some disturbing discrepancies between the WYSHPO's data for Yellowstone, the Midwest Archeology Center's data for Yellowstone, and the park's own archeological site data. In response, SAC staff started the process of reviewing all of the original site reports to identify the best information. This large project will continue into FY05.

Predicting archeological site probability. In FY04, SAC staff began an effort to divide the park into areas of high, medium, and low probability for archeological sites of different ages. The probability analysis is based on data from known sites and on the professional knowledge of the park's archeologist. SAC staff will complete the project in the spring of FY05.

Hardware/software support. Approximately

650 hours were spent on YCR hardware/software issues, mainly on troubleshooting problems and answering questions. SAC staff fixed problems in printers, plotters, desktops, laptops, network access, GPS units, software, and power supplies. The problems ranged from simple printer access questions to more complex server security questions. Because SAC staff upgraded to a new version of GIS software in FY04, there were many more “How do I do this?” questions than usual. In addition, SAC staff provided training for people wanting to use GPS units, software, plotters, and digital cameras.

Research permitting database. SAC staff worked with the Research Permit Office to design, create, and populate a spatial database of permitted research in the park. The goal is to answer questions about what type of research occurs where in the park, and to keep a spatial record of the type, amount, and location of unattended equipment left in the field.

Resource inventories. SAC staff continued to support resource inventory projects (wetlands, rare plants, archeology sites, historic structures, thermal areas, soils, fish, and wildlife) associated with the Federal Highways program. This involved creating and updating databases, providing GPS support, mapping locations in the field, and creating maps. SAC staff also acquired copies of older (pre-1990) data and incorporated them into the newer databases.

External (non-Yellowstone) support. SAC staff spent approximately 1,300 hours supporting projects for people who do not work directly for Yellowstone National Park. These included projects for other national parks, GYA-wide projects funded by the Greater Yellowstone Coordinating Committee (GYCC) or the Greater Yellowstone Network (GRYN), servicewide projects, and requests from other federal agencies, researchers, and the general public. A few highlights included:

Resource extraction database. Resource extraction activities have the potential to negatively impact the resources that Yellowstone National Park, Grand Teton National Park, and Bighorn Canyon National Recreation Area are mandated to protect. This project documented the type and location of over 10,000 active mining (gravel extraction and hard rock mining) claims and leases, oil and gas leases, and geothermal leases within 20 miles of each park. Most of this activity was concentrated north of Yellowstone

or south of Bighorn Canyon. Yellowstone has 3,900 sites within 20 miles of its border. Until now, this information was not available to park managers. Extensive data mining efforts were necessary to determine where the best information was stored. Ultimately, the data were obtained from the LR2000 database from the Bureau of Land Management’s Denver office. SAC staff joined these data to a map of the Public Land Survey System (PLSS) to make a GIS database for analysis and display of the information.

Grand Teton National Park (GRTE) utilities. After seeing the successful implementation of field data collection for water and wastewater utilities in Yellowstone, GRTE staff were interested in starting a similar program. SAC personnel traveled to GRTE for numerous information-sharing meetings and spent two weeks training GRTE staff in field data collection and data management techniques. SAC staff continued to work with GRTE on their field data collection throughout the summer.

Microbe book. SAC staff assisted Kathy Sheehan, from the Montana State University Microbiology Department, with her book about microbes in Yellowstone. Staff created numerous maps for *Seen and Unseen: Discovering the Microbes of Yellowstone*, to be published in spring 2005.

Grand Teton National Park Thermal Inventory. In cooperation with GRTE staff, SAC staff inventoried GRTE’s frontcountry and backcountry geothermal features. Low water conditions in Jackson Lake exposed the normally inaccessible thermal springs along the western shore near Colter Canyon, and allowed easy access to the thermal springs near Webb Canyon. The popular swimming hole of Kelly Warm Spring was inventoried, as was the Huckleberry/Polecat Creek area, just south of Yellowstone. A total of 100 thermal springs were found in GRTE.

GYA fire fuels database. SAC staff worked with the federal agencies that comprise the GYCC to create a GYA-wide fire fuels layer that can be used to model fire spread across agency boundaries. SAC staff collected the best fuels or vegetation data available from each unit and combined it into one seamless data layer. SAC staff also helped organize a fire modeling workshop so that all the federal agencies could come together and discuss models, data, and ways of working together. This work was done at the request of, and with guidance from, the Fire

Management Officers of the GYA.

GYA fire history database. SAC staff continued to work on a GYA-wide fire history project that began three years ago. Staff is building two databases: one for fire starts, and one with perimeter data for all fires larger than 100 acres. So far, the database contains information on more than 13,400 fires, including the location of more than 3,940,000 burned acres (see Table 1).

Table 1. Examples from fire history database.

Administrative Unit	Years	Fire Starts	Total Acres
Beaverhead-Deerlodge NF	1940–2001	2,679	8,354
Bridger-Teton NF	1951–2003	2,700	412,628
Caribou-Targhee NF	1986–2001	1,123	488,327
Custer NF	1986–2003	1,311	430,361
Gallatin NF	1940–2003	1,999	223,156
Grand Teton NP	1970–2003	500	169,856
Shoshone NF	1970–2002	881	192,038
Yellowstone NP	1931–2004	2,281	2,015,404

Watershed classification. As part of the Vital Signs Monitoring Program, Outstanding Natural Resource Waters (ONRWs) are given a high priority for long-term monitoring. Therefore, the GRYN, which includes Bighorn Canyon Recreation Area, Grand Teton National Park, and Yellowstone National Park, must develop a sampling plan for its ONRWs that ensures adequate monitoring of these resources. Due to the large number of aquatic resources in the GRYN and the various scales at which the problem can be analyzed, the number of sites chosen for sampling can grow exponentially as the problem is addressed. To make this process manageable, SAC staff and Todd Koel of the Aquatics Section developed a classification scheme for grouping similar watersheds, based on physical characteristics, for all three park units. The final data and report were provided to GRYN in April 2004.

SAC staff fulfilled numerous data and map requests for information about the park's thermal areas. These were received at a rate of 5–10 per month, with more requests in the summer and fewer in the winter. The majority of requests came from people with valid research permits, working in Yellowstone's thermal areas. SAC staff also provided guides and chaperones to people working in thermal areas. This service is designed to protect the resource, increase researcher safety, and promote

the exchange of information between the park and researchers.

SAC Administration

A tremendous amount of hidden effort goes into managing, maintaining, and improving the Spatial Analysis Center each year. In 2004, SAC staff spent nearly 1,400 hours solving SAC hardware and software problems; maintaining SAC systems (nightly and weekly data backups, maintaining and repairing printers and plotters, finding viruses, fixing network access problems); maintaining data (adding new data, documenting data, updating existing data); and managing the program (budget, hiring, supervision, and training).

All of the park's spatial data is stored on a server in the GIS lab. In 2004, SAC staff installed larger

and faster hard drives on the server to decrease the time users have to wait for data and increase SAC storage space to 200 gigabytes. SAC staff also acquired digital, geo-referenced copies of recent, color infrared, aerial photography for most of the park. A new computer was added to the lab, and all GIS software was upgraded to the current version, ArcGIS 9. Anyone with access to the park network can run this software from their own desktop, free of charge.

Finally, SAC staff acquired software designed to spatially examine the pros and cons of different planning scenarios, which will be useful for both WUI and Foundation Planning projects. This year, Canon U.S.A., Inc., donated a new, 42-inch, photo-quality plotter to the GIS lab. It prints poster-sized images, and anyone with access to the park's network can print to this plotter.

Resource Information Team

The Resource Information Team (RIT) translates, produces, and synthesizes scientific and technical information into language and formats that are accessible to researchers, scientists, members of the public, and park managers who need access to

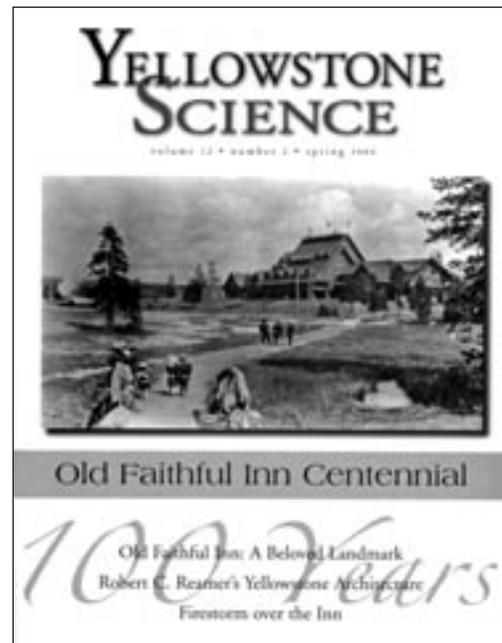
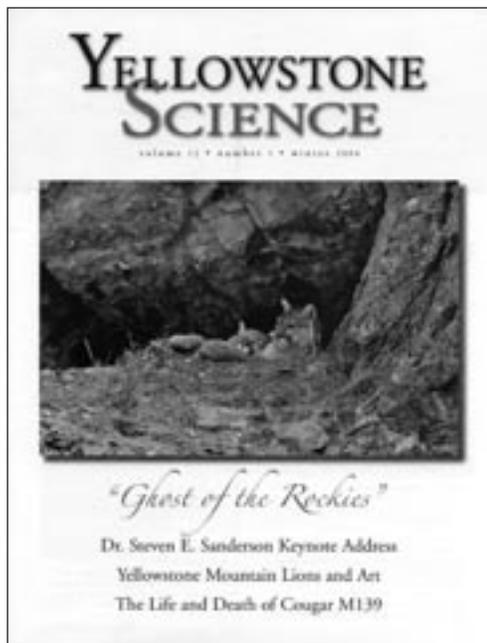
results from scientific research in order to make informed decisions about park issues. The RIT had three staff changes in FY04. Virginia Warner accepted a term position as an editorial assistant, and Alice Wondrak Biel entered a flexiplace agreement that allows her to continue her work for the YCR from her new home in Bryce Canyon National Park, Utah. Roger Anderson served as Acting Chief of Cultural Resources in addition to continuing his RIT duties.

Publications

In 2004, the quarterly journal *Yellowstone Science* entered its twelfth year with a new look. RIT staff completely re-designed the magazine, ushering in its new appearance with three full-color issues and a variety of articles highlighting many aspects of Yellowstone's natural and cultural resources. Four issues were published and distributed to a subscription readership of nearly 2,500 individuals and institutions. Among the highlights this year was a well-received commemorative issue in spring 2004 dedicated to the centennial of the Old Faithful Inn (48 pages), and a winter issue devoted to mountain lions in Yellowstone. Other feature stories this year included a look at the archeological excavation of Osprey Beach; historical sketches of the Red Sowash saloon and early park entrepreneur Harry Horr; a review of Richard Saunders's *A Yellowstone Reader*; the text of Theodore Roosevelt IV's keynote speech,

delivered on the occasion of the hundredth anniversary of the Roosevelt Arch; and a brief history of research permitting in the park (researched and written by a team member). "Nature Notes" published in 2004 included an update of birds on the park checklist; the life and death of cougar M139; and a personal account of the 1988 North Fork Fire.

Other publications included five issues of the *Buffalo Chip* newsletter, the 2003 *YCR Annual Report*, 2003 *Wolf Project Annual Report*, 2003 *Yellowstone Bird Report*, 2003 *Yellowstone Pronghorn Report*, and 2003 *Yellowstone Fisheries and Aquatic Sciences Annual Report*. FY04 also saw the publication of retired NPS historian Mary Shivers Culpin's "*For the Benefit and Enjoyment of the People:*" *A History of Concession Development in Yellowstone National Park, 1872-1966*, edited and designed by RIT staff, who also supervised its print production. This is Volume II of Yellowstone's Historic Resource Studies. Volume I was *The History of the Construction of the Road System in Yellowstone National Park, 1872-1966*. This study began as a response to the Federal Highway Administration's multi-decade road construction project in the park to meet the compliance needs of the National Historic Preservation Act of 1966 (as amended in 1980), but grew into a more comprehensive work. A draft of Volume III was revised in 2004 and is in review. It will address historic structures and the history of administration in the park.



Yellowstone Science, the park's journal of natural and cultural resources, got a new look in FY04.

Seventh Biennial Scientific Conference

The Seventh Biennial Scientific Conference on the Greater Yellowstone Ecosystem, *Beyond the Arch: Community and Conservation in Greater Yellowstone and East Africa*, took place on October 6–8, 2003. This conference reached beyond the boundaries of Yellowstone National Park to seek commonality and difference with parks built on the Yellowstone model, but in wholly separate social contexts. Through a publicly-oriented discussion of issues that drew together national parks in the Greater Yellowstone and East Africa, managers, scientists, policymakers, and the public came together to discuss and consider the interdependence of both nature–society relations and natural and cultural history in local and global contexts. Conference attendance broke all previous records, with 188 pre-registered participants and attendees, and several walk-up registrants. Paper and panel presentations included discussions of local ranchland dynamics; national policy and the rights of local peoples; conservation trends in East Africa and the Greater Yellowstone Ecosystem; environmental perception and imagery; comparative ecosystem analyses; and the sometime



Dr. Dan Flores delivered the Aubrey L. Haines lecture at the Seventh Biennial Scientific Conference.

collision of conservation efforts and cultural agendas. The conference attracted speakers and attendees from across North America and from Africa. Keynote speakers included Drs. Richard Leakey, Dan Flores, A.R.E. Sinclair, Steven Sanderson, Charles

Preston, Lee Talbot, and Robin Reid. Conference planning was aided by a Cooperative Ecosystem Studies Unit task agreement with Montana State University. Sponsors included the Yellowstone Association; Xanterra Parks and Resorts; Montana State University's Big Sky Institute; the University of Wyoming's American Studies Program, School of Environment and Natural Resources, and Research Office; the Buffalo Bill Historical Center's Draper Museum of Natural History, and the U.S. Agency for International Development's Global Livestock Collaborative Research Support Program. Editing and layout of the conference proceedings was completed; they will be published in FY05. This conference series was launched in 1991, and is sponsored by the National Park Service in partnership with other agencies, universities, and professional societies. The seven conferences, and the seven large proceedings volumes they have produced, have been called perhaps the single most significant new source of scientific information on Greater Yellowstone in the history of the region.

Presentations, Assistance, and Outreach

RIT staff responded to requests for information on a variety of park topics, made resource-related presentations to a variety of internal and external audiences (including the park's seasonal orientation), and coordinated talks by YCR staff with subject matter expertise.

Throughout 2004, staff provided collaboration, consultation, and support to other park divisions and outside entities. RIT staff assisted the service-wide Benefits-Sharing EIS team by reviewing and editing chapters, designing layout, and producing graphic elements in support of the final product. They also performed editing and layout for the park's Temporary Winter Use Environmental Assessment; provided professional assistance to the Greater Yellowstone Coordinating Committee by performing writing, editing, and layout services for the GYCC's five-year report on stewardship projects; and worked in partnership with the Division of Interpretation to develop an online photo database containing over 8,000 images to serve employees throughout the park.

In addition, RIT staff (in conjunction with the SAC) provided support through a CESU task agreement to authors at Montana State University's

Thermal Biology Institute with editing and graphic elements for *Seen and Unseen: Discovering the Microbes of Yellowstone*, a full-color book on Yellowstone microbes (in press); provided ongoing support to the Superintendent's Office in the preparation of speeches and remarks for the superintendent and visiting dignitaries at various public functions throughout the year; coordinated the submission of and authored three articles from Yellowstone for the *2003 NPS Natural Resource Year in Review*; compiled YCR's submission for the Superintendent's Annual Report; edited and designed the Management Team's "Foundation Planning" brochure; and provided technical support to YCR and other park divisions by scanning images, producing graphics, assisting with software issues, creating covers, posters, brochures, newsletters, and reports, and helping with audio-visual needs, including PowerPoint presentations.

RIT staff also revived work on the proceedings from the Fourth Biennial Scientific Conference, *People and Place: The Human Experience in Greater Yellowstone*. Edited and designed this year, these proceedings will be published in FY05. Staff reviewed *To Save the Wild Bison: Life on the Edge in Yellowstone*, forthcoming, drafted a response to Congress on the 2002 National Academy of Sciences report on the park's northern range, reviewed a variety of publications for the Division of Interpretation, drafted a publications style guide, assisted with the drafting of the YCR publications policy, and assisted with decision-making and organization of the RIT space and YCR lobby.

Research Permit Office

In FY04, Yellowstone's Research Permit Office issued 208 research permits to scientists from across the United States and from six foreign countries. A majority were renewals of previously ongoing studies; 33 requests for new projects were approved by Yellowstone's Research Review Team. An additional 20 scientists inquired about conducting research in FY04, but did not pursue obtaining a research permit. Thirty-nine investigators reported the conclusion of their studies and submitted their research findings and publications to the park.

The Research Review Team, composed of representatives from each park division (Maintenance;

Planning, Compliance, and Landscape Architecture; Resource Management and Visitor Protection; Interpretation; and Yellowstone Center for Resources), was formed in 1996. The group supports Yellowstone's scientific research program by carefully screening research projects for compliance with NPS regulations and policies, as well as their potential impacts to park resources, operations, and visitor experience. The Research Permit Office also works closely with other YCR staff on research projects that require additional review or guidance.

Though Yellowstone is widely known for its abundant wildlife and unique geothermal features, a wealth of research related to other topics occurs in the park. A breakdown of this year's research studies, by topic, is as follows:

Microbiology	44
Air, Soil, and Geology	36
Vegetation	23
Education and Interpretation	19
Fish and Aquatic Life	13
Other Wildlife Species	11
Elk and Other Ungulates	7
Geographic Information Sciences	7
Lakes, Streams, and Groundwater	7
Entomology	6
Paleontology	6
Archeology	5
Wildland Fire	5
Wolves	5
Resource Management Planning	4
Bears	3
Birds	3
Bison	3
Social Science Studies	1

The Research Permit Office staff continued to provide general park information and logistical support (such as housing, specimen curation, training, and uniformed escorts) to researchers throughout the year. Staff also worked diligently to improve communications between researchers and Yellowstone staff by disseminating annual research reports, publications, and theses, as well as organizing research seminars.

The Research Permit Office worked jointly on two projects with Montana State University's Thermal Biology Institute (TBI). The researcher check-in

pilot project aimed to improve researcher–ranger communications through a web-based communication system. While in the park, researchers were able to report their whereabouts and contact information on a website. Rangers were able to query and access researcher entries specific to their management areas.

The second Yellowstone–TBI project involved the creation of an educational brochure and video for researchers. The brochure and video conveyed to researchers a field approach comparable to the Leave No Trace ethic promoted to hikers nationwide by the National Outdoor Leadership School. These educational materials provided examples of ways researchers can conduct fieldwork without leaving lasting evidence of their presence at field locations. The brochure and video also promote safe work habits while researchers conduct field studies in Yellowstone.

Staff also worked closely with YCR’s Spatial Analysis Center staff on a mapping project of locations where research is conducted throughout the park, and of locations where researchers collect specimens and install equipment in the field.

NPS Servicewide Benefits-Sharing Environmental Impact Statement

The first-ever servicewide Environmental Impact Statement (EIS) will evaluate how best to manage benefits-sharing arrangements with the small number of park-permitted researchers who are commonly characterized as bioprospectors. Bioprospecting is the search for valuable substances in nature—usually bioactive molecules and genetic components—and in the national parks is subject to research permitting regulations. Currently, the National Park Service (NPS) facilitates research in parks, but no direct benefits are returned to the parks if a permitted research

project results in a financially valuable discovery. Existing laws allow for agreements that return benefits to parks if research leads to commercial success. The National Parks Omnibus Management Act of 1998 (Public Law 105-391) specifically authorized



Research Permit Coordinator Christie Hendrix helps archeologist Kevin Thorsen take soil samples from site 24YE353.

the NPS to enter into “negotiations with the research community and private industry for equitable, efficient benefits-sharing arrangements.” In 1998, a legal challenge to a benefits-sharing agreement, a CRADA (cooperative research and development agreement) negotiated between Yellowstone National Park and Diversa Corporation, resulted in the judge dismissing the case with prejudice. CRADAs were ruled to be consistent with the National Park Service Organic Act and Yellowstone National Park’s enabling legislation. As a result of a prior order from the same court, the NPS was directed to conduct an analysis under NEPA (the National Environmental Policy Act of 1969), which this EIS effort addresses. The EIS process provides for public dialogue on issues surrounding benefits-sharing as well as a means to evaluate potential environmental effects related to a set of alternative approaches to managing benefits-sharing when research involving biological specimens collected from NPS units yields commercially valuable results.

This EIS, which applies to all units of the National Park System, evaluates and compares potential

means to implement benefits-sharing within the NPS and their resultant effects, including a “no action” alternative that would preclude parks from engaging in benefits-sharing. None of the actions proposed by the National Park Service would weaken long-standing research and collection approval policies intended to protect park resources, nor would additional collections be authorized under benefits-sharing agreements. Prohibitions on the sale and unauthorized transfer of specimens collected in NPS units would not be altered by any of the actions proposed.

Staffing and EIS Teams

In FY04, the benefits-sharing NEPA team consisted of YCR staff Sue Mills (Project Manager), John Varley, and Ann Deutch; and Preston Scott, Thom Minner, and Mansir Petrie of the World Foundation for Environment and Development, contracted to draft and review portions of the EIS and provide legal and technical expertise in the fields of bioprospecting and benefits-sharing. Additional YCR staff members provided key assistance to the EIS effort, including Sara Housley, who re-organized and maintained the EIS’s administrative record. Alice Wondrak Biel and Sarah Stevenson provided editorial and graphical layout expertise. In support of the EIS effort, the NEPA team worked with the NPS’s Washington-level Bioprospecting Management Committee and the EIS’s Interdisciplinary Team (IDT), which provided input and feedback on the development of the draft EIS. The IDT included members from representative parks and central offices from all regions of the NPS. The Bioprospecting Management Committee was co-chaired by John Varley and Mike Soukup, NPS Associate Director for Natural Resources in the Washington Office.

Funding and Personnel

Base Operating Budget

Superintendent Suzanne Lewis and deputy superintendent Frank Walker approved a base operating budget of \$3,988,400 for the YCR on December 12, 2003. This represented an increase of \$569,700 from FY03 funding levels, specifically earmarked for lake trout control operations and the winter use monitoring program. The base allocation was 58% of the

total YCR budget for FY04.

Additional Funding

Recreation Fee Demonstration funds. New funding of \$133,000 was made available in order to continue the rare books restoration project, northern range riparian studies, geothermal features inventory, and whirling disease survey. No funds were granted for new resource management project starts in FY04 under this program. The overall amount allocated to YCR since the inception of the program is approximately \$1,533,000 for 18 individual projects.

Fish Fee program. The YCR received authorization to use \$332,600 from fishing permit fee revenue to partially cover the estimated \$892,000 total cost of the aquatic resources program in FY04.

Federal Lands Highway Program. The Federal Highway Administration funded \$623,500 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. In FY04, the Branch of Natural Resources received \$92,600 from this funding source to continue the elk calf mortality study begun in FY03, finish the survey for Canada lynx, and install groundwater monitoring wells for potential repository sites for the McLaren mine tailings mitigation project.

The Branch of Cultural Resources successfully competed for a total of \$470,400 in special emphasis program funding. These funds were used for relocation of the museum, archives, and library collections to the new Heritage and Research Center, maintenance of the historic vehicle collection, completion of a joint ethnographic resource inventory with Grand Teton National Park, two ethnographic studies, three cataloging projects, support for an historic structures maintenance volunteer program, and continuation of Phase II of the Black Canyon archeological site salvage project.

Other National Park Service funds. Three significant planning projects were undertaken in FY04 on non-base funds: the servicewide Benefits-Sharing EIS, the Brucellosis Vaccine EIS, and a study on the relationship between bison migration patterns and winter road grooming efforts for the Winter Use EIS.

Other federal funds. The Greater Yellowstone

Coordinating Committee elected to fund three Yellowstone projects in FY04, including two aquatic resources projects focusing on native cutthroat trout conservation in the Upper Yellowstone and Snake River regions, and a fuels model mapping project for wildland fire applications.

Private funds. A total of \$229,200 was donated to the park by private organizations or individuals in support of whirling disease surveys, westslope cutthroat trout restoration, Yellowstone cutthroat trout conservation efforts, grizzly bear management operations, a lynx population survey, wolf recovery program operations, an experimental electronic data collection project called *Eyes on Hayden*, and a volunteer program for historic structures conservation.

Personnel

There were 250 personnel actions processed by YCR in FY04. Of special note were the following:

- Long-time employee and Chief of Cultural Resources Sue Consolo Murphy accepted a promotion to the position of Chief of Science and Resource Management at Grand Teton National Park and left Yellowstone in mid-October 2003. YCR's Roger Anderson accepted the Acting Chief of Cultural Resources assignment, which continued through the fiscal year as management debated the best way to permanently fill the vacancy.
- Barbara Cline joined the National Park Service and YCR staff as the division secretary (vice-Beth Taylor) on November 30, 2003.
- Resource Management Specialist Mary Hektner recruited and hired term Geologist Cheryl Jaworowski to integrate geological information into the park's GIS database and assist with development of Yellowstone's geol-

ogy program. Cheryl began her appointment on January 12, 2004.

- After many years of trapping bears and counting bison, first as a volunteer, then eventually as a permanent employee, Wildlife Biologist Mark Biel accepted a promotion at Bryce Canyon National Park as a Resource Management Specialist, and departed Yellowstone in February 2004.
- With the continued growth in size and complexity of the aquatic resources summer field operation at Lake, it was determined that the program needed a full-time administrative assistant on site to assist Supervisory Fisheries Biologist Todd Koel. Former Bureau of Land Management employee Denice Swanke accepted the challenge, and began work on April 4, 2004.

Assistance Agreements

Thirty assistance agreements and task orders were processed in FY04, totaling obligations of \$916,700. Significant investments involved research in support of winter use studies, administration of the Montana Water Compact, archeological surveys and evaluations, aquatic resources studies, a Canada lynx survey, and research on the riparian habitats of Yellowstone's northern range.

Procurement Actions

There were 890 procurement actions processed in FY04, totaling approximately \$1,149,800.

Clerical Support

There were 1,185 pieces of correspondence and 489 travel authorizations processed in FY04.

Table 1. Funding history (FY 1993–2004), Yellowstone Center for Resources, Yellowstone National Park (new allocations only).

YCR Base Increase	FY	National Park Service Funds												
		Park Base	Nat Res Project Funds	Cult Res Project Funds	Fish Fee	FLHP	Fee Demo	Other NPS	Other Federal	Private	Total			
	'93	\$1,004,600	16,000	-	-	-	-	-	-	-	785,000	188,000	20,000	2,013,600
\$245,400	'94	1,250,000	260,000	33,200	65,000	43,300	-	43,300	-	-	320,600	79,600	10,000	2,061,700
\$250,000	'95	1,500,000	420,000	45,000	65,000	303,600	-	303,600	-	-	59,800	20,000	5,300	2,418,700
\$44,100	'96	1,544,100	404,000	201,100	274,500	626,700	-	626,700	-	-	157,800	65,000	31,500	3,304,700
\$130,000	'97	1,674,100	204,000	228,400	213,400	433,700	340,000	433,700	340,000	340,000	42,700	398,300	48,000	3,582,600
\$571,500	'98	2,245,600	130,500	242,100	284,800	330,800	31,000	330,800	31,000	31,000	24,000	65,300	37,700	3,391,800
\$286,300	'99	2,531,900	-	221,900	285,000	396,500	298,000	396,500	298,000	298,000	152,900	105,200	56,700	4,048,100
\$36,700	'00	2,568,600	237,500	101,000	280,000	214,900	631,000	214,900	631,000	631,000	1,418,000	41,300	52,700	5,545,000
\$93,300	'01	2,661,900	297,000	216,700	285,100	409,000	-	409,000	-	-	-	15,000	85,500	3,970,200
\$772,900	'02	3,434,800	293,000	198,700	261,900	293,200	6,000	293,200	6,000	6,000	-	11,700	126,400	4,625,700
\$(16,100)	'03	3,418,700	101,000	326,300	250,000	431,000	103,000	431,000	103,000	103,000	454,400	24,000	224,300	5,332,700
\$569,700	'04	3,988,400	92,600	470,400	332,600	623,500	133,000	623,500	133,000	133,000	855,000	22,400	229,200	6,747,100

Table 2. YCR distribution of FY04 funds (includes carryover).

Program	National Park Service Funds										% of Total Funding			
	Park Base	Nat Res Project Funds	Cult Res Project Funds	Fish Fee	FLHP	Fee Demo	Other NPS	Other Federal	Private	Total				
Cultural Resources	428,800	-	470,400	-	283,200	33,000	-	33,000	-	-	-	8,200	1,223,600	18%
Natural Resources	2,618,400	92,600	-	332,600	300,900	166,300	505,000	166,300	505,000	505,000	17,500	220,100	4,253,400	62%
Professional Support	941,200	-	-	-	39,400	29,500	350,000	29,500	350,000	350,000	4,900	900	1,365,900	20%
Total	3,988,400	92,600	470,400	332,600	623,500	228,800	855,000	228,800	855,000	855,000	22,400	229,200	6,842,900	100%

Notes

Appendix I: Personnel Roster for FY 2004

			FTE	Borrowed FTE
Professional Support Branch				
Management and Administration				
1	Wayne Brewster	Deputy Director	1.00	
2	Elizabeth Cleveland	Administrative Support Assistant	0.25	
3	Barbara Cline	Administrative Support Assistant	0.84	
4	Ann Deutch	Administrative Support Assistant	0.62	
5	Christie Hendrix	Environmental Protection Specialist	1.00	
6	Sara Housley	Center Clerk	0.03	
7	Melissa McAdam	Supervisory Budget Analyst	1.00	
8	Sue Mills	Environmental Protection Specialist	1.00	
9	Joy Perius	Budget Analyst	1.00	
10	Christine Smith	Administrative Support Assistant	0.40	
11	Beth Taylor	Secretary		0.02
12	John Varley	Director	1.00	
13	Colleen Watson	Administrative Support Assistant	1.00	
14	Marlene Whiteside	Maintenance Worker		0.02
<i>subtotal Management & Administration</i>			9.14	0.04
Resource Information Team				
15	Roger Anderson	Resource Management Specialist	0.50	
16	Tami Blackford	Technical Writer-Editor	0.74	
17	Mary Ann Franke	Technical Writer-Editor	0.24	
18	Paul Schullery	Resource Naturalist	0.44	
19	Sarah Stevenson	Technical Writer-Editor	0.29	
20	Virginia Warner	Editorial Assistant	0.50	
21	Alice Wondrak Biel	Technical Writer-Editor	1.00	
<i>subtotal Resource Information</i>			3.71	
Spatial Analysis Center				
22	Nicholas Bonzey	Cartographic Technician	0.22	
23	Erin Campbell	Cartographic Technician	1.00	
24	Michael Demmon	Cartographic Technician	0.36	
25	Carrie Guiles	Cartographic Technician	0.64	
26	Steve Miller	Cartographic Technician	0.50	
27	James Napoli	Cartographic Technician	0.93	
28	Ann Rodman	Supervisory GIS Specialist	1.00	
29	Shannon Savage	GIS Specialist	0.84	
<i>subtotal Spatial Analysis:</i>			5.49	
Professional Support Branch FTE			18.34	0.04

			FTE	Borrowed FTE
Natural Resources Branch				
Natural Resources Administration				
1	Sherman Burson	Ecologist		0.50
2	Tom Olliff	Chief, Branch of Natural Resources	1.00	
3	Rebecca Wyman	Administrative Support Assistant	1.00	
<i>subtotal NR Admin FTE:</i>			2.00	0.50
Wildlife Resources Team				
4	Mark Biel	Wildlife Biologist	0.40	
5	Hillary Billman	Biological Science Technician	0.38	
6	Doug Blanton	Biological Science Technician	1.00	
7	Brian Buchanan	Biological Science Technician	0.34	
8	Susan Chin	Biological Science Technician	1.00	
9	Lisa Coleman	Biological Science Technician	0.30	
10	Tyler Coleman	Biological Science Technician	0.44	
11	Troy Davis	Biological Science Technician	1.00	
12	Mary Donovan	Biological Science Technician		0.36
13	Ben Dorsey	Cartographic Technician	0.74	
14	Julie Garton	Biological Science Technician		0.34
15	Michael Gegg	Biological Science Technician	0.42	
16	Chris Geremia	Biological Science Technician	1.00	
17	David Graves	Cartographic Technician	0.28	
18	Rachael Gray	Biological Science Technician	0.22	
19	Christine Greve	Visitor Use Assistant		0.08
20	Deb Guernsey	Program Assistant	0.98	
21	Carrie Guiles	Cartographic Technician	0.11	
22	Kerry Gunther	Wildlife Biologist	1.00	
23	Jennifer Jones	Biological Science Technician	0.08	
24	M.T. Jones	Biological Science Technician	0.83	
25	Daniel Krapf	Forestry Technician		0.01
26	Karen Lovelace	Biological Science Technician	0.56	
27	Peter Lundberg	Biological Science Technician	0.38	
28	Tim McGrady	Animal Packer		0.02
29	Terry McEneaney	Wildlife Biologist	1.00	
30	Rick McIntyre	Biological Science Technician	0.52	
31	Mary McKinney	Biological Science Technician		0.35
32	Steve Miller	Cartographic Technician	0.08	
33	Kerry Murphy	Wildlife Biologist	0.98	
34	Gary Nelson	Park Ranger		0.03
35	Glenn Plumb	Supervisory Wildlife Biologist	1.00	
36	Derek Poinsette	Biological Science Technician	0.42	
37	Tiffany Potter	Biological Science Technician	0.31	
38	Gina Poulson	Biological Science Technician	0.36	
39	Lori Roberts	Biological Science Technician	0.50	

		FTE	Borrowed FTE
40	Ryan Rummelhart	0.25	
41	Monty Simenson		0.50
42	Doug Smith	1.00	
43	Dan Stahler	1.00	
44	Janice Stroud	0.10	
45	John Treanor	0.38	
46	Rick Wallen	1.00	
47	Kim West		0.04
48	P.J. White	1.00	
49	Travis Wyman	0.98	
<i>subtotal Wildlife FTE</i>		22.34	1.73

Fisheries and Aquatic Resources

50	Melissa Anacker	0.28	
51	Krisinda Anderson	0.38	
52	Jeff Arnold	1.00	
53	Pat Bigelow	1.00	
54	Tim Bywater	0.09	
55	Trevor Clark	0.09	
56	Stephen Conley	0.32	
57	Alice Cook	0.23	
58	Chris Dixon	0.53	
59	Philip Doepke	1.00	
60	David Elwood		0.02
61	Debra Elwood		0.31
62	Brian Ertel	1.00	
63	Joseph Facendola	0.51	
64	Scott Favrot	0.34	
65	Michael Jones	0.23	
66	Maureen Kavanaugh	0.40	
67	Shane Keep	0.52	
68	Todd Koel	1.00	
69	Nicole Legere	0.35	
70	Dan Mahony	1.00	
71	Brad Olszewski	0.41	
72	Barbara Rowdon	1.00	
73	Melinda Sefton		0.08
74	Stacy Sigler	0.50	
75	Amber Steed	0.05	
76	Denice Swanke	0.45	
77	Gary Vonderohe	0.10	
78	Charles Walton	0.25	
79	Don Wethington	0.52	
80	Davina White	0.09	
<i>subtotal Aquatic Resources FTE</i>		13.64	0.41

			FTE	Borrowed FTE
Vegetation Management				
81	Heidi Anderson	Botanist	0.91	
82	William Edwards	Biological Science Technician	0.28	
83	Mary Hektner	Resource Management Specialist	1.00	
84	John Klaptosky	Biological Science Technician	0.45	
85	Vicki Pecha	Biological Science Technician	0.68	
86	Roy Renkin	Vegetation Management Specialist	1.00	
87	Jennifer Whipple	Botanist	0.83	
<i>subtotal Vegetation FTE</i>			5.15	
Geology and Physical Sciences				
88	Henry Heasler	Supervisory Geologist	1.00	
89	Cheryl Jaworowski	Geologist	0.68	
90	Steve Miller	Physical Science Technician	0.42	
91	Tim Thompson	Physical Science Technician	0.08	
<i>subtotal Geology FTE</i>			2.18	
Natural Resources Branch FTE			45.31	2.64
Cultural Resources Branch				
1	David Ammott	Museum Technician	0.22	
2	Roger Anderson	Chief, Branch of Cultural Resources	0.50	
3	Sean Cahill	Museum Technician	0.16	
4	Maria Capozzi	Museum Technician	0.39	
5	Bridgette Case	Museum Technician	0.45	
6	Alicia Coles	Archeological Technician		0.05
7	Sue Consolo Murphy	Chief, Branch of Cultural Resources	0.05	
8	Colleen Curry	Curator	1.00	
9	Herbert Dawson	Historic Architect	0.79	
10	Tasha Felton	Cultural Resources Technician	0.98	
11	Jessica Gerdes	Museum Technician	0.25	
12	Elaine Hale	Cultural Resources Technician	0.97	
13	Maurine Hinckley-Cole	Administrative Support Assistant	0.92	
14	Harold Housley	Archives Specialist	1.00	
15	Sarah Housley	Center Clerk	0.05	
16	Ann Johnson	Archeologist	1.00	
17	Alice Newton	Registrar		0.21
18	Charissa Reid	Cultural Anthropologist	0.13	
19	Rosemary Sucec	Cultural Anthropologist	1.00	
20	Steven Tustanowski-Marsh	Museum Technician	1.00	
21	Lee Whittlesey	Archivist	0.99	
Cultural Resources Branch			11.85	0.26
TOTAL YCR FY04 FTE			75.50	2.94

Appendix II:

Publications, Reports, and Papers

Professional Publications

- Bangs, E.E., J. Fontaine, T. Meier, C. Niemeyer, M. Jimenez, D.W. Smith, C. Mack, V. Asher, L. Handegard, M. Collinge, R. Krischke, C. Sime, S. Nadeau, and D. Moody. 2004. Restoration and conflict management of the gray wolf in Montana, Idaho, and Wyoming. Pages 89–105 in *Transactions of the 69th North American wildlife and natural resources conference*, J. Rahm, ed. (Washington, D.C.: Wildlife Management Institute).
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- Hale, E.S., and J. Fitzke. 2004. *Trilobite Point paleontological resource survey report* (Mammoth, Wyo.: Yellowstone National Park).
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- Smith, D.W. 2004. The wolf in fairy tales. Pages 39–40 in *Encyclopedia of animal behavior*, Marc Bekoff, ed. (Westport, Conn.: Greenwood Press).
- Smith, D.W., T.D. Drummer, K.M. Murphy, D.S. Guernsey, S.B. Evans. 2004. Winter prey selection and estimation of wolf kill rates in Yellowstone National Park, 1995–2000. *Journal of Wildlife Management* 68:153–166.
- Wallace, L.L., F.J. Singer, and P. Schullery. 2004. The fires of 1988: a chronology and invitation to research. Pages 3–9 in L.L. Wallace, ed. *After the fires: the ecology of change in Yellowstone National Park* (New Haven: Yale University Press).

- Wallen, R., and G. Plumb. 2003. Interagency Bison Management Plan for Yellowstone and Montana: Yellowstone National Park's role in implementing this plan. *Proceedings of the annual meeting of the U.S. Animal Health Association*, 258–262.
- Whittlesey, L. Music, song, and laughter: Yellowstone's Fountain Hotel, 1891–1916. *Montana the Magazine of Western History* 53 (Winter 2003):22–35.
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- Podruzny S., and K. Gunther. 2004. Spring ungulate availability and use by grizzly bears in Yellowstone National Park. Pages 26–30 in C.C. Schwartz and M.A. Haroldson, eds. *Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2003* (Bozeman, Mont.: U.S. Geological Survey).
- Servheen, C., M. Haroldson, K. Gunther, K. Barber, M. Bruscino, M. Cherry, B. DeBolt, K. Frey, L. Hanauska-Brown, G. Losinski, C. Schwartz, and B. Summerfield. 2004. *Yellowstone mortality and conflicts reduction report* (Missoula, Mont.: U.S. Fish and Wildlife Service), 25pp.
- Smith, D.W., D.R. Stahler, and D.S. Guernsey. 2004. *Yellowstone Wolf Project: annual report, 2003* (Yellowstone National Park,

- Wyo.: National Park Service, Yellowstone Center for Resources), YCR-NR-2004-04.
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- White, P.J., R.A. Garrott, and L.E. Eberhardt. 2003. *Evaluating the consequences of wolf recovery on northern Yellowstone elk* (Yellowstone National Park, Wyo.: National Park Service, Yellowstone Center for Resources), YCR-NR-2004-02.
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- Gunther, K.A. 2004. Bears and menstruating women. Information Paper No. BMO-7. U.S. Department of the Interior, National Park Service, Yellowstone National Park. 2pp.
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Information Papers

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- Gunther, K.A. 2004. Yellowstone National Park bear-related injuries/fatalities. Information Paper No. BMO-1. U.S. Department of the Interior, National Park Service, Yellowstone National Park. 2pp.
- Gunther, K.A. 2004. Food habits of grizzly bears and black bears in the Yellowstone ecosystem. Information Paper No. BMO-3. U.S. Department of the Interior, National Park Service, Yellowstone National Park. 3pp.
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Notes

Appendix III: Partnerships

Standing Partnerships

YCR staff contribute to international, national, and regional resource stewardship efforts by participating in the following ongoing partnerships:

Air Quality Monitoring

Partner: Montana Department of Environmental Quality

Mission: To monitor air quality (carbon monoxide and particulate matter (PM_{2.5})) at the park's West Entrance.

Commitment: A three-year cooperative agreement.

YCR representative: Mary Hektner

2004 highlights: A significant decrease in snowmobile traffic during the 2003–2004 winter season was mirrored by decreases in the concentrations of particle matter and carbon monoxide. All observed concentrations of PM_{2.5} and CO were below the National Ambient Air Quality standards set by the EPA. The maximum rolling 24-hour average concentration for PM_{2.5} decreased by about 60%, and the maximum 1-hr and 8-hr CO concentrations decreased by about 24% at Old Faithful. Peak values, as indicated by maximum 1-hour or by the ninetieth percentile, also decreased. The combination of less traffic, cleaner engine exhaust, ethanol-enhanced fuels, and less idling time appears to have successfully improved the air quality at the two monitoring locations.

Cooperative Mid-sized Carnivore Inventory and Research

Partner: U.S. Forest Service

Mission: To improve research and inventory-related studies on mid-sized carnivores in the Greater Yellowstone Ecosystem.

Commitment: 20 workdays.

YCR representative: Kerry Murphy

2004 highlights: Biologists from Yellowstone

National Park, the U.S. Forest Service Rocky Mountain Research Laboratory, and the U.S. Forest Service Region 1 office initiated joint planning and fund-raising for cooperative wolverine studies to begin during fall 2005.

Ethnographic Resources Inventory (ERI) National Data Standards and Implementation Committee

Partners: Various National Park Service (NPS) units and regions, and a private contractor.

Members include the NPS's Chief Ethnographer; the NPS's Archeology and Ethnography Program Manager; regional representatives from the Alaska, Midwest, Northeast, and Southeast regions; NPS ethnographers from Yellowstone and Olympic national parks, and the contractor who developed the software.

Mission: To consider how the ERI system is operating, identify any needed changes, consider interface with other servicewide data systems, and address operational and conceptual needs as they arise.

Commitment: Telephone conference calls every quarter and on an as-needed basis. Attendance at the annual meeting of NPS ethnographers.

YCR representative: Rosemary Sucec

2004 highlights: In 2004, an updated version of the ERI was approved for use. However, the database still remains technologically rudimentary, and the National Park Service is exploring ways not only to increase the capacity of the database, but also to make it more user friendly for park compliance, planning, resource management, and visitor education staff (staff other than ethnographers). By the end of 2004, almost 200 ethnographic resources had been entered into the park database.

Federal Highways Road Team

Partner: Federal Highway Administration

Mission: Context-sensitive design, improvement, and reconstruction of Yellowstone National Park's

principal historic roads. The road team is intimately involved in all phases of National Environmental Policy Act planning, historic preservation, wetlands, and Endangered Species Act compliance.

Commitment: Weekly conference calls, two four-day sessions walking the road corridor along each segment of road to be reconstructed, winter meetings.

YCR representatives: Mary Hektner and Elaine Hale

2004 highlights: This partnership continues to be highly productive and mutually beneficial. The design engineers at Western Federal Lands Division were awarded the Federal Highway Administration's 2004 Excellence in Highway Design Award for the Madison-to-Old Faithful road segment.

Greater Yellowstone Area Clean Air Partnership

Partners: Grand Teton National Park; Gallatin, Custer, Beaverhead, Shoshone, Bridger-Teton, and Targhee national forests; Red Rock Lakes National Wildlife Refuge; Idaho National Environmental and Energy Laboratory; Montana, Idaho, and Wyoming Departments of Environmental Quality

Mission: The partnership serves as an advisory group to the Greater Yellowstone Coordinating Committee, and is a forum for information exchange to facilitate air program coordination and the implementation of consistent air quality management strategies.

Commitment: Annual meeting.

YCR representative: Mary Hektner

2004 highlights: Yellowstone National Park hosted the annual meeting, during which information was shared on visibility data, air quality rulemaking, Yellowstone's "greening" efforts, and snow deposition chemistry studies.

Greater Yellowstone Bald Eagle Working Group

Partners: Greater Yellowstone Area state and federal government agencies, and non-governmental organizations

Mission: Established in 1982, this group monitors bald eagle productivity and other information.

Commitment: Previously annual meetings, but a

meeting has not been held in the last four years.

Information is communicated via e-mail.

YCR representative: Terry McEaney

2004 highlights: A meeting was held in 2004, but the YCR representative was unable to attend due to budget constraints.

Greater Yellowstone Interagency Brucellosis Committee (GYIBC)

Partners: U.S. Department of Agriculture; states of Montana, Wyoming, and Idaho

Mission: The GYIBC was formed through a Memorandum of Agreement between the Secretaries of the Department of Agriculture and Interior and the governors of Montana, Wyoming, and Idaho. The GYIBC has an executive committee, two subcommittees, a technical subcommittee, and an information and education subcommittee. The scope of work for the GYIBC includes developing options and recommendations for member agencies in charting a management program for brucellosis-affected wildlife populations and their habitat in the Greater Yellowstone Area (GYA); providing coordination of agency responsibilities without usurping agency mandates; encouraging cooperation in resolving resource problems and conflicting interests related to brucellosis in wildlife; and providing guidance and oversight to subcommittees. The technical subcommittee, which serves at the direction of the executive committee, will develop a comprehensive, objective, and scientific base of information and recommend strategies based on common understanding of brucellosis and its impacts on the resources of the GYA, and serve as the scientific advisor to the GYIBC. The information and education subcommittee will develop factual information regarding the purpose of the GYIBC for public distribution and will develop a brucellosis information and education strategic plan for the GYIBC.

Commitment: The National Park Service-IMR Regional Director is represented on the executive committee by the Associate Regional Director for Natural Resources and Science. Yellowstone provides a representative for the technical subcommittee. Technical and executive committee meetings are held three times annually.

YCR representative: Wayne Brewster

2004 highlights: The group initiated an update of the enabling Memorandum of Understanding in 2004. The MOU is expected to be completed in 2005.

Greater Yellowstone Peregrine Falcon Working Group

Partners: Two peregrine falcon working groups, the states of Montana and Wyoming, and the Peregrine Fund.

Mission: To continue to facilitate the recovery of the peregrine falcon in the Greater Yellowstone Area.

Commitment: Wyoming has an informal working group, with coordination done over the telephone. Montana has a more formalized working group with an annual meeting.

YCR representative: Terry McEneaney

2004 highlights: The YCR representative attended the group's meeting in 2004.

Greater Yellowstone Trumpeter Swan Working Group

Partner: Greater Yellowstone Area agencies

Mission: To collect annual population and production data on trumpeter swans in the Greater Yellowstone Area.

Commitment: Management activities are communicated between agencies at meetings.

YCR representative: Terry McEneaney

2004 highlights: The YCR representative attended the group's meeting in West Yellowstone.

Harlequin Duck Working Group

Partner: This group is an international (U.S. and Canada) and interagency (state, federal, and provincial) assemblage.

Mission: To share harlequin duck information and data.

Commitment: Yellowstone National Park is a member of the working group.

YCR representative: Terry McEneaney

2004 highlights: The YCR representative was unable to attend the group's meeting due to budget constraints.

Integrated Science in Central Yellowstone

Partners: Montana State University, California State University–Monterey Bay

Mission: To build an integrated and multidisciplinary research program dedicated to producing objective science with the goal of advancing our knowledge of the central Yellowstone ecosystem, supporting sound natural resource management, and communicating our knowledge and discoveries to the visiting public to enhance their experience and enjoyment of the park.

Commitment: The Yellowstone Center for Resources is a full partner in this project, and has committed resources and staff for the duration of the project.

YCR representative: P.J. White

2004 highlights: The partnership was awarded a 5-year, \$1.5 million grant from NASA's Office of Earth Science Enterprises (Earth Science REASoN—Research, Education, and Application Solutions Network: A Distributed Network of Data and Information Providers for Earth Science Enterprise Science, Applications and Education) to integrate data and models through remote sensing, innovative mapping, and dynamic, interactive, visualization, and provide products and solutions to three broad groups of people involved in the park's decisionmaking processes: 1) park staff who will use the products to make wise decisions, implement solutions, and communicate information to stakeholders; 2) practitioners of wildlife ecology and remote sensing who will benefit from the new, benchmark technologies and approaches for integrating, understanding, and communicating information about the earth's systems; and 3) the park's 3 million annual visitors and additional "virtual visitors" through the world-wide web and other outreach avenues.

Interagency Grizzly Bear Study Team

Partners: U.S. Geological Survey-Biological Resources Discipline, National Park Service, U.S. Forest Service, states of Idaho, Montana, and Wyoming.

Mission: The Interagency Grizzly Bear Study Team (IGBST) conducts research that provides information needed by various agencies for immediate and

long-term management of grizzly bears inhabiting the Greater Yellowstone Ecosystem. With increasing demands on most resources in the area, current quantitative data on grizzly bears are required for formulation of management decisions that will ensure the survival of the population.

Commitment: Two to six meetings annually. Meetings typically range from one to two days.

YCR representative: Kerry Gunther

2004 highlights: In 2004, IGBST members provided managers with pertinent information on grizzly bear survival, mortality, cub production, population estimates, key foods, habitat, and conflicts with humans. In addition, team members published in peer reviewed scientific journals, papers on nutritional ecology of ursids, use of naturally occurring mercury to estimate grizzly bear consumption of cutthroat trout, interactions between wolves and female grizzly bears with cubs, grizzly bear-human conflicts, and management of habituated grizzly bears.

McLaren Mill Mine Tailings and Great Republic Smelter Reclamation

Partner: Montana Department of Environmental Quality

Mission: To address the potential reclamation of the McLaren Mill and Mine tailings sites, and other water quality issues in the Cooke City, Montana, area.

Commitment: Meeting participation.

YCR representative: Mary Hektner

2004 highlights: The park and the Montana Department of Environmental Quality signed a cooperative agreement wherein the National Park Service will transfer funds to the state so that it can conduct key groundwater investigations. The data gathered will help to assess the suitability of the state's proposed site for a mine waste repository. Three groundwater monitoring wells are now scheduled to be installed in the spring of 2005.

Montana Bird Records Committee

Partners: Various government agencies

Mission: To review new and rare bird records, and to keep the park up-to-date on the latest advances in ornithology.

Commitment: The group meets once or twice each year, depending on the volume of information to be addressed.

YCR representative: Terry McEneaney

2004 highlights: Attended annual meeting in Great Falls, Montana.

Montana Fluvial Arctic Grayling Workgroup

Mission: This group develops short- and long-term goals and works toward the restoration of populations in the upper Missouri basin.

Commitment: A one-day meeting each year plus any required field activities.

YCR representative: Todd Koel

2004 highlights: Arctic grayling are declining throughout their natural range in southwest Montana. Yellowstone National Park has initiated research to determine the status of fluvial arctic grayling within the Gibbon River system.

National Partnership for the Management of Wild and Native Coldwater Fisheries

Mission: This group provides leadership and recommendations for the Whirling Disease Initiative and the Montana Water Center.

Commitment: One three-day meeting each year.

YCR representative: Todd Koel

2004 highlights: The Whirling Disease Initiative will continue to fund research projects with a focus on the development of tools to mitigate the effects of the disease.

Natural Resources Advisory Group

Partners: National Park Service regions; each region has three representatives: a central office representative, a field resources representative, and a superintendent.

Mission: To advise the Associate Director for Natural Resources, Mike Soukup, on servicewide issues.

Commitment: Annual meeting and between-meeting assignments.

YCR representative: Tom Olliff

2004 highlights: This group met March 23–27 in Homestead, Florida. The group discussed Resource Stewardship Plans, the Planning Environment and

Public Comment (PEPC) web-based planning program, the Marine Protected Areas Initiative, Training and Professional Development, an evaluation of the WASO Natural Resources Program, and the new Performance Management System.

Neotropical Migrant Working Groups

Partners: Partners in Flight of Montana, Partners in Flight of Wyoming, Western Working Group Partners in Flight

Mission: They are currently focused on prioritizing species and developing conservation plans.

Commitment: Meetings occur twice a year, usually in different areas of the West.

YCR representative: Terry McEneaney

2004 highlights: The YCR representative was unable to attend the group's meetings due to budget constraints.

New World Mining District Response and Restoration Project

Partners: U.S. Department of Agriculture, U.S. Environmental Protection Agency

Mission: In 1998, an interagency Memorandum of Understanding was established between the U.S. Department of Agriculture, Environmental Protection Agency, and Department of Interior. This MOU provides the framework and responsibilities for intra-governmental coordination of the development, selection, implementation, and oversight of certain response and natural resource restoration activities in the New World Mining District by the federal agencies in conjunction with the states of Montana and Wyoming and public participation. The U.S. Forest Service is the lead agency.

Commitment: In FY04, as the Department of Interior's Project Coordinator, Mary Hektner participated in three public and agency meetings related to the ongoing restoration work, and reviewed, commented upon, and concurred with the U.S. Forest Service's quarterly progress reports to Congress.

YCR representative: Mary Hektner

2004 highlights: Mary Hektner prepared and compiled DOI comments on the draft removal action engineering and environmental cost analysis, *Mining waste on National Forest System lands located*

along Soda Butte Creek, Cooke City area, Montana, and the draft 2004–2005 New World Response and Restoration Work Plan.

Northern Yellowstone Cooperative Wildlife Working Group

Partners: Montana Fish, Wildlife and Parks, Gallatin National Forest, U.S. Geological Survey-Northern Rocky Mountain Science Center

Mission: To preserve and protect the long-term integrity of the northern Yellowstone winter range by increasing scientific knowledge of its species and habitats, promoting prudent land management activities, and encouraging an interagency approach to answering questions and solving problems.

Commitment: Bi-annual meetings and work assignments on annual wildlife surveys and reports. Member agencies share costs and duties for monitoring ungulates on the northern range (inside and outside the park).

YCR representatives: Glenn Plumb and P.J. White

2004 highlights: The Working Group completed cooperative counts and/or classifications of northern Yellowstone elk, pronghorn, and mountain goats, the results of which were summarized in an annual report.

Partnerships with 26 American Indian Tribes

Partners: Twenty-six park-affiliated American Indian tribes and 54 bison-interested tribes

Mission: Interagency consultation with the goal of enabling the park to manage its cultural and natural resources in a sensitive, culturally informed manner.

Commitment: Each spring, tribes are invited to come to the park for a full day's meeting to hear about the most pressing management issues in natural and cultural resources. A welcoming potluck is held, and field trips are usually offered. In the fall, park personnel travel to one of the reservations of a park-associated tribe to learn more about them, as well as any needs the tribe has with which Yellowstone National Park managers might be able to help.

YCR representative: Rosemary Sucec

2004 highlights: In the fall of FY04, park managers traveled to Fort Hall, Idaho, to meet with the

governing council of the Shoshone-Bannock Tribes. In the spring of 2004, at the general intergovernmental consultation meeting, tribes expressed their frustration that bison continued to be killed. Suggestions by delegates were made to improve next year's meeting and will be implemented by the park. Two benchmark events occurred with respect to tribal involvement in bison management. The Intertribal Bison Cooperative was granted a seat on the Greater Yellowstone Interagency Brucellosis Committee, and a quarantine pilot project was initiated that would enable tribes to obtain live buffalo. Tribes view both of these actions as evidence that the agencies involved in bison management are beginning to listen to them. Bison remain probably the most significant ethnographic resource at Yellowstone for the majority of tribes. Almost all of the tribes that remain involved with the bison management issue at the park also have cultural traditions that direct their involvement in the stewardship of bison. That direction is supernaturally derived and is also linked to the belief that if the buffalo do not survive, the persistence of those tribes will also be at risk. Additionally, buffalo constitute physical, cultural, and spiritual sustenance for many of the same tribes.

Rocky Mountain Cluster Natural Resource Managers Group

Partners: National Park Service units of the Rocky Mountain Cluster

Mission: To discuss important cluster resource issues and funding initiatives, and to receive updates on servicewide issues.

Commitment: A two-day annual meeting.

YCR representative: Tom Olliff

2004 highlights: This group met February 11–12, 2004. Topics included introductions to the Tehabi Intern Program (sponsored by the National Park Service and Utah State University) and updates on the Intermountain Region Natural Resources, Research, and Technology group, the Intermountain Natural Resources SEPAS funding process, Resource Stewardship Planning, the Rocky Mountain CESU, and the Inventory and Monitoring Program.

Snow Survey

Partner: Natural Resources Conservation Service

Mission: To collect snowpack and related climate information in order to monitor and help manage surface water supply derived from snowmelt in the higher mountainous areas of the West.

YCR representative: Mary Hektner

Commitment: Ranger staff collect monthly snow depth and average water content data (January–May) at five manual snow courses and 7 of 10 automated SNOTEL sites. YCR staff conduct resource inventories required to allow site modifications needed to install additional equipment.

2004 highlights: The NRCS added snow depth sensors to the SNOTEL stations to collect snow depth measurements in addition to the snow water equivalent (SWE), precipitation, and temperature data historically collected at the sites. This information will help NRCS hydrologists more accurately assess hydrologic and climate conditions relating to water supply conditions and provide for better management decisions.

Snowshoe Hare (*Lepus americanus*)

Abundance Study

Partner: University of Montana

Mission: To document abundance of snowshoe hare in selected Yellowstone National Park forest habitat types.

Commitment: 10 workdays.

YCR representative: Kerry Murphy

2004 highlights: To estimate the abundance of snowshoe hares, University of Montana researchers Drs. Karen Hodges and L. Scott Mills conducted fecal pellet counts and deployed live traps across a broad range of Yellowstone forest types. In 2004, areas burned by the 2003 East Fire were sampled to document the effects of the fire on hares and habitat conditions. Essentially no hares were found in post-fire habitats. Numerous unburned sites were also sampled parkwide. Results clearly showed that snowshoe hares are uncommon in Yellowstone. The highest densities were less than one hare per hectare, and densities even above 0.5 hares per hectare were rare in the park. The majority of the stands had no evidence of snowshoe hares. Only six stands had enough pellets to indicate a reasonable resident

hare population. Even on these best plots, the pellet counts were quite low, reflecting small numbers of hares.

Tauck Volunteer Program

Partners: Tauck World Discovery/Tauck Bridges

Mission: To provide Tauck guests the opportunity to volunteer in Yellowstone National Park, and allow the park to complete projects that otherwise would not have been done.

Commitment: Approximately one week per month during spring through fall, plus several days each month during winter.

YCR representative: Herb Dawson

2004 highlights: Volunteers prepared and stained eight employee cabins on the Lower Loop of the Old Faithful Lodge Cabin Complex; prepared and log-oiled the Nez Perce Patrol Cabin; painted 110 fire hydrants at the Grant Village and Old Faithful developed areas; helped Maintenance personnel from the Grant subdistrict to replace and stain log guardrails; cleaned the parking lot and picnic area at West Thumb Geyser Basin; and prepped and stained 500 bumper logs at campsites in the Bridge Bay Campground.

Virginia City National Historic Landmark District Stabilization Partnership

Partner: Montana Heritage Commission (MHC)

Mission: To administer the expenditures of a \$1.7 million grant to the MHC from the National Park Service, and provide technical assistance and liaison with the MHC, the National Park Service, private consultants, contractors, and the Montana State Historic Preservation Commission.

Commitment: Three days per month.

YCR representative: Herb Dawson

2004 highlights: The YCR representative oversaw interior rehabilitation of Contents Corner, one of the original 1863 stone structures; assisted with planning for the Gilbert Brewery and Hops Tower, one of the oldest still standing frontier breweries in the West; continued to review work; and provided technical assistance to the Virginia City Historic Preservation Crew.

Wyoming Important Bird Area Technical Review Committee (WIBATRC)

Partner: Wyoming Audubon

Mission: The WIBATRC is responsible for reviewing, designating, and implementing important land tracts in Wyoming for bird conservation.

Commitment: Meetings.

YCR representative: Terry McEneaney

2004 highlights: Due to budget constraints, attended meeting via conference call. Reviewed over one dozen new areas.

Wyoming Rare Plant Technical Committee

Mission: To coordinate activities between different government agencies with rare plant responsibilities, and promote awareness of rare plants statewide.

Commitment: Two days.

YCR representative: Jennifer Whipple, chairperson

2004 highlights: Coordinated activities between agencies and started preliminary discussions for the next native plant conservation workshop.

Yellowstone River Task Force

Partners: Landowners, sportsmen, and community leaders

Mission: Commissioned by the governor of Montana in 1998 and continued through 2003, this task force seeks to develop a shared understanding of the issues and competing values and uses that impact the upper Yellowstone River, and to encourage a comprehensive approach to action taken along the river to ensure that its integrity remains intact.

Commitment: Monthly meetings and annual field trips. Yellowstone sits on the task force as an ex-officio member.

YCR representative: Tom Olliff

2004 highlights: This group completed its task of making recommendations to the Governor of Montana in October 2004, then disbanded.

Project-Based Partnerships

YCR staff enlist a variety of external partners from universities, federal and state agencies, non-governmental organizations, and private groups on a short-term basis to meet some of the park's specific resource stewardship objectives. These partnerships normally last one-to-three years, are formed to achieve specific objectives, and disband when the objectives are achieved. The following partnerships were active in FY04:

Cooperator/ Partner	Contact/ Principal Investigator	Project	Benefiting Program	Fund Source	Amount
A Naturalist's World	Drs. Kerry Murphy (YCR) & James Halfpenny, Kerry Gunther (YCR)	The presence and distribution of lynx (<i>Lynx canadensis</i>) in Yellowstone	Lynx project	NPS, Yellowstone Park Foundation, National Fish and Wildlife Foundation	\$61,000
Ballistic Technologies, Inc.	Rick Wallen (YCR), Dr. Rick Hansen	Accuracy of pneumatic remote delivery equipment	Bison Ecology and Management	USGS-BRD (paid out in FY04) ONPS-Bison Mgt.	\$96,000
Bear Creek Council	Rosemary Sucec (YCR)	Support for the potluck welcoming American Indian tribes to Yellowstone	Ethnography	in-kind	publicity, set-up, food, logistics
Bridger-Teton National Forest, Grand Teton NP	Rosemary Sucec (YCR), Jamie Schoen	Research, inventory, assessment, and coordinated management of wickiups in the Greater Yellowstone Area	Ethnography	ONPS-Ethnography	\$19,000
California State University-Monterey Bay, Montana State University (Ecology)	Drs. Fred Watson, Robert Garrott, Susan Alexander, & P.J. White (YCR)	Systems integration and visualization of Yellowstone	Yellowstone Center for Resources	NASA	\$2,500,000

Note: A list of acronyms used in this table appears on page 128.

Cooperator/ Partner	Contact/ Principal Investigator	Project	Benefiting Program	Fund Source	Amount
Clearwater National Forest, Nez Perce National Historic Trail, Nez Perce National Historic Trail Foundation, Yellowstone Historic Center, Confederated Tribes of the Colville Indian Reservation, Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe	Sandi McFarland, Paul Wapato, Paul Shea, Albert Andrews Redstar, Roberta Conner, Vera Sonneck, Rosemary Sucec (YCR)	Creation of a compact-disc recording of oral histories of elders among the Colville, Nez Perce, and Umatilla Tribes regarding their recollections of the 1877 Nez Perce war and the events that transpired at Yellowstone NP	Ethnography	USFS (Nez Perce National Historic Trail), Nez Perce National Historic Trail Foundation, Yellowstone Historic Center	\$7,000
Colorado State University (Chemistry), USDA-ARS, State of Wyoming (Game and Fish)	Dr. David Grainger, Rick Wal-len (YCR), Dr. Steve Olsen, Dr. Terry Kreeger	<i>Brucella abortus</i> survivorship during photopolymerization encapsulation	Bison Ecology & Management	ONPS-Bison Management	\$16,200
Colorado State University (Fish and Wildlife)	Will Clements, Donna Kashi-an, Jeff Arnold (YCR), Cathie Jean (GRYN)	Integrated water quality monitoring protocol	Yellowstone NP, Grand Teton NP, Bighorn Canyon NRA	GRYN	\$49,697
Colorado State University (Forest, Rangeland, and Watershed)	Dr. David Cooper, Mary Hek-tner (YCR)	Fens of Yellowstone NP: identification, classification, geochemistry, floristics, and vegetation	Vegetation	Canon USA, Inc., ONPS-Vegetation	\$54,100 awarded FY04 for 2-yr study + \$10,000 (ONPS)
Gallatin National Forest	Ann Rodman (YCR)	Development of a Greater Yellowstone Area-wide fuels model and database	GIS/Vegetation	GYCC	\$7,500
Grand Teton National Park, National Elk Refuge	Jacquelin St. Clair, Laurie Shannon, Rosemary Sucec (YCR)	An ethnographic overview and assessment for Grand Teton NP and the National Elk Refuge	Ethnography	ONPS-CRPP Base	\$59,000
Grand Teton National Park, National Elk Refuge	Jacquelin St. Clair, Laurie Shannon, Rosemary Sucec (YCR)	American Indian use of Grand Teton NP, the National Elk Refuge, and Yellowstone NP (traditional use study)	Ethnography	ONPS-CRPP Base	\$85,000

Cooperator/ Partner	Contact/ Principal Investigator	Project	Benefiting Program	Fund Source	Amount
Idaho State University (Biological Sciences), USGS (Geological Survey Amphibian Research and Monitoring Initiative)	Dr. Chuck Peterson, Debra Patla, Steve Corn, Rob Bennetts (GRYN)	Amphibian monitoring	Yellowstone NP, Grand Teton NP	GRYN	\$42,988 (FY03 funding)
Iowa State University	Dr. Diane Debinski	Investigation into insects as a monitoring vital sign	Yellowstone NP, Grand Teton NP, Bighorn Canyon NRA	GRYN	\$2,500
Montana Conservation Corps	Mark Hektner (YCR)	Turbid Lake Road restoration	Natural Resources	Canon U.S.A., Inc.	\$5,600
Montana State University (Big Sky Institute)	Steve Gray, Rob Bennetts (GRYN)	Climate monitoring protocols	Yellowstone NP, Grand Teton NP, Bighorn Canyon NRA	GRYN	\$39,000
Montana State University (Big Sky Institute), U.S. Agency for International Development (Global Livestock Collaborative Research Program), Colorado State University, State of Montana (Fish, Wildlife & Parks), Tanzania National Parks	Drs. Lisa Graulich, Glenn Plumb (YCR), Robin Reid, Michael Coughenour, Kurt Alt, & Emmanuel Gereta	Managing national parks in the context of changing human populations and economies: a proposal to strengthen collaborations between researchers and managers working in and around Yellowstone and Serengeti parks	Yellowstone NP	U.S. Agency for International Development (Global Livestock Collaborative Research Program)	\$100,000
Montana State University (Center for Invasive Plant Management)	Janet Clark, Mary Hektner (YCR)	Conduct Gardiner Basin native vegetation/ungulate winter range restoration workshop	Vegetation	Yellowstone Park Foundation, GYCC, RM-CESU	\$17,500
Montana State University (Ecology)	Steve Kalinowski and Dr. Todd Koel (YCR)	Cutthroat trout genetics	Yellowstone NP	GRYN	\$7,000
Montana State University (Ecology)	Dr. Andy Hansen, Danielle Jones, Rob Bennetts (GRYN)	Land use monitoring protocol	Yellowstone NP, Grand Teton NP, Bighorn Canyon NRA	GRYN	\$49,983

Cooperator/ Partner	Contact/ Principal Investigator	Project	Benefiting Program	Fund Source	Amount
Montana State University (Ecology)	Drs. P.J. White (YCR), John Borkowski, Scott Creel, Robert Garrott, & Amanda Hardy	Motorized winter recreation and glucocorticoid stress responses in elk	Winter Use Studies	ONPS-Winter Use Monitoring	\$7,000
Montana State University (Ecology)	Drs. Robert Garrott & P.J. White (YCR)	Evaluating the abundance, distribution, and stress hormones of ungulates in relation to winter human use in west-central Yellowstone NP	Winter Use Studies	ONPS-Winter Use Monitoring	\$8,000
Montana State University (Ecology)	Drs. Robert Garrott & P.J. White (YCR)	Collaborative ungulate habitat and population monitoring	Wildlife	ONPS-Ungulates, Winter Use, Bison	\$31,400
Montana State University (Ecology)	Drs. Robert Garrott & P.J. White (YCR), Julie Fuller	Bison demography in relation to groomed roads during winter	YCR, Winter Use Studies	ONPS-YCR, Winter Use Monitoring	\$49,000
Montana State University (Ecology)	Drs. Thomas McMahon & Todd Koel, Brian Ertel (YCR)	Life history of Yellowstone cutthroat trout of the upper Yellowstone River	Aquatic Resources and Fisheries	Fish Fee	\$8,000
Montana State University (Ecology)	Drs. Alexander Zale & Todd Koel (YCR)	Spatial dynamics of Arctic grayling in the Gibbon River	Aquatic Resources and Fisheries	Fish Fee	\$33,460
Montana State University (Ecology)	Drs. Billie Kerans & Todd Koel (YCR)	Examination of Yellowstone cutthroat trout infection risk as part of the Yellowstone NP whirling disease study	Aquatic Resources and Fisheries	Fee Demonstration, Fish Fee	\$33,839
Montana State University (Ecology)	Lynn Kaeding, Dr. Todd Koel (YCR)	Yellowstone cutthroat trout recruitment related to stream temperature and flow	Aquatic Resources and Fisheries	In-kind	Support as needed
Montana State University (Ecology)	Dr. Robert Garrott, Rick Wallen (YCR), Jason Bruggeman	Spatial dynamics of the central Yellowstone bison herd	Bison Ecology & Management	ONPS-Bison	\$72,000 (paid in FY02)
Montana State University (Land Resources & Environmental Sciences)	Dr. Rick Lawrence, Lisa Landenburger, Dan Reinhardt (YELL)	Whitebark pine map	Yellowstone NP and Grand Teton NP	GRYN	\$26,467
Montana State University (Land Resources & Environmental Sciences)	Drs. Lisa Rew & Bruce Maxwell, Mary Hektner (YCR), Cathie Jean (GRYN)	Non-native vascular plant inventory of Yellowstone's northern range	Yellowstone NP	GRYN	(FY03 funding) \$41,000

Cooperator/ Partner	Contact/ Principal Investigator	Project	Benefiting Program	Fund Source	Amount
Montana State University (Land Resources & Environmental Sciences)	Shannon Savage (YCR), Dr. Rick Lawrence, Ann Rodman (YCR)	Non-forest vegetation mapping and change detection using LANDSAT ETM imagery in the northern range of Yellowstone NP	Vegetation	ONPS-Vegetation	\$5,000 (committed in FY03)
Montana State University (Land Resources & Environmental Sciences)	Shannon Savage (YCR), Dr. Rick Lawrence, Ann Rodman (YCR)	Remote sensing of non-forest vegetation in Yellowstone's northern range	SAC	ONPS base funds	\$28,575 (committed in FY02)
Montana State University (Mathematical Sciences)	Drs. John Borkowski, P.J. White (YCR), & Robert Garrott	Evaluating wildlife responses to motorized winter use in Yellowstone NP, 1998–2004	Winter Use Studies	ONPS-Winter Use Monitoring	\$20,000
Montana State University (MT/USFWS Whirling Disease Initiative)	Drs. Todd Koel (YCR) & Bille Kerans, Silvia Murcia	Development and testing of risk assessment tools for <i>Myxobolus cerebralis</i> ("whirling disease") infection of native cutthroat in Yellowstone NP	Aquatic Resources and Fisheries	MT/USFWS Whirling Disease Initiative	\$49,690
Montana State University (MT/USFWS Whirling Disease Initiative)	Dr. Todd Koel (YCR), Gretchen Rupp	<i>Myxobolus cerebralis</i> in a pristine environment: the role of American white pelicans as a dispersal vector in the Greater Yellowstone Ecosystem	Aquatic Resources and Fisheries	MT/USFWS Whirling Disease Initiative	\$17,599
Montana State University (MT/USFWS Whirling Disease Initiative)	Dr. Todd Koel (YCR), Gretchen Rupp	Use of high-resolution thermal imagery as a tool to locate <i>Tubifex tubifex</i> in Pelican Creek, a <i>Myxobolus cerebralis</i> -positive stream in Yellowstone NP	Aquatic Resources and Fisheries	MT/USFWS Whirling Disease Initiative	\$36,925
Montana State University (Museum of the Rockies)	Drs. Leslie Davis and Ann Johnson (YCR)	Various projects, including Section 106 compliance	Archeology	FHWA, ONPS, CRPP base	~\$70,000 (FY03 funding)

Cooperator/ Partner	Contact/ Principal Investigator	Project	Benefiting Program	Fund Source	Amount
Montana State University (Thermal Biology Institute), Western Oregon University, USGS, Portland State University, Idaho National Engineering & Environmental Laboratory, University of New Mexico	Drs. William Inskeep, Sarah Boomer, Darrell Nordstrom, Anna-Louise Reysenbach, Frank Roberto, & Cristina Takacs-Vesbach, Ann Rodman (YCR)	Create a research coordination network for geothermal biology and geochemistry in Yellowstone	Geology/Geothermal Resources	National Science Foundation	\$100,000
Montana State University (USFWS Fish Health Lab)	Crystal Hudson, Dr. Todd Koel (YCR)	Laboratory assessment of Yellowstone cutthroat trout whirling disease infection as part of the Yellowstone NP whirling disease study	Aquatic Resources and Fisheries	National Whirling Disease Initiative Partnership	\$12,914
National Museum of Natural History, Fossil Butte National Monument, NPS International Volunteer Program, Yellowstone Gateway Museum of Park County, Montana	Dr. Ellis Yochelson, Arvid Aase, Anton Gerasimensko, Brian Sparks, Elaine Hale (YCR)	Trilobite Point paleontological resource survey: lab analysis of field specimens and final project report	Geology/Paleontology	Yellowstone Park Foundation	\$12,000
National Park Service (IMR, Biological Resource Management Division), USFWS	Kerry Gunther (YCR), Dr. Kathy Tonnesen, Peter Dratch, Dr. Chris Servheen	Management of habituated grizzly bears in North America	Bear Management	ONPS, USFWS	Participant salaries
Natural Resources Conservation Service, Bridger Plant Center, Montana Conservation Corps	Mary Hektner (YCR)	Restore native vegetation/pronghorn habitat at former gravel pit/new Heritage Center site	Vegetation/Wildlife	Yellowstone Park Foundation (Coin Fund), DOI Cooperative Conservation Initiative	\$108,000 (awarded FY03 for 5-year project)
Nez Perce National Historic Trail	Sandi McFarland, Rosemary Sucec (YCR)	Oral histories at Yellowstone's 1877 war sites with the Nez Perce elders among the Confederated Tribes of the Colville Indian Reservation, Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce Tribe	Ethnography	ONPS-Ethnography	\$6,000

Cooperator/ Partner	Contact/ Principal Investigator	Project	Benefiting Program	Fund Source	Amount
Oregon State University, University of Wisconsin at Stevens Point	Drs. William Ripple, Eric Larsen, & Doug Smith (YCR), Roy Renkin (YCR)	Aspen regeneration on Yellowstone's northern range	Vegetation	ONPS	\$5,000
RM-CESU, Colorado State University	Drs. David Cooper & Tom Hobbs, Roy Renkin (YCR)	Persistence of willows on the northern range of Yellowstone NP	Vegetation	ONPS-Vegetation, ONPS-Wildlife, Fee Demonstration	\$51,712
Russian Federation Ministry of Health (Research Centre for Toxicology and Hygienic Regulation of Biopreparations), USDA-ARS, Texas A&M University	Drs. Alexander Denisov, Glenn Plumb (YCR), Steven Olsen, & Gary Adams	Comparative studies of immunobiological characteristics of live brucellosis vaccines	Bison Ecology and Management	U.S. State Department (Nuclear Threat Initiative)	\$1,200,000
Southern Illinois University-Carbondale (Plant Ecology)	Dr. Sedonia Sipes, Jennifer Whipple (YCR)	Pollination and reproductive ecology of <i>Abronia amorphilla</i> , a plant endemic to Yellowstone NP	Vegetation	Yellowstone Park Foundation (Canon Eyes on Yellowstone), National Fish and Wildlife Foundation, Southern Illinois University	\$39,778 (over two years), in-kind
State of Montana (Bureau of Mines and Geology)	Edmond Deal, Dr. Henry Heasler (YCR)	Yellowstone controlled groundwater area database administration	Montana Water Compact	ONPS-Geology	\$25,534
State of Montana (Department of Environmental Quality)	John Koerth, Mary Hektner (YCR)	Groundwater investigation for mine waste repository at McLarren tailings site on Soda Butte Creek	Air Land and Water Resources	NPS-Water Resources Division	\$14,600
State of Montana (Natural Resources and Conservation, Bozeman)	Scott Compton, Dr. Henry Heasler (YCR)	Yellowstone controlled groundwater area water rights administration	Montana Water Compact	ONPS-Geology	\$23,000
State of Wyoming (Fish & Game)	Steve Yekel, Jason Burckhardt, Dr. Todd Koel (YCR), Brian Ertel (YCR)	Life history of Yellowstone cutthroat trout of the upper Yellowstone River	Aquatic Resources and Fisheries	Fish Fee	\$11,040
State of Wyoming (Fish & Game)	Jim Barner and Steve Sharon, Dr. Todd Koel (YCR)	Establishment of a Yellowstone cutthroat trout broodstock in Wyoming	Aquatic Resources and Fisheries	In-kind	Staff support as needed

Cooperator/ Partner	Contact/ Principal Investigator	Project	Benefitting Program	Fund Source	Amount
Sun Ranch (Madison Valley, Montana)	Roger Lang, Buddy Drake, Dr. Todd Koel (YCR)	Westslope cutthroat trout broodstock development	Aquatic Resources and Fisheries	Fish Fee	\$5,000
U.S. Animal Health Association	Drs. Rick Willer, Bret Marsh, Glenn Plumb (YCR)	An initiative to enhance brucellosis vaccines, vaccine delivery, and surveillance diagnostics for bison and elk in the Greater Yellowstone Area	Interagency Bison Management Plan for Yellowstone NP and the State of Montana	NPS, USFWS, USGS-BRD, USDA-APHIS	\$150,000
University of Calgary (Environmental Science), USGS (Alaska Biological Science Center), NPS Alaska Support Office, State of Alaska (Fish and Game)	Dr. Stephen Herrero, Tom Smith, Terry DeBruyn, Kerry Gunther (YCR), Colleen Matt	Brown bear habituation to people: safety, risks, and benefits	Bear Management	University of Calgary, ONPS, Alaska Department of Fish and Game	Participant salaries
University of Calgary, University of Montana	Drs. Cormack Gates, Len Broberg, Glenn Plumb (YCR)	Bison movement and dispersal	Yellowstone NP	National Park Service	\$339,212
University of Colorado at Boulder (Library Administration)	Colleen Curry (YCR), Harold Housley (YCR)	Save America's Treasures: consolidation, inventory, and re-housing of Yellowstone NP's architectural drawings	Archives	Save America's Treasures (NPS, National Endowment for the Arts, National Endowment for the Humanities)	\$60,000
University of Idaho	Drs. P.J. White (YCR) & John Byers, Kerey Barnowe-Meyer	Conservation of the declining Yellowstone pronghorn population	Wildlife Resources	RM-CESU	\$15,000
University of Minnesota (Ecology)	Drs. Glenn Plumb (YCR) & Craig Packer, Dan McNulty	Conduct wildlife research in conjunction with remote Canon cameras (Canon Eyes on Hayden Project)	Wildlife Resources	Yellowstone Park Foundation/Canon, U.S.A., Inc.	\$110,000
University of Minnesota (Fisheries and Wildlife), USGS-BRD	Drs. P.J. White (YCR) & David Mech, Shannon Barber	Multi-trophic-level ecology of wolves, elk, and vegetation in Yellowstone NP (elk calf mortality)	Wildlife Resources	NRPP Natural Resources Management, USGS Park-Oriented Biological Support	\$58,000
University of Montana	Dr. Marc Hendrix, Elaine Hale (YCR)	Paleontological survey, geologic recommendations, monitoring, and interpretive assistance	Geology/Paleontology	FHWA	\$4,253

Cooperator/ Partner	Contact/ Principal Investigator	Project	Benefiting Program	Fund Source	Amount
University of Montana	Drs. Karen Hodges, L. Scott Mills, & Kerry Murphy (YCR)	Abundance and distribution of snowshoe hares and red squirrels in Yellowstone NP	Lynx Project	RM-CESU	\$10,000
University of Montana (Economics)	Drs. John Duffield and Glenn Plumb (YCR)	What price Yellowstone? The role of wolves in the regional economy	Wildlife Resources	Yellowstone Park Foundation	\$144,000
University of Montana (Flathead Biological Station), Yellowstone Ecological Research Center	Dr. Robert Crabtree, Roy Renkin (YCR)	Development and utility of multispectral, remotely-sensed imagery to map willow distribution in northern Yellowstone	Vegetation	Fee Demonstration	\$23,500
University of Montana (Forestry and Conservation)	Drs. L. Scott Mills, Karen Hodges, & Kerry Murphy (YCR)	Temporal dynamics of snowshoe hares in Yellowstone NP	Lynx project	NPS-IMR Regional Block Grant	\$20,000
University of Montana (Wildlife Biology), USFS-RMRS	Drs. Dan Pletscher & Kerry Murphy (YCR), Jeff Copeland	Conservation of at-risk wolverines in Yellowstone NP	Wolverine Project	RM-CESU, Yellowstone Park Foundation, USFS-RMRS	\$70,000
University of New Mexico	Dr. Grant Meyer, Roy Renkin (YCR)	Beavers, climate, and environmental change over millennial timescales in the northern range of Yellowstone NP: radiocarbon dating of stratigraphic samples	Vegetation	Fee Demonstration	\$11,989
University of New Mexico, Portland State University, USGS	Drs. Cristina Takacs-Vesbach, Anna-Louise Reysenbach, & Kirk Nordstrom, Ann Rodman (YCR)	A microbial inventory of Greater Yellowstone Ecosystem features	Geology/Geothermal Resources	National Science Foundation	\$150,000
University of Oregon	Dr. Andrew Marcus, Jim Meacham, Ann Rodman (YCR)	Atlas of Yellowstone project	Yellowstone Center for Resources	Yellowstone NP, University of Oregon	\$10,000
University of Utah (Geology and Geophysics)	Drs. Robert Smith & Henry Heasler (YCR)	Seismic and GPS monitoring of Norris Geyser Basin	Geology	ONPS-Geology	\$10,000
University of Wyoming (NPS Research Center, AMIK Ranch)	Drs. Henry Harlow & Glenn Plumb (YCR)	Cooperative research program support	Research	ONPS-Research	\$5,750
University of Wyoming (OWSA)	David Eckles, Elaine Hale (YCR)	Archeological investigations for FY2004	Cultural Resources	FHWA	\$99,000

Cooperator/ Partner	Contact/ Principal Investigator	Project	Benefitting Program	Fund Source	Amount
University of Wyoming (OWSA)	David Eckles, Elaine Hale (YCR)	Archeological site testing on the Yellowstone and Lamar rivers, Yellowstone NP	Archeology	FHWA	\$109,919 (FY03 funding)
University of Wyoming (OWSA)	David Eckles, Robert Rosenberg, Elaine Hale (YCR)	Cultural Resource Survey and evaluation of historic road features	Cultural Resources	FHWA	\$6,400
University of Wyoming (OWSA)	David Eckles, Elaine Hale (YCR)	National Register testing of a precontact archeological site in the area of potential effect of road improvements at Virginia Cascade Drive	Archeology	FHWA	\$22,000
University of Wyoming (OWSA)	David Eckles, Dr. Ann Johnson (YCR), Elaine Hale (YCR)	Archeological data recovery for mitigation of FHWA Golden Gate-to-Norris road segment	Archeology	FHWA	\$99,999
University of Wyoming (Wyoming Cooperative Fish and Wildlife Unit)	Drs. Wayne Hubert & Todd Koel (YCR), Pat Bigelow (YCR)	Predicting lake trout spawning areas in Yellowstone Lake as part of the native Yellowstone cutthroat trout preservation program in Yellowstone	Aquatic Resources and Fisheries	ONPS-Lake Trout	\$29,268
University of Wyoming (Wyoming Natural Diversity Database)	Douglas A. Keinath, Roy Renkin (YCR), Cathie Jean (GRYN)	Bat inventory	Yellowstone NP, Grand Teton NP, Bighorn Canyon NRA	GRYN	\$32,000 (FY03 funding)
University of Wyoming (Zoology and Physiology)	Drs. Bob Hall & Todd Koel (YCR), Lusha Tronstad	Trophic consequences of lake trout and whirling disease invasion of Yellowstone Lake	Aquatic Resources and Fisheries	In-kind	boat and logistic support as needed
USDA-APHIS	Rick Wallen (YCR), Dr. Ryan Clarke	Rate of <i>Bruce/la abortus</i> exposure in Yellowstone bison	Bison Ecology & Management	USDA-APHIS, ONPS-Bison Management	\$21,000
USGS Rocky Mountain Science Lab	Drs. Bruce Pugsek & Todd Koel (YCR)	Trophic implications of Yellowstone cutthroat trout decline	Aquatic Resources and Fisheries	Unfunded	\$0
USGS-BRD	Dr. Don Despain, Roy Renkin (YCR), John Klapotosky (YCR), Dr. Eric Larsen	Browse history of tree-sized aspen on Yellowstone's northern range	Vegetation	ONPS	support as needed

Cooperator/ Partner	Contact/ Principal Investigator	Project	Benefiting Program	Fund Source	Amount
USGS-BRD	Drs. Francis Singer, P.J. White (YCR) & Doug Smith (YCR), Roy Renkin (YCR)	Willow height release and riparian community expansion as a potential consequence of wolf reintroduction	Vegetation	Fee Demonstration	\$9,000
USGS-BRD	Drs. Francis Singer, P.J. White (YCR), & Doug Smith (YCR), Linda Zeigenfuss, Roy Renkin (YCR)	Willow persistence and distribution in Yellowstone NP: interactive effects following wolf reintroduction	Vegetation	Fee Demonstration	\$9,000
USGS-BRD (IGBST)	Dr. Charles Schwartz, Mark Haroldson, Kerry Gunther (YCR)	Black bear demographics in Yellowstone NP	Bear Management	USGS, ONPS Base	As time is available
USGS-BRD (IGBST), State of Montana (Fish, Wildlife & Parks), Grand Teton National Park, State of Idaho (Fish and Game)	Kerry Gunther (YCR), Mark Haroldson, Kevin Frey, Steve Cain, Jeff Copeland, Dr. Charles Schwartz	Grizzly bear-human conflicts in the Greater Yellowstone Ecosystem	Bear Management	ONPS, USGS-BRD, State of Montana (Fish, Wildlife & Parks), State of Idaho (Department of Fish and Game)	Participant salaries
USGS-BRD (IGBST), University of Idaho	Mark Haroldson, Kerry Gunther (YCR), Dan Reinhart, Shannon Podruzny, Chris Cegelski, Lisette Waits, Travis Wymann (YCR), Jeremiah Smith (YCR)	Estimates of grizzly bear numbers visiting Yellowstone Lake spawning streams	Bear Management	USGS-BRD, ONPS, University of Idaho	Participant salaries
USGS-BRD, Brigham Young University	Drs. Don Despain & Rex Cates, Roy Renkin (YCR)	Analysis of aspen secondary compounds	Vegetation	ONPS-Vegetation, USGS Park-Oriented Biological Support	\$5,676
USGS-FCRU	Drs. Al Zale & Todd Koel (YCR), Dan Mahony (YCR)	Westslope cutthroat trout restoration in Fan Creek	Aquatic Resources and Fisheries	Unfunded	\$0
USGS-FCRU	Drs. Al Zale & Todd Koel (YCR), Dan Mahony (YCR)	Status of Arctic grayling in the Gibbon River system	Aquatic Resources and Fisheries	Fish Fee	\$40,000
USGS-WRD (Central Region, Denver)	George Ingersoll, Jeff Arnold (YCR)	Analysis of heavy metals deposition in snowpack for correlation between chemical concentrations and snowmachine use	Winter Use Studies	ONPS-Winter Use Monitoring	\$15,000

Cooperator/ Partner	Contact/ Principal Investigator	Project	Benefiting Program	Fund Source	Amount
USGS-WRD (Montana District)	Drs. Robert Davis & Henry Heasler (YCR)	Assess water discharge and selected chemical and physical parameters of waters in Yellowstone NP	Montana Water Compact	USGS-WRD (Competitive), ONPS-Geology	\$61,400
USGS-WRD (National Water Quality Laboratory, Denver)	Gary Cottrell, Jeff Arnold (YCR)	Analysis of surface water chemistry for volatile organic compounds collected in Yellowstone NP for correlation between chemical concentrations and snowmachine use	Winter Use Studies	ONPS-Winter Use Monitoring	\$6,283
USGS-WRD (Utah District)	David Susong, Dr. Henry Heasler (YCR)	Dye testing to determine the source of turbidity along the Middle Fork of the Shoshone River in Yellowstone NP	Montana Water Compact	FHWA	\$12,000
USGS-WRD (Utah District)	David Susong, Dr. Henry Heasler (YCR)	Technical expertise and hydrologic assistance to the NPS in the administration of the NPS/State of Montana Water Compact, and with other hydrologic issues	Montana Water Compact	USGS-WRD (Competitive), ONPS-Geology	\$14,400
Washington State University, USGS-BRD (IGBST)	Charles Robbins, Dr. Charles Schwartz, Robert Rye, Kerry Gunther (YCR)	Application of stable isotopes and trace elements to understanding potential effects of long-term changes in food resources of Yellowstone grizzly bears	Bear Management	Yellowstone NP	\$6,500
Washington State University, USGS-BRD (IGBST), University of Idaho	Laura Felicetti, Dr. Charles Schwartz, Robert Rye, Kerry Gunther (YCR), James Crock, Mark Haroldson, Lisette Waits, Charles Robbins	Use of naturally occurring mercury to determine the importance of cutthroat trout to Yellowstone grizzly bears	Bear Management	University of Washington, USGS-BRD, ONPS, University of Idaho	Participant salaries
Yellowstone National Park Bear Management and Wolf Project Offices	Kerry Gunther (YCR), Dr. Doug Smith (YCR)	Interactions between wolves and female grizzly bears with cubs	Bear Management, Wolf Project	ONPS	Participant salaries

Acronyms

FHWA: Federal Highway Administration
 GRYN: Greater Yellowstone Inventory and Monitoring Network
 GYCC: Greater Yellowstone Coordinating Committee
 IMR: Intermountain Region
 NASA: National Aeronautics and Space Administration
 NPS: National Park Service
 ONPS: Operation of the National Park Service
 ONPS-CRPP: Operation of the National Park Service-Cultural Resources Preservation Program
 OWSA: Office of the Wyoming State Archaeologist
 RM-CESU: Rocky Mountains Cooperative Ecosystem Studies Unit
 USDA-APHIS: U.S. Department of Agriculture-Animal and Plant Health Inspection Service
 USDA-ARS: U.S. Department of Agriculture-Agricultural Research Service
 USFS: U.S. Forest Service
 USFS-RMRS: U.S. Forest Service Rocky Mountain Research Station
 USFWS: U.S. Fish and Wildlife Service
 USGS: U.S. Geological Survey
 USGS-BRD: U.S. Geological Survey Biological Resources Discipline
 USGS-BRD (IGBST): U.S. Geological Survey Biological Resources Discipline, Interagency Grizzly Bear Study Team
 USGS-FCRU: U.S. Geological Survey Fish Cooperative Research Unit
 USGS-WRD: U.S. Geological Survey Water Resources Discipline
 YCR: Yellowstone Center for Resources



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