

YELLOWSTONE CENTER FOR RESOURCES



ANNUAL REPORT
2004
FISCAL YEAR

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



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

YCR-2005-03



Suggested citation: Yellowstone Center for Resources. 2005. Yellowstone Center for Resources Annual Report, Fiscal Year 2004. National Park Service, Mammoth Hot Springs, Wyoming, YCR-2005-03.

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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 Renshawe; 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

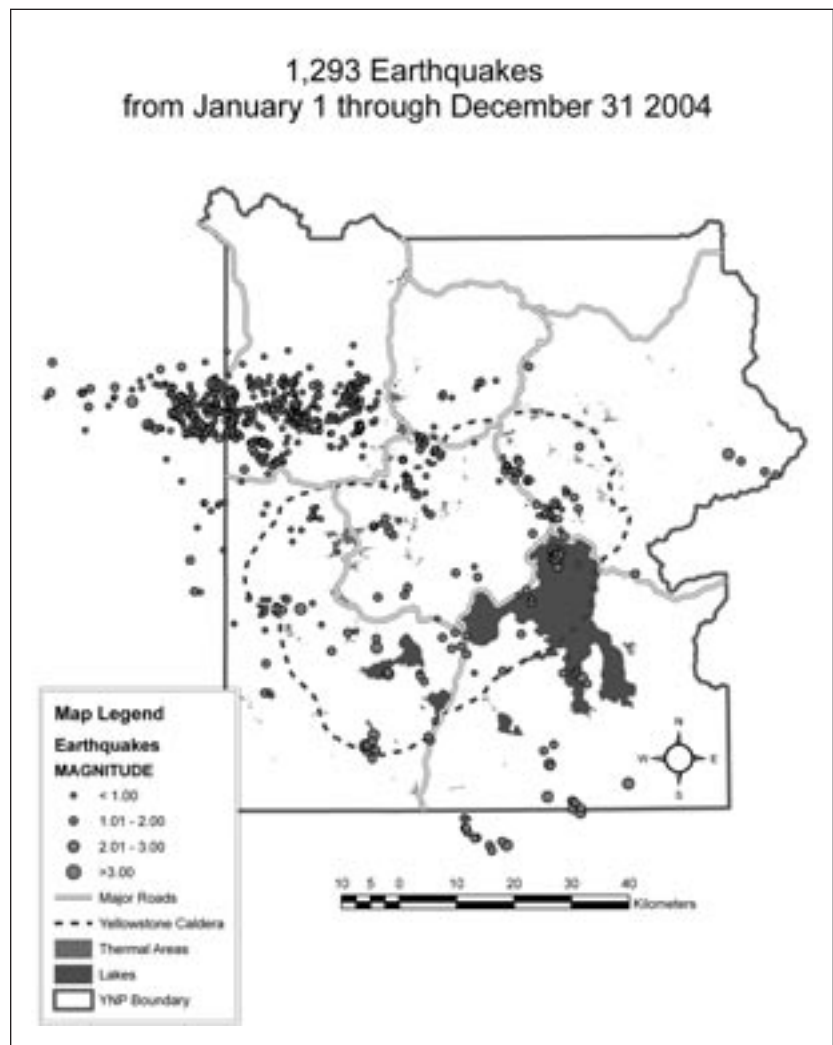
studies by Yellowstone Volcano Observatory scientists and others will increase understanding of the changes in heat and hydrology that occur during thermal disturbances. Data from these two thermal disturbances clearly show why the term “annual” disturbance is errant.

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.

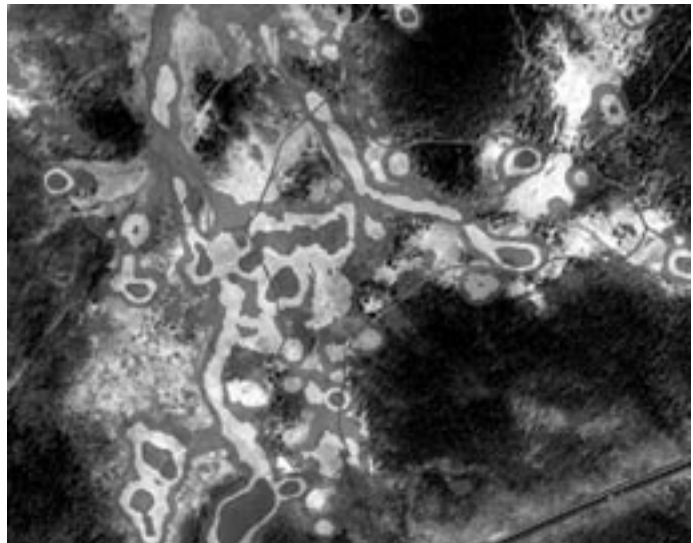
East Entrance Road construction. Geology personnel discussed the geology and geologic hazards of the East Entrance Road with land-

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 back-country 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 concessions 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